ADEQUACY OF ANTENATAL CARE: ASSOCIATED FACTORS AND PREGNANCY OUTCOMES AMONG WOMEN ATTENDING PUBLIC HEALTH CLINICS IN SELANGOR, MALAYSIA

YEOH PING LING

FACULTY OF MEDICINE
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YEOH PING LING

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ABSTRACT

Malaysia has remarkable achievement in maternal-child–health over past decades. Relevant tracers continue to be excellent, and there has been increasing number of antenatal visits. Recent progress in pregnancy outcomes however does not improve with equal pace: maternal mortality has been stagnant since over a decade, birth weight <2,500g was higher than neighbouring countries, and stillbirth doubling that of developed nations. These pose the questions related to limitation of coverage indicators and need for assessing adequacy of antenatal care. The purpose of this study was to determine adequacy of antenatal care, its associated factors and pregnancy outcomes. Adequacy of antenatal care included adequacy of utilisation and adequacy of content that were analysed separately. Wherein, adequacy of utilisation referred to the concept of Adequacy of Prenatal Care Utilisation Index which is defined by adequacy in initiation of care and observed-to-expected visits ratio adjusted for gestational age of delivery. Adequacy of content is defined as adequacy in compliance to recommended routine care. The study was conducted using retrospective cohort study design where data was extracted from individual records of public health clinics. The findings pointed to high proportion (63%) of intensive utilisation, with intensive utilisation noted among nearly 60% of low-risk women, while 26% of high-risk women did not have the expected intensive utilisation. The findings also highlighted inadequacy of routine care provided with 52% of women receiving <80% of recommended content; delivery of antenatal advice scored the lowest. High-risk had lower content score than low-risk (76% versus 78%, p=0.001). Women attended the smallest clinics had higher content score (80% versus 75-77%, p<0.001). Examining association between utilisation and pregnancy outcomes revealed that adequate utilisation appeared to lower the odds of preterm birth and maternal complications, compared to inadequate and intensive

utilisation. Intensive utilisation however did not seem to lower the odds of preterm birth, low birth weight and maternal complications. Adequate content was significantly associated with lower odds (OR=1.00) of preterm birth than inadequate content (OR=3.72, 95%CI=1.58-8.72); but appeared to result in higher odds of stillbirth and maternal complications, indicating the influence of other aspect of care. The study presented several contributions to research on antenatal care adequacy. One, intensive utilisation does not seem to improve pregnancy outcomes. While it is justified for high-risk to have more frequent visits for additional care, there is no reason for low-risk to have higher number of visits than standard schedule. Two, over half of women had <80% of routine content indicates need to improve technical performance of care. All women should be given complete routine care. Three, the findings have resulted in an accompanying insight on the need to review the current guidelines, spinning from reviewing guidelines from countries with better pregnancy outcomes. Lastly, the methods used could be reviewed as to their utility in expanding monitoring and evaluation framework for improving quality and informing policy formulation. Further researches are required to assess how technical performance of routine antenatal care can be improved, in particular, delivery of antenatal advice. Future studies may consider qualitative study involving stakeholders responsible for guidelines and policy formulation, examining rationale of excluding and including certain practices.

Keywords: antenatal care; ANC; utilisation; content; guidelines; adherence; adequacy; quality of care; pregnancy outcomes; preterm birth; low birth weight; stillbirth; maternal complications.

ABSTRAK

Malaysia telah menikmati pencapaian yang mengagumkan di bidang kesihatan ibu dan anak semenjak beberapa dekad kebelakangan ini. Prestasi petunjuk yang berkaitan masih kekal cemerlang manakala bilangan lawatan penjagaan antenatal semakin meningkat. Walaubagaimanapun, prestasi pencapaian penjagaan kehamilan tidak meningkat pada kadar yang sama, di mana: kadar kematian ibu tidak berganjak dalam lebih sedekad, berat kelahiran <2,500g masih lebih tinggi daripada negara-negara jiran, dan kadar kelahiran mati adalah dua kali ganda kadar negara maju. Ini menimbulkan persoalan berkenaan ketepatan petunjuk liputan dan keperluan untuk menilai tahap penjagaan antenatal. Tujuan kajian ini adalah untuk menentukan tahap adekuasi penjagaan antenatal, faktor-faktor yang berkaitan dan pencapaian prestasi penjagaan kehamilan. Adekuasi penjagaan antenatal termasuk adekuasi utilisasi dan adekuasi kandungan penjagaan antenatal yang dianalisa secara berasingan, di mana, adekuasi utilisasi antenatal merujuk kepada konsep "Adequacy of Prenatal Care Utilisation Index" yang ditakrifkan sebagai adekuasi permulaan penjagaan, dan nisbah lawatan sebenar dengan lawatan jangkaan yang diselaraskan untuk usia kandungan; manakala adekuasi kandungan penjagaan antenatal ditakrifkan sebagai kecukupan penjagaan rutin yang disyorkan. Kajian ini menggunakan kaedah kohot secara retrospektif di mana data diambil daripada rekod individu di klinik kesihatan awam. Hasil kajian menunjukkan tahap penggunaan intensif pada kadar yang tinggi (63%), di mana pemerhatian menunjukkan penggunaan intensif berlaku di kalangan hampir 60% wanita berisiko rendah, sedangkan penggunaan intensif yang dijangka, tidak berlaku ke atas 26% wanita berisiko tinggi. Penekanan keatas penjagaan rutin yang diberikan didapati kurang di mana 52% wanita menerima <80% kandungan asas antenatal yang dicadangkan, seperti penyampaian nasihat antenatal yang mendapat skor terendah. Wanita berisiko tinggi mendapat skor kandungan lebih rendah daripada wanita berisiko rendah (76% vs 78%,

p=0.001). Wanita yang menghadiri klinik-klinik kecil mendapat skor kandungan yang lebih tinggi (80% vs 75-77%, p<0.001). Utilisasi antenatal tahap mencukupi dikaitkan dengan kemungkinan kelahiran pramatang dan komplikasi ibu yang lebih rendah, berbanding dengan tahap penggunaan antenatal yang tidak mencukupi mahupun intensif. Penggunaan tahap intensif bagaimanapun tidak mengurangkan kemungkinan untuk kelahiran pramatang, berat lahir rendah, dan komplikasi ibu. Kandungan penjagaan antenatal yang mencukupi didapati berkaitan dengan kemungkinan kelahiran pramatang yang lebih rendah (OR=1.00) berbanding dengan kandungan penjagaan antenatal yang tidak mencukupi (OR=3.72, 95%CI=1.58-8.72); tetapi kemungkinan yang lebih tinggi untuk kelahiran mati dan komplikasi ibu. Ini menunjukkan terdapat kepentingan bagi aspek penjagaan yang lain. Kajian ini memberi sumbangan kepada penyelidikan mengenai adequasi tahap penjagaan antenatal. Pertama, penggunaan intensif nampaknya tidak meningkatkan hasil pencapaian kehamilan. Wanita berisiko tinggi wajar mempunyai lawatan yang lebih kerap untuk penjagaan tambahan, namun wanita berisiko rendah tidak ada sebab untuk membuat lawatan antenatal lebih daripada jadual standard. Kedua, lebih daripada separuh wanita mempunyai <80% kandungan penjagaan rutin dan ini menunjukkan terdapat keperluan untuk meningkatkan prestasi penjagaan antenatal dari segi teknikal supaya semua wanita diberi penjagaan rutin yang lebih lengkap. Ketiga, kajian ini menimbulkan keperluan bagi mengkaji semula garis-panduan semasa yang boleh dilakukan dengan berteraskan garis-panduan daripada negara-negara yang mempunyai pencapaian penjagaan kehamilan yang lebih baik. Akhir sekali, kaedah yang digunakan boleh diguna pakai bagi pemantauan penjagaan antenatal yang lebih menyeluruh dan rangka kerja penilaian penjagaan antenatal yang telah dibentuk boleh dirujuk oleh pengubal dasar bagi meningkatkan kualiti penjagaan antenatal. Kajian lanjut diperlukan untuk menilai bagaimana prestasi teknikal penjagaan antenatal secara rutin boleh dipertingkatkan, khususnya, berkenaan penyampaian nasihat antenatal. Selain itu, adalah dicadangkan agar kajian penjagaan antenatal ini dibuat secara lebih mendalam dengan melakukan kajian kualitatif ke atas pihak-pihak yang berkepentingan serta bertanggungjawab di dalam pembentukkan garis-panduan penjagaan antental yang berkesan.

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LIST OF SYMBOLS AND ABBREVIATIONS

ACOG	:	American College of Obstetricians and Gynaecologists
AHMAC	:	Australian Health Ministers' Advisory Council
ANC	:	Antenatal Care
aOR		Adjusted Odds Ratio
APNCU	:	Adequacy of Prenatal Care Utilisation Index
BP	:	Blood Pressure
BSP	:	Blood Sugar Profile
CEMD		Confidential Enquires into Maternal Deaths
CI	:	Confidence Interval
CN	:	Community Nurse
DHS		Demographic and Health Survey
DTP3		Three doses of Diphtheria, Tetanus and Pertussis vaccines
GDM	:	Gestational Diabetes Mellitus
GINDEX	:	Graduated Index of Prenatal Care Utilisation
Hb	:	Haemoglobin
HC	:	Health Clinic
IE/PE		Impending Eclampsia/ Preeclampsia
IMR	:	Infant Mortality Ratio
LBW	:	Low Birth Weight
IOM		Institute of Medicine
M&E		Monitoring and Evaluation
MCH		Maternal Child Health
MDG		Millennium Development Goals
MGTT	:	Modified Glucose Tolerance Test
MMR	:	Maternal Mortality Ratio
MO	:	Medical Officer
MOH	:	Ministry of Health
NICE	:	National Institute for Health and Clinical Excellence (UK)
NND	:	Neonatal Death
O/E	:	Observed-to-Expected
OR	:	Odds Ratio
PIH	:	Pregnancy Induced Hypertension

POG	:	Period of Gestation
PP	:	Placenta Praevia
PPH		Postpartum Haemorrhage
RME	:	Routine Medical Examination
RME1		The First Routine Medical Examination
RME2		The Second Routine Medical Examination
SD	:	Standard Deviation
SFH	:	Symphysis-Fundal Height
SGA		Small for Gestational Age
SN	:	Staff Nurse
STI		Sexually Transmitted Infections
UHC		Universal Health Coverage
US	:	Ultrasound
UTI	:	Urinary Tract Infection
WHO	:	World Health Organisation

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CHAPTER 1: INTRODUCTION

1.1 DEFINITION AND IMPORTANCE OF ANTENATAL CARE

The antenatal period presents opportunities for reaching pregnant women with interventions that may be vital for the health and well-being of both mother and child (WHO, 2014c). Antenatal care (ANC) refers to care for the women and foetus during pregnancy (WHO, 2006). The purpose of ANC is to monitor and improve the wellbeing of the mother and foetus, detect complications, respond to women's complaints, prepare for birth, and promote healthy behaviours (WHO, 2009). Worldwide, around 800 women die from pregnancy or childbirth-related complications every day, many of which are preventable if women have access to antenatal care in pregnancy, skilled care during childbirth, and care and support in the weeks after childbirth (WHO, 2014a). Antenatal care, which is recognised as one of the effective strategies to improve maternal and neonatal health (Adam et al., 2005; Health Evidence Network, 2005), has since been incorporated into the board health strategy of many countries. The World Health Organization (WHO) recommends a minimum of four antenatal visits for uncomplicated pregnancy that is goal-oriented based on a review of the effectiveness of different models of antenatal care. The recommended risk-oriented ANC strategy involves: (i) routine care to all women, (ii) additional care for women with moderately severe diseases and complications, (iii) specialised obstetrical and neonatal care for women with severe diseases and complications (WHO, 2009).

Receiving ANC at least four times, which is a Millennium Development Goals indicator, increases the likelihood of receiving effective interventions during antenatal visits (WHO, 2014c). For this reason, WHO guidelines are specific on the content of antenatal care visits, which should include the followings (WHO, 2014c):

- Physical examinations: uterine height, blood pressure, maternal weight/ height;

- Laboratory testing: blood testing to detect syphilis and severe anaemia (and others such as HIV, malaria as necessary according to the epidemiological context), detection of sexually transmitted infections (STI)s, urine test (multiple dipstick), blood type and Rhesus;
- Provision of preventive care: tetanus toxoid given, iron/ Folic acid supplementation provided;
- Health education/ counselling;
- Preparation for birth and emergency: gestational age estimation, recommendation for emergencies/ hotline for emergencies.

ANC utilisation or coverage measurement includes single indicators such as attendance for any ANC, coverage for the first or fourth ANC visit(s), gestational age of first visit, and number of ANC visits. These indicators, though commonly used, often do not provide information on adequacy of ANC. For example, the indicator that has been used globally—coverage of first visit—does not provide any other information after the first visit. Though WHO has now included the indicator for the fourth visit, it remains not routinely collected and provides no indication concerning the content of the care (WHO, 2014b). Studies have also showed that the number of ANC visits had no association with perinatal outcome (Fujita et al., 2005; Villar et al., 2001).

Earlier studies on adequacy of ANC utilisation commonly used the trimester of ANC initiation, but it had long been found to be an inaccurate indicator because it provides no information on ANC utilisation after the initiation of ANC (Forrest & Singh, 1987). Since the 1970's, there have been a number of developments in measuring the adequacy of ANC utilisation. The indexes combine the timing of the first ANC visit as well as the number of ANC visits after the initiation. These include the Kessner/Institute of Medicine [Kessner/IOM] Index (Research & Kessner, 1973); the Graduated Index of

Prenatal Care Utilisation [GINDEX] (G. R. Alexander & Cornely, 1987) and the subsequently Revised-GINDEX [R-GINDEX] (G. R. Alexander & Kotelchuck, 2001); the Adequacy of Prenatal Care Utilisation Index [APNCU] which is also called the Kotelchuck Index (Kotelchuck, 1994); and other variants such as an index derived from the recommendation of the U.S. Public Health Service Expert Panel on Prenatal Care [PHS-REC] (G. R. Alexander & Kotelchuck, 1996) as well as variants of the APNCU (VanderWeele, Lantos, Siddique, & Lauderdale, 2009).

In a nutshell, single indicators on antenatal visit do not give information about the completeness, content or quality of care provided. Composite indicators that include both the number of visits and the timing of the first visit are more useful, although these also do not indicate the content of care.

1.2 STUDY BACKGROUND: SNAPSHOT OF MATERNAL AND CHILD HEALTH IN MALAYSIA

1.2.1 Organisation of Health Services

Health care in Malaysia operates a dual health care system consisting of both a tax-funded government-run universal health care system and a co-existing private healthcare system (Chee, 2008; Jaafar, Mohd Noh, Abdul Muttalib, Othman, & Healy, 2013). The public sector provides about 82% of inpatient care and 35% of ambulatory care, while the private sector provides about 18% of inpatient care and 62% of ambulatory care (Jaafar, et al., 2013). The MOH offers a comprehensive range of services including health promotion, disease prevention, curative and rehabilitative care delivered through clinics and hospitals; while special institutions provide long-term care (Ministry of Health Malaysia, 2013). Several other government ministries also provide health services, for example, the Ministry of Higher Education which owns teaching hospitals and the Ministry of Defence which has possession of military hospitals. The private health sector provides health services mainly in urban areas through physician clinics and private hospitals with a stronger focus on curative care (Jaafar, et al., 2013; Ministry of Health Malaysia, 2015; National Clinical Research Centre, 2014). Public hospital beds accounted for approximately 75% of total beds, compared to contribution of private sector of 25% (Ministry of Health Malaysia, 2014).

Overall, the health system is considerably centralised and uniform across all the 16 states and federal territories in Malaysia. The public sector in each state shares similar health services organisation and protocols, especially in Peninsula Malaysia (Ministry of Health Malaysia, 2013).

The MOH emphasises cost-effective preventive primary care and employs more medical assistants and nurses than higher cost doctors (Ministry of Health Malaysia, 2013). It has also shifted the more expensive inpatient care and procedures to the more cost- and service-efficient day care centres (Jaafar, et al., 2013).

1.2.1.1 Primary Health Care

Since 1970, a two-tier primary health care model consisting of community clinics and health clinics has been provided by the public sector. The planned population coverage for a health clinic is around 15,000 to 20,000 population and a community clinic about 2,000 to 4,000 population. A health clinic is staffed by doctor(s), dentist, pharmacist, assistant medical officer(s), public health nurses, and assistant pharmacy officer(s). Services include outpatient services, dental care, maternal-child-health (MCH) care, health promotion, and family planning. At the same time, the health clinic oversees several community clinics which are run by community nurses or midwives offering MCH care, home care and family planning (Jaafar, et al., 2013).

The health clinics are classified and designed according to the expected daily workload in the catchment area. The MOH developed standard medical brief of requirements for each type of health clinics which typically consists of the followings (Ministry of Health Malaysia, 2008a):

- HC Type 1 (>800 visits daily) - new standard and very few constructed;
- HC Type 2 (500-800 visits daily) - new standard and very few constructed;
- HC Type 3 (300-500 visits daily);
- HC Type 4 (<300 visits daily);
- HC Type 5 (<150 visits daily);
- HC Type 6 (<50 visits daily).

It had been acknowledged that there is a shortage of MOH health clinics in densely populated areas such as the Klang Valley. This users encounter long waiting times; and the overall clinic-population ratio of 1:33,600 has not met the target of 1:20,000 (Jaafar, et al., 2013).

In terms of service provision, a survey on primary care showed that public-funded primary care clinics provide more comprehensive primary health care services than private clinics (National Clinical Research Centre, 2014). It was observed that a high proportion of public clinics provided obstetrics and gynaecological services such as antenatal/ postnatal care and pap-smear screening compared to private clinics (91.2% versus 67.5% and 100.0% versus 73.3% respectively). As for antenatal services, all public clinics in the states, except for Federal Territory Kuala Lumpur, offered complete pregnancy care services (Note: the maternal and child health services in Federal Territory Kuala Lumpur is offered by the local municipality, hence not all the MOH clinics offer complete maternal and child health services in this location). In comparison, private clinics offered different level of antenatal services that ranged from first trimester only care to third trimester care. For example, among the private clinics offering antenatal services in Selangor and Putrajaya, only 54% of these clinics provided ANC up to the third trimester, while the remaining offered care up to either the first trimester (16%) or the second trimester (34%).

1.2.1.2 Information System, Monitoring and Evaluation

At present, the public sector in Malaysia has a functioning health information and management system, collecting utilisation data from all levels of care. The health facilities submit the data in electronic format in a bottom-up approach. As seen from the annual reports generated by the Health Informatics Centre of the Ministry of Health, these are aggregate reporting in which the scope of data collection focuses on single indicators related to attendance, specific care given and output/workload (Ministry of Health Malaysia, 2010a, 2012a, 2012b). This aggregate reporting does not allow for disaggregation of personal data of each individual. As such it is not able to associate user characteristics with utilisation and care patterns or health outcomes.

Monitoring and evaluation in maternal and child health relies on single indictors in three main areas: (i) performance - clinic attendances, home visits, deliveries, immunisations etc.; (ii) utilisation - average ANC attendance per episode of pregnancy, average clinic visits per child by age group, etc.; and (iii) evaluation - coverage, specific mortality rates, morbidity rates, etc. (Ministry of Health Malaysia, 2012a).

The MOH Malaysia believes in information communication technology as an important mechanism for improving the quality and efficiency of health services (Jaafar, et al., 2013). The public sector of Malaysian health care was one of the firsts in the world to embark on electronic medical records, starting at tertiary hospital sector since the mid-90s. There was also a pilot project on computerisation of maternal and child health services at the primary health care sector around the end-90s, and a pilot on tele-primary care around the mid-2000. Besides, there was an ambitious initiative to implement a nationwide electronic personalised healthcare plan for each population since the mid-90s. However, implementation of information communication technology is expensive and its roll-out has been problematic and slow (Jaafar, et al., 2013). Otherwise, a nationwide electronic health information system would have added great advantages to the health sector; in particular this would enable an electronic monitoring and evaluation system at the point of care.

1.2.2 Maternal-Child-Health Achievements

Historically, Malaysia had great success in maternal and child health. In year 1968, infant mortality rate (IMR) per 1,000 live births was 40.7 and maternal mortality ratio (MMR) per 100,000 live births was 160 [MMR was around 550 in 1949; (Pathmanathan & Liljestrand, 2003)]. Forty years later in 2008, the figure has tremendously reduced to 6.4 and 30 respectively (Ministry of Health Malaysia, 2009). In a detailed review of the Malaysian experience in investing in maternal health, Pathmanathan and Liljestrand (2003) neatly summed up the Malaysian approach that used a synergistic package of health and social services to reach the poor:

> The Malaysian experience illustrates one model for reducing maternal mortality in a developing country using mainly public financing and provision of maternal health services. MMR reduction has been rapid and sustained. Health policies and programs evolved through successive phases of health systems development and were facilitated and supported by related policies in education, rural development, and poverty reduction. Success has been achieved with modest public expenditures on health and on maternal health care, and maternal health services have been largely free to clients who wanted them. An outstanding feature has been the success in making critical services accessible to the poor (Pathmanathan & Liljestrand, 2003, p. 102-103).

The ANC services delivered by the over two thousand public-funded primary health care facilities has significantly contributed to the improvement in these vital health indicators in Malaysia (Pathmanathan & Liljestrand, 2003). The public sector health care system has been providing remarkable equitable access for its population. In general, the population are able to enjoy relatively good quality health services at all levels which are affordable. In particular, the primary health care services including ANC offered by the public sector, which are literally "free-of-charge" whereby the citizen users only need to pay a small token for registration fee, are remarkable in terms of their contribution to progress in the nation's vital health indicators (Pathmanathan & Liljestrand, 2003). Until today, health services offered by the Malaysian government remained affordable; user fee for primary health care preventive and curative services is only a token of USD0.30, all inclusive.

At the same time, the performance of relevant tracers for maternal and child health continues to be excellent. Crude coverage of antenatal care (ANC, ≤ 1 visit) was 97%, skilled birth attendants during delivery 99%, and DTP3 immunisation among one year-old 99% (WHO, 2014b). Besides, there has been increasing average number of ANC visits per pregnancy. Recommended schedule of ANC for normal uncomplicated pregnancy is ten visits for primigravida and seven visits for multigravida in Malaysia (Ministry of Health, 2010). In 2001, the average ANC visits per pregnant woman at public sector health facilities were around eight (Ministry of Health, 2002); by 2010, the figure increased to 11 (Ministry of Health Malaysia, 2012a).

As shown in Table 1.1, coverage for at least 4 visits is not monitored in Malaysia. However, given the average total ANC visits of over 10 visits per pregnancy, it can be assumed that coverage for at least 4 visits is satisfactorily high. Nearly 60% of the women had their first visit to the health clinic by the recommended 12 weeks gestation; 31.4% at 13 to 24 weeks; and 8.2% at 25 weeks or later. However, the categorical interval of 13 to 24 weeks for the aggregate data is too wide to allow for meaningful analysis on initiation of care. For example, having first visit at 17 weeks and first visit at 24 weeks will have different implication in delivery of care.

Table 1.1: Selected Maternal and Child Health Indicators in Malaysia and Selected Countries

Selected MCH Indicators	Malaysia	Indo-nesia	Thai-land	Viet-nam	Singa-pore	Aus-tralia	UK	US
ANC coverage at least 1 visit, % (2006-2013)	97	96	99	94	100	96	-	-
ANC ≥ 4 visits, % (2006-2013)	-	88	80	60	-	90	-	97
Births attended by skilled personnel, % (2006-2013)	99	83	99	92	100	99	-	99
Births by caesarean section, % (2006-2012)	16 (public hospitals only)	12	-	20	-	32	-	33
Contraceptive prevalence, any method, % (2006-2012)	52, year 2004 [5th survey due in 2014, (Jaafar, 2014)]	62	80	78	-	-	84	76
DTP3 immunisation coverage among 1-year-old, % (2012)	99	64	99	97	96	92	97	95
ANC average number of visits	10.4 (2010)	-	-	-	-	-	-	-
Gestational period of first visit, %	(Ministry of Health Malaysia, 2012a)							
0-12 weeks	59.8 (2010)	-	-	-	-	-	-	-
13-24 weeks	31.4 (2010)	-	-	-	-	-	-	-
≥25 weeks	8.2 (2010)	-	-	-	-	-	-	-
Preterm birth rate, per 100 live births(2010)	12	16	12	9	12	8	8	12
LBW, % (2005-2010)	11	9	7	5	-	-	-	-
Stillbirth rate per 1,000 total births (2009)	6	15	4	13	2	3	4	3
MMR per 100,000 live births (2013)								
1990	56	430	42	140	8	7	10	12
2000	40	310	40	82	19	9	11	13
2013	29	190	26	49	6	6	8	28

Sources: (Ministry of Health Malaysia, 2012a; WHO, 2012, 2014b)

In terms of pregnancy outcome indicators such as preterm birth, LBW, stillbirth and maternal mortality, Malaysia is consistently behind the more developed nations such as Australia, Singapore and United Kingdom, as well as somehow the United States which has long been troubled by health inequality. Compared with neighbouring ASEAN countries such as Indonesia, Thailand and Vietnam, there is a mixed pattern of better and poorer performance of these indictors, although Malaysia might have better ANC coverage.

1.2.3 Confidential Enquiries into Maternal Deaths

Malaysia employed the system for Confidential Enquiries into Maternal Deaths (CEMD). Data for the period from 2001-2005, which was the latest officially published CEMD report, showed that maternal deaths analysed by places of delivery and death were mostly (70%-80%) at public hospitals. Maternal deaths by colour coding also revealed an increasing trend among the low-risk white and green-tag women managed at the health clinics, from 15.3% in 2001 to 36.0% in 2005 (Ministry of Health Malaysia, 2008b). As of 2010, maternal mortality by places of death still showed majority (78%) occurred at public hospitals, 9% at home, 5% at private hospitals and 8% others (Jaafar, 2010).

The CEMD report explained that the higher maternal deaths at the public hospitals could be due to transfer of cases from homes and private hospitals where they had delivered (Ministry of Health Malaysia, 2008b). However, analysis of the same CEMD data showed that 70%-80% of the maternal deaths had delivered at public hospitals and 11%-15% at private hospitals. Comparing by place of death, it was consistently high that 73%-78% occurred at public hospitals and 4%-7% at private hospitals. In general, majority of these women had delivered and died at the public hospitals. Although the information about the ANC providers of the women was not included in the analysis, the referral system imposes women to seek ANC at public clinics if they want to deliver at the affordable public hospitals. Therefore, it could be assumed that majority of the maternal death cases had received ANC at a public clinic.

Table 1.2: Maternal Deaths by Causes of Death, 1991-2008

Year	Obstetric Embolism	Postpartum Haemorrhage (PPH)	Associated Medical Conditions	Hypertensive Disorders in Pregnancy	Obstetric Trauma
1991	16.5	27.2	8.6	20.1	4.6
2000	15.8	21.2	15.1	8.9	8.2
2008	30.8	20.6	17.6	10.7	3.8

Source: Confidential Enquiries into Maternal Deaths in Malaysia (CEMD), MOH cited in (Jaafar, 2010)

Table 1.2 provides a summary of the major causes of maternal deaths for the past two to three decades. The top five leading causes are considerably consistent, namely: obstetric embolism, postpartum haemorrhage (PPH), associated medical conditions, hypertensive disorders in pregnancy, and obstetric trauma. Obstetric embolism, PPH, and obstetric trauma may be related to and often only emerge during labour/ delivery and postnatal period. On the other hand, associated medical conditions and hypertensive disorders in pregnancy may have already present before or during the pregnancy. Obstetric embolism, PPH, and obstetric trauma may be concerned with the preparedness of emergency obstetric care and postnatal care.

It was reported that the common remediable clinical factors were failure to appreciate severity, failure to diagnose and failure to inform seniors. Lack of clinical knowledge and skills resulted in failure to recognise early warning. The presence of patient factor such as unbooked case and non-compliance to advice, admission or therapy was also identified as a contributory factor to maternal deaths (Ministry of Health Malaysia, 2008b). The recommendation of the committee could be summarised as the followings:

- Pregnant women with medical conditions were to be reviewed by physician early in pregnancy and managed accordingly;
- Strengthen midwifery skills and preparedness in obstetric emergencies;
- Improve quality of care during antepartum, intra-partum and postpartum period;

- Post-mortem examination should be offered with complete information in all maternal deaths to facilitate well-informed choice;
- Strengthen family planning services to high-risk women;
- Use health information to make improvements through regular maternal death meetings to identify weakness and substandard care;
- Postnatal nursing should focus on detecting deep vein thrombosis and postnatal depression;
- Women with history of mental disorder, domestic violence and addicted spouse or self-harm should be monitored during and after birth;
- Strengthen the existing referral system.

1.3 DEFINING QUALITY AND ADEQUACY OF CARE

1.3.1 Quality of Care

1.3.1.1 Defining Quality by Structure, Process and Outcome

The definition of quality in health care has been using the structure, process, and outcome dimensions of health care since decades (Donabedian, 1966, 1988). This system model, in summary, explains that **structure** includes all the factors that affect the context in which care is delivered. It deals with the organisation of a health care system, including physical facility, staff, financing, and equipment. According to Donabedian (1966), structure is often easy to measure and it may be the upstream cause of problems identified in process. Indicators on structural level evaluate whether certain facilities are present or offered, but do not assess whether the care is optimally carried out (de Jonge, Sint Nicolaas, van Leerdam, & Kuipers, 2011).

Process is the sum of all actions that constitute health care. It entails the entire range of interaction between the health care providers and the health care users (patients). These commonly include diagnosis, treatment, preventive care, and patient education but may be expanded to include actions taken by the patients or their families. An example of such an indicator is the number of patients that has received a certain therapy. It is thus an extension of the structural level as it assesses whether the required care is indeed carried out (de Jonge, et al., 2011; Donabedian, 1966).

Outcome refers to the effect of health care on patients or population. Outcome is sometimes seen as the most important indicators of quality because improving patient health status is the primary goal of healthcare. However, accurately measuring outcomes that can be attributed exclusively to healthcare is difficult. Drawing connections between process and outcomes often requires large sample size, case-mix adjustment and long-term follow-up because outcomes may take considerable time to become observable (Donabedian, 1966, 1980). It should be noted that variation in clinical outcome does not necessarily mean difference in quality of care. There were four explanations that can attribute to observed differences between healthcare facilities concerning clinical outcomes. First, the patients managed by different healthcare providers may differ socio-demographically, severity of disease, or presence of co-morbidity. It is important to adjust for these confounders (case-mix adjustment). Second, differences in outcome can be due to differences in measurement methods, especially in the absence of clear definitions or standards such as the case in measuring patient satisfaction. Thirdly, observed differences can have occurred just by random variation between providers. This relates to the number of cases, the expected frequency of events, and time of follow-up. Finally, differences in outcome reflect the real variation in quality between health care settings or providers (de Jonge, et al., 2011).

During recent decades, the need to focus on quality care has evolved for several reasons. Politically, democratisation movements have led politicians to consider more carefully the demands of citizens for better quality care. At the same time, the economic problems in all countries have limited their ability to improve quality by spending more. Countries have realised that improvements in quality must come by improving the efficiency and effectiveness of current resources. At facility level, managers see the need for more cost recovery, but realise that it will be difficult to charge for services unless the quality is improved. Overall, the success of quality management approaches employed by industry in Japan, and recently in the United States and Europe, has inspired health care organisations to apply these same methods to their quality assurance programs (Brown, Franco, Rafeh, & Hatzell, 1992).

1.3.1.2 Effectiveness and Efficiency

The concept of quality care in general also concerns effectiveness and efficiency. These two add an economic dimension to health care. In its pure form, effectiveness is defined as the ability to produce the intended results (Cambridge Dictionaries Online). In medicine, effectiveness refers to how well a treatment works in practice, i.e. the extent to which a treatment achieves its intended purpose (MediLexicon). In management, effectiveness relates to getting the right things done (Drucker, 2006).

Assessing effectiveness consists of measuring the effects of medical practices and techniques—therapeutic, diagnostic, surgical and pharmacological—on the individual's health and wellbeing. This must consider not only observed improvements in health but also negative impacts such as side effects and iatrogenic effects. Assessing effectiveness in health care considers clinical, economic, ecological and social justice aspect. The clinical and economic perspective could be seen in the following examples (Madore, 1993):

- Assessing effectiveness of two interventions that have the same effect. For example, when two drugs are each used to treat an illness, the more effective drug will be the one that treats the illness more quickly with fewer side effects; it is called the more clinically effective drug.

- The economic dimension of effectiveness introduces the concept of cost, thus refers to cost-effectiveness and cost reduction. For example, if two drugs have the same effects in all respects (same duration of treatment and same side effects), the more economically effective drug is the one that costs less.

Assessing effectiveness makes it possible to determine the medical practices and techniques that actually improve health and make good use of resources. Since resources allocated to health care are limited, only effective practices and techniques should be used. Effectiveness in the health care system continues to have two elements: the greatest possible improvement in health at the best possible cost (Madore, 1993).

Efficiency, a much broader concept, is the relationship between the level of resources invested in the health care system and the volume of services or, what amounts to the same thing, improvements in health achieved. The purpose of efficiency is to maximise results effectively or services delivered given a particular budget (Madore, 1993; Palmer & Torgerson, 1999). According to this concept, each service must be delivered at the lowest possible cost, have benefits of value equal to or greater than its cost, and make optimum use of the resources invested. Efficiency is distinct from effectiveness in that it considers costs in relation to benefits.

Palmer and Torgerson (1999) asserted that inefficiency exists when resources could be reallocated in a way which would increase the health outcomes produced. In brief, technical efficiency addresses the issue of using given resources to maximum advantage; productive efficiency of choosing different combinations of resources to achieve the maximum health benefit for a given cost; and allocative efficiency of achieving the right mixture of healthcare programmes to maximise the health of society (Palmer & Torgerson, 1999).

Countries have often not paid enough attention to effectiveness and responsibility in health care funding. As a result, health care systems have evolved without mechanisms to assure accountability for the effectiveness, efficiency and appropriateness of care provided (Evans, 1993).

1.3.1.3 Defining Quality in Maternity Care

On the other hand, Pittrof, Campbell and Filippi (2002) asserted that maternity care differs from other areas of health care in the following ways:

- Most users of maternity services are well. Maternity services need to beware of over-treating and over-medicalising pregnancy and childbirth, as this can lead to iatrogenic complications and waste of resources.
- Some users of maternity services will develop conditions requiring higher level of care; many of these conditions are unpredictable and life-threatening. Maternity services therefore need to beware of under-treating some women.
- Maternity care is intended for at least two recipients—mother and baby. Outcomes for both are important, implications for each need to be balanced.
- Maternity services deal with culturally and emotionally sensitive area of childbirth. Non-biomedical outcomes may be more important for childbirth than others.

These differences insinuate the need to relook the definition and assessment of quality in maternity care. The authors therefore proposed a comprehensive definition specific to quality of care in maternity services that encompassed attributes related to processes, user and providers perspectives as well as medical outcomes (Pittrof, et al., 2002):

> High quality of care in maternity services involves providing a minimum level of care to all pregnant women and their newborn babies and a higher level of care to those who need it. This should be done while obtaining the best possible medical outcome, and while providing care that satisfies women and their families and their care providers. Such care should maintain sound managerial and financial performance and develop existing services in order to raise the standards of care provided to all women (Pittrof, Campbell and Filippi, 2002, p. 278).

The proposed definition is in line with WHO's risk-oriented ANC strategy in which it advocates the provision of routine care to all women and additional or specialised care for women with complications (WHO, 2009). It could be seen from the definition that quality maternity care also encompasses the dimensions of quality conceptualised by Donabedian such as provision of care by risk level (process), achievement of outcomes (outcome), and to certain extent, the managerial and financial aspects that support and direct the provision of care (structure). The definition could be applicable to all situations but is particularly important in developing countries where health services often achieve less than ideal outcomes for a given level of resources, unaccountable and unresponsive to user and provider needs. It was stressed that the success of strategies to improve quality of maternity care requires local standards and criteria for the components identified (minimum care for all women, higher level of care for some women, users' and providers' satisfaction with care, best outcomes for mother and baby, and sound managerial and financial performance) because these are influenced by cultural values, expectations and availability of resources (Pittrof, et al., 2002).

1.3.2 Assessing Quality of Antenatal Care: Adequacy of Antenatal Care

As a matter of fact, similar to other fields of care, ANC is concerned with provision of care according to needs and standards, as well as issues of over-treating and under-treating (Pittrof, et al., 2002; WHO, 2009). Assessing quality of ANC therefore include measuring the "adequacy" of care. Literature search for "adequacy" related to ANC revealed that the term was often used in the discussions on adequacy of antenatal care utilisation which concentrated on initiation of care and number of visits (G. R. Alexander & Kotelchuck, 1996; Koroukian & Rimm, 2002; Kotelchuck, 1994; Krueger & Scholl, 2000; VanderWeele, et al., 2009). It has been pointed out that the term "adequacy of care" was not consistently defined in studies on antenatal care. It could encompass quantitative and qualitative indicators of quality of antenatal care such as number of visits (Petrou, Kupek, Vause, & Maresh, 2003; Raatikainen, Heiskanen, & Heinonen, 2007; Deborah S. Walker et al., 2002; D. S. Walker, McCully, & Vest, 2001), initiation of care (Baker & Rajasingam, 2012; Forrest & Singh, 1987; Tucker, Ogutu, Yoong, Nauta, & Fakokunde, 2010) or content of care/ compliance to recommended practices (Dhar, Nagpal, Bhargava, Sachdeva, & Bhartia, 2010; Majrooh, Hasnain, Akram, Siddiqui, & Memon, 2014; Victora et al., 2010). Some studies have also equated adequacy of care content in terms of compliance to recommended practices with quality of care (Dhar, et al., 2010; Victora, et al., 2010). Nevertheless, as understood from the definitions discussed earlier on the quality of care in general and maternity care in particular, adequacy of content or compliance to recommended practices is only a subset of quality of care which also includes other dimensions (structure and outcome).

It was stated that measurement for "adequacy of antenatal care" was developed because accurate measurement of antenatal care utilisation is a critical step in the development of public health programmes to improve antenatal care services and ultimately to improve birth outcomes (Kotelchuck, 1994). The indices for measuring adequacy of antenatal care have been conceptualised differently, this led to differences in definitions of the "adequacy" criteria (Beeckman, Fred Louckx, Masuy-Stroobant, Downe, & Putman, 2011) and interpretations of results (VanderWeele, et al., 2009). The most commonly used Adequacy of Prenatal care Index (APNCU) defines "adequacy of care" by the number of ANC visits adjusted for the month when the care was initiated and the expected number of visits which was adjusted for gestational age at birth (Kotelchuck, 1994). There are however limitations to the APNCU Index: (i) it is a measure for adequacy of ANC utilisation which does not measure the adequacy of ANC content; (ii) it also does not adjust for risk conditions of pregnant woman because the recommended number of visits based upon is for women with uncomplicated pregnancies (Kotelchuck, 1994). Assessment of the risk profiles of the pregnancy will determine, in part, the intensity of antenatal care. Pregnancy complications itself could be both an effect and a cause of antenatal care utilisation. However, to carry out such analyses would require data on the antenatal care utilisation pattern and pregnancy complications (VanderWeele, et al., 2009).

Alexander and Kotelchuck (1996, 2001) had suggested since a long time ago the need for more comprehensive adequacy indices which should also include qualitative aspects of ANC such as indicators of content. Improvement to the adequacy indices would enable better monitoring of ANC utilisation patterns and compliance to care guidelines as well as evaluation of current policies and practices (Kogan et al., 1998).

In essence, based on decades of researches by the experts in the field as well as the concept of quality maternity services, understanding the quality of pregnancy care will need comprehensive knowledge on, one, utilisation of services by the women; and two, the content of care provided to the women.

Furthermore, the concepts of quality maternity care and risk-oriented ANC also dictate how adequacy of ANC should be defined and assessed. Both concepts imply the need for rational use of ANC according to need and provision of care that contributes to intended outcomes. These two concepts, quality maternity care and risk-oriented ANC, also entail all women be given a minimum level of care regardless of their risk level. However, what constitutes "adequacy" will differ from country to country and from health provider to another (public versus private), which are partly influenced by resource allocation. It might also differ from culture to culture. In general, "adequacy" in health care is much more driven by available resource than by culture. The definition and assessment of "adequacy of ANC" will therefore need to reflect the local standards, i.e. the recommended schedule and the routine care content designed for all women of a given study setting.

In line with international standards for measuring the quality of antenatal care, "adequacy of ANC" in this thesis is defined as adequacy of utilisation and adequacy of content, in which, adequacy of utilisation followed the definition of APNCU index which is defined by adequacy in initiation of care and observed-to-expected number of visits according to local guidelines adjusted for gestational age of delivery; and adequacy of content is defined by adequacy in compliance to recommended routine care standards according to local guidelines.

1.4 PROBLEM STATEMENTS: CURRENT ISSUES ON MATERNAL-CHILD-HEALTH/ ANTENATAL CARE IN MALAYSIA AND WORLDWIDE

Despite such remarkable performance of relevant tracers and continuing high ANC attendances, pregnancy outcomes in Malaysia do not improve with equal pace. MMR has remained stagnant at around 28-30 per 100,000 live-birth since over a decade (Kaur & Singh, 2011; Ministry of Health Malaysia, 2010a), and the country was not be able to meet the MDG target of reducing MMR to 11 per 100,000 live births (Jaafar, 2014). Some of the key pregnancy outcome measures reported were also poorer than some neighbouring countries as well as developed countries. Birth weight under 2,500g was reported at around 11% of total live births, compared to Indonesia at 9%, Thailand 7%, and Vietnam 5% (WHO, 2012); stillbirths was around 4.4 per 1,000 total births (Ministry of Health Malaysia, 2010b). These pose the questions concerning the limitation of coverage indicators and the need for assessing adequacy of ANC provided.

Recent strategic papers on monitoring of health services affirmed that while ANC is an effective preventive measure, quality is still a problem that requires additional monitoring and evaluation (Boerma, AbouZahr, Evans, & Evans, 2014; Requejo, Newby, & Bryce, 2013). The aim of the current global initiate that all member states of World Health Organization committed, Universal Health Coverage (UHC), is to provide quality services (WHO, 2013). In the context of intervention area of pregnancy care, the first or fourth ANC visits are "crude" intervention coverage indicator which requires additional indicator to capture the quality of the intervention, e.g. type of ANC services received (Boerma, AbouZahr, et al., 2014). In short, most service coverage indicators need additional data collection and indicators to examine the quality of the implementation of the interventions.

It was discussed that indicator disaggregation should be possible by key socio-demographic and socio-economic stratifiers; and data collection strategy should allow for disaggregation by geographical area/ subnational monitoring (Boerma, AbouZahr, et al., 2014; Ng et al., 2014), in particular, the importance of subnational monitoring of effective coverage that helps to pinpoint gaps in services delivery (Ng, et al., 2014). Data collection at health facility level is encouraged due to the possibility of subnational disaggregation by geographic area, and the continuity (Boerma, AbouZahr, et al., 2014).

Coverage for ANC in Malaysia is monitored for the first visit (new antenatal attendance); no data is compiled for the coverage of the 4th visit (Ministry of Health

Malaysia, 2012a). It was captured that approximately 74% of the first ANC visit was seen at the MOH's health clinics, 2% by the government hospitals, and 6.5% by the private clinics/hospitals. In 2010, this translated to 434,823 out of 587,479 estimated number of pregnant mothers attending MOH's health clinics for their first ANC visit (Ministry of Health Malaysia, 2012a).

In addition to the globally-used indicators, additional ANC indicators routinely collected in Malaysia include: gestational week of first visit to health facility, total ANC attendances by facility, coverage of anti-tetanus toxoid for pregnant women, haemoglobin level of pregnant women at ±36 weeks gestation, and total number of medical referrals by facility (Ministry of Health Malaysia, 2012a). However these utilisation and content-related indicators are reported as aggregated figure for each facility. They are assessed independently from each other without associating the interventions to pregnancy outcomes. In short, while the health facilities contain a wealth of information on ANC, as a rule, these data are not comprehensively extracted and analysed.

1.4.1 Studies on Antenatal Care Utilisation and Outcomes in Malaysia

While there were several studies on ANC in the 80s (Abdul Majid, 1989), 90s (Gan CY, 1993) and after the millennium (Ahmad, 2005), these studies focused on the utilisation aspect or number of ANC visits. No research has been conducted on ANC content in Malaysia. Or when it was included the focus was on "complete visits" of uncomplicated pregnancies only.

In the 2001 study conducted in Larut Matang district in Malaysia on validity of colour coding as a risk approach strategy in antenatal management, it was found that there was no significant association between the number of ANC visits (four or more) and maternal intra-partum complications or low birth weight (Wahid, 2001). The mean number of ANC visits was 9, as compared to the recommended 8 visits then. The study found that around 25% of the women had inadequate ANC visits, of which approximately 42% were risk-pregnancies (yellow and red tagged); and low-risk cases has more visits than the recommendation. It was also found that only 9% of the women came at or before 12 gestational weeks (recommended initial visit then was 12 weeks or earlier). The study did not research on the content aspect of the ANC. It recommended that there was a need to reduce the number of ANC visits for low-risk pregnancies and to emphasise on ANC for high-risk. Thus, the need to identify minimum number of ANC visits for normal pregnancies and to allow for more care for those in need.

In 2005, a study on the optimum number of ANC visits for low-risk pregnancy was conducted at the district of Kuala Muda Kedah, in Malaysia (Ahmad, 2005). The study was a cross-sectional study in which the data was obtained through face-to-face interview with the mother during postnatal check-up and through data extraction from the records. The outcome measurement was birth weight; and focused on low-risk pregnancy only (white or green tag during the last ANC visit). In addition, the study included only "complete ANC visits" and excluded those visit solely for the purpose of ultrasound examination, blood pressure monitoring and other single procedures. A "complete visit" denotes measurement of weight, blood pressure, urine analysis, haemoglobin, fundal height and foetal heart monitoring. The study concluded that the optimum number of ANC visits was 10 visits per low-risk pregnancy. Less than 8 visits had twice the risk of having low birth weight as compared to those with 8 or more visits (crude OR=2.33, 95% CI=1.24-4.10, p=0.006).

It is of the opinion that this Kuala Muda study has a number of limitations. The main limitations are: First, the study omitted those visits made for a single procedure and yet concluded that those who had less than 8 complete visits had twice the risk of having low birth weight. Those pregnant women who had to come more frequently for monitoring of single parameter such as blood pressure, haemoglobin or etcetera might be borderline risk pregnancy predisposed to low birth weight, and yet this information was not captured and analysed. In addition, those who had extra visits for single procedure might end up receiving less than 8 complete ANC check-ups because the care providers might focus on the problem that warranted extra single procedure visits. Second, the procedures included in the definition of "complete visit" consisted of very basic procedures. It was not known if health education, iron/folic acid supplementation, or other essential procedures were provided. Third, the study did not take into consideration the difference in the duration of pregnancies. For example, a premature birth may naturally experience lesser ANC visits and subject to low birth weight as compared to a term birth. Fourth, many of the data collected through face-to-face interviews are found to be unnecessary. For examples, the study asked the mothers for basic data such as age, ethnicity, education, income, marital status, last menstrual period before this pregnancy, initial ANC visit and etc., which could be easily extracted from the records. Questions such as last menstrual period before this pregnancy and initial ANC visit after the birth of the child may subject to recall bias. Moreover, the data obtained from the mother were still cross-checked with patient records where patient records prevailed should there be discrepancy.

Furthermore, the Deputy Director of Family Health Development has expressed that the problem faced is the increasing ANC visit which is now approaching 11 visits per pregnancy, compared to the WHO recommendation of 4 visits (Appendix A). What is of utmost interest is to find out what is actually being done during each visit that warrants such high number of visits. Are all these visits necessary? Is the consumption of resources justified (i.e. who uses more ANC, the uncomplicated or complicated pregnancies)? Also, is it sufficient to rely on single indicator that lacks the quality dimension to measure ANC?

In this context, the arisen research questions are:

1. What is the status of ANC adequacy in Malaysia in terms of utilisation and content? Who uses the services and what services are delivered?
2. What are the factors that may influence adequacy of ANC?
3. What are the consequences of ANC adequacy? Is there an association between adequacy of ANC and pregnancy outcomes?
4. How could adequacy of ANC be enhanced and resources for ANC optimised?

1.5 RATIONALE OF STUDY: MOTIVATION AND PUBLIC HEALTH SIGNIFICANCE

The issues discussed earlier highlights the need for comprehensive monitoring and evaluation of ANC to enable a better understanding of current state of ANC provided. Useful information on ANC is often obtained from large scale survey such as the Demographic Health Survey that is not conducted in Malaysia. The National Health and Morbidity Survey that has been carried-out since 1986 focuses on non-communicable lifestyle-related diseases and does not include ANC. A few ANC studies conducted thus far only focused on the utilisation aspect without considering gestational age of initiation and length of pregnancy. These studies also did not research into the content of the care provided comprehensively. In addition, the study design of a previous study on uncomplicated pregnancies might have affected the validity of its finding as that study did not capture the visits for single procedure or the reasons for these visits which might have predetermined the pregnancy outcomes.

ANC bears health and socio-economic consequences to the women and their family as well as the health system. Appropriate utilisation and quality content are of paramount importance. Under-utilisation may subject the women and the products of the pregnancy to higher morbidity or mortality risk. This in turn will have an impact on the family and the health system. A maternal morbid condition, a deceased mother, or a sick or deceased newborn will have socio-economic effect to the family and the health system. On the other hand, inappropriate over-utilisation of ANC will burden the health system unnecessarily, in particular the public sector which is already struggling with rising need for health resources. Likewise, quality of ANC content has enormous implication on pregnancy outcomes and health system. This research therefore attempted to bridge the gap in information related to adequacy of ANC (utilisation and content) provided by the public health clinics in Malaysia.

1.5.1 Motivation

The researcher was motivated to seek out the earlier mentioned gaps that might help to address some of the issues encountered. It is felt that research on adequacy of ANC that covered both utilisation and content aspects will be useful as it will examine the quality dimension and not just counting the number of visits. It is also strongly felt that Malaysia should move away from relying on single indicators such as crude coverage and should look into more comprehensive measurement that addresses quality aspect.

The interest in maternal health began as a subconscious comparison of pregnant women in developed versus under-developed settings. Having been trained and worked in a tertiary hospital in Singapore, it was an eye-opener to see maternal health services in under-developed setting for the first time in Malawi many years ago. Subsequently, having learned the contextual issues of these settings, one could appreciate the challenges encountered in trying to improve maternal health. Every day, approximately

800 women die from preventable causes related to pregnancy and childbirth; and 99% of all maternal deaths occur in developing countries. Many of these deaths are preventable by the interventions that have been taken for granted in the developed world. For example, access to skilled care before, during, and after childbirth.

All these aforementioned factors had motivated the researcher to learn about maternal health services, in particular, the antenatal aspect. But, why was it that working in Singapore and Malawi made Malaysia the study area? Maternal health services of Malaysia, as a middle-income developing country, might have encountered different problem as compared to the less developed countries. For example, the issue in Malaysia was the increasing ANC visits as opposed to the issues of under-utilisation in the less developed countries. However, Malaysia had a success story concerning the past achievement in maternal health. Learning the antenatal care of Malaysia would therefore produce a two-prong benefit. At one end, the study dealt with the Malaysian ANC standard that was considerably higher than most developing countries. At the other end, it had to research into the recommended standards of the more developed countries in order to appreciate the current standing of Malaysia and to grasp the window for improvement.

1.5.2 Public Health Significance

There is a gap regarding available information on the use and delivery of ANC since these have not been studied comprehensively. It is expected that the findings of the study will contribute to policy formulation on the use and content of ANC provided. For example, while the MOH recognises problem related to increasing ANC visits, it is difficult to address the issue without a clearer picture of what warrants such higher number of visits, and whether the visits has been appropriately made by those in need. Learning about the risk level of women who consumed the most ANC visits will help to assess if the services have been justly utilised and delivered. This is particularly useful as previous study conducted in a district in Malaysia revealed that close to half of the women who have inadequate ANC were from the high-risk group. The results of the study can also assist the policymakers to have a better understanding on current state of technical performance (compliance to guidelines); this will facilitate formulation of measures to address any gap observed. In effect, research on adequacy of ANC, its associated factors and pregnancy outcomes will help to examine ANC in another dimension which has not yet been attempted. This will perhaps reveal the possible reason related to increasing ANC visits and yet stagnant or no improvement to indicators such as MMR, low birth weight and stillbirths.

The findings of the study, coupled with other studies such as cost-outcome analysis, will also contribute to improving the efficiency and effectiveness of ANC in Malaysia. These will be useful in facilitating the development of minimum care package of ANC within the context of the ongoing Health Sector Review initiative that is looking into preparation of a national health financing scheme.

Furthermore, this study shows a new approach in assessing adequacy of ANC in terms of both utilisation and content in Malaysia, instead of relying solely on the coverage indicators which do not provide useful information on adequacy of ANC. The methods used in the study may be useful for the policy-makers/ Ministry of Health or relevant institutions to consider their use for expanding the current monitoring and evaluation framework of ANC. This will be relevant within the context of health sector reform where it is envisaged that the Ministry of Health would no longer play the provider role but would have a stronger role in stewardship as well as monitoring and evaluation function.

Lastly, the study reviews the current ANC content delivered, in particular the effectiveness of the practices currently adopted as well as proven practices that have not yet been incorporated into the current care guidelines. This will help to identify the areas for further improvement.

1.6 GENERAL AIM AND OBJECTIVES OF STUDY

1.6.1 General Objective

The general objective of this study is to determine the adequacy of ANC in the public health clinics of Selangor in Malaysia. Adequacy of ANC is defined as adequacy of utilisation and adequacy of content, in which, adequacy of utilisation followed the definition of APNCU index which is defined by adequacy in initiation of care and observed-to-expected number of visits according to the MOH guidelines adjusted for gestational age of delivery; and adequacy of content is defined by adequacy in compliance to recommended routine care standards according to the MOH guidelines.

1.6.2 Specific Objectives

The specific objectives of this study are:

1) To assess the status of ANC adequacy in terms of the proportion of pregnant women who have adequate:
    a) **ANC utilisation** based on an utilisation index that includes both gestational age at first ANC visit; and observed-to-expected ANC visits ratio;
    b) **ANC content** based on weighted scores for physical examination, health screening, case management, and health education;
    c) **ANC adequacy** which considers both **adequacy of utilisation and content**.

2) To determine if there is an association between the adequacy of **ANC utilisation** among pregnant women and the followings:

a) socio-demographic and socio-economic factors;
b) obstetric factor;
c) risk level of pregnancy.

3) To determine and compare the extent of adherence to recommended routine ANC content set by MOH in term of **ANC content** score, among:
   a) primigravida and multigravida;
   b) risk level of pregnancy;
   c) providers by qualification (in term of proportion of total visits attended by specific providers);
   d) pregnant women seeking ANC in different type of health clinics as determined by expected daily workload.

4) To examine the extent of adherence to selected recommended practices and to compare the national ANC guidelines with recommended guidelines from other countries.

5) To determine if there is an association between ANC adequacy (utilisation and content) as well as other factors and pregnancy outcomes, based on:
   a) preterm birth (<37 weeks gestation at birth);
   b) low birth weight (birth weight <2,500g);
   c) stillbirth;
   d) maternal complications (intra- or postpartum complications including maternal death).

1.7 STRUCTURE OF THE THESIS

The main body of this thesis after the introduction chapter begins with Chapter 2 on literature review relevant to ANC. Amongst others, the review includes detailed review of several ANC guidelines, influence of ANC on pregnancy outcomes, issues associated with utilisation and content, measuring adequacy of ANC, and current global initiatives. This chapter ends with the conceptual framework for the study.

Chapter 3 details the methods of the study. It explains the study design, setting, population, and sampling design including sample size, sampling approach, inclusion and exclusion criteria. The variables concerned are listed and explained, including confounding control. These are followed by data collection approach and activities. Data analysis explains how the main variables were handled and delineates the statistical procedures and approaches in testing association.

The results of the study are presented in Chapter 4. It first presents the respondent characteristics before providing the results in accordance to the study objectives, namely status of ANC adequacy; factors associated with adequacy of ANC; adherence to recommended routine ANC content and selected recommended practices; association of ANC utilisation, content, and other factors with pregnancy outcomes. The discussion in the subsequent Chapter 5 mirrors the content and flow of the findings, attempting to explain the expected and unexpected findings. In the end, this chapter discusses the strengths and limitations of the study.

Chapter 6 deliberates the recommendations for the way forward based on the findings of the study, contemplating the current global strategies and taking into consideration relevant contextual issues as well as possible implications for health services delivery. Finally, Chapter 7 concludes the study with key messages drawn from the study and self-reflection of the researcher on the experiences gained in conducting the study and developing this thesis.

CHAPTER 2: LITERATURE REVIEW

This chapter begins with a historical account of ANC development, followed by the principles of ANC and development of guidelines which were very much driven by evidence-based practices. Detailed review of several ANC guidelines is presented with the aim to understand what is being done differently in Malaysia as compared to other countries. Examining the association of ANC and pregnancy outcomes is inherent to any study on ANC; this gives an appreciation of what the experts or scholars said on their findings concerning the influence of ANC on pregnancy outcomes. This also covers the relevant outcome indictors (foetal and maternal). Chapter 2 goes on to review the factors associated with ANC utilisation which includes socio-economic, obstetric, risk and enabling factors. ANC content aspect looks into the extent of and issues surrounding adherence to recommended ANC content including the associated factors and pregnancy outcomes. In order to appreciate the approach in measuring adequacy of ANC, this chapter reviews numerous studies that attempted to assess adequacy of ANC utilisation and content. To keep abreast with the development in related field, the review also includes the current global health initiatives. Lastly, this chapter outlines the conceptual framework of this study.

The literature search used a combination of keywords: subject headings (antenatal care, prenatal care, ANC, pregnancy, maternal health) and those related to the content of care (guidelines, content, compliance, adherence, quality, adequacy, provider), as well as those related to access variables, population characteristics or outcomes (utilisation, accessibility, socioeconomics, pregnancy outcomes, preterm birth, low birth weight, stillbirth, maternal complications). The searches used the University of Malaya's electronic resources and online search engines to obtain information. The databases searched include PubMed, Science Direct, JSTOR, EMBASE, MEDLINE, the

University of Malaya's library catalogue, and the Department of Social and Preventive Medicine's achieve for dissertations. Other search engines used were Google Scholar and Google. In addition, website of organisations known to be active in the field and formal institutions of Malaysia were searched. The collection of annual returns, ANC guidelines and publications of the Ministry of Health were referred. The searches for recommended practices were limited to guidelines within the past 5 years, while where applicable, majority of the searches on relevant studies focused on publications within the past 10 years.

Considering Malaysia is a middle-income developing country aiming for developed status, the searches on recommended practices included developed nations such as Australia, the United Kingdom, the United States, and the European Union. This was also because the detailed guidelines of these countries were often published and widely accessible. Literature searches in general attempted to strike a balance to obtain an overview of developing as well as developed nations.

2.1 EVOLUTION OF ANTENATAL CARE

The term "antenatal" first surfaced in 1891 when Dr J. W. Ballantyne tried to find a term that best described interweaving subjects related to teratology, foetal diseases, early pregnancy infections, heredity morbidity (Ballantyne, 1921). The state of knowhow and materials then were not possible to make significant progress toward solving the problems of antenatal diagnosis and treatment. It was therefore urged that in order to make a breakthrough in pregnancy care, services delivery needed to be reorganised, and new means of investigation should be undertaken on a large scale systematically (Ballantyne, 1901, 1914, 1921). The diligent push in the field has resulted in the birth of organised antenatal care (Ballantyne, 1901, 1921) and researches in antenatal (Ballantyne, 1914).

Subsequently in 1929, the British Ministry of Health issued a Memorandum on antenatal clinics outlining the concepts of antenatal care. It recommended that pregnant women should be seen by 16 weeks (as early as possible), continuing at 4-week intervals until 28 weeks, thereafter every two weeks until 36 weeks and weekly until delivery (U. K. Ministry of Health, 1929). This translated to typically a total of at least 12 ANC visits for a 40-week pregnancy, or approximately 13-14 visits based on earlier initiation. This model of care has also communicated a message that the risk increased with advancement of pregnancy, as manifested by increasing frequency of care near term.

For many years, nobody disputed the rationales of this model of care. This preventive care programme continued to be carried out for about 50 years before the idea of evaluating its effectiveness emerged in the 80s (Bergsjo, 2001). By then, a variety of models of care has appeared across the countries, even among those with similar foetal and infant mortality (Blondel, Pusch, & Schmidt, 1985). There were also substantial practice differences among the countries. Interventions were added according to national or local needs in addition to a basic set of interventions. What was recommended versus what was actually practised was also differed (Heringa & Huisjes, 1988). The incongruent state of ANC then warranted a call to look into what actually worked and what did not in a broader and scientific context.

2.2 PERINATAL CARE PRINCIPLES AND ANTENATAL CARE GUIDELINES

In 1998, the World Health Organization (WHO) proposed a set of principles for perinatal care that protect, promote and support effective antenatal and postnatal care (WHO Regional Office for Europe, 1998). These principles were:

- care for normal pregnancy and birth should be de-medicalised;

- care should be based on the use of appropriate technology;
- care should be evidence-based, regionalised (localised), multidisciplinary, holistic, family centred, culturally appropriate, and should involve women in decision-making.

Upholding these principles, there have been initiatives to develop or update the national ANC guidelines in some countries. ANC guidelines had been the subject of many reviews and researches over the past three decades, stemming from the notion that routine ANC has developed without evidence of how much care is really required and useful to optimise maternal and neonatal health (G. R. Alexander & Kotelchuck, 2001; Dowswell et al., 2010; Munjanja, Lindmark, & Nyström, 1996; Villar, et al., 2001). Many asserted that some of the ANC interventions are not effective but still in use because of tradition (Health Evidence Network, 2005; A. Langer & Villar, 2002). One example is the measurement of symphysis-fundal height at ANC visits that has very little evidence to show that it leads to better perinatal outcomes (Neilson, 2000). In addition, studies show that routine late pregnancy ultrasound in low-risk women does not benefit mother or baby; routine foetal-movement counting is not effective for prevention of late foetal death in normally formed singleton; and antenatal cardiotocography for foetal assessment has no effect on perinatal outcomes (Health Evidence Network, 2005).

These findings have contributed to the review and revision of ANC guidelines in several countries with orientation towards evidence-based practices. Notably, the United Kingdom's National Institute for Health and Clinical Excellence (NICE) revised their ANC guidelines in 2008 ([NICE] National Institute for Health and Clinical Excellence, 2008). The American Academy of Pediatrics (AAP) and American College of Obstetricians and Gynaecologists (ACOG) updated their Guidelines for Perinatal Care in 2012 ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012). In Australia, the 3-Centres Collaboration was established to standardise ANC guidelines of Victoria State since the beginning of 2001 (3centres Collaboration Victoria Australia, 2006). To take up the standardisation further, in 2008, the Australian Health Ministers' Advisory Council (AHMAC) initiated the development of their first National Evidence-Based Antenatal Care Guidelines. Module 1 of the Australian guidelines which was officially released in 2013 cover ANC in the first trimester of pregnancy ([AHMAC] Australian Health Ministers' Advisory Council, 2012). Module 2 which was endorsed in October 2014 addresses care in the second and third trimesters of pregnancy and provides guidance on core practices, lifestyle considerations, clinical assessments, common conditions and maternal health tests for healthy pregnant women ([AHMAC] Australian Health Ministers' Advisory Council, 2014). The Guidelines complement the Australian Dietary Guidelines, the Australian Guidelines to Reduce Health Risks from Drinking Alcohol, the National Perinatal Depression Initiative and the Australian National Breastfeeding Strategy 2010-2015.

The compilation of these national ANC guidelines, in particular the NICE and AHMAC guidelines, drew on evidence-based practices through extensive systematic reviews in which the details of the methodology as well as evidences used to update each recommended practice were explained. The guidelines also attempted to localise the guidelines through incorporation of findings from local researches.

The MOH Malaysia has also updated the Perinatal Care Manual including the ANC guidelines in 2010 (Ministry of Health, 2010). As compared to the aforementioned guidelines, the Malaysian guidelines were comparatively less informative. For example, the rationale for certain practices was not explained. In order to comprehend the “standing” of Malaysian ANC guidelines, the routine ANC interventions for healthy pregnant women and uncomplicated pregnancy of selected countries were tabulated (Appendix B). The following discussion would refer to the tabulation in Appendix B which consisted of the WHO’s recommended model of routine ANC (Villar, et al., 2001), Malaysia (MOH), United Kingdom (NICE), United States (ACOG), and Australia (AHMAC) guidelines, as well as a survey on ANC guidelines in 25 European Union member states (Bernloehr, Smith, & Vydelingum, 2005). Both the WHO model and the EU survey did not include the complete ANC guidelines, only selected interventions were available.

2.2.1 Recommended Schedule for Antenatal Care Visits

The multicentre randomised control trial (RCT) by WHO evaluated the outcomes of a new model of routine ANC (four visits) versus the standard model of ANC. It showed that the new model with reduced visits did not seem to affect maternal and perinatal outcomes (Villar, et al., 2001). The trial, which was conducted in Argentina, Cuba, Saudi Arabia, and Thailand, was considered the most rigorous research on evidence for reduced ANC visits.

There have also been several studies on reduced ANC visits in developed countries in which the findings supported the safety and efficacy of reduced ANC visits for low-risk pregnancy (Blondel, et al., 1985; Deborah S. Walker, et al., 2002). The United Kingdom (UK) guidelines referred to two systematic reviews (Carroli et al., 2001; Villar, et al., 2001) based on the same RCTs—four trials conducted in developed countries and three in less developed countries (n=57,418)—and concluded that antenatal care for women without risk or complications might be provided with fewer visits than traditionally offered ([NICE] National Institute for Health and Clinical Excellence, 2008). As a result, the recommended schedules of the ANC guideline of UK for nulliparous and multiparous with uncomplicated pregnancy is scheduled for ten visits and seven visits, respectively, for a 40-week pregnancy ([NICE] National Institute for Health and Clinical Excellence, 2008).

Table 2.1: Recommended Schedule for Antenatal Care of Healthy Pregnant Women in United Kingdom & Malaysia (based on a 40-Week Pregnancy)

United Kingdom		Malaysia	
Nulliparous (weeks)	**All (weeks)**	**Primigravida (weeks)**	**Multigravida (weeks)**
10 (booking)	10 (booking)	12	12
16	16	18	20
18-20 (if women chooses to have ultrasound to detect structural anomalies)	18-20 (if women chooses to have ultrasound to detect structural anomalies)	24	-
25	-	28	28
28	28	32	32
31	-	36	36
34	34	37	-
36	36	38	38
38	38	39	-
40	-	40	40
TOTAL = 10 visits at 40 weeks gestation	**TOTAL = 7 visits at 40 weeks gestation**	**TOTAL = 10 visits at 40 weeks gestation**	**TOTAL = 7 visits at 40 weeks gestation**

Source: ([NICE] National Institute for Health and Clinical Excellence, 2008), (Ministry of Health, 2010)

NICE recommends that ANC booking should ideally take place by the 10th week (Table 2.1). There is limited evidence to determine exactly when the first antenatal visit should take place (Villar, et al., 2001), however, late booking means that women may not have the opportunity to benefit from screening tests, antenatal education and health advice, or supported decision making regarding the place and choice of delivery (Baker & Rajasingam, 2012). The Confidential Enquiry into Maternal and Child Health reported in 2007 that 17% of maternal deaths in the UK were amongst women who had booked for care after 22 weeks of gestation, or had missed more than four routine visits, associating this pattern of behaviour with social vulnerability and an increased risk of maternal death (Lewis, 2007). The latest CEMD revealed that among the women who died and who had received any ANC, 43% had their ANC booking at ≤ 10 weeks of gestation, 31% at 11-12 weeks and only 20% at >12 weeks (Knight et al., 2015). This means over 70% of the women who died had their booking by 12 weeks of gestation (which is considerably acceptable and recommended by some guidelines) and only 20% had their booking after 12 weeks of gestation. For all intents and purposes, such data reiterated the issue concerning limited evidence to determine when should the first antenatal visit be initiated.

The recommended ANC schedules of MOH Malaysia referred to the recommendation of NICE. The guideline recommended that ANC visits for healthy pregnant women with uncomplicated pregnancy were also ten visits for primigravida and seven visits for multigravida (Ministry of Health, 2010). The recommended initiation period was by 12 weeks of pregnancy, two weeks later than the NICE recommendation (Table 2.1).

In Australia, prior to the introduction of the "3Centres Consensus Guidelines on Antenatal Care" in 2006, it followed the traditional schedule of 14 visits (3centres Collaboration Victoria Australia, 2006). Subsequently, the ANC guidelines were further reviewed and standardised nationwide. The Australian guidelines consider a schedule of ten visits to be adequate for a primigravida without complications and seven visits to be sufficient for subsequent uncomplicated pregnancies (multigravida). Booking visit is recommended to take place by the 10^{th} week of gestation ([AHMAC] Australian Health Ministers' Advisory Council, 2012). The Australian AHMAC guidelines cited Dowswell et al.'s (2010) Cochrane review of studies conducted in high-, middle- and low-income countries. The systematic review found no strong evidence of differences in the number of preterm births or low birth weight between groups receiving reduced number of ANC visits (eight visits in high-income countries and fewer than five visits in low-income countries) and standard care. The number of inductions of labour and births by caesarean section were also similar in women receiving reduced visits compared with standard care. However, there was some evidence that in low- and middle-income countries, perinatal mortality may increase with reduced visits. As such, the review suggested that where the number of visits is already low, these should not be further reduced (Dowswell, et al., 2010).

Compared to the aforementioned guidelines, the American College of Obstetricians and Gynaecologists (ACOG) recommends higher number of ANC visits; it recommends 13 visits with initiation in the first trimester (12 weeks). Pregnant woman with uncomplicated first pregnancy was to be examined every four weeks for the first 28 weeks of gestation, every two weeks until 36 weeks of gestation, and weekly thereafter. Uncomplicated subsequent pregnancy might attend ANC less frequent ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012).

Elsewhere, the Society of Obstetricians and Gynaecologists of Canada recommends 12 visits without indicating the schedule (Jarvis et al., 2011). The German College of Obstetricians recommends about 14 ANC visits in intervals of four weeks during the first four months of pregnancy, intervals of three weeks during the following three months, followed by bi-weekly and weekly intervals in the last months (Reime et al., 2009).

In summary, the recommended ANC schedules of both NICE and AHMAC were based on systematic reviews, and the Malaysian schedule used the NICE guidelines as reference. On the other hand, the basis of ACOG and others that recommended 13-14 visits was not explained; and might be a case of following the tradition.

2.2.2 Routine Antenatal Care Interventions for Healthy/ Uncomplicated Pregnancy

As mentioned in Chapter 1, the risk-oriented ANC strategy recommended by WHO involves: (i) routine care to all women, (ii) additional care for women with moderately severe diseases and complications, (iii) specialised obstetrical and neonatal care for women with severe diseases and complications (WHO, 2009). The strategy means that all women, regardless of their risk status, should receive routine antenatal care. This routine care is actually the care that is designed for healthy and uncomplicated pregnancy. Over the past decade, a number of guidelines for healthy uncomplicated pregnancy have been reviewed and revised, with an orientation toward evidence-based practices ([AHMAC] Australian Health Ministers' Advisory Council, 2012, 2014), Malaysia (Ministry of Health, 2010), the United Kingdom ([NICE] National Institute for Health and Clinical Excellence, 2008) and the United States ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012).

There have also been efforts to standardise the ANC among the countries. In 1988, a study attempted to examine the antenatal screening practice of 67 teaching hospitals in the European Community. Though there were minor differences in the average numbers of tests performed in different countries, there was limited agreement on the selection of tests that were performed among the countries (Heringa & Huisjes, 1988).

In 2005, in an attempt to examine the benefit and possible standardisation of content of routine ANC for the member states of the European Union, a survey on ANC guidelines involving all the 25 member states was conducted. It was found that member states with GNP below EU-average recommended more tests than others. The findings showed that 20 out of 25 member states have a national guideline and 47 types of test were reported. Around half (23) of these tests were recommended for routine ANC by over 50% of the countries and apply to over 50% of the population which were supported by scientific evidence. (Bernloehr, et al., 2005). This meant the remaining 24 types of test done were not evidence-based.

Considering the possible differences among different guidelines, the literature review therefore compared the recommended routine ANC of several guidelines. The comparison tabulated in Appendix B provided some interesting insight and room for deliberation. Differences in recommended routine ANC were discussed below and would focus on the guidelines of Australia ([AHMAC] Australian Health Ministers' Advisory Council, 2012, 2014), Malaysia (Ministry of Health, 2010), the United Kingdom ([NICE] National Institute for Health and Clinical Excellence, 2008) and the United States ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012). Though the guidelines from Australia, United Kingdom, and United States drew the findings from various studies to substantiate their recommendations, the discussion in this paper will refer to these guidelines instead of the original studies to maintain the originality of the comparison and guidelines as well as to reflect referencing to these consented and recommended guidelines.

2.2.2.1 Comparison of Recommended Practices: The Differences

The comparison focused on differences in key recommended practices. Overall, the NICE, ACOG, and AHMAC guidelines are comprehensive guidelines substantiated with systematic review of studies in many areas of care, in particular the NICE and AHMAC guidelines appear to be up-to-date and evidence-based. The Malaysian guidelines in comparison are more of perinatal care manuals that were designed to provide easy reference to care providers. AHMAC refers to findings of NICE review and recommendation in many areas as well as the ACOG and other American guidelines. AHMAC also localised the guidelines by including the findings of studies conducted among the Australian population. Both NICE and AHMAC guidelines also provide substantial guidelines related to lifestyle considerations.

(a) Weight

Both MOH Malaysia and ACOG recommend weighing at booking and at every scheduled visit, while AHMAC and NICE recommend weighing at early contact/ booking only and repeated weighing only if clinical management is likely to be influenced. Routine weighing to monitor the nutrition of all pregnant women was begun in antenatal clinics in London in 1941. NICE cited the finding of a retrospective study of 1,092 pregnant women that weight at booking was the only factor that had an association with birthweight. Low maternal booking weight was most effective in detecting small-for-gestational-age infants (positive predictive value, PPV 20%), compared to low weekly maternal weight gain (<0.20kg) with PPV of 13%. Also weight loss or failure to gain weight over a two-week interval during third trimester was observed in 46% of the samples. NICE concluded that while there is a correlation between maternal weight gain and infant birthweight, this is not effective for screening for small size (low birthweight) babies. It is important to measure maternal weight and height at booking, but routine measurement of weight during pregnancy should be abandoned to avoid producing unnecessary anxiety with no added benefit. Except for women in whom nutrition is of concern. NICE remained firm in this recommendation, citing no new evidence to support the benefit of routine weighing during the recent “static list” consensus in December 2013 ([NICE] National Institute for Health and Clinical Excellence, 2013). AHMAC cited the risk of low and high weight gain during pregnancy, and recommend weight and height measurement as well as BMI calculation at the first visit.

(b) Body Mass Index (BMI)

The Malaysian guidelines do not include calculation of BMI, while all other three guidelines recommend calculating BMI at booking. Besides, both ACOG and AHMAC also recommend estimation of pre-pregnancy weight/BMI based on self-reported weight. AHMAC also cited the recommendation of the Institute of Medicine (IOM) of United States for weight gain monitoring in pregnancy based on pre-pregnancy BMI (Table 2.2). Though the Malaysian guidelines do not include BMI, it was noted that a few health clinics had started to calculate the BMI of pregnant women out of their own initiative. This reflects the recognition on the need to review the current guidelines.

Table 2.2: IOM Recommendations for Weight Gain in Pregnancy by Pre-Pregnancy Body Mass Index

Pre-pregnancy BMI	<18.5	18.5 to 24.9	25.0 to 29.9	30.0 to 34.9	35.0 to 39.9	≥40
Recommended Weight Gain	12.7–18.1kg	11.3–15.9kg	6.8–11.3kg	5–9kg	5–9kg	5–9kg

Source: cited in ([AHMAC] Australian Health Ministers' Advisory Council, 2012)

(c) Beast examination

Both MOH Malaysia and ACOG recommend routine breast examination, whereas NICE and AHMAC cited routine examination for promotion of postnatal breastfeeding is not recommended. NICE asserts that breast examination at the antenatal booking appointment was traditionally used to identify potential problems related to breastfeeding. Pregnant women were examined for the presence of flat or inverted nipples as potential obstacles to breastfeeding so that breast shields or nipple exercises could be prescribed to alleviate the situation. However, as cited by NICE, an RCT examining the effectiveness of breast shields versus no breast shields or nipple exercises (Hoffman's exercises) versus no exercises found that the presence of flat or inverted nipples did not imply that women could not successfully breastfeed. In fact, breast shields reduced the chances of successful breastfeeding and no differences in breastfeeding were found between the two exercise groups.

(d) Symphysis-fundal height (SFH)

It appears that all four recommends SFH measurement to assess foetal growth. However, NICE recommends SFH monitoring from 24 weeks onwards, two weeks later than the Malaysia recommendation of 22 weeks onwards. ACOG and AHMAC do not indicate the initiation gestation.

(e) Foetal presentation

Malaysia recommends to initiate from 32 weeks onwards, whereas both NICE and Australia indicated to initiate at 36 weeks or later.

(f) Foetal heart auscultation

NICE does not recommend routine listening unless requested by women for reassurance. Auscultation of the foetal heart has long been an integral part of a standard antenatal examination. NICE establishes that although foetal heart auscultation may confirm that the foetus is alive, there seems to be no other clinical or predictive value. This is because it is unlikely that detailed information on the foetal heart (e.g. decelerations or variability) can be heard on auscultation. However, NICE recommends that when requested by the mother, auscultation of the foetal heart may provide reassurance. NICE stated that the perception among doctors and midwives that foetal heart rate auscultation is enjoyable and reassuring for pregnant women and thus worthwhile, is not based on published evidence and may not be true assumption. Furthermore, research done on attitudes of women towards auscultation compared with electronic foetal monitoring in labour revealed that many women found the abdominal pressure from auscultation uncomfortable therefore, perhaps their attitudes to antenatal auscultation cannot be presumed.

(g) Urine protein

Both Malaysia and NICE indicate routine urine protein testing at every schedule visit. Both ACOG and AHMAC recommend obtaining baseline screening to assess renal status at booking; and both offer subsequent testing only if a woman has risk factors or clinical indication of preeclampsia. Australia recommends use of automated dipstick reader as visual inspection is the least accurate.

(h) Urine sugar

Only Malaysia recommends testing urine sugar at every scheduled visit. The others recommend risk factors screening at booking instead. NICE offers pregnant women with risk factors to test for gestational diabetes mellitus (GDM). ACOG and AHMAC offer blood glucose screening to most/ all pregnant women at 24-28 weeks.

(i) Hb or FBC

All offers Hb or FBC testing at booking. Though Malaysia does not specify the frequency of subsequent testing in their guidelines, Hb level is routinely checked for all pregnant women, and at around 36 weeks as evidenced by the national M&E indicator – antenatal mother by three categories of Hb level at 36 weeks (Ministry of Health Malaysia, 2012a). In comparison, NICE, ACOG and AHMAC offer repeat testing at 28 weeks.

(j) Obstetric ultrasound

Malaysia recommends ultrasound at booking for gestational age assessment before 24 weeks; the frequency and gestational period was less specific. The other three guidelines offer early ultrasound for gestational age assessment before 14 weeks, and again offer between 18-20 weeks to detect structural anomalies. NICE and AHMAC also offer at 32 weeks to those with placenta extended over the internal cervical os during the 18-20 week scan.

(k) Hepatitis B

NICE, ACOG, and AHMAC recommend routinely offering and recommending hepatitis B virus testing at the first antenatal visit as effective postnatal intervention can reduce the risk of mother-to-child transmission. Malaysia guideline also specifies hepatitis B screening at booking; however, it appears that this has not been practised.

(l) Other screening tests

It appears that NICE, ACOG and AHMAC offer considerable numbers of other routine screening tests as compared to Malaysia.

- Urine culture test: All three other guidelines (NICE, ACOG, AHMAC) recommend routinely offering urine culture test early in pregnancy to detect asymptomatic bacteriuria. NICE quoted incidence of asymptomatic bacteriuria (ASB) in 2-10% of women in the USA, with the higher incidence among women of lower socio-economic status, and in 2-5% of pregnant women in UK. RCTs indicated an increased risk between ASB and maternal and foetal outcomes, such as preterm birth and pyelonephritis, among untreated women compared with women without bacteriuria. Studies affirmed that antenatal screening for asymptomatic bacteriuria can have important healthcare resource consequences associated with the reduction of maternal and infant morbidity, that is, save the future costs of treating pyelonephritis and preterm birth as well as the possible resulting lifetime costs of disability associated with preterm birth. Furthermore, screening and treating pregnant women can lead to healthier mothers and infants and does not lead to a choice to end a pregnancy. Therefore, screening and consequent treatment has only positive benefits for pregnant women and their children. Based on economic analysis, NICE concluded that a policy of either of the screening strategies (leukocyte esterase-nitrite dipstick versus culture test) is more cost-effective than no screening. Though the culture test is relatively more expensive, it has a higher sensitivity and specificity. NICE recommends culture test in view of cost-effectiveness. AHMAC recommends routine urine culture screening for ASB and referred closely to the finding and recommendation quoted by NICE. AHMAC added that in Australia, available estimates suggest that asymptomatic bacteriuria during pregnancy may be more common among Aboriginal and Torres Strait Islander women (who have lower SES in general).

- Chlamydia testing: This is routinely offered to pregnant women below 25 years old by these three guidelines. NICE's 2008 review included 19 studies, prevalence of genital Chlamydia ranged from 7% to over 14%, with high prevalent among younger women. However, NICE concluded there was no good quality evidence which would support routine antenatal screening for genital Chlamydia. Asymptomatic Chlamydia infection during pregnancy has been associated with adverse outcomes of pregnancy (LBW, preterm delivery, PROM) and neonatal morbidities (respiratory tract infection and conjunctivitis). A causal link between the organism and adverse outcomes of pregnancy however, have not been established; the evidence therefore remains difficult to evaluate in relation to neonatal morbidities. Where a causal link between organism and outcome has been established, rapid identification and good management of affected neonates is thought to be a clinical and cost-effective alternative to screening. Although NICE stated that Chlamydia screening should not be offered as part of routine antenatal care, taking into account that there is an ongoing National Chlamydia Screening Programme and in order to support the implementation of this national programme, at the booking appointment, healthcare professionals should inform pregnant women younger than 25 years about the high prevalence of Chlamydia infection in their age group and give details of their local National Chlamydia Screening Programme. Therefore, it is likely that this policy might change in view of the national screening programme. AHMAC referred to the review of NICE and recommends not to routinely offer Chlamydia testing to all women as part of antenatal care but routinely offer Chlamydia testing at the first antenatal visit to pregnant women younger than 25 years and in areas with a high prevalence of sexually transmitted infections to consider offering Chlamydia and gonorrhoea testing to all pregnant women.

- Group B streptococcal: Group B streptococcus is a common bacterium that can colonise people of all ages without symptoms. It is generally found in the gastrointestinal tract, vagina, and urethra. The bacteria can be passed from mother to baby during labour and lead to infection in the first week of life (early onset infection). Late onset infection can develop up to 3 months of age. Prevention focuses on early onset infection, which is the most common cause of serious infection in newborn babies. Both ACOG and AHMAC offer the test at 35-37 weeks, whereas NICE disputes the benefit because evidence of its clinical and cost-effectiveness remains uncertain. NICE maintains that further research into the effectiveness and cost-effectiveness of antenatal screening for streptococcus group B is needed. Review conducted by AHMAC cited that positive result for Group B streptococcus on urine culture may be a risk factor for preterm labour, premature rupture of the membranes, intra-partum fever and chorioamnionitis. Early onset Group B streptococcus may also affect babies before birth and increase the risk of preterm, birth or caesarean section. In the newborn, the infection is usually evident as respiratory disease, general sepsis, or meningitis within the first week after birth. Population-based surveillance in the United States suggested a neonatal death rate of around 5% of affected babies. Based on these findings, AHMAC recommends offering either routine antenatal screening for Group B streptococcus colonisation or a risk factor-based approach to prevention, depending on organisational policy. If antenatal screening is offered, testing is to be arranged to take place at 35–37 weeks gestation.

- Genetic screening: NICE, ACOG and AHMAC recommend offering the genetic screening test to all women in the first trimester regardless of maternal age. At the first antenatal visit, AHMAC recommends giving all women information about the purpose and implications of testing for chromosomal abnormalities to enable them to make informed choices about whether or not to have the tests, according to a pathway of screening and diagnosis of chromosomal abnormalities in the first trimester.
- Screening for haemoglobinopathies (sickle cell disease/ haemoglobin disorders): Many health clinics in Malaysia routinely perform full blood count for all pregnant women at booking, and some health clinics use the results to screen for thalassaemia—mean corpuscular volume (MCV) and mean corpuscular haemoglobin (MCH) which are low in thalassemia. Level of haemoglobin is used to detect anaemia owing to iron deficiency or haemoglobinopathy. Further blood analysis for sickle cell disease/ haemoglobin disorders and thalassaemia will be based on the result of the screening. In the UK, the screening process for haemoglobin disorders involves testing a woman for carrier status early in pregnancy and then testing her partner if she is proven to be a carrier. If both parents are confirmed as carriers, DNA analysis may be undertaken to confirm this. The unborn baby is tested using amniocentesis or chorionic villus sampling. The aim of antenatal testing for haemoglobin

disorders is to inform parents and provide them with the option of pregnancy termination at an early stage of pregnancy if their child has a serious haemoglobin disorder. NICE recommends that screening for sickle cell diseases and thalassaemias should be offered to all women as early as possible in pregnancy (ideally by 10 weeks). The type of screening will depend on the prevalence and can be carried out in either primary or secondary level of care. Where prevalence of sickle cell disease is high (foetal prevalence above 1.5 cases per 10,000 pregnancies), laboratory screening, preferably high-performance liquid chromatography, should be offered to all pregnant women to identify carriers of sickle cell disease and/or thalassaemia. Where prevalence of sickle cell disease is low (foetal prevalence 1.5 cases per 10,000 pregnancies or below), all pregnant women should be offered screening for haemoglobinopathies using the Family Origin Questionnaire which will determine the need of subsequent screening.

(m) Multivitamin supplement

All four guidelines advise pregnant women to consume folic acid before the 12th week due to its obvious benefit in preventing neural tube defect. Both Malaysia and ACOG encourage other multivitamin supplement, while the stand of NICE was not found. However, AHMAC advises women that taking vitamins A, C or E supplements is not of benefit in pregnancy and may cause harm ([AHMAC] Australian Health Ministers' Advisory Council, 2012).

(n) Routine medical examination (RME) by doctor

Malaysia standard includes at least two RME for each pregnant woman. In contrast, this is not necessary for the other three countries since uncomplicated pregnancy can be managed by midwife.

(o) Foetal movement monitoring

All the four guidelines encourage pregnant women to monitor foetal movement and discuss during ANC visit. NICE is against routine formal foetal-movement counting, whereas Malaysia emphasises on routine formal counting whereby the charting by women is checked and enforced during the ANC visits starting from around 28 weeks. Australia encourages discussion of foetal movement from 20 weeks onwards, whereas Malaysia starts giving instruction from 28 weeks onwards.

2.2.3 Risk Assessment in Antenatal Care

The American College of Obstetrics and Gynaecology (ACOG), World Health Organisation (WHO) and the Institute for Clinical Systems Improvement (ICSI) recommended comprehensive risk assessment at the first obstetric visit; reason being the frequency of follow-up visits should be based on the individual needs and assessment of the pregnant women (Krans & Davis, 2012). Malaysia seems in the right track as the Malaysian public sector has been using the risk approach system which categorise pregnant women according to a colour coding system since 1989 (Ministry of Health Malaysia, 1989). The system assesses all antenatal mothers according to the level of severity of risk factors. Each colour determines the care providers, place of ANC, and place of delivery.

Despite the usefulness of comprehensive risk assessment in guiding care decision, Krans and Davis (2012) stated that the "…ability to accurately define, assess and address maternal and foetal risk is challenging". They proposed defining risk into three broad categories: (i) medical risk - maternal medical co-morbidities, e.g. chronic hypertension, gestational diabetes, history of pregnancy complications such as preterm birth; (ii) psychosocial risk - chronic maternal stress, lack of social support, substance abuse, and psychiatric diagnoses; and (iii) low-risk - pregnant women without medical and psychosocial risk.

In comparison, the main objective of the Malaysian risk assessment is to determine the care providers, place of care and delivery by colour coding according to predefined risk factors. The colour-coding system was revised in 1991 (Ministry of Health Malaysia, 1991), the third revision in 2003 (Ministry of Health Malaysia, 2003), and was updated and incorporated in the 2010 update of the national Perinatal Care Manual – Antenatal Care (Ministry of Health, 2010).

The risk assessment in Malaysia is to be conducted up to five times throughout the pregnancy depending on the period of initiation and length of gestation, at 1-12 weeks, 13-20 weeks, 21-28 weeks, 29-32 weeks, and 33-36 weeks (Ministry of Health, 2010). The result of the risk assessment classifies the pregnant women into the following colour codes:

- **Red** - urgent medical attention was required; the woman was to be referred to the hospital immediately;
- **Yellow** - immediate referral to the O&G specialist (hospital) or Family Medicine Specialist (health clinic) within 48 hours;
- **Green** - referred to Medical Officer at the health clinic for decision on subsequent care provider (MO or staff nurse at health clinic, or community nurse at community clinic);
- **White** - pregnant woman/pregnancy without any risk factors whereby ANC shall be provided by staff nurse or community nurse at the health clinic or community clinic.

The list of risk factors for code yellow in the 2010 guidelines was expanded compared to the 2003 version. A single mother who was previously under code white is now coded as yellow. Other additions in code yellow are women with medical condition that requires co-management at the hospital, women involved in medico-legal issue, teenage pregnancy, and women with Hb less than 9.5gm% (Ministry of Health, 2010; Ministry of Health Malaysia, 2003).

In a 2001 study conducted in Larut Matang district in Malaysia on validity of colour coding as a risk approach strategy in antenatal management, it was found that there was no significant association between coding done at booking or during last ANC visit by health staff with maternal intra-partum complications or low birth weight. However, there were 27.8% of women who were wrongly coded at their last ANC visits (Wahid, 2001). When the cases were recoded correctly for their last visit, it was found that there was significant association between risk level (low-risk versus high-risk) and maternal intra-partum complications or low birth weight. High-risk women had higher risk of maternal intra-partum complications or low birth weight compared to low-risk. The study concluded that the colour coding system is a good managerial tool if the guidelines were followed strictly, and that it would be useful to streamline the guidelines to be more concise and easy to use.

In 2003, Ravindran, Shamsuddin and Selvaraju concluded in their study that the risk coding system as it was used was not effective in term of the level of appropriate management and pregnancy outcome. It was urged that focusing on the details of antenatal care and streamlining communication between providers instead of spending time on coding should assure the continuous improvement of the Malaysian reproductive care programme (Ravindran, Shamsuddin, & Selvaraju, 2003). Therefore, the system should be revised. However, the study did state that the colour coding risk assessment system was not meant to predict risk but to be used as a managerial tool. This would enable a midwife to admit a patient to a specialist unit without red tape and allowed a patient with a problem to be evaluated speedily by a specialist. The authors acknowledged that the value of the system as a management tool was not evaluated.

2.3 ANTENATAL CARE AND PREGNANCY OUTCOMES

2.3.1 Pregnancy Outcome Indicators

Studying ANC necessitates defining appropriate outcome measures. Pregnancy outcomes commonly include birth/ foetal outcomes and maternal outcomes and may relate to gestational age at birth, birth weight, stillbirth, and maternal complications.

Gestational age at birth has long been broadly defined as: (i) preterm - less than 37 weeks of gestation; (ii) term - 37 to 41 weeks of gestation; and (iii) post-term - 42 weeks of gestation and beyond. However, definitions for subgroups of infants within these categories have not been well defined and there have been numerous suggestions to further refine the subcategories (Engle, 2006; Fleischman, Oinuma, & Clark, 2010). In November 2013, the American College of Obstetricians and Gynecologists Committee on Obstetric Practice Society for Maternal-Fetal Medicine issued a Committee Opinion on definition of term pregnancy (ACOG, 2013). The Committee recommended that the label "term" be replaced with the following designations to more accurately describe deliveries occurring at or beyond 37 0/7 weeks of gestation:

- early term (37 0/7 weeks of gestation through 38 6/7 weeks of gestation);
- full term (39 0/7 weeks of gestation through 40 6/7 weeks of gestation);
- late term (41 0/7 weeks of gestation through 41 6/7 weeks of gestation);
- post-term (42 0/7 weeks of gestation and beyond).

There has also been an assortment of literatures to further define the subcategories due to the importance of gestational age in assessing risks for morbidity and mortality in neonates. For example, late preterm referred to 34 0/7 to 36 6/7 weeks of gestation since the first day of the mother's last normal menstrual period (Engle, 2006).

2.3.1.1 Birth/ Foetal Outcome Indicators

Birth/ foetal outcome measures used in studies related to ANC include:

- early neonatal mortality rate - number of deaths in the first 7 days of life per 1,000 livebirths (Raatikainen, et al., 2007);
- neonatal mortality rate - number of deaths in the first 7 or 28 days of life per 1,000 livebirths (Chen, Wen, Yang, & Walker, 2007);
- perinatal mortality rate - number of stillbirth/foetal deaths of at least 22 weeks gestation or neonatal deaths in the first 7 days of life per 1,000 livebirths (Petrou, et al., 2003);
- stillbirth - intrauterine deaths of at least 22 weeks gestation or over 500g weight (Raatikainen, et al., 2007; Reime, et al., 2009). Stillbirth was used instead of perinatal mortality to control for confounders since the aetiology of stillbirth may differ from neonatal death (Reime, et al., 2009);
- low birth weight (LBW) rate - number of newborns weighing less than 2500g per 1,000 livebirths or birth weight (Habibov & Fan, 2011; Jarvis, et al., 2011; Petrou, et al., 2003; Raatikainen, et al., 2007);
- small-for-gestational-age (SGA) – defined as birth weight below the 10th percentile for a given gestational age (Koroukian & Rimm, 2002; VanderWeele, et al., 2009);

- preterm birth rate - number of births before 37 weeks gestation per 1,000 livebirths or gestational age at birth (Jarvis, et al., 2011; Peacock, Bland, & Anderson, 1995; Ratzon, Sheiner, & Shoham-Vardi, 2011);
- admission of neonate to a special care unit (Petrou, et al., 2003).

Although infant mortality rate (number of infant deaths in the first year of life per 1,000 livebirths) is a standard indicator used to evaluate national health, it is an inaccurate indicators for ANC as infant mortality is influenced by other factors (Fiscella, 1995). Fiscella maintained that perinatal and neonatal mortality rates reflect pregnancy health more accurately than infant mortality; but only a few studies have the sample size and statistical power required to detect differences in these rates. In the States, LBW is the most commonly used outcome measure because (Fiscella, 1995):

- It is the biggest contributor to infant mortality therefore serves as a surrogate indicator of mortality;
- It is easily quantifiable and readily available on birth certificates;
- It requires smaller sample sizes than mortality indicators to detect differences;
- It is the most common indicator to evaluate ANC, although it fails to distinguish premature from small for gestational age infants.

Very Low Birth Weight rate (VLBW - number of newborns weighing less than 1500g per 1,000 livebirths) is a surrogate for very preterm birth rate and is closely linked to neonatal mortality and morbidity (Fiscella, 1995).

While preterm birth is related to LBW and is supposedly more precise because it measures births resulting from preterm delivery, it is said to be less reliable indicator than LBW because expected date of delivery is often based on menstrual cycle (Kramer, McLean, Boyd, & Usher, 1988). Therefore, preterm birth rate is usually used in conjunction with other indicators (Fiscella, 1995).

Nevertheless, there had been studies that used gestational age at birth as the main outcome measure in which the gestational age was calculated from the date of delivery and gestational age at booking based on maternal dates and early ultrasound examination as was routinely practiced at the time of the study (Peacock, et al., 1995). Because gestational age has a negatively skewed distribution, this becomes difficult to apply the regression method, therefore the length of gestation was categorised. In addition, the study used the usual 37 completed weeks as cut-off point for preterm versus term birth because there was only a small number of very early births (Peacock, et al., 1995).

Worldwide, it is reported that more than 80% of all newborn deaths result from three preventable and treatable conditions—complications due to prematurity, intra-partum related deaths including birth asphyxia, and neonatal infections (WHO & UNICEF, 2014). Newborn survival and health and prevention of stillbirths were not specifically addressed in the Millennium Development Goals (MDG), and received less attention and investment. Consequently, newborn deaths and stillbirths are reducing at a much slower rate than under-5 deaths and maternal deaths (Mason et al., 2014; WHO & UNICEF, 2014). Within this context, preterm birth and stillbirth are among the important birth/ foetal outcome indicators for pregnancy-related studies. Newborn death is less relevant as pregnancy outcome since the aetiology may have no association with pregnancy care (Reime, et al., 2009). For example, newborn death is commonly associated with neonatal infections (WHO & UNICEF, 2014).

In reducing the burden of preterm birth and stillbirth, however, it was highlighted that lack of adequate data hinders visibility, formulation of effective policies, and research in these areas. Overall, only few countries have realisable national preterm birth prevalence data which is not available in the majority of the low- and middle-income countries; although the rates are generally highest in the low- and middle-income countries. Likewise, only about 2% of all stillbirths are counted through vital registration (Lawn, Gravett, Nunes, Rubens, & Stanton, 2010).

2.3.1.2 Maternal Outcome Indicators

a) Maternal Mortality

The key indicator for monitoring maternal outcome for maternal health is maternal mortality ratio, which is defined as "the ratio of the number of recorded (or estimated) maternal deaths during a given time period per 100,000 livebirths during the same time period". Maternal death is defined as "…a female death from any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy" (Countdown to 2015. & Health Metrics Network., 2011). The denominator, livebirths, is actually a surrogate for a more desirable but more difficult to assess denominator—pregnant women, which are the full population at risk for maternal death (S. Alexander et al., 2003).

It is acknowledged that because maternal mortality is a relatively rare event, large sample sizes are needed if household surveys are used, increasing the cost of data collection (Countdown to 2015. & Health Metrics Network., 2011). Earlier, a renowned maternal health expert, Bergsjo (2001), had affirmed that the difficulty in measuring maternal mortality was the reason why little work has been done in proving the effectiveness of ANC in reducing maternal mortality. Bergsjo (2001) reasoned that:

- Prospective trial comparing one ANC programme to no ANC programme is out of the question due to ethical and other reasons;

- Maternal mortality in developed countries is so low that attempt at reaching the number of samples needs for statistical power is bound to be unsuccessful;
- Even the randomised trials in the late 90s on effect of fewer ANC visits typically used preterm delivery, LBW, Apgar score, caesarean section, preeclampsia and other maternal morbidity; and that none of these studies had the power to study an effect on maternal mortality which has been the problem of all ANC studies;
- Though evaluation can also be done by statistical monitoring of events, it is difficult to draw conclusions on causal relationship. Plus, there will be biases and confounding that cloud the situation. Despite, statistical monitoring is still a prerequisite as background information to contribute to planning and improvement;
- Even in countries with good vital registration, it could not be assumed that every maternal death would be recorded; official rates are underestimated to varying extents.

Nevertheless, the PERISTAT group[1] that is responsible for identifying common maternal health outcome indicators for Europe highlighted that maternal mortality is still an important measure for European countries and improving maternal mortality data remains the priority; although it may seem strange considering that maternal mortality is rare in Europe (S. Alexander, et al., 2003). Furthermore, accurate MMR requires inclusion of sufficient number of not less than 100,000 births; this will require a span of many years for smaller countries. However, maternal mortality indicator is still crucial because of the huge impact related to maternal death. Death in childbirth is a major disaster for a young and generally healthy woman, as well as her spouse and

[1] PERISTAT group is now called EURO-PERISTAT; the project's goal is to monitor and evaluate maternal and child health in the perinatal period - pregnancy, childbirth and the postpartum - in Europe using valid and reliable indicators. (http://www.europeristat.com/)

children. Maternal death can be likened to death in service to the community and is potentially trans-generational. Moreover, maternal death is generally deemed as a reflection of quality of care (S. Alexander, et al., 2003).

(b) Other Maternal Outcome Indicators and Maternal Morbidity

Other maternal outcome measures used in ANC studies included:

- Maternal intra-partum complications consisting of caesarean section, instrumental delivery, postpartum haemorrhage, manual removal of placenta, preterm birth or uterine inversion (Wahid, 2001);
- Postpartum haemorrhage (Tucker, et al., 2010);
- Caesarean section, included as one of the "adverse perinatal outcomes" consisting of delivery by caesarean section (elective or emergency); delivery of a low birth weight infant (<2,500 g); admission of infant to a special care baby unit; and perinatal mortality (stillbirth or death of infant during the first 7 days following birth) (Petrou, et al., 2003);
- Severe maternal morbidity (S. Alexander, et al., 2003).

In Europe, maternal age and caesarean rates has increased, both for risk-factor caesarean and elective caesareans. Maternal mortality by mode of delivery found that death was most likely with caesarean deliveries and least likely with spontaneous vaginal deliveries. However, available data then did not allow for distinguishing caesareans for maternal conditions from the low-risk situations such as breech or previous caesarean (S. Alexander, et al., 2003).

Severe maternal morbidity was estimated to be between 9.5 and 16 cases per 1,000 deliveries in Europe. Attention to this factor as an indicator for quality of obstetric care represents a shift in interest from maternal deaths. Severe maternal morbidity widens the scope of inquiry to include what was termed ‘‘near-miss’’ cases, where a death was narrowly averted. The main rationale for measuring severe maternal morbidity is to gain better understanding of differences in mortality ratios. These are related both to the prevalence of the morbid condition and to the likelihood of dying from the condition when it occurs. There is no widely accepted definition or inclusion criterion for the conditions that constitute severe maternal morbidity. Morbidity measures might include the diagnosis of specific pathologies (haemorrhage, eclampsia), medical interventions, including blood transfusions, and transfers to intensive care units. The EURO-PERISTAT group agreed on an operational definition that includes markers of both conditions and interventions and consists of the following components (S. Alexander, et al., 2003; EURO-PERISTAT, 2012). As defined by the EURO-PERISTAT group, it is *"Severe acute morbidity resulting during pregnancy, delivery or the puerperium period (<42 days) as a proportion of all women delivering live or stillborn births" (EURO-PERISTAT, 2012)*. The indicators agreed by the group consist of (S. Alexander, et al., 2003; EURO-PERISTAT, 2012):

- Eclampsia includes convulsion following specified or unspecified hypertensive disorders (that are not due to unknown epilepsy) during pregnancy, delivery or the puerperium. Corresponds to ICD-10 code O150.
- Hysterectomy [surgical remove of the uterus (partial or total, body and/or cervix) for stopping the untreatable postpartum haemorrhage] or embolisation [the process by which a blood vessel is obstructed by the lodgement of a material mass (or an embolus) to stop severe obstetric haemorrhage].
- Blood transfusion [all acts or processes of transferring blood into the vein, including transfusion of red blood cells, platelets (thrombocytes) and fresh frozen plasma]. Collected by units of blood (3 units or more, 5 units or more, other amount, no units specified).

- ICU >24 hours (admission during pregnancy, delivery or the puerperium to any facility or unit providing intensive or acute care or resuscitation—whether inside or outside of the maternity unit—for greater than 24 hours).

Having reviewed a variety of pregnancy outcome indicators, this present study concluded to incorporate indicators for both foetal outcomes and maternal outcomes. Foetal outcomes will include:

- LBW due to the advantages identified earlier (Fiscella, 1995).
- Preterm birth as dating scan was commonly used in Malaysia to estimate the expected date of delivery (personal communication with Selangor State Health Department, Appendix A). This study used the usual 37 completed weeks as cut-off point for preterm as it was expected that there was only a small number of very preterm births (Peacock, et al., 1995).
- Stillbirth as it is gaining recognition on the importance of prevention of stillbirths (Mason, et al., 2014; WHO & UNICEF, 2014). Other study on ANC utilisation has also use stillbirth as the outcome (Reime, et al., 2009).

Other foetal outcome such as admission to neonatal special care unit or intensive care unit is less reliable in controlling for confounder since the aetiology may not relate to pregnancy care.

As for maternal outcomes, considering the low rate of MMR in Malaysia at around 30 per 100,000, it was decided to include maternal morbidity. The specific conditions of "severe maternal morbidity" as defined by the EURO-PERISTAT group may not be feasible in the present research setting since these details might not be captured in the postnatal records of the health clinics and the delivery notification sheets provided by the hospitals. As such, proxy conditions related to these definitions would be used instead. These included any documented conditions on preeclampsia or impending eclampsia, postpartum haemorrhage, retained placenta, postnatal severe anaemia (≤ 8gm%), postnatal infections, postnatal high blood pressure, unknown reasons for hospital admission or long stay.

2.3.2 Association of Antenatal Care and Pregnancy Outcomes

2.3.2.1 Antenatal Care and Birth/ Foetal Outcomes (Preterm Birth, Low Birth Weight, Stillbirth)

In assessing the independent role of ANC in preventing recurrent preterm delivery, Ratzon et al. (2011) found that recurrent preterm delivery was not associated with having had prenatal care in the second pregnancy. However, lack of ANC was significantly associated with adverse pregnancy outcomes which encompassed perinatal mortality, small for gestational age, gestational age <34 weeks, and Apgar ≤ 7 [OR(95%CI)=4.03 (2.04–7.97)], in a multivariable logistic analysis controlling for all variables significantly associated with adverse pregnancy outcomes at the univariate analysis. The study concluded that ANC might reduce the risk of adverse pregnancy outcomes in recurrent preterm delivery, even if recurrence cannot be prevented. It is therefore important that quality prenatal care is accessible to women who had a preterm delivery in the past (Ratzon, et al., 2011).

A study conducted in the USA using the APNCU Index and two variants of this index, which was based on the recommended schedule of ACOG, reported that there were poorer preterm birth outcomes in the adequate-plus and inadequate categories, compared with the adequate category (VanderWeele, et al., 2009). In that study, based on the original APNCU Index, the odds of preterm birth in the adequate-plus category was 8.51, and the odds in the inadequate category was 3.69, compared to the adequate level. Using two variants of the modified index, the odds in the adequate-plus category was 4.51-5.15, and the odds in the inadequate category was 2.13-2.17. Though modified indexes were used, the direction was essentially the same.

Tucker et al. (2010) compared the pregnancy outcome of unbooked and booked women of similar parity and ethnic background over a period of 18 months in a retrospective cohort study at a London hospital. The study found that unbooked women were more at risk of adverse foetal and maternal outcomes; unbooked mothers were five times more likely to have preterm delivery [OR(95%CI)=6.44 (2.24-18.50)]; three times more likely to have low birth weight babies [OR(95%CI)=2.87 (1.21-6.82)]. The authors concluded that unbooked women were twice as likely to have postpartum haemorrhage [OR(95%CI)=1.85 (0.69-4.98), p=0.3].

Raatikainen et al. studied pregnancy outcomes of Finnish women having low numbers (1-5) of ANC visits and no ANC visits and compared with those who had 6-18 visits where ANC were free and easily accessible. The logistic regression after controlling for confounding, showed significantly more LBW in under- and non-attenders [OR(95%CI)=9.18 (6.65-12.68) and 5.46 (3.90-7.65) respectively]; more foetal deaths as defined by intrauterine death of a foetal over 22 weeks or over 500g [OR=12.05 (5.95-24.40) and 5.19 (2.04-13.22)], and more neonatal deaths as defined by death during the first seven days after birth [OR=10.03 (3.85-26.13) and 8.66 (3.59-20.86) respectively] (Raatikainen, et al., 2007).

The study by Koroukian and Rimm (2002) in the USA using the APNCU Index found that the odds for LBW in the adequate-plus category were 1.89, and in adequate category were 0.60, compared to the inadequate category.

A study in Azerbaijan, a low-income transitional country with low ANC coverage, used the number of ANC visits and a quality index of ANC and found that ANC improved birthweight. An additional ANC visit increased birthweight by 26g, and a unit increase in quality of ANC increased birthweight by 21g or around 1.3% of the birthweight (Habibov & Fan, 2011).

On the other hand, after 25 years of the issuance of Preventing Low Birthweight policy statement, the resulting expansion and increased in ANC utilisation in the States failed to decrease LBW (Krans & Davis, 2012). Krans and Davis (2012) asserted that a single, standardised ANC model was ineffective in preventing LBW in a heterogeneous group of pregnant women with a variety of risk factors.

Another study which was conducted in Canada did not reproduce the results of other studies which documented association between inadequate ANC and preterm birth or LBW. It was explained that this was because the study sample did not adequately represent all uninsured women (Jarvis, et al., 2011).

Based on the widely used ANC utilisation index, APNCU Index, and neonatal death defined as livebirths died within 28 days of life, it was concluded that inadequate ANC was associated with increased neonatal death in both the presence and absence of antenatal high-risk conditions in the States, in which the observed association might be mediated by increased risk of preterm delivery and LBW (Chen, et al., 2007). That study also associated over-utilisation of ANC with potential risks for foetal and neonatal development, leading to increased neonatal mortality. This finding casted doubt on the proposal to improve neonatal mortality by simply recommending more ANC visits to improve ANC in high-risk women.

A German study by Reime et al. (2009) reported that the odds of stillbirth in the inadequate category was 1.14, compared to adequate category among the total study population. However, in studying the association of underutilization of ANC and stillbirth among migrants in Germany, Reime et al. (2009) found inconsistent association patterns between stillbirth and area of origin and utilisation patterns. Among women from Mediterranean, higher ANC utilisation rates might relate to lower stillbirth rate, but adequate ANC did not totally eliminate excess risks for stillbirths among women from Central and Eastern Europe and the Middle East (Reime, et al., 2009).

The searches for association of ANC and foetal outcomes revealed that majorities of the studies focused on ANC utilisation and rarely on ANC content. The review showed that the extent of utilisation was associated with foetal outcomes such as preterm birth and LBW in some settings. Its association with stillbirth was less studied and conclusive. Inclusion of ANC content is important as ANC utilisation alone may not reveal possible reason for adverse outcome. Based on this review, the present study included both the categorical utilisation and content variables in the analysis of ANC adequacy and pregnancy outcomes. This review also validated the selection of preterm birth, LBW and stillbirth as the foetal outcome indicators.

2.3.2.2 Antenatal Care and Maternal Outcomes

The Malaysian study in Larut Matang on validity of colour coding as a risk approach strategy in antenatal management found that there was no significant association between the number of ANC visits (<4 versus four and above) and maternal intrapartum complications or low birth weight (Wahid, 2001).

Bergsjo, as discussed earlier, had acknowledged the difficulty to assess and prove the relative contribution of ANC in maternal deaths. However, the author asserted that the role of ANC in prevention, that is as a tool to prevent maternal deaths, is paramount (Bergsjo, 2001). ANC presents an opportunity for early detection, proper management, and educating pregnant women on the conditions that are directly or indirectly resulting in maternal deaths such as:

- Haemorrhage which may happen any time during pregnancy, birth, and puerperium. While bleeding due to spontaneous early abortion may be self-limiting, bleeding due to separation of placenta is life-threatening due to acute blood loss and subsequent coagulopathy;
- Anaemia since this condition will worsen the effects of bleeding, and correcting/improving the anaemic status of pregnant women might reduce the reduce the need for postpartum blood transfusion;
- Puerperal sepsis due to unclean home delivery, pathogenic genital tract infection, poor hygiene, and delay after membrane ruptured;
- Preeclampsia through blood pressure monitoring and urine protein testing as well as education on early signs and how to react to pregnant women and their partner or family;
- Obstructed labour since the best predictor is previous obstructed labour;
- Unsafe abortion in which education on family planning and the dangers of abortion can be provided during ANC.

In essence, Bergsjo highlighted that there is little factual evidence that ANC does reduce maternal mortality, but the prevention role of ANC may contribute to preventing maternal deaths (Bergsjo, 2001). Earlier, Fiscella had shared similar opinion when reviewing the role of ANC in improving birth outcomes (Fiscella, 1995), in which the author advised that ANC should not be evaluated solely on the basis of its effect on birth outcomes. Instead, ANC should be evaluated as an integral component of women's healthcare whereby the impact of ANC on maternal health has been documented extensively, and that ANC serves as a vital gateway into ongoing healthcare for women.

For example, many women, particularly adolescents, minorities, and low income women, may receive their first comprehensive health assessment during ANC. In addition, ANC provides an opportunity for women at high risk to receive family planning counselling, parenting education, and linkage with community resources including nutrition and social service programs. Hence, the author urged policymakers and third-party payers to consider ANC as a vital link in continuous health care for women.

Similar to foetal outcomes, analysis on ANC and maternal outcomes also included both utilisation and content variables. This review also confirmed the selection of proxy conditions for maternal complications as previously listed.

2.3.3 Other Factors Associated with Pregnancy Outcomes

Few studies on ANC adequacy and pregnancy outcomes presented or discussed the effect of other independent variables or associated factors on pregnancy outcomes. Even when these factors were discussed, these were often limited to a few factors.

In preventing recurrent preterm delivery, Ratzon et al. (2011) found it is important that quality antenatal care is accessible to women who had a preterm delivery in the past. Raatikainen et al. (2007) found that there was significantly more LBW, more foetal deaths, and more neonatal deaths among the under- and non-attenders of ANC who were associated with social and health behavioural risk factors such as unmarried status, lower educational level, young maternal age, smoking and alcohol use (Raatikainen, et al., 2007).

Koroukian et al. (2002) reported the odds of LBW were higher among women with maternal medical risk factors e.g. pregnancy associated hypertension, incompetent cervix, uterine bleeding, eclampsia; the odds for these risk ranged from 2.49 to 3.78.

The odds of LBW among the women with previous premature birth were 3.06. In the same study, the odds for LBW among women aged ≤ 19 and ≥ 35 were 1.12 and 1.25, compared to women aged 20-34 (Koroukian & Rimm, 2002).

Smoking, nulliparous, high parity, teenage pregnancy, advanced maternal age, short inter-pregnancy interval (<11 months) and not employed during pregnancy were risk factors for stillbirth (Reime, et al., 2009). The risk of stillbirth was found to differ according to the women's area of origin; migrants had a higher risk of stillbirth (Reime, et al., 2009).

Caesarean section was more common among the high-risk pregnancies (for both primiparae and multiparae), and LBW had higher prevalence among the high-risk primiparae (Petrou, et al., 2003). On the other hand, Chen et al. found that inadequate ANC was associated with increased neonatal death (which might be mediated by increased risk of preterm delivery and LBW) with or without high-risk conditions (Chen, et al., 2007).

Based on the data collected during 1988-1989 from the second Malaysian Family Life Survey, it was found that preterm birth appeared to be the most important proximate determinant of neonatal mortality in Malaysia (Mohamed, Diamond, & Smith, 1998). The odds of dying for neonates born one month or earlier than expected were about 43 times higher than those of the full-term births. In the study, 3.5% of the neonates were born one to four weeks earlier, of which 7% of them died in their first month of life. Around 1.3% were born more than one month earlier and about 32% of these neonates died in their first month of life. The same study showed that maternal education, year of birth, state and birth interval were variables that have significant direct associations (at 1% level) with preterm birth (Mohamed, et al., 1998):

- The higher the level of maternal education, the higher the probability of having preterm birth – The authors discussed that one possible explanation was that educated women may have lower risk of a miscarriage, but keeping the high-risk foetal longer increased the risk of prematurity. However, this could be also due to underreporting among uneducated women;
- The less recently a neonate was born the higher the probability that it was born premature – This was presented as could be due to advancement in medical care. However, this could be also due to underreporting among those born a very long time before the survey;
- Neonates in the economically disadvantaged states had a higher probability of being born preterm;
- Neonates with preceding birth intervals of less than 18 months and neonates who were firstborns had higher probability of born preterm.

Peacock et al. (1995) conducted a prospective study from 1982 to 1984 at a London hospital using preterm delivery as the main outcome concluded that lower social class, less education, single marital status, low income, trouble with depression or nervous, minimal help from professional agencies and little contact with neighbours were all significantly associated with an increased risk of preterm birth; and there were no apparent effects of smoking, alcohol, or caffeine on gestational age though there was an association between smoking and very early term birth (before 32 weeks). Smoking however had a strong effect on birth weight for gestational age (Peacock, et al., 1995).

Though both the studies by Mohamed et al. (1998) and Peacock et al. (1995) used data at the same era, there was contradictory finding concerning the effect of maternal education on preterm birth. This perhaps points to the fact that factor associated with pregnancy outcomes may vary in different setting even when controls for certain associated factors. This might be due to the difference in the maternal care provided.

This review concluded the need to study other factors that may associate with pregnancy outcomes besides ANC utilisation and content. Thus, the present study included other independent variables such as maternal age, ethnicity, maternal education, occupations, parity, risk level, history of complications in previous pregnancy, history of complications in previous delivery, user default. Health behavioural risk factors such as alcohol and smoking were not included due to inconsistency of documentation for this data field at the health clinics.

2.4 ANTENATAL CARE UTILISATION AND ASSOCIATED FACTORS

Many have studied on utilisation of ANC services. Most of the ANC utilisation studies were part of the large scale nationwide surveys such as Demographic and Health Survey (DHS) or other surveys that were repeated over the years (Celik & Hotchkiss, 2000; Fan & Habibov, 2009; Frankenberg, Buttenheim, Sikoki, & Suriastini, 2009; Kishowar Hossain, 2010; Sepehri, Sarma, Simpson, & Moshiri, 2008; Titaley, Dibley, & Roberts, 2010; Vecino-Ortiz, 2008), while some are studies of smaller communities (Bashour, Abdulsalam, Al-Faisal, & Cheikha, 2008; Charreire & Combier, 2009; Liu, Zhou, Yan, & Wang, 2011; Ny, Dykes, Molin, & Dejin-Karlsson, 2007; Ren, 2011; Sunil, Spears, Hook, Castillo, & Torres, 2010; Titaley, Hunter, Heywood, & Dibley, 2010). In Malaysia, there were a number of studies conducted related to factors affecting the utilisation of ANC, predominantly in the 80s and 90s and few after the new millennium (Abdul Majid, 1989; Gan CY, 1993; Joyce, 1987; Muhd Khairi, 1990; Rosliza & Muhamad, 2011; Zulkifli, U, Yusof, & Wong, 1994). There have been many studies conducted on factors affecting the utilisation of ANC in recent years, where it was found that the use of ANC is associated with socio-economic and obstetric factors.

2.4.1 Socio-demographic Factors

2.4.1.1 Maternal Age

There were studies that found younger women received more ANC than women aged 35 years and older (Kishowar Hossain, 2010), and women younger than 20 years received more ANC than those aged 20-34 (Kishowar Hossain, 2010). In contrast, some studies found the reverse in which older women have a higher probability of using ANC in Columbia (Vecino-Ortiz, 2008), and that inadequate ANC was more prevalent among younger women below 25 years in the States (Chen, et al., 2007). There were also studies that found maternal age to have no significant effect on ANC use in Turkey (Celik & Hotchkiss, 2000).

2.4.1.2 Ethnicity

Ethnicity had significant independent impact on timing of the first visit, in which ethnic minorities were less likely to have first visit during the first trimester (Ren, 2011), and late antenatal booking was high among the indigenous (ethnic minorities) pregnant women (Rosliza & Muhamad, 2011). It was also found that ethnic minorities of a country were less likely to use ANC (Celik & Hotchkiss, 2000; Ren, 2011), and less likely to have adequate number of visits (Ren, 2011). Inadequate ANC was more prevalent among black women (Chen, et al., 2007).

However, there was also a study that found no statistically significant difference in ANC utilisation by ethnicity, once other individual, household, and commune characteristics are accounted for (Sepehri, et al., 2008).

2.4.1.3 Marital Status/ Stable Relationship

Pregnant women who were married or had stable relationship were more likely to use ANC and had further visits than unmarried or divorced pregnant women (Raatikainen, et al., 2007; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008).

Inadequate ANC was more prevalent among unmarried pregnant women (Chen, et al., 2007).

2.4.1.4 Maternal Education Level

Pregnant women's education level was a strong predisposing factor and the best predictor of ANC utilisation. Pregnant women with higher education were more likely to use antenatal care from trained providers (Fan & Habibov, 2009; Kishowar Hossain, 2010; Raatikainen, et al., 2007; Ren, 2011; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008), and there is significant positive association between maternal education and frequency of ANC utilisation—higher education attainment increased the frequency of ANC utilisation (Fan & Habibov, 2009; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010).

Although educated pregnant women were generally more likely to use ANC as compared to non-educated women, the level of influence by the level of education differed though across the studies. For example, in Turkey, women with one to five years of education (Primary incomplete or complete) were 4.6 times more likely to use ANC than women without any schooling; while women with six or more years education (secondary incomplete or complete, or above) were only 1.8 times more likely to use ANC than women without any education (Celik & Hotchkiss, 2000). In contrast, in Bangladesh and China, higher proportion of women with secondary or higher education use ANC as compared to women with primary education (Kishowar Hossain, 2010; Ren, 2011).

It was generally found that educated women were more likely to initiate ANC visit earlier than less educated women, and better educated women were also more likely to receive adequate ANC.

2.4.1.5 Spouse's Education Level

Spouse's education was found to have no effect on ANC utilisation (Vecino-Ortiz, 2008).

2.4.1.6 Pregnant Women's Occupation

One study found that working pregnant women had a 1.19 times higher probability of underutilisation as compared to non-working pregnant women (Titaley, Dibley, et al., 2010).

2.4.1.7 Spouses' Occupation

Pregnant women whose spouses worked in skilled and service-related occupations were significantly less likely to use ANC (Celik & Hotchkiss, 2000). Pregnant women with unemployed spouses were 1.71 times more likely for underutilisation (Titaley, Dibley, et al., 2010).

2.4.1.8 Household Economic Status/ Household Wealth Index

Household economic status had an effect on the uptake of ANC services. Frequency of utilisation decreased among pregnant women with low household wealth index (Celik & Hotchkiss, 2000; Fan & Habibov, 2009; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008).

2.4.1.9 Place of Residence (Urban versus Rural)

The use of ANC was also significantly associated with place of residence, where urban dwellers tend to use more ANC (Kishowar Hossain, 2010; Paredes, Hidalgo, Chedraui, Palma, & Eugenio, 2005; Titaley, Dibley, et al., 2010; Zhao, Guo, Li, Cui, & Wu, 2005). In the contrary, there were studies that showed urban/rural residency to be not important in determining ANC utilisation (Vecino-Ortiz, 2008). Other studies found that living in developed regions—with corresponding more accessible healthcare—was positively and significantly associated with ANC use, as compared to less developed regions, regardless of urban/ rural status (Celik & Hotchkiss, 2000; Sepehri, et al., 2008; Vecino-Ortiz, 2008).

2.4.1.10 Residency Status

In 1994, there was a cross-sectional study of the citizens and migrants in Sabah, Malaysia where a total of 1,515 women were interviewed from a multi-stage random sample of households in eight urban centres to examine the difference between the two groups (Zulkifli, et al., 1994). The study found that significantly fewer migrants obtained any antenatal care during pregnancy as compared to the citizens. Citizens tended to initiate care as early as three months but migrants as late as seven months. Despite these differences, only the infant mortality rate, and not pregnancy wastage, was statistically significantly higher among migrants. Likewise, a study in Germany showed higher proportion of inadequate ANC utilisation among the migrants (Reime, et al., 2009).

2.4.2 Obstetric Factors

2.4.2.1 Gravidity or Parity

High parity was associated with no and/ or low utilisation of ANC (Celik & Hotchkiss, 2000; Kishowar Hossain, 2010; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008). High parity women were more likely to rely on their past pregnancy experiences and therefore might not feel the need for ANC (Celik & Hotchkiss, 2000; Kishowar Hossain, 2010; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008). In addition, these women might not have time for ANC check-up as they have to take care of other children (Kishowar Hossain, 2010; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008). Also, pregnant women might be more cautious during their first pregnancy due to perceived risk associated with first pregnancy (Celik & Hotchkiss, 2000; Kishowar Hossain, 2010).

2.4.3 Risk Level of Pregnancy

Complication-free pregnancy was associated with low utilisation as the women might not perceive that ANC visits were necessary (Ren, 2011; Titaley, Dibley, et al., 2010).

2.4.4 Enabling Factors

2.4.4.1 Distance and Access to Trained Providers

Distance to health services was an enabling factor that could hinder the uptake and/or frequency of ANC (Fan & Habibov, 2009; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010). Access to a trained provider was found to contribute significantly to the use of ANC regardless of the women's education level (Frankenberg, et al., 2009). Likewise, absence of health facility in a community decreased frequency of use or increased the probability of not using ANC (Fan & Habibov, 2009).

2.4.4.2 Financing for Health Services

Reporting problem to pay for health services deterred the use of ANC (Titaley, Dibley, et al., 2010; Titaley, Hunter, et al., 2010). Having health insurance was found to have positive significant effect on ANC utilisation (Celik & Hotchkiss, 2000; Jarvis, et al., 2011; Sepehri, et al., 2008; Vecino-Ortiz, 2008). Uninsured pregnant women presented late for ANC, less likely to have adequate screening tests, and more likely to receive "inadequate care" as compared to insured pregnant women (Jarvis, et al., 2011).

2.4.5 Other Factors

In addition, desire for pregnancy was another need factor affecting the uptake of ANC. Undesired pregnancy was not only associated with low utilisation, but was also associated with late initiation of ANC as well as less frequent ANC visits (Titaley, Dibley, et al., 2010). However, other study found that unwanted pregnancy have no significant influence on the likelihood of seeking ANC and the number of visits (Sepehri, et al., 2008).

Non-attenders and under-attenders of ANC were significantly more common among smokers, statistically (Raatikainen, et al., 2007). In addition, health knowledge on relevant subjects such as complications of pregnancy (Titaley, Dibley, et al., 2010), sex knowledge (Fan & Habibov, 2009) or importance of ANC (Titaley, Hunter, et al., 2010) was also found to be important utilisation factor. Limited health knowledge reduced frequency of utilisation.

2.5 ADHERENCE TO RECOMMENDED ANTENATAL CARE CONTENT

2.5.1 Extent of Adherence to Recommended Antenatal Care Content

Adherence to recommended routine ANC content appeared to be challenging over the years. Studies that attempted to assess the extent of adherence revealed that majority were unable to meet the national or official ANC standards (Chaibva, Ehlers, & Roos, 2011; Dhar, et al., 2010; Handler, Rankin, Rosenberg, & Sinha, 2012; Majrooh, et al., 2014; Pembe et al., 2010; Victora, et al., 2010; White, 2006; Yoong, Lim, Hudson, & Chard, 1992). In numerical sense, the extent of adherence disclosed in a study showed that 77% of pregnant women scored below 80% of the recommended routine content, that is, only 33% of the pregnant women received 80% and above of the recommended ANC content (34% among high-risk women and 24% among low-risk women). Fifty-three (53) percent of the pregnant women received 50-79% of the recommended care, and 14% received less than 50% of care (Handler, et al., 2012). Another study found that only 23% of pooled actions dictated by protocols were performed (Yoong, et al., 1992). Likewise, Trinh et al. found that only 17% of the women received adequate level

(75% and above) of minimum ANC content (Trinh, Dibley, & Byles, 2006). A recent study also revealed that the providers that followed >80% of the steps enlisted in the checklist of assessment, treatment and counselling of the women were 5%, 44% and 2% respectively (Majrooh, et al., 2014).

Other studies found that over 20% to 70% of selected procedures related to physical examination, health education, and prescriptions were not performed (Dhar, et al., 2010; Victora, et al., 2010); 42% of the pregnant women were not informed of any pregnancy danger signs (Pembe, et al., 2010), and 30% to 55% of the pregnant women did not receive 11 out of 22 recommended health education topics (White, 2006).

Overall, physical assessment and/or basic blood and urine screening had higher compliance rate than health education (Dhar, et al., 2010; Handler, et al., 2012; Majrooh, et al., 2014; Trinh, et al., 2006; Victora, et al., 2010; White, 2006). Obstetric ultrasound was frequently performed in many settings—public and private, poor and rich (Dhar, et al., 2010; Victora, et al., 2010; White, 2006); even when it was not part of the national recommended practices (Victora, et al., 2010), and over-intervention—more than 3 routine ultrasounds—was reported (Dhar, et al., 2010).

2.5.2 Adherence to Recommended Antenatal Care Content and Associated Factors

It was noted that the extent of documented adherence to recommended ANC standards was mostly associated with provider perspectives, e.g. provider site/organisation of services (Boller, Wyss, Mtasiwa, & Tanner, 2003; Dhar, et al., 2010; Handler, et al., 2012; Victora, et al., 2010), qualification of providers (Boller, et al., 2003; Pembe, et al., 2010), specific risk factors—high maternal age, uncertain gestation (Yoong, et al., 1992), as well as health seeking behaviours of pregnant women e.g. timing of initiation and frequency of visits which were associated with socio-economic factors (Dhar, et al., 2010; Handler, et al., 2012; Jarvis, et al., 2011; Victora, et al., 2010; Yoong, et al., 1992). High risk referral did not appear to have a strong effect on content adherence (Handler, et al., 2012).

Provider sites or organisation of health services made significant contribution to the extent of adherence to ANC content. A study on low-income pregnant women revealed that these studied subjects may have better outcome in a more organized healthcare setting which have support services and personnel to make appropriate referrals and provide information and education than the physician offices (Handler, et al., 2012). Another study that was conducted in high, middle and low-income areas demonstrated that providers at the poorer areas were unable to comply to the national ANC standards; while over-intervention, for example ultrasound assessment which did not conform to evidence-based practices, was observed in richer areas where health seeking at private sector were common (Dhar, et al., 2010).

Boller et al. (2003) compared the quality of ANC including compliance to care guidelines provided by public and private providers, and found that private providers were significantly better than public providers. Healthcare personnel in private sector had higher qualification. In the public sector, MCH auxiliary with two years training performed almost all consultations (88%); whereas in the private sector, 60% of the consultations were carried out by midwife or nurse and only 30% by MCH auxiliary. The study showed that the more highly trained personnel performed better in the quality aspects of care (Boller, et al., 2003).

However, when the study was conducted within the same level of care and same sector i.e. primary health facilities of public sector, it demonstrated that nursing professional with higher qualification was least likely to provide health information on pregnancy danger signs than the lower qualified nursing staff, and had the least interaction time with the women (Pembe, et al., 2010).

Socio-economic background of the pregnant women was associated with attendance patterns that affect ANC content score (Dhar, et al., 2010; Jarvis, et al., 2011; Victora, et al., 2010). Women from poor areas or had precarious status tended to have late initiation and less visits, which in turn reduced the opportunities for the delivery of recommended content (Dhar, et al., 2010; Handler, et al., 2012; Jarvis, et al., 2011; Victora, et al., 2010).

Ethnicity did not appear to have association with ANC content score (Victora, et al., 2010). Although a study in UK showed higher ANC content adherence among the black women, that was mainly due to socio-economic reason because black women often had lower socio-economic status in UK and was deemed as “high-risk” (Yoong, et al., 1992).

2.5.3 Adherence to Recommended Antenatal Care Content and Pregnancy Outcomes

Alexander and Kotelchuck (2001) asserted the difficulties related to assessing the association between ANC content and pregnancy outcomes given the wide-ranging features of ANC content which might not be evidence-based or effective. Previous studies have showed different results related to ANC content provided and pregnancy outcomes.

Handler et al.’s study found low adherence to recommended ANC content (<80% of documented recommended standard practices) was associated with overall increase odds of preterm birth among low-income pregnant women regardless of the provider site (aOR=1.8, 95%CI=1.0-3.4), but had no effect on the odds of LBW before controlling for provider site (aOR=1.0, 95%CI=0.5-1.9). When provider site was considered, the study found that low adherence to recommended ANC content was associated with increase odds of preterm birth (aOR=2.6, 95%CI=1.0-6.4) and LBW among low-income pregnant women receiving ANC at physicians' offices [aOR=3.1, 95%CI=1.0-9.4, (Handler, et al., 2012)].

On the other hand, a study showed no association between adherence to ANC content and preterm birth (White, 2006). However, this study categorised adherence to ANC content dichotomously: "yes" or "no" for "received all recommended advice/ procedures." The rigid method of analysis might result in inability to demonstrate the influence of ANC content on preterm birth.

Jarvis et al. compared selected ANC content provided to the insured and uninsured pregnant women. It was found that uninsured pregnant women presented late for ANC more likely to have "inadequate" ANC utilisation and less likely to have adequate antenatal investigations/ screening, although there was no significant difference in physical examination provided to the insured and uninsured pregnant women (53.9% versus 46.1%, p=0.183). The study showed no significant differences in the pregnancy outcomes assessed—gestational age and birth weight—between these two groups (Jarvis, et al., 2011). Although this paper indicated no significant difference in pregnancy outcomes between the two groups who had significant difference in routine antenatal investigations/ screening, the association between pregnancy outcomes and ANC content was not tested in this paper. The authors stated that the potential risk to mother and foetus of failing to have routine antenatal testing is difficult to quantify. Furthermore, the ANC content assessed was not exhaustive as it was limited to initial screening testing and physical examination.

Bloom, Lippeveld and Wypij (1999) studied ANC adequacy including ANC content at initial visit, median visit, and final visit as well as specific interventions occurred sometime during the pregnancy. The study did not examine the direct association of ANC content with pregnancy outcome but the association with using trained assistance at delivery and delivering in health facility. The finding showed strong positive association between level of care obtained during pregnancy and the use of safe delivery care which may help to explain why ANC could also be associated with reduced maternal mortality.

2.6 APPROACH IN MEASURING ADEQUACY OF ANTENATAL CARE

2.6.1 Measuring Adequacy of Antenatal Care Utilisation

2.6.1.1 Development in Antenatal Care Utilisation Indexes

As mentioned earlier, ANC utilisation or coverage measurement includes single indicators such as any ANC, first ANC visit, gestational age of first visit, and number of ANC visits. These indicators, though commonly used, often do not provide comprehensive information on adequacy of ANC. For example, the indicator that has been used by WHO, coverage of first visit, does not provide any other information after the first visit. Though WHO has now included the indicator for the 4^{th} visit, it provides no indication concerning the content of the care. This indicator also remains not routinely collected in the more developed nations since these countries generally have average ANC visits that is much higher than four visits (WHO, 2014b). Studies have also showed that the number of ANC visits had no association with poor perinatal outcome (Fujita, et al., 2005; Wahid, 2001).

Earlier studies on adequacy of ANC utilisation commonly used the trimester of ANC initiation, but it had long been found to be an inaccurate indicator because it provides no information on ANC utilisation after the initiation of ANC (Forrest & Singh, 1987).

Since the 1970's, there have a number of development in measuring the adequacy of ANC utilisation. These indexes combine the timing of the first ANC visit as well as the number of ANC visits after the initiation. These include the Kessner/Institute of Medicine Index [Kessner/IOM, (Research & Kessner, 1973)]; the Graduated Index of Prenatal Care Utilisation [GINDEX, (G. R. Alexander & Cornely, 1987)] and the subsequent Revised-GINDEX [R-GINDEX, (G. R. Alexander & Kotelchuck, 2001)]; the Adequacy of Prenatal Care Utilisation Index (APNCU) which is also called the Kotelchuck Index (Kotelchuck, 1994); and other variants such as an index derived from the recommendation of the U.S. Public Health Service Expert Panel on Prenatal Care [PHS-REC, (G. R. Alexander & Kotelchuck, 1996)] as well as the variants of the APNCU (VanderWeele, et al., 2009). For ease of comparison, Table 2.3 below presents a summary of these ANC utilisation indices by their key attributes.

Table 2.3: Comparison of Antenatal Care Indices by Key Attributes

Attributes	Indices				
	Kessner/IOM	GINDEX	R-GINDEX	APNCU	PHS-REC[b]
Basis for standard	ACOG[a]	ACOG[a]	ACOG	ACOG	PHS
Adequate initiation of care	1-3 months	1-3 months	1-3 months	1-4 months	1-2 months
Adequate number of visits at 40 weeks	9	9	13	11	7 (multi-para) 9 (primi-para)
"Intensive visit" category	no	yes	yes	yes	No
"Missing" category	no	yes	yes	yes	No
"no care" category	no	yes	yes	no	No
Standard computer programme	no	yes	yes	yes	No
Risk modified	no	no	no	no	yes (parity)

[a] does not follow full ACOG ANC visit recommendation for term and post-term births.
[b] based on the recommendation of the U.S. Public Health Service Expert Panel on Prenatal Care (PHS/EPPC) which emphasises early initiation and number of visits based on parity, an indicator of pregnancy risk.
Source: (G. R. Alexander & Kotelchuck, 1996)

These indexes were developed for developed countries with high recommended number of ANC visits (9 to 13 visits for low-risk pregnancy at 40 weeks), and earlier initiation of visit (first to third or fourth month) (G. R. Alexander & Kotelchuck, 1996). Therefore, these indexes will need to be adjusted for setting with lower recommended number of ANC visits and later initial visit as commonly found in less developed countries. Among the indexes, the most studied is the APNCU which evolved from the earlier indexes such as Kessner/IOM and the GINDEX (G. R. Alexander & Cornely, 1987; G. R. Alexander & Kotelchuck, 1996, 2001; Kotelchuck, 1994).

(a) Kessner/IOM Index

Developed in the early 1970s, the Kessner/IOM Index was the main index used in the United States for over 20 years to measure adequacy of ANC utilisation. Kessner/IOM Index is a three-factor services utilisation index that includes information about the gestational month of the first ANC visit, the number of ANC visits (adjusted for the length of gestation), and the type of care provider (private versus public clinic) (Research & Kessner, 1973). The type of care provider was meant as a measure of quality of care, this variable was subsequently excluded by the researchers using this index because this information was either not available or not agreed as a measure of quality (G. R. Alexander & Kotelchuck, 2001). The two factors, gestational month of ANC initiation and number of ANC visits, are linked into an easy to understand index with three levels of adequacy (adequate, intermediate, and inadequate). A score of "adequate" denotes ANC initiation in the first trimester and have nine ANC visits for a normal-length pregnancy (Kotelchuck, 1994).

Over the years, a number of weaknesses in the Kessner/IOM Index has been identified and have resulted in proposals for several alternate indices of ANC utilisation (G. R. Alexander & Cornely, 1987; Gortmaker, 1979; Kotelchuck, 1994). In the early 90s, Kotelchuck conducted a detailed evaluation of Kessner/IOM Index and pointed out its four main weaknesses: (i) It merely measures the timing of initiation of ANC; (ii) It does not distinguish inadequacy due to late initiation from inadequacy due to insufficient visits; (iii) It is unable to characterise ANC utilisation for normal-term and post-term births; (iv) It lacks sufficient documentation, leading to non-standardised definitions and discrepancies in calculation (Kotelchuck, 1994).

(b) GINDEX/ R-GINDEX

The graduated index, GINDEX, proposed by Alexander and Cornely was a modification of the Kessner/IOM Index. It presented the first conceptualisation of a category of "intensive" use of ANC services. This index expanded the three levels of the Kessner/IOM Index to six categories; the additional categories are "no care," "missing," and "intensive." The GINDEX classified the women who had unexpectedly high number of ANC visits as "intensive," taking into account gestational age at birth and the month their ANC initiated (G. R. Alexander & Cornely, 1987). The intention of this category was not to increase the adequacy of utilisation scale; instead, it was to separate a category of cases with a utilisation pattern suggesting a high-risk condition needing more than the standard recommended number of ANC visits (G. R. Alexander & Kotelchuck, 1996). Most importantly, failing to separate these cases could confound investigations of the impact of ANC utilisation with birth outcomes (G. R. Alexander & Kotelchuck, 1996).

(c) APNCU Index

The weaknesses of Kessner/IOM prompted Kotelchuck to develop an alternative index called the Adequacy of Prenatal Care Utilisation (APNCU) Index. This index also proposed a category of "intensive" ANC utilisation but based on a different approach from the GINDEX. This two-component index characterises the adequacy of two independent and distinctive dimensions: adequacy of initiation of ANC in terms of the month in which ANC is initiated, and adequacy of received services in terms of the observed-to-expected (O/E) visits ratio from initiation till delivery (Kotelchuck, 1994). The APNCU Index combines the number of actual ANC visits to the number of expected visits which is based on the recommended ANC schedule of the American College of Obstetrics and Gynecology (ACOG), the timing of initiation, and gestational age at birth. The ratio of observed-to-expected visits is grouped into four categories: Inadequate (less than 50% of expected visits), Intermediate (50%-79%), Adequate (80%-109%), and Adequate-plus (≥ 110%) (G. R. Alexander & Kotelchuck, 1996; Kotelchuck, 1994). All pregnant women who booked in month 5 and onwards of gestation are categorised as having received inadequate care; and it defines adequate received services as having at least 80% of expected visits (Kotelchuck, 1994). The summary of the APNCU Index could be visualised from Figure 2.1 below.

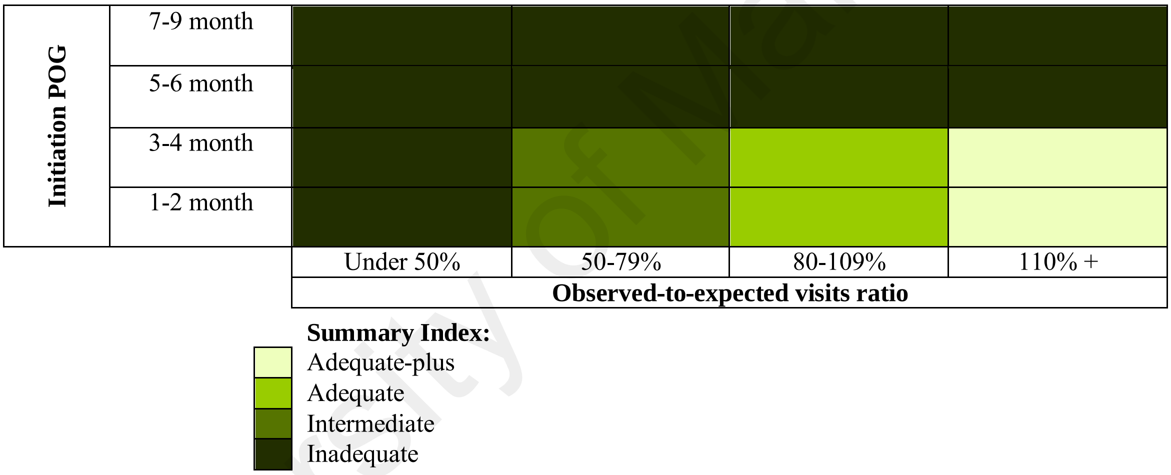


Figure 2.1: Summary of Original APNCU Index

Source: APNCU Index (Kotelchuck, 1994)

The creator of the index however, acknowledged that this index simply assesses the utilisation of ANC, but not the content of ANC. Another weakness pointed out by Kotelchuck himself is that the index does not adjust for the risk conditions of the pregnant woman because the ACOG recommendations which the index is based are for the women with uncomplicated pregnancies. Therefore, the index produces a slightly conservative estimate of inadequate ANC utilisation because it underestimates the actual need for ANC visits (Kotelchuck, 1994).

2.6.1.2 Review and Adaptation of APNCU Index in Antenatal Care Studies

Over the years, the APNCU Index has been reviewed/compared with other indices to analyse the trends in ANC and birth outcomes (G. R. Alexander & Kotelchuck, 1996, 2001; Kogan, et al., 1998; Koroukian & Rimm, 2002; Kurtzman, Wasserman, Suter, Glantz, & Dozier, 2014; VanderWeele, et al., 2009), and has also been frequently used with modification to reflect local ANC practice in some studies (Beeckman, et al., 2011; Jarvis, et al., 2011; Trinh, et al., 2006).

Koroukian and Rimm (2002) conducted a systematic examination of the APNCU Index and to determine biases that may impede its use in analysing the association between resource utilisation and birth outcomes (LBW, SGA, preterm birth). The review showed LBW rate was 11.8% in the adequate-plus category, compared to 9.4% in the inadequate category, and 3.3% and 3.5% in each of the intermediate and adequate categories, respectively. Preterm births were disproportionately represented in the adequate-plus category: 61.2% of births prior to 37 weeks were from the adequate-plus category, whereas only 18.9% of term births were from adequate-plus. The authors presented that this apparent bias results from the fact that the ACOG schedule of antenatal visits allocates nearly one third of the total visits to the last 4-5 weeks of gestation. A shorter gestational age implies fewer numbers of expected visits, a smaller denominator in the observed-to-expected (O/E) visits ratio, and O/E ratios exceeding 100% by large margins. In fact, the observed number of visits exceeds the expected number of visits by only one or two in 40.1% of all births grouped in the adequate-plus category. Consequently, the Index yields misleading results indicating that women grouped in the adequate-plus category (or O/E ratios > 110%) are most likely to deliver LBW infants. In this review, Koroukian and Rimm (2002) questioned the validity of the conclusion drawn by Kogan et al. (1998) that more intensive use of antenatal resources has not yielded the much-desired improvements in birth outcomes; and recommended that all utilisation index be subjected to systematic and independent review to determine their appropriateness to study the association between ANC utilisation and birth outcomes. Koroukian and Rimm also acknowledged that content of care remains an important gap in these studies, however conclusions drawn solely on utilisation studies still carry important policy implications with respects to providing ANC guidelines in health delivery.

VanderWeele et al. (2009) compared the performance of the Kessner index, the GINDEX, the APNCU index and two variants modified from the APNCU index in analysing the association between adequacy of ANC and LBW, preterm birth, and infant mortality. The comparison showed that when the indices were used in small-for-gestational-age outcome models, the conclusions suggested by the various indices were similar. In contrast, the models using various indices for preterm birth and infant mortality gave widely differing results. Unlike the use of other indices, the use of the GINDEX paradoxically suggested that birth outcomes were better in the inadequate, intermediate, and intensive categories than in the adequate category. The conclusions drawn concerning the association between prenatal care utilisation and small-for-gestational-age seem relatively robust in the sense of being consistent across indices. In analysing associations between ANC and preterm birth or infant mortality, care must be taken in choosing indices, because results differ substantially across indices. The authors suggested that when the APNCU index is used to study the association between ANC utilisation and preterm birth or infant mortality, the results might actually be sensitive to the biases noted by Koroukian and Rimm (2002). Therefore, the two modified APNCU indexes might be preferable for preterm models since the modification attempted to correct for these biases. Both the modified indexes did not classify as "adequate-plus" if the actual number of visits exceeded the expected number of visits by just one visit; this partly evaded the bias noted by Koroukian and Rimm earlier.

Despite the challenges encountered in using APNCU index, this index continues to be widely used in assessing ANC resource utilisation and birth outcomes. Some studies had also modified the index to suit the recommended ANC schedule of the study setting. Jarvis et al. (2011) modified the index to match Canadian practice which offered 12 antenatal visits instead of the 13 visits used by the APNCU Index as recommended by the American College of Obstetricians and gynaecologists. Likewise Beeckman et al. (2011) adapted the index to the recommended number of visits of Belgian guidelines.

Trinh et al. (2006) adapted the concept of measuring ANC utilisation using a combination of gestational age at first visit and number of ANC visits to suit the Vietnamese context that had later initiation of ANC and lower number of ANC visits in general. The adapted index used the recommendation from WHO of four months instead of the three months as recommended by the Vietnamese government for first ANC visit; and the recommendation of three visits from the Vietnamese government was used instead of WHO's recommendation of four visits.

2.6.2 Measuring Adequacy of Antenatal Care Content

While there have been several methods to measure adequacy of ANC utilisation, there were few indicators available to measure ANC contents. Content measurements used in studies ranged from: (i) proportion of study population receiving selected single interventions (Dhar, et al., 2010; Jarvis, et al., 2011); (ii) "all versus not all" of interventions performed (Joshi, Torvaldsen, Hodgson, & Hayen, 2014; White, 2006); (iii) total scores of interventions based on direct point assignment (Habibov & Fan, 2011; Victora, et al., 2010); (iv) classification of adequacy according to total score of interventions based on direct point assignment (Handler, et al., 2012; Trinh, et al., 2006); and (v) classification of adequacy according to the number and timing of interventions (Beeckman, et al., 2011).

Jarvis et al. (2011) compared selected ANC content provided to the insured and uninsured pregnant women through retrospective audit of medical databases, in which it included routine antenatal investigations/screening—initial screening blood test, cervical swabs for STIs, Pap testing, ultrasound and early genetic screening—as well as physical examination (cardiovascular, respiratory, and gynaecologic examination). The pregnancy outcomes assessed were gestational age and birth weight (Jarvis, et al., 2011). This paper examined the difference in pregnancy outcomes between the two groups who showed significant difference in routine antenatal testing; however, the association between pregnancy outcomes and ANC content was not tested (the authors stated that the potential risk to mother and foetus of failing to have routine antenatal testing is difficult to quantify). Furthermore, the ANC content assessed was not exhaustive as it was limited to health screening and physical examination.

Joshi et al. (2014) defined good quality ANC as care that included all seven recommended interventions: blood pressure, urine tests for detecting bacteriuria and proteinuria, blood tests for syphilis and anaemia and provision of iron supplementation, intestinal parasite drugs, tetanus toxoid injections and health education (any one of three topics). This method might be appropriate for places with low ANC attendance in which the type and frequency of these interventions was expected to be low. Also, the list was not differentiated by visits.

Victora et al. (2010) listed 11 care items that were grouped into physical examination and counselling (breast, gynaecological, pap smear, counselling for breastfeeding), measurements (uterine height, blood pressure, blood test, urine test) and prescriptions (tetanus toxoid, iron, vitamins). Each of the 11 items was assigned one point if it was performed, and the total scores tabulated. Ultrasound was analysed separately. Likewise, the list was not exhaustive, and might be appropriate only in settings with low ANC attendance as well as frequency of ANC interventions. Also, other essential health education topics were not included, and the list was not differentiated by visits.

Handler et al. (2012) studied adherence to recommended ANC content and its association with provider site (independent variable), as well as its association with adverse pregnancy outcomes (preterm birth and LBW). The extent of adherence was measured as the percent of 19 ACOG recommended standard ANC practice, which were categorised into a three level categorical variable: low (<50%), medium (50-79%), and high (80% or higher). The authors asserted that these cut-off points *"…mirrored those of Kotelchuck's Adequacy of Prenatal Care Utilisation Index."* However, when assessing the relationship with birth outcomes, the extent of adherence variable was recoded dichotomously as: <80% compared to ≥ 80%, because the <50% and 50-79% categories showed similar measures of effect (Handler, et al., 2012).

Dhar et al. (2010) evaluated the quality of maternity care including ANC services using a list of common physician practices. The common ANC practices encompassed iron supplementation, tetanus toxoid, urine test, haemoglobin test, ultrasound, health education (i.e. explained signs and symptoms of preterm labour, labour analgesic/pain relief, diet counselling). In general, the ANC content included was limited to selected common ANC practices at the study setting since the purpose of the study was to evaluate the quality of ANC services and not to associate the care with pregnancy outcomes.

2.6.3 Measuring Adequacy of Antenatal Care Using Composite Index for Utilisation and Content

Assessment on ANC adequacy rarely uses a combination of ANC utilisation and content in one composite index. Researches on adequacy of ANC often involve separate analysis of utilisation and content components (Dhar, et al., 2010; Habibov & Fan, 2011; Jarvis, et al., 2011; Joshi, et al., 2014; Victora, et al., 2010). Thus far, there were only few studies attempted integrating both the utilisation and content components into a composite index (Beeckman, et al., 2011; Bloom, et al., 1999; Trinh, et al., 2006). An earlier study by Bloom et al. (Bloom, et al., 1999) used a weighted scoring system based on pooled expert opinions to items related to ANC utilisation and content, which included a predefined benchmark for number of visits, initiation periods and selected ANC interventions according to the sequence of ANC visits. Another study combined an adjusted ANC utilisation index and categorisation of total score of selected ANC interventions which were counted equally without weightage; the combined utilisation and content composition was translated into an "ANC overall adequacy" index (Trinh, et al., 2006). A more recent study developed a tool that incorporated initiation of care, number, and timing of interventions which was categorised into levels of adequacy (Beeckman, et al., 2011).

Bloom et al. (1999) developed a list consisting of 20 input items covering visit frequency (benchmark was at least two visits) and ANC content. Weightage was assigned to each items based on the average of pooled expert opinions. These 20 items were grouped into 5 listings: (i) ANC visits and initiation information; (ii) initial visit content; (iii) median visit content; (iv) final visit content; and (v) content occurred sometime during pregnancy. This composite measure was used to examine the effect of ANC on the likelihood of using safe delivery care. However, it did not evaluate its effect on maternal and foetal outcomes directly, a limitation acknowledged by the authors that was imposed by small sample size (N=300). The finding demonstrated strong positive association between level of care obtained during pregnancy and the use of safe delivery care which may help to explain why ANC could be associated with reduced maternal mortality.

Considering the design of the tool by Bloom et al. (1999), it would be appropriate for places with low ANC attendance (e.g. benchmark used was only two visits) and would not be able to cope with places with known high number of ANC visits. Though health education was expected during the initial, median and final visits; the list did not specify the topic of health education. This is inadequate to examine the quality of services considering the wide ranges of health education. Taking into the account the need to analyse the appropriateness of ANC delivered, it is essential to know what have been performed during each visit. It was therefore necessary to design a form that enabled collection of data on what have been done on each visit.

Trinh et al. (2006) measured ANC overall adequacy in terms of extent of adequacy in ANC utilisation and ANC content. In this study, the ANC utilisation index considered a pregnant women as having sufficient utilisation if she had three or more visits and the initial visit during the first four months. ANC content consisted of 13 items: seven items on biomedical assessments - body weight, blood pressure, fundal height, foetal heart rate, vaginal examination, urine test and ultrasound; four items on care provision - tetanus toxoid immunisation, provision of tablets or advice on iron/folate supplement, malaria prevention, and preparation for safe delivery; and two items on health promotion/education - resting and nutrition. ANC content were reported in terms of the total number of care items provided to a pregnant woman and classified as “Fair” (10 or more items, or more than 75%), “Intermediate” (7 to 9 items or from 50% to 75%), “Poor” (0 to 6 items or less than 50%), “Missing” (unable to recall or not recorded”, and

“No care” (Trinh, et al., 2006). The study did not examine the association of the level of adequacy with any outcome measure. The ANC content was severely affected by recall biases. Consequently, the proportion of women with adequate overall ANC was very low (12%) and therefore not sensitive to change. The authors concluded that the utilisation index of three visits and initial visit within the first four months was the most suitable index for the study setting.

Besides, the weakness related to evaluation of ANC content in the study by Trinh et al. (2006) was that the ANC content was based on a list of interventions that was not differentiated by visits or frequency. For example, if the respondent reported that she attended three ANC visits during her pregnancy and said blood pressure and urine sample was taken, it could not be determined if blood pressure and urine test was taken for each visit or only once; this difference would have substantial implication on the adequacy of ANC content. In general, this tool would be more appropriate for places with low ANC attendance.

Beeckman et al. (2011) attempted to develop a Content and Timing of care in Pregnancy (CTP) tool that integrated timing of initiation of care, content of care and whether the interventions were received at appropriate time (number and timing of selected interventions) to assess the adequacy of ANC. The tool compared the finding with the APNCU Index that only measure the initiation and frequency of ANC visits. However, that study did not examine the association of the level of adequacy using both tools with pregnancy outcome.

The ANC content included were only three interventions—ultrasound, blood pressure and blood screening—which are effective in ANC. The authors acknowledged that the list of content was not exhaustive, and that the tool would include only 3-4 interventions to determine if this would alter the definition of adequate care when compared to the standard APNCU Index. The finding showed 17 cases classified as "Adequate" or "Adequate-plus" by the APNCU Index were considered "Inadequate" by the CTP. This finding suggested that despite having high number of visits, these women did not receive the minimal recommended content and appropriate timing of care (Beeckman, et al., 2011).

While the CTP tool by Beeckman et al. (2011) provided a more detailed assessment of ANC adequacy than the APNCU index, this tool over-simplified the requirements of ANC; other important components of care were not included. Although the tool might be expanded to include more care components, given the design of the tool, it would be difficult to cope with more care components or interventions.

In short, assessing adequacy of ANC might be tackled from the perspective of utilisation, content or the combination of both utilisation and content, depending on the objective of the assessment. Assessing adequacy of utilisation might yield better understanding on user patterns of initiation and frequency of visits, however, the quality aspects and compliance to care guidelines would not be known. On the other hand, assessing adequacy of content might reveal the current standard of ANC; however, this might be less meaningful without considering the utilisation aspect, especially since studies showed that standard recommended ANC could be delivered in reduced visits (Carroli, et al., 2001; Dowswell, et al., 2010; Ana Langer et al., 2002; Mathai M, 2011; Villar, et al., 2001). Moreover, considering the definition and objective of audit in healthcare and quality of maternal services, it is imminent to consider both utilisation and content aspects when assessing adequacy of ANC.

2.7 MONITORING AND EVALUATION WITHIN THE CONTEXT OF UNIVERSAL HEALTH COVERAGE

In 2005, all Member States of World Health Organisation (WHO) made a commitment to achieve universal health coverage (UHC). The commitment was a collective expression of the belief that all people who need health services should be able to receive the health services without incurring financial hardship (WHO, 2010). In 2010, WHO called for concerted efforts to achieve UHC. In essence, UHC has two interrelated components: (i) the full spectrum of good-quality, essential health services according to need; and (ii) protection from financial hardship including possible impoverishment due to out-of-pocket payments for health services (WHO, 2010).

Though the ideology of UHC outlined by WHO was viewed as noble and ambitious, it was criticized for lack of specificity in defining milestones for monitoring progress (Bennett, Ozawa, & Rao, 2010). The 2013 World Health Report pointed out that the definition and measurement of progress towards UHC are topics for investigation, both at the country and global levels (WHO, 2013). Recently in 2014, there was a collection of publications on UHC, providing insights concerning monitoring of UHC that drew from 5 technical paper and 13 country case studies on the experience of the implementation, monitoring and evaluation (The PLOS Medicine Editors, 2014). In essence, monitoring of UHC should consider indicators that can adequately capture the multiple components underlying the UHC initiative, the emphasis is the simultaneous monitoring of intervention coverage and financial protection, with an equity focus (Boerma, AbouZahr, et al., 2014; Boerma et al., 2014; The PLOS Medicine Editors, 2014).

The aim of UHC is to provide quality services (WHO, 2013). Naturally the monitoring and evaluation framework for intervention coverage of UHC emphasises on quality dimension (Boerma, AbouZahr, et al., 2014). While some of the intervention coverage indictors have the quality element included, many still need additional data collection and indicators to capture the quality of the implementation of the interventions (Boerma, AbouZahr, et al., 2014).

UHC monitoring can be fully embedded in the often existing, regular overall monitoring of progress and performance in health sector (Boerma, Eozenou, et al., 2014). The countries review shows that even before the existence of specific UHC monitoring framework, indicators related to accessibility, quality, and affordability of health care are often regularly tracked by the countries presented in the country case studies. The Singapore experience demonstrates that indicators evolve as the countries undergo changes socioeconomically and epidemiologically (Tan, Tan, Bilger, & Ho, 2014). Therefore, in order to evaluate the performance of health system effectively, the indicators should be tailored to each country's context and its policy goals. However, it is equally important to have a common small set of global indicators for cross-country comparisons (Boerma, AbouZahr, et al., 2014; Tan, et al., 2014).

For monitoring of intervention coverage, it was discussed that indicator disaggregation should be possible by key socio-demographic and socio-economic stratifiers and that data collection strategy should allow for disaggregation by geographical area, i.e. subnational monitoring (Boerma, AbouZahr, et al., 2014; Ng, et al., 2014). Data collection at health facility level is encouraged due to the possibility of subnational disaggregation by geographic area and the continuity in data collection (Boerma, AbouZahr, et al., 2014). In general, some of the key features concerning monitoring within the context of UHC, in particular monitoring of intervention coverage include the followings (Boerma, AbouZahr, et al., 2014):

- Progress towards UHC should be tracked using tracer intervention coverage indicators selected on the basis of objective considerations and designed to keep the numbers of indicators small and manageable while covering a range of health interventions to capture the essence of the UHC goal.
- UHC is about progressive realization, and countries differ in epidemiology, health systems, socioeconomic development, and people's expectations; hence, the indicator sets will not be the same everywhere.
- Coverage indicators should cover promotion and prevention as well as treatment, rehabilitation, and palliation. While there are several suitable indicators for the first two, there are major gaps for coverage indicators of treatment, as population need for treatment is difficult to measure.
- A small set of well-established international intervention tracer coverage indicators can be identified for monitoring UHC. Where no good indicators are currently available, proxy indicators and equity analysis of service utilization can provide some insights.
- Special attention needs to be paid to quality of services, either through the tracer indicator itself (referred to as effective coverage) or through additional indicators on quality of services or health impact of the intervention.
- Targets should be set in accordance with baseline, historical rate of progress, and measurement considerations.
- The main data sources of intervention coverage indicators are household surveys and health facility reports. Investments in both are needed to improve the ability of countries to monitor progress towards UHC.
- It is essential to find effective ways of communicating progress towards UHC in ways that are meaningful to the general public and that capture the attention of policy makers.

A concept that is relevant for monitoring of intervention or service coverage within UHC is "effective coverage." As opposed to crude coverage which focuses only on intervention access or use, effective coverage measures intervention need, use, and quality in a single metric (Ng, et al., 2014). These mean that the health sector needs data on a person's need for an intervention, use or exposure to an intervention, and if a particular intervention had its intended effect (usually measured by a biological marker or health outcome). For example, to measure effective coverage of diabetes management, information would need to be collected on: (i) the prevalence of diabetes in a population (i.e., individuals who need treatment for diabetes); (ii) the proportion of people with diabetes who receive treatment; and (iii) the effectiveness of their treatments (i.e., whether levels of fasting plasma glucose declined with treatment). The use of effective coverage can help to understand the health gains delivered by interventions at a range of levels, from individual benefits to national impact. This metric can also be used across resource settings. Lower-income countries can harness data from existing survey data to feed into effective coverage estimations. Nevertheless, the broader use of effective coverage remains hindered by the availability and quality of health data, especially at subnational levels (Ng, et al., 2014).

In the context of intervention area of pregnancy care, it was affirmed that while ANC is an effective preventive measure, quality is still a problem that requires additional monitoring and evaluation (Boerma, AbouZahr, et al., 2014; Requejo, et al., 2013). The first or fourth ANC visits are "crude" intervention coverage indicator which requires additional indicator to capture the quality of the intervention, e.g. type of ANC services received (Boerma, AbouZahr, et al., 2014).

While the effective coverage metric may be useful in measuring some of the services coverage, this concept may have lesser added value to the monitoring of pregnancy care in some countries. For example, to measure effective coverage of ANC, information that would need to be collected are: (i) the estimated pregnant women in a population (i.e., individuals who need ANC); (ii) the proportion of pregnant women who receive ANC; and (iii) the effectiveness of their treatments/ ANC (i.e., whether adverse pregnancy outcomes declined with ANC). This metric may be useful in a setting where the proportion of pregnant women who receive ANC remains low. However, this metric may not provide new insights in Malaysia where there is high proportion of pregnant women with high average number of ANC visits and stagnating pregnancy outcomes. Instead, it is more relevant to explore the type of ANC services received by the pregnant women in a comprehensive manner, or adequacy of ANC.

Finally, a country has to consider several factors in monitoring the progress towards UHC. First, a country must identify its overall health needs and priorities. Second, a country has to develop specific strategies for collecting data on need, use, and quality of selected interventions. Third, a country has to devote resources to enhance both national and subnational capacity to collect and monitor health information (Ng, et al., 2014). Though Ng et al. asserted the aforementioned are the requirements to optimally use effective coverage as a metric for monitoring healthy system improvement or progress towards UHC (Ng, et al., 2014), these will still apply to any setting regardless of the indictor sets adopted.

2.8 CONCEPTUAL FRAMEWORK AND RESEARCH MODEL

While there have been attempts to study adequacy of ANC in Malaysia, these studies used only the “number of ANC visits” or the “number of complete ANC visits” as the variable for ANC utilisation. Neither gestational age of first visit nor gestational age of pregnancy was integrated. Thus far, there was also no study focused on comprehensive ANC content in Malaysia.

Moreover, considering the average ANC visits of over 10 visits per pregnant woman (Ministry of Health Malaysia, 2012a), it appears that there could be an over-utilisation of ANC as compared to the ANC guidelines. It is therefore essential to examine what was actually being done (ANC content) during the visits to gain some insight concerning the necessity of the high number of ANC visits.

2.8.1 Conceptual Framework of Factors Associated with Antenatal Care (Utilisation and Content) and Pregnancy Outcomes

A conceptual framework of ANC adequacy that included both utilisation and content was used in the study. The development of this framework was driven by the finding from literatures that adequacy of ANC should capture these two aspects that were complementary to each other. Adequacy in ANC utilisation alone did not imply adequacy in ANC (Koroukian & Rimm, 2002; Kotelchuck, 1994), but conclusions drawn solely on utilisation studies still carried important policy implications (Koroukian & Rimm, 2002). The conceptualisation of this framework was also informed by the literatures on quality care, factors associated with ANC utilisation and adherence to ANC content, approaches in assessing ANC adequacy specifically the association of ANC and pregnancy outcomes, and the local experience of the researcher.

The development of the framework also referred to the latest behavioural model of Andersen—the final Phase 4 emerging model of health services utilisation which consisted of environment (healthcare system, external environment); population characteristics (predisposing, enabling and need factors); health behaviour (personal health practices, use of health services); and health status outcomes (Andersen, 1995).

For background information, the behavioural model of health services use was initially developed over 35 years ago in the 1960s to assist in the understanding on use of health services, to examine equitable access to health services, and to assist in developing policies to promote equitable access (Andersen, 1968). This initial model was designed to explain the use of formal personal health services rather than to focus on health outcomes. Increased utilisation was a major policy goal then and cost was not really the concern as it is today (Andersen, 1995). Over the years, from inception to the final model, the model underwent four phases of review. The final model emphasises the dynamic nature and multiple influences on health services utilisation model and subsequently on health outcomes (Andersen, 1995). It also recognises that outcome in turn affects subsequent predisposing factors and perceived need for services as well as health behaviour (Andersen, 1995).

Figure 2.2 illustrates the conceptual framework of the study which assumes ANC utilisation is influenced by the predisposing characteristics of pregnant women and need factors, which in turn contributes to pregnancy outcomes. On the other hand, ANC content is influenced by the characteristics of the ANC providers (e.g. healthcare workers' qualification and type of health facilities), and likewise influences pregnancy outcomes.

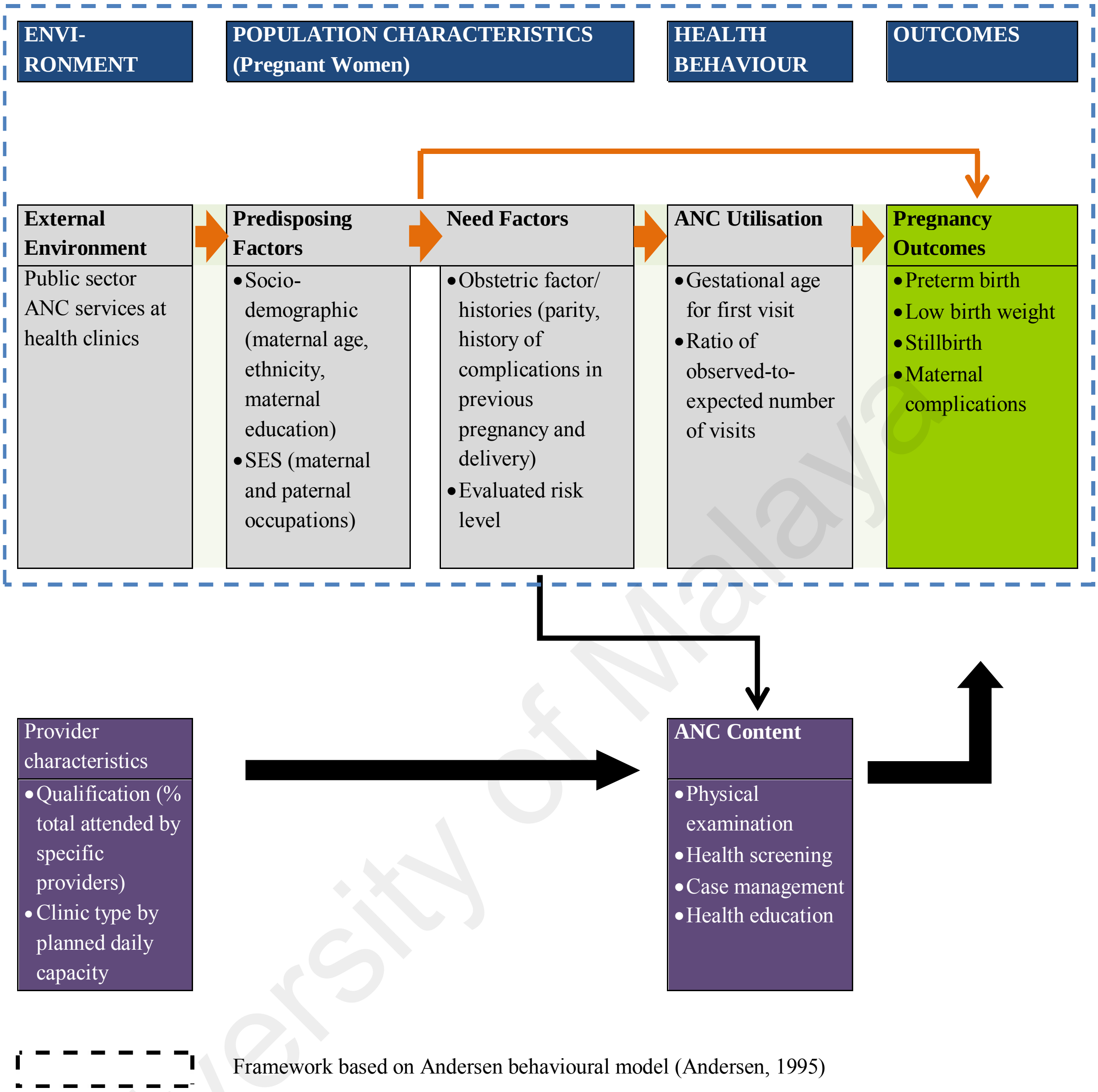


Figure 2.2: Conceptual Framework of Factors Associated with Antenatal Care (Utilisation and Content) and Pregnancy Outcomes

The conceptual framework (Figure 2.2) predominantly adapted the behavioural model of Andersen (1995) for ANC utilisation aspect to group the factors potentially associated with utilisation of ANC and pregnancy outcomes. This is demarcated as dotted line in Figure 2.2. The “enabling factors” of Andersen’s model was not emphasised as the study was conducted at the public sector health clinics whereby the services provided were highly affordable and the issues identified thus far were not related to low coverage or utilisation. As for ANC content, the theoretical framework was informed by the literature review which implied the association of ANC content with provider sites (Boller, et al., 2003; Dhar, et al., 2010; Handler, et al., 2012; Victora, et al., 2010), qualification of providers (Boller, et al., 2003; Pembe, et al., 2010), and specific risk factors (Yoong, et al., 1992). Though high risk referral did not appear to have a strong effect on content adherence (Handler, et al., 2012), risk level was included to assess if there was difference between the ANC content provided to low-risk and high-risk.

2.9 SUMMARY: LITERATURE REVIEW

ANC has been carried out for decades before it was thought to evaluate the effectiveness of ANC in the 80s, stemming from the notion that routine ANC has developed without evidence of how much care is really required and useful to optimise maternal and neonatal health. Since then, ANC guidelines had been the subject of many reviews and researches over the past three decades and contributed to the review and revision of ANC guidelines in several countries with orientation towards evidence-based practices. Recent review on monitoring of health services however affirmed that while ANC is an effective preventive measure, quality is still an issue that requires additional monitoring and evaluation.

Studies on association of ANC and pregnancy outcomes had been predominantly on utilisation and rarely on content. Inclusion of ANC content is important as ANC utilisation alone may not reveal possible reason for adverse outcome. Hence, it is crucial to include both the utilisation and content in the analysis of ANC adequacy and pregnancy outcomes. preterm birth, LBW and stillbirth were valid foetal outcome indicators.

MMR remains an important indicator for maternal health. While there might be little factual evidence that ANC reduces maternal mortality, the preventive role of ANC may contribute to preventing maternal deaths. Nevertheless, in setting with considerable low MMR like Malaysia, maternal morbidity should be considered as maternal outcomes.

Study on pregnancy outcomes should also incorporate independent variables for socio-demographic and socioeconomic factors, obstetric factors, and health behavioural risk factors. The influencing factors of ANC utilisation vary depending on the country context. In general, ANC utilisation is influenced by predisposing factors including socio-demographic, and need factors associated with previous pregnancy experience as well as other enabling factors. Socio-economic background affecting ANC attendance pattern may also affect ANC content score because late initiation and reduced visits lower the opportunities for delivery of recommended content. In addition, the extent of adherence to recommended ANC content are mostly associated with provider perspectives and risk factors.

There are a number of approaches in measuring adequacy of ANC utilisation, namely any number of ANC use, first ANC visit, gestational age at first visit, number of ANC visits. Many studies adopted the concept of the APNCU Index that incorporates both adequacy of initiation and adequacy of observed-to-expected visit ratio. The Index was also often modified to accommodate the local condition.

Several studies have been conducted in assessing adequacy of ANC content; these often focused on selected key ANC interventions and did not provide comprehensive information on the content of ANC. For example, antenatal education were often simplified as given or not. Therefore, these tools might be more appropriate in setting with low ANC attendance and lesser scope of interventions. Taking into the account the need to analyse the quality of ANC, it is essential to know what have been performed during each visit.

In essence, assessing adequacy of ANC might be addressed from the perspective of utilisation, content or the combination of both utilisation and content, depending on the objective of the assessment. Assessing adequacy of utilisation might provide better understanding on user patterns of initiation and frequency of visits; however, the quality aspects of compliance to care guidelines would not be revealed. On the other hand, assessing adequacy of content alone would be less useful without understanding the utilisation aspect, especially since standard ANC could be delivered in reduced visits. Moreover, considering the definition and objective of audit and quality of maternal services, it is imminent to consider both utilisation and content aspects when assessing adequacy of ANC. It is also crucial that pregnancy outcomes be evaluated in relation to ANC adequacy. This is especially relevant when increased utilisation is no longer the goal of health policy but effectiveness and efficiency.

CHAPTER 3: METHODS

The methods chapter presents the study design, setting and population. It details the sampling method including the inclusion and exclusion criteria. The variables define the dependent/outcome variables and the independent variables/predictors. Data collection section describes the development of data collection tool and data collection activities. This is followed by detailed description on the approach to data analysis, including the development of adequacy indexes used in the present study. Statistical procedures are explained in terms of the variables involved and the statistical procedures applied for testing the association.

3.1 STUDY DESIGN

In order to study the utilisation and content of ANC for a complete pregnancy, a longitudinal study is required. This study involved studying a cohort of pregnant women attending the selected clinics and delivering at the same period of time—that is, people who share a certain characteristic—following up from their first ANC visit to after their delivery. It was therefore a "cohort study" (Bryman, 2012). A retrospective approach was adopted in which the data regarding the women who had delivered were extracted and analysed. In summary, this was a retrospective cohort study of women who were pregnant, went for ANC at the selected health facilities, and delivered within a defined period (Baker & Rajasingam, 2012).

A retrospective study design was chosen because this study aimed to document the actual practices of ANC rendered to the pregnant women. A perspective cohort study design where the researcher is present during the ANC sessions or where the ANC providers are aware of a particular study will result in "reactive effects," which are likely to occur in any research where participants know they are the focus of investigation (Bryman, 2012). In this case, the nurses who provide ANC might change their usual behaviour when they are under survey, thus, might tend to follow the ANC guidelines more strictly when they are being observed or when they know that a study is being conducted.

Another key benefit of retrospective cohort studies is that they typically require less time to complete as compared to prospective studies (Bryman, 2012). The time to complete a retrospective study is only as long as it takes to collect and interpret the data, which is an advantage for an academic study where there are time and resource constraints. As the study objectives require analysis of the pregnancy outcomes, a perspective study design will need to follow-up the entire length of a pregnancy, from the first visit to after the delivery. Furthermore, retrospective studies are better for analysing multiple outcomes (Hyde, 2004) such as expected in this ANC study that will have multiple pregnancy outcomes. In a medical context, retrospective studies can potentially address rare diseases or events, which would necessitate extremely large cohorts in prospective studies. In the case of retrospective studies, diseased people or events have already been identified so the study design is especially helpful in addressing diseases or events of low incidence. For example, the events for maternal deaths and stillbirths in Malaysia are considerably low; it would require an extremely large cohort of pregnant women in a prospective study design to capture these events (Miller-Keane Encyclopedia, 2003). As a result, retrospective studies are generally less expensive than prospective studies which may be another key benefit. These studies tend to be less expensive in part because outcome and exposure have already occurred, and the resources are directed at mainly collection of data (Hyde, 2004).

There are limitations associated with retrospective studies vis-a-vis prospective studies. Among the disadvantages of retrospective studies using medical records are information bias related to the quality of documentation which relies on others for accurate recordkeeping (Hyde, 2004) and that additional data cannot be collected as a result of the retrospective aspect (Miller-Keane Encyclopedia, 2003).

Nevertheless, considering that there was no similar study using the proposed methods in Malaysia, it was of the opinion that the conclusions drawn from a retrospective study would still carry important implications. This study included only those who completed their pregnancies in year 2013 in order to reflect the current or more recent ANC practices as much as possible. This would enhance the timeliness and relevance of the results to current ANC guidelines implemented by the public health clinics.

3.2 STUDY SETTING

The study site was the selected health clinics in Selangor state, Malaysia. In general, all the states in Malaysia shares similarity in the organisation of health services delivery due to the considerably centralised and uniform health system throughout Malaysia, with some variations in East Malaysia to cater for the need of remote areas there.

The official ethnic composition of Malaysia is Bumiputera (67.4%), Chinese (24.6%), Indians (7.3%) and Others [0.7%, (Department of Statistics, 2011)]. Among the 16 states and federal territories, Selangor is among the four states—Melaka, Negeri Sembilan, Selangor and Perak—that have the ethnic composition that are closest to the overall national composition (Department of Statistics, 2011). In addition, it is located in the central region and thus convenient for coordination of the study related procedures.

3.3 STUDY POPULATION

The study population were the pregnant women who attended the public sector health clinics for ANC in the selected study areas. The study was done on those who have attended their first and subsequent ANC visits, completed their pregnancy, and delivered within a defined period of time.

This present study included both white-tagged and colour-tagged pregnant women to draw a complete picture of ANC, in particular to examine the differences between the low-risk and the high-risk pregnancies.

The study population included only the users of the public sector clinics and excluded the users of the private sector clinics. This was because the private sector did not necessarily use the recommended guidelines of the MOH and the characteristics of the key care providers were different in the two settings. In addition, the private sector charged user-fee for services provided as opposed to the literally free services provided by the public sector. As such, the characteristics of the users of private sector might differ from the users of public sector. Inclusion of private sector in the study would therefore confound the association between the predictors and outcomes. Furthermore, as had already been mentioned in Chapter 1, private clinics offered different level of antenatal services. Some private clinics offered antenatal services for first trimester care only while some offered care up to second and third trimester. It was found that among the private clinics offering antenatal services in Selangor and Putrajaya, only 54% of these clinics provided ANC up to the third trimester (National Clinical Research Centre, 2014). Lastly, the study aimed to assess adequacy of ANC at the public sector and was not designed to compare the differences between the two sectors.

3.4 SAMPLING

3.4.1 Sample Size Estimation

The sample size for this study was computed based on the requirements of the two important study objectives, namely:

- To estimate the proportion of pregnant women who have adequate ANC (utilisation and content); and
- To determine if there is an association between the adequacy of ANC and pregnancy outcome, specifically the incidence of low birth weight.

To estimate the proportion of pregnant women with adequate ANC, the following formula for the estimation of a single proportion was used:

$$n = \frac{z^2 P Q}{d^2}$$

where:

z = 1.96, corresponding to a 95 % confidence level;

P = 50%, the expected value of the percentage of pregnant women with adequate ANC;

Q = 50% (the complement of P, where P + Q = 1). This is also the assumed value of the percentage of pregnant women with inadequate ANC;

d = 5% margin of error for the resulting estimates.

In estimating the percentage of pregnant women with adequate ANC, there are no existing values from previous studies which considered both utilisation and content in Malaysia. It was therefore decided to use the value of 50% for sample size determination since this is where maximum heterogeneity is attained leading to the most conservative sample size requirement for a given margin of error (Bryman, 2012; Lwanga & Lemeshow, 1991).

Since this study makes use of a retrospective cohort study design, the statistical tool to be used to measure the association between the adequacy of ANC utilisation and pregnancy outcomes will be the relative risk (RR). Although this study considers four types of pregnancy outcomes (gestational age at birth; birth weight; birth outcome;

maternal outcome), only the association between adequacy of ANC utilisation and birth weight was considered for sample size determination due to the following reasons:

- Since the incidence of stillbirths and maternal deaths which are among the main indicators for birth and maternal outcomes are very low—stillbirth at 4.4 per 1,000 total births (Ministry of Health Malaysia, 2010b) and MMR of 30-40 per 100,000 live-births (Ministry of Health Malaysia, 2012a)—the estimation of the relative risk using these parameters will necessitate extremely huge sample sizes requiring several thousand subjects. As such, these indicators will be used only at the descriptive rather than at the inferential level in this study.
- There are no available data on the incidence of preterm births and its relationship with ANC. Preterm birth rate was not yet compiled by the World Health Statistics at the time of sample size estimate; preterm term birth rate was first included in the World Health Statistics 2014 (WHO, 2014b). The Family Health Department's annual report does not contain data for preterm births (Ministry of Health Malaysia, 2012a).

Previous studies conducted indicate that the incidence of low birth weight (LBW) in Malaysia from 2006 to 2010 was 11% (Unicef, 2012). In addition, a study conducted in Finland which used logistic regression analysis to determine the relationship between ANC and birth weight showed an odds ratio of 5.46 (Raatikainen, et al., 2007). Using these values as basis, the sample size needed to determine the relative risk between ANC utilisation and low birth weight was computed using the following formula:

$$n = z^2{}_{1-a/2}\,[(1 - P_1)/\,P_1 + (1 - P_2)/\,P_2]/\,[\log_e(1 - \varepsilon)]^2$$

where:

z = 1.96, corresponding to a 95% confidence level;

P_1 = 50%, the assumed incidence of LBW among pregnant women with inadequate ANC;

P_2 = 10%, the assumed incidence of LBW among pregnant women with adequate ANC;

ε = 25%, the relative precision for the resulting estimate of the relative risk (RR).

The assumed values of P_1 and P_2 are based on the odds ratio of 5.46 cited earlier from the Finland study (Raatikainen, et al., 2007). This means that the incidence of LBW among those with inadequate ANC is expected to be five times higher compared to those with adequate ANC. Although the incidence of LBW in Malaysia was found to be 11% (Unicef, 2012), the value of 10% was used as the value for P_2 in actual sample size computation to facilitate the use of existing tables of pre-computed sample sizes for the estimation of the relative risk.

Table 3.1: Sample Size Requirements for Different Study Objectives

Study Objective	Assumed values of parameters	Statistical Specifications	Required Sample Size
1. To estimate the proportion of women who have adequate ANC (utilisation and content).	P = 50% (the proportion of women with adequate ANC – utilisation and content)	95% confidence level 5% margin of error	384
2. To determine if there is an association between the adequacy of ANC and pregnancy outcome, specifically the incidence of low birth weight.	RR= 5, the assumed relative risk P_2 = 10%, the incidence of LBW among pregnant women with adequate ANC	95% confidence level 25% relative precision	465

The required sample sizes corresponding to these two important study objectives are summarized in Table 3.1 above. Since tables for pre-computed sample sizes for the estimation of proportions and relative risks are already available, the required sample sizes for this present study were extracted from these tables (Lwanga & Lemeshow, 1991). Table 3.1 shows that a sample size of 384 is needed for the first objective while a sample size of 465 is required to meet the second objective. To meet the needs of both objectives, it is decided to use a sample size of 500 pregnant women for this research.

3.4.2 Sampling – Health Clinics and Pregnant Women (Antenatal Care Records)

The sampling was based on a multi-stage random sampling design, using type of health clinics by their expected daily workload as the stratification variable. In summary, these separate stages were involved:

- Stratified/grouped all the health clinics of Selangor into three strata by expected daily workload of: 301-500 and above, 150-300, and below 150; then sampled two health clinics from each stratum (total six health clinics). Though there are six types of health clinics in Malaysia (Chapter 1.2), the more common types are these aforementioned three (as advised by the State Health Department, Selangor).
- Sampled pregnant women (ANC records) from each of the six health clinics according to proportional allocation.

3.4.2.1 Stage 1: Sampling of Health Clinics

The first stage of the selection was the selection of health clinics from each stratum, making health clinics as the primary sampling unit (PSU). Sampling theory requires the selection of at least two PSUs per stratum to ensure variability (Lwanga & Lemeshow, 1991). This means a total of six health clinics are required. The second or ultimate stage was the selection of sample respondents (ANC records) from each selected clinic based on the proportionate samples required for the strata.

Table 3.2: Stratification of Health Clinics and Health Clinics Selection

	301-500 and above		150-300		below 150	
	District	Health Clinic	District	Health Clinic	District	Health Clinic
1	Klang	Pandamaran	Klang	Bukit Kuda	Klang	Pulau Indah
2	Klang	Bandar Botanik, Klang	Klang	Kapar	Klang	Pulau Ketam
3	Klang	Klinik Aneka Klang (no MCH, excluded)	Klang	Meru	Gombak	Batu Arang
4	Petaling	S7 Shah Alam	Klang	P. Klang	Hulu Langat	Beranang
5	Petaling	Puchong	Petaling	S19 Shah Alam	Kuala Langat	Tg. Sepat
6	Petaling	Taman Medan	Petaling	Kelana Jaya	Kuala Langat	Teluk Datok
7	Gombak	Selayang Baru	Petaling	Seri Kembangan	Kuala Langat	Sijangkang
8	Gombak	Sungai Buloh	Gombak	Rawang	Kuala Langat	Bukit Changgang
9	Hulu Langat	Kajang	Gombak	Kuang	Kuala Langat	Tk Panglima Garang
10	Hulu Langat	Ampang	Gombak	AU2	Kuala Langat	Jenjarom
11			Gombak	Taman Kenangan	Kuala Langat	Bandar
12			Gombak	Taman Ehsan	Hulu Selangor	Sungai Selisik
13			Hulu Langat	Semenyih	Hulu Selangor	Kalumpang
14			Hulu Langat	Batu 14	Hulu Selangor	Rasa
15			Hulu Langat	Batu 9 Cheras	Hulu Selangor	Soeharto
16			Hulu Langat	Bandar Baru Bangi	Kuala Selangor	Tanjung Karang
17			Hulu Langat	Bandar Seri Putra	Kuala Selangor	Ijok
18			Hulu Langat	Sg Chua, Kajang	Kuala Selangor	Batang Berjuntai
19			Hulu Selangor	Ulu Yam Bharu	Kuala Selangor	Jeram
20			Hulu Selangor	Serendah	Sabak Bernam	Sungai Besar
21			K Selangor	Kuala Selangor	Sabak Bernam	Sekinchan
22			Sepang	Salak	Sabak Bernam	Parit Baru
23					Sabak Bernam	Sg Air Tawar
24					Sabak Bernam	Bagan Terap
25					Sepang	Dengkil
26					Sepang	Sungai Pelek
STAGE 1: CLINICS SELECTION						
# of health clinics required		2		2		2
Health clinics selected	Hulu Langat	Ampang	Petaling	Seksyen 19, Shah Alam	Kuala Langat	Bukit Changgang
	Petaling	Puchong	Hulu Langat	Batu 9 Cheras	Sabak Bernam	Sekinchan

Table 3.2 above shows the listing of health clinics by stratum and the health clinics selected. Health clinics were randomly selected based on simple random sample method with the aid of Excel's random selection function "=RANDBETWEEN(#1,#n)". Two clinics were required from each stratum; from the list of the random numbers generated, the first two non-repeat numbers were chosen.

3.4.2.2 Stage 2: Sampling of Pregnant Women (ANC Records)

For selection of samples, the required 500 sample size was first proportioned according to the expected daily workload for each stratum and each selected clinic in the stratum. The required sample size for each clinic was then allocated according to the estimated proportion between the normal (white-tag) and risk (colour-tag) pregnant women, using proportional allocation, and based on the percentage distribution of these two groups in the population (Table 3.3).

As it was not possible to get the official data for the percentage distribution of white-tags and colour-tags in Malaysia, this study estimated the figures based on available proxy indicator and the criteria used for ANC risk assessment system (colour-tagging) in Malaysia. For example, according to the ANC risk assessment guidelines, pregnant women whose haemoglobin level is less than 11g% will be tagged as "green" cases and is considered pregnancy with risk factor. In 2010, the proportion of pregnant women at approximately 36 gestational weeks with Hb level of less than 11g% in Malaysia was around 21% and in Selangor around 24 % (Ministry of Health Malaysia, 2012a). Taking into account the other wide ranging criteria for ANC risk assessment as well as personal communication with the nursing officers of several health clinics (Appendix A), it is estimated that around 70% of the pregnant women attended the public health clinics are colour-tagged (green, yellow or red).

Table 3.3: Proportionate Sample Size by Stratum and Colour Code

	301-500 and above		150-300		below 150	
	District	**Health Clinic**	**District**	**Health Clinic**	**District**	**Health Clinic**
Health clinics selected	Hulu Langat	Ampang	Petaling	Seksyen 19, Shah Alam	Kuala Langat	Bukit Changgang
	Petaling	Puchong	Hulu Langat	Batu 9 Cheras	Sabak Bernam	Sekinchan
STAGE 2: A) PROPORTIONAL SAMPLE ALLOCATION ACCORDING TO EXPECTED DAILY WORKLOAD						
Total number of health clinics		9		22		26
Estimated number of average daily outpatient attendances for EACH health clinic under the same stratum		400		225		75
Estimated number of average daily outpatient attendances for ALL health clinics under the same stratum		3,600		4,950		1,950
Proportion of estimated total workload (total estimated workload = 10,500), %		34%		47%		19%
Proportional sample size for each stratum (total sample size = 500)		171		236		93
Approximate sample size required for each health clinic in the stratum		86		118		47
STAGE 2: B) PROPORTIONAL SAMPLE ALLOCATION ACCORDING TO NORMAL & RISK CASES						
Proportional allocation for normal cases (white-tagged) in each clinic, 30%		26		35		14
Proportional allocation for risk cases (colour-tagged) in each clinic, 70%		60		83		33

Sampling of individuals (ANC records) used a system of selecting every fifth records systematically, starting from the left to the right of the shelf/box. The number of records systematically picked would be around double the actual requirement as the records would subject to criteria screening (refer to inclusion and exclusion criteria below). If systematic selection was to be repeated from the same shelf/box due to inadequate yield from the first cycle, the repeat cycle would then use a system of selecting every third records to optimise randomisation. All the selected records would then be screened based on the inclusion and exclusion criteria until the required number of samples was reached.

3.4.3 Inclusion and Exclusion Criteria

3.4.3.1 Inclusion Criteria

- Malaysian citizens only since foreigners may have different health-seeking behaviours due to different social and cultural practices.
- Completed pregnancy and delivered at POG ≥22 weeks because the Malaysian classification of stillbirth includes birth weight of at least 500g, or having reached a gestational age of at least 22 weeks (based on reporting format for stillbirth and neonatal death, MOH Malaysia).
- Completed pregnancy and delivered during the period from January to June 2013 (±1 month) to ensure as much as possible the consistency of standard care.

3.4.3.2 Exclusion Criteria

- Transfer-in cases from other health clinics because most of the care provided at previous clinic visits will not be captured in the record of the clinic that took over the case, and the standard care might vary from clinic to clinic.
- Transfer-out cases to other health providers or clinics due to the obvious reasons that there will be gap in the record of the care provided throughout the pregnancy.
- Multiple pregnancies since this will influence the need or content of care.

3.5 VARIABLES

3.5.1 Dependent Variables

The dependent variables of this study included the variables presented in Table 3.4 below.

Table 3.4: Dependent Variables

	Dependent variables and definitions
Pregnancy outcomes	Preterm birth (less than 37 weeks of gestation at birth)
	Low birth weight (less than 2,500g at birth)
	Stillbirth (intrauterine deaths of at least 22 weeks gestation or over 500g weight
	maternal complications (intra- or postpartum complications including maternal death) [women with any combination of these conditions - retained placenta, PPH, IE/PE, postnatal high BP, postnatal infection (infected wound or systemic e.g. fever), postnatal severe anaemia, unknown reason for admission or long hospital stay, maternal death]
Adequacy of ANC Utilisation	Utilisation index based on modified APNCU Index which integrate gestational age at first visit, and observed-to-expected visit ratio
Adequacy of ANC Content	ANC content scores

3.5.2 Independent Variables

The independent variables that would be tentatively included were presented in Table 3.5. These tentative independent variables were subsequently tested for multi-collinearity before the construction of models to determine the association with the study outcomes. As such, a few variables were not included in the model analysis.

The categorisation of education and occupation is according to the categorisation used by the Department of Statistics Malaysia, in which the categories of occupation are based on the Malaysia Standard Classification of Occupation (Ministry of Human Resources, 2010).

ANC utilisation (gestational age at first visit and total number of ANC visits) is both a dependent as well as an independent variables. This is because according to the conceptual framework on adequacy of ANC delineated in Figure 2.2, pregnant women's characteristics may influence the utilisation of ANC. In this case, ANC utilisation is a dependent variable. At the same time, utilisation pattern of ANC may contribute to pregnancy outcome, in which ANC utilisation is an independent factor.

Likewise, ANC content is both a dependent as well as independent variable in which the degree of adherence may be influenced by the providers' characteristics (i.e. ANC content is a dependent variable), while the ANC content may also induce the pregnancy outcome (i.e. ANC content is an independent variable).

Table 3.5: Independent Variables

	Independent variables
Pregnant women characteristics	**Socio-demographic:** Maternal age at booking (≤ 19, 20-34, ≥ 35 years old) Ethnicity (Malay, Chinese, Indian, Indigenous, Others) Maternal education (no formal education or primary, secondary, tertiary) Working status
	Socio-economic Status: Pregnant women's occupation Spouse's occupation
	Obstetric Factors and Histories: Gravidity (primigravida or multigravida) Parity (nulliparous or multipara) Risk level by tagging (low-risk and high-risk) Risk code at last visit (white, green, yellow, red) History of miscarriage History of complications during previous pregnancy (mainly GDM, PIH, anaemia, PP, miscarriage) History of complications during previous delivery (PREM, LSCS, assisted delivery, PPH, stillbirth, NND)
	Default History: Ever defaulted
Provider characteristics	Clinic type by expected daily workload (below 150, 150-300, 301-500) Percentage of total visits attended by CN Percentage of total visits attended by SN with postgraduate Percentage of total visits attended by MO
Adequacy of ANC Utilisation	Gestational age at first visit, observed-to-expected visit ratio
Adequacy of ANC Content	ANC content scores

3.5.3 Confounding Control

Confounder, also known as a third variable, usually distorts the relationship between an independent (predictor) and a dependent (outcome) variable (Bryman, 2012). The distortion can then lead to inaccurate conclusion. Therefore, confounding must be controlled for. Aschengrau and Seage (2013) postulated that confounding can be controlled through the design and analysis stages. For the design stage, randomisation, restriction, and matching of the dependent variables could be prescribed (Aschengrau & Seage, 2013). This means that all study participants or samples should be randomly selected to reduce the possibility of chance.

The sampling of this study adopted a multi-stage random sampling design to achieve randomisation at design state. Besides, the inclusion and exclusion criteria served to control for confounding by restricting the potential difference in the respondents and providers characteristic. Where feasible, data field was designed to capture continuous data at data collection, this would allow for flexible categorisation of variables into suitable width to control for confounder.

Using the same principles, as in the design stage, confounding can be controlled for at the analytical stage through standardisation (e.g. age and race), stratified analysis, and multivariate analysis (Aschengrau & Seage, 2013). In statistical analysis stage, for example, age, a known confounder, was grouped into age-groups that were known to share similar risk – women aged 20-34 and women aged $\leq$ 19 and $\geq$ 35 years old. Additional variables were also collected to enable further analysis of contingency table for possible confounding or moderating that might affect the conclusions. For example, ANC check-up elsewhere prior to the first visit, histories of complications in previous pregnancy and user behaviour. Multivariate regressions (e.g., logistic regression model) were used to control the effect of confounders.

3.6 DATA COLLECTION

3.6.1 Development of Data Collection Tool

The data collection tool was developed based on the study objectives, as well as the data fields of the ANC record format used by the health clinics during the period year 2012/Q4 and 2013/Q3 (refer to data collection tool attached in Appendix C).

The form was refined after pre-testing at Ampang Health Clinic in mid-June 2013, to ensure that the form was in-line with the data fields of the ANC records used by the clinics in year 2012/2013. This would ensure the compatibility of the form with the ANC recording booklet during that specific period.

Subsequently, a few days after the commencement of data collection on 22nd of July 2013, the form was again reorganised to enhance the flow of data recording. For example, separated the standard and additional lab investigations and rearranged a few sequence of the information. The form was also revised to capture information such as internal and external referrals, POG when defaulted appointment, data field for phone reminder as well as simplified the format of past pregnancy histories. The form was also trialled in regards to the coding for data entry and analysis.

3.6.2 Data Collection Contents

3.6.2.1 Pregnant Women's Profile and Antenatal Care Information

The details of each ANC record were recorded individually in a data collection form, which consisted of the following sections:

- Basic study information - district, health clinic, record registration number, women/spouse contact number, and date reviewed/recorded.
- Defaulting behaviour - POG of each defaulted appointment, duration of each default (from appointment due date to clinic visit).
- Socio-demographic information - Malaysian citizenship, birth year and month, ethnicity, education level, occupation, spouse' occupation.
- ANC utilisation - gestational age at first visit, indication if seen at other provider prior to the booking visit including gestation and purpose, total ANC visits recorded at the surveyed clinic.

- Risk level of current pregnancy - colour tag and risk factor at first and last visit prior to delivery, POG retagged/diagnosed.
- Place of delivery - hospital (include hospital name) or home.
- Route of delivery - SVD, assisted/instrumental delivery, emergency caesarean, elective caesarean, caesarean with unknown indication.
- Pregnancy outcomes - gestational age at birth, birth weight, birth outcome (live-birth or stillbirth); maternal outcome and maternal complications if any.
- Obstetric history, family planning.
- ANC provided for each visit - checklist consists of standard care according to MOH guidelines (physical examination, health screening, case management and health education) and additional lab investigations.
- Attending provider(s) for each visit.
- Antenatal home visit or phone reminder and reason.

The ANC content checklist has built-in feature to assess the data quality. For example, the completeness of health education page, completeness of information for previous pregnancies, and other observations.

3.6.2.2 Providers and Facilities Profile

The provider profile of the healthcare workers at the health clinics were captured based on the staffing records provided by the nursing officer of the health clinics. Information extracted including the position, qualification by type of professional training received, and years of working experience.

This inventory focused on providers who were regularly involved in the delivery of ANC, and who have directly attended to the pregnant women during their ANC visits. The main cadre of providers that were used for data analysis included community nurses by years of services, staff nurses with and without post-graduate training, medical officers by years of services, family medicine specialist who could be either in-house or visiting specialist, and others (e.g. nutritionist or dietician).

3.6.3 Data Collection Arrangement

Data collection was conducted by the researcher since it was not possible to seek for the assistance of the nursing staff at the health clinics who are already burdened with various responsibilities and workloads. This arrangement of not engaging the clinic staff in data collection might also reduce information biases when the extracted data were found to be not in favour of the providers' performance.

In addition, it was not easy to find enumerator with relevant background on ANC and MCH. The enumerator would need to have some clinical background to understand the ANC notes and to interpret what have actually been done for the pregnant women based on the notes.

3.6.4 Data Collection Process and Quality Control

The researcher first systematically selected ANC records from the storage shelf/box as described in the sampling section earlier. Each selected record was then screened according to the inclusion and exclusion criteria until the required number of samples was reached. Each record that passed all the criteria would then be reviewed and data extracted into a set of forms. Once the recording of a record was completed, it would be put aside and the review/recording process would be repeated for the next record.

At the end of the day, each filled-out form would be scrutinised for completeness of data. Forms with missing data were rechecked against the ANC record. A total of 533 records were collected; only data from 522 records were entered because there were 11 records that did not meet the eligibility criteria.

3.6.5 Selection of Mortality Records (Stillbirth and Maternal Death)

Systematic randomised selection of records as described was applied to all cases except for mortality cases (stillbirth and maternal death). This was because all death records were kept separately, and given the fact that there were not many deaths, all death records that met the selection criteria and where the ANC records were available, were all purposively included. This is in-line with the approach of the sample size estimation, in which it was asserted that the review of death records was not meant to generalise the mortality rate, but to examine the pattern of association.

The health policy at district level requires that all stillbirths and maternal deaths are to be reported to the health clinic that serves the residential address of the deceased (personal communication with nursing officers of the clinics and district matrons, Appendix A). These include un-booked cases and antenatal cases seen by private sector, which means there will be no ANC records available for these cases at this health clinic. It is therefore necessary to include only mortality cases that were seen and followed-up at the surveyed health clinics. In addition, inclusion of death cases follow-up at other sector or level of care might introduce confounder associated with possible variations in care.

3.7 DATA ANALYSIS

Data entry, processing, and analysis were done using statistical software IBM SPSS Statistics Version 21. The analysis used pregnant women as the unit of analysis for general analysis of respondent characteristics. Both descriptive and inferential analysis was performed:

- Descriptive statistics:
  - Initially descriptive statistics were computed to describe the respondents characteristics using univariate analysis such as distribution (frequency

distribution), central tendency (mean, median, mode), and dispersion (standard deviation). These included socio-demographic, obstetric histories, risk level, default behaviour, distribution by adequacy indexes.

  - Correlation was then performed to examine the association of adequacy with selected socio-demographic and obstetric factors or providers.

- Inferential analysis was performed using:
  - Ordinal regression to analyse factors associated with ANC utilisation.
  - GLM univariate to examine factors associated with ANC content.
  - Binary logistic regression to determine the association of ANC utilisation and ANC content with pregnancy outcomes (preterm birth, low birth weight, stillbirth and maternal complications), and to determine other risk factors of undesirable pregnancy outcomes.

3.7.1 Analysis on Adequacy of Antenatal Care Utilisation

The analysis on adequacy of ANC utilisation was based on a modified APNCU Index that uses the timing of first visit and the observed-to-expected visits ratio. The summarised concept of the original APNCU Index is presented in Figure 3.1.

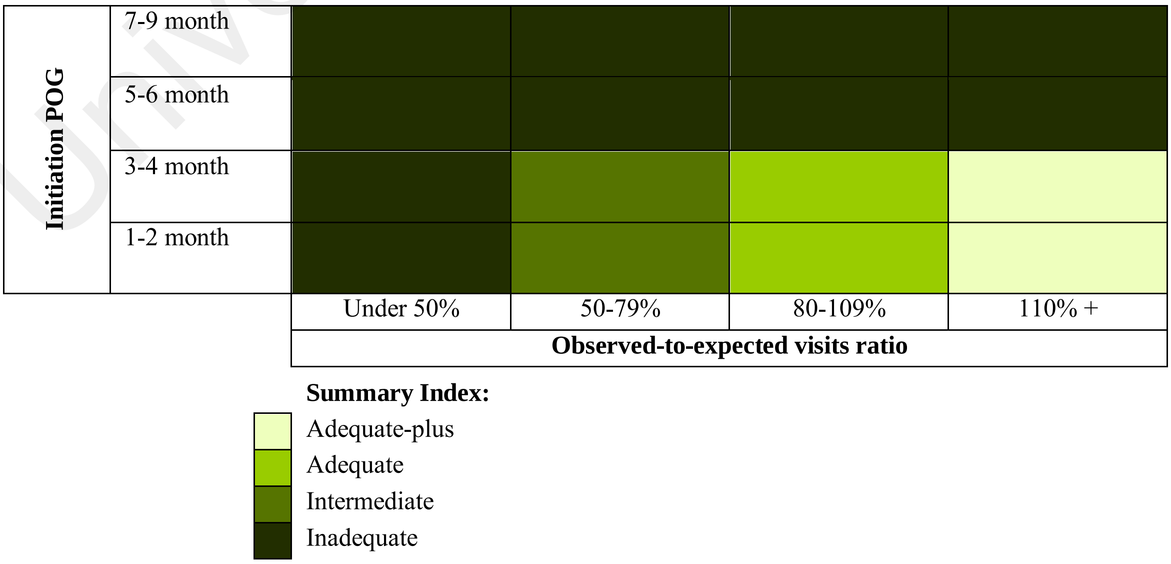


Figure 3.1: Summary of Original APNCU Index
Source: APNCU Index (Kotelchuck, 1994)

3.7.1.1 Definition of Parameters Used in Adequacy of Utilisation Index

The definitions for the parameters related to adequacy of utilisation index were explained in the Table 3.6 below.

Table 3.6: Operative Definitions for Parameters related to Adequacy of Utilisation Index

#	Parameters	Operative Definitions
1	POG at first visit	The gestational age in week of the first visit at the surveyed clinic for this pregnancy.
2	Expected number of visits	Based on the recommended number of visits according to the recommended schedule, adjusted for gestational age at birth.
3	Number of visits for ANC/ consultation	Included routine ANC check-up, consultation with healthcare providers including appointment for ultrasound since it involved doctor's attendance, dietary consultation by dietician.
4	Number of visits for specific procedure(s) only	Included sample taking for laboratory testing (e.g. MGTT, BSP), in which no consultation was provided, but excluded BP monitoring since records for BP monitoring was not consistently available.
5	Total number of visits	Total counts of #3 and #4.
6	ratio observed-to-expected visits, adjusted for gestational age	Proportion of #5 over #2 (which had already been adjusted for gestational age at birth).

3.7.1.2 Modification of Adequacy of Utilisation Index

The original APNCU Index was based on 13 recommended visits at 40-week gestation. In contrast, the Malaysian ANC guideline recommends ten visits for primigravida and seven visits for multigravida at 40-week gestation. This lower recommended visits results in increased "sensitivity" of the utilisation index.

To explain this, Table 3.7 presents the ranges of APNCU observed-to-expected visit ratio (≥ 110%, 80-109%, 50-79%, <50%) and the required corresponding actual number of ANC visits. For example, the corresponding actual number of visits for the observed-to-expected visits ratio of ≥ 110% range is 15 visits according to the APNCU Index, which mean additional two visits and above to the recommended 13 visits (Table 3.7). However, when this is applied to the Malaysian recommendation of ten and seven visits respectively, one additional observed visit compared with expected visit will fall into the range of ≥ 110% (adequate-plus), which is the bias critiqued by Koroukian and Rimm (2002). On the other hand, one additional visit at the recommended visits of 13 which the original index was based upon will still be within the 80-109% range.

Table 3.7: APNCU Index's Observed-To-Expected Visit Ratio Ranges and What It Looks like on the Recommended Antenatal Care Schedule of Malaysia

		APNCU				Malaysia MOH Primigravida				Malaysia MOH Multigravida			
recommended # of visits at POG40		**13**				**10**				**7**			
observed-to-expected visit ratio range (%)		**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**	**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**	**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**
≥ 110%	110%	15	115%	+2	15%	11	110%	+1	10%	8	114%	+1	14%
80-109%	109%	14	108%	+1	8%	10	100%	0	0%	7	100%	0	0%
	80%	11	85%	-2	-15%	8	80%	-2	-20%	6	86%	-1	-14%
50-79%	79%	10	77%	-3	-23%	7	70%	-3	-30%	5	71%	-2	-29%
	50%	7	54%	-6	-46%	5	50%	-5	-50%	4	57%	-3	-43%
< 50%	≤ 49%	6	46%	-7	-54%	4	40%	-6	-60%	3	43%	-4	-57%

Examples of these differences are further illustrated in Figure 3.2.

Figure 3.2: Implication of Original APNCU Index's Cut-off Points on the Recommended Antenatal Care Schedule of Malaysia

expected ANC visits / **observed ANC visits**	**original APNCU Index 13 visits**	**primigravida (Malaysia) 10 visits**	**Multigravida (Malaysia) 7 visits**
1	8%	10%	14%
2	15%	20%	29%
3	23%	30%	43%
4	31%	40%	57%
5	38%	50%	71%
6	46%	60%	86%
7	54%	70%	100%
8	62%	80%	114%
9	69%	90%	129%
10	77%	100%	143%
11	85%	110%	157%
12	92%	120%	171%
13	100%	130%	186%
14	108%	140%	200%
15	115%	150%	214%
16	123%	160%	229%

observed-to-expected (O/E) visit ratio category (%):	original O/E ratio category (APNCU Index)
	<50%
	50-79%
	80-109%
	>/=110%

The observed-to-expected visit ratio cut-off points therefore need to be modified to accommodate the lower Malaysia MOH's recommended visits (Table 3.8).

Table 3.8: Modification of APNCU Index's Observed-To-Expected Visit Ratio Cut-off Points to accommodate the lower recommended Antenatal Care Schedule of Malaysia

		APNCU				Malaysia MOH Primigravida				Malaysia MOH Multigravida				Modified observed-to-expected visit ratio range (%)
recommended # of visits at POG40		**13**				**10**				**7**				
observed-to-expected visit ratio range (%)		**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**	**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**	**corresponding actual # of visits**	**ratio (%)**	**difference to # of recommended visits**	**difference (%)**	
110%	110%	15	115%	2	15%	13	130%	3	30%	10	143%	3	43%	≥130%
80-109%	109%	14	108%	1	8%	12	120%	2	20%	9	129%	2	29%	90-129%
	80%	11	85%	-2	-15%	9	90%	-1	-10%	7	100%	0	0%	
50-79%	79%	10	77%	-3	-23%	8	80%	-2	-20%	6	86%	-1	-14%	60-89%
	50%	7	54%	-6	-46%	6	60%	-4	-40%	5	71%	-2	-29%	
<50%	≤ 49%	6	46%	-7	-54%	5	50%	-5	-50%	4	57%	-3	-43%	<59%

The modified ratio cut-off points become the following and is best illustrated in Figure 3.3 in comparison to the original APNCU Index:

- ≥ 130% (total ≥ 13 visits for primigravida or ≥10 visits for multigravida, which is an additional of ≥ 3 visits);
- 90-129% (total 9-12 visits or 7-9 visits respectively);
- 60-89% (total 6-8 visits or 5-6 visits respectively);
- <59% (total ≤ 5 visits or ≤ 4 visits respectively).

Figure 3.3: Cut-off Points for Observed-To-Expected Visits Ratio used in the Original APNCU Index and the Modified Index for this study in Malaysia

expected ANC visits / observed ANC visits	original APNCU Index 13 visits	primigravida (Malaysia) 10 visits	multigravida (Malaysia) 7 visits
1	8%	10%	14%
2	15%	20%	29%
3	23%	30%	43%
4	31%	40%	57%
5	38%	50%	71%
6	46%	60%	86%
7	54%	70%	100%
8	62%	80%	114%
9	69%	90%	129%
10	77%	100%	143%
11	85%	110%	157%
12	92%	120%	171%
13	100%	130%	186%
14	108%	140%	200%
15	115%	150%	214%
16	123%	160%	229%

observed-to-expected (O/E) visit ratio category (%):	original O/E ratio category (APNCU Index)	modified O/E ratio category for Malaysia study
	<50%	<59%
	50-79%	60-89%
	80-109%	90-129%
	>/=110%	>/=130%

In essence, these modified O/E ranges address the bias noted by Koroukian and Rimm (2002), circumvents the classification of "adequate-plus" when the actual number of visits exceeds the expected visits by just one visit. The categorisation for the gestational age of initiation followed the basis of APNCU Index, but was converted into weeks instead of the original unit of measure in "month" since the data recorded at the health clinics was in "week." This modified APNCU Index with adjusted observed-to-expected visit ratio presented in Figure 3.4 (APNCU-Malaysia).

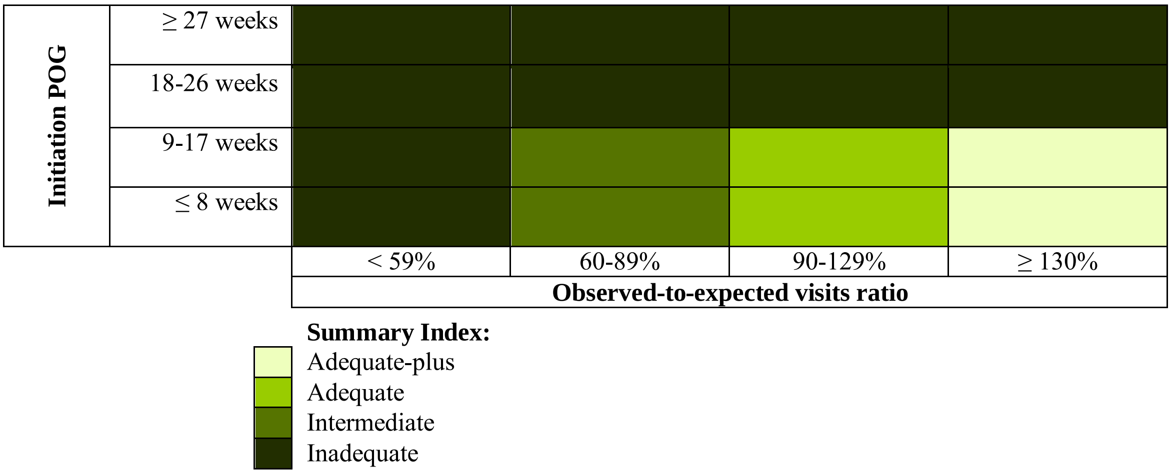


Figure 3.4: Modified APNCU Index Adjusted for the Recommended Schedule of Malaysia (APNCU-Malaysia)
Source: Adapted from APNCU Index (Kotelchuck, 1994)

The cut-off points for the observed-to-expected visit ratio of the adequacy categories were discussed with the Family Health Development Unit of Selangor State Health Department. It was agreed that the modified cut-off points were reasonable, especially considering the bias noted in the original index. In Malaysia where the average total visits for a pregnancy is already higher than the recommended schedule, lowering the proposed cut-off point might result in almost all pregnant women classified as had "adequate" and "adequate-plus." This would not be able to demonstrate the association or difference between utilisation level and pregnancy outcomes. On the other hand, raising the proposed cut-off points further would imply that the current recommended ten visits for primigravida and seven visits for multigravida are inadequate/ too low.

3.7.1.3 Adjustment to POG of Initiation for Prior Visit to other Provider

The POG at first visit was transformed into one of the four categories for POG of initiation: ≤ 8 weeks, 9-17 weeks, 18-26 weeks, ≥ 27 weeks. The classification according to the POG of initiation considered and provided for adjustment related to prior visit to other provider before the first visit at the health clinic. The purpose of this prior visit at other health facility had to be for "ANC check-up" only and did not consider prior visit made for pregnancy confirmation test (urine test or ultrasound). This was because pregnancy confirmation visit did not necessarily include antenatal check-up.

For prior ANC check-up at other health facility where the exact POG of check-up was indicated, this POG would be used as the POG of initiation (adjusted POG of initiation). When the POG of prior ANC check-up at other health facility was not known, the POG of initiation would then be adjusted by assigning to a level earlier than the POG of first visit at the health clinic. For example, if a pregnant woman had the first visit to the health clinic at 20 weeks of gestation, and the record indicated that the woman had ANC check-up at private clinic prior without stating when was the check-up done, the POG of initiation would then be adjusted to the "9 to 17 weeks" range.

3.7.2 Analysis on Adequacy of Antenatal Care Content

3.7.2.1 Compliance Criteria for Scoring

The routine ANC content for all women was based on the MOH guidelines (Ministry of Health, 2010), whereby the listing for health education was based on the listing in the MOH ANC booklet used during the first half of year 2013 (Ministry of Health). The routine ANC standards is categorised into four assessment components:

- Physical examination (PE)
- Health screening (HS)
- Case management (CM)
- Health education (HE)

The compliance criteria for scoring for each ANC intervention were explained in Appendix D. Where applicable, the criteria considered factors such as gestational age of birth, gestation of initiation, and user behaviour (number of visits made). This was important because the extent of adherence to ANC content, which had an implication on the quality of services delivery, would be inaccurate if for example late initiation of ANC or low number of visits due to user default were not considered.

The minimum requirement for routine medical examination (RME) was two RME. The first RME (RME1) was to be conducted at booking or by POG 24 weeks and the second RME (RME2) at 36 weeks. Owing to variation in practice across the clinics, this study set the cut-off points for RME2 at 31-36 weeks (±1 week).

3.7.2.2 Weighting of Compliance Score

As showed in Appendix D, each assessment component consists of varying number of ANC items. For example, PE has 14 items, HS has 9, CM has 7, and HE has 14. A straight forward totalling of scores therefore is not suitable. In addition, there is different level of importance among the four components. Weighting is therefore required, and the following weighting factor was adopted for each component:

- Physical examination (PE) = 0.30
- Health screening (HS) = 0.25
- Case management (CM) = 0.30
- Health education (HE) = 0.15

The assignment of weight for these assessment components was discussed with the Family Health Development Unit of Selangor State Health Department, based on the following reasoning:

- The stakeholders were of the opinion that PE and CM are the two most important aspects, while HS is compulsory to support the clinical care.
- Though HE is crucial, among all the components, the quality of HE is the least that could be standardised as there is many variants in terms of content, duration, delivery methods in which the information is not available for each

case in this retrospective study. Standardisation for HE in this study could only be based on whether a HE topic was covered. Therefore, it is less meaningful and inappropriate to assign heavier weight for HE.

- The weighting of 0.30, 0.25. 0.30 and 0.15 for various assessment component as showed above represents an optimal combination. This combination is able to establish a higher priority on PE and CM, followed by HS, and a reasonable lower weighting for HE as explained above. Other combinations would be less ideal as illustrated below:
  - 0.30, 0.30, 0.30, 0.10 – This combination is not able to demonstrate the difference between the importance of PE and CM versus HS;
  - 0.35, 0.25, 0.35. 0.05 – The difference between the highest weighting and lowest weighting is nearly one-third of the total. The extreme low assignment of weight to HE gives the impression that HE is insignificant.

The formula for computation of weighted score for each component is as below, and Table 3.9 presents the example for computation of weighted scores.

Formula of weighted score (E):

$$\frac{\text{score for an assessment component (B)}}{\text{max points for this assessment component (A)}} * \text{ weighting factor (C)} * \text{ total points for all components (D)}$$

Table 3.9: Example for Computation of Weighted Score

	(A)	(B)		(C)	(E)	
Assessment component	**max points**	**case X's score**	**case Y's score**	**weighting factor**	**weighted score (case X)**	**weighted score (case Y)**
PE (physical exam)	14	10	14	**0.30**	9.4	13.2
HS (health screening)	9	7	9	**0.25**	8.6	11.0
CM (case management)	7	5	7	**0.30**	9.4	13.2
HE (health education)	14	12	14	**0.15**	5.7	6.6
	(D) 44	**34**	**44**	**1.00**	**33.1**	**44.0**

Using the example of scores presented in Table 3.9, the computation is as follows:

e.g. E for PE (case X) =	10 / 14 * 0.3 * 44 = 9.4
e.g. E for PE (case Y) =	14 / 14 * 0.3 * 44 = 13.2

3.7.2.3 Cut-off Points/ Classification of Content Score

The total weighted scores of all the four assessment components are classified into the following categories of content adequacy:

- Adequate (80-100%)
- Intermediate (50-79%)
- Inadequate (<50%)

For inferential analysis, there are only two categories: adequate (≥ 80%), and inadequate (≤ 79% or <80%). The categorical cut-off points were consulted with the Family Health Development Unit of Selangor State Health Department; supporting that "adequate" ANC content should score at least 80% of the total scores since the ANC content assessed represents the minimum care content that a pregnant woman should receive. Other previous studies on ANC content also used the same cut-off points (Handler, et al., 2012; Majrooh, et al., 2014).

3.7.3 Analysis on Adequacy of Antenatal Care – Utilisation and Content

Initially, the researcher had planned to analyse the adequacy of ANC using a composite index of utilisation and content as illustrated below in Figure 3.5. The result of the composite index was originally planned to be used to determine the association between ANC adequacy (combined index) and the independent/ dependent variables considered in this study.

Adequacy of Content					
	< 50% Inadequate (1)	Inadequate	Inadequate	Inadequate	Inadequate
	50-79% Intermediate (2)	Inadequate	Intermediate	Intermediate	Intermediate
	80-100% Adequate (3)	Inadequate	Intermediate	Adequate	Adequate
		Inadequate (1)	**Intermediate (2)**	**Adequate (3)**	**Adequate plus (4)**
		Adequacy of Utilisation			

Summary Combined Index:
Adequate
Intermediate
Inadequate

Figure 3.5: Original Plan - Analysis of Antenatal Care Adequacy Using Composite Index

The composite index would be generated using SPSS's "Transform/Compute Variable" feature, using the following conditions/commands:

IF (Adeq_Content=3 & (Adeq_Uti=3 | Adeq_Uti =4)) Combi_index=Adequate.

IF ((Adeq_Content=2 | Adeq_Content=3) & (Adeq_Uti=1)) Combi_index=Inadequate.

IF ((Adeq_Content=1) & (Adeq_Uti <=4)) Combi_index=Inadequate.

ELSE=Intermediate [RECODE Combi_index (SYSMIS=2)]

Upon consultation with the statistician of the faculty, it was decided that using the composite index to determine the association of inadequate ANC with pregnancy outcomes would be less useful. The composite index would not be able to pinpoint if the adverse pregnancy outcomes was associated with utilisation inadequacy or content inadequacy, and thus, less specific in diagnosing the possible gap in delivery of ANC. Instead, analysis on ANC adequacy and pregnancy outcomes used binary logistic regression model which contained both utilisation adequacy and content adequacy as the predictors (independent variables).

3.7.4 Statistical Procedures and Approaches for Testing Association

Statistical procedures and approaches used to examine the study objectives, in particular in analysing the association of independent and dependent variables are detailed in Appendix E. In summary:

Objective 1 - cross-tabulation and chi-square test were used to estimate proportion of pregnant women who have adequate or inadequate ANC (utilisation and content).

Objective 2 - ordinal regression was used to determine the associated factors of ANC utilisation. Link function of "Complementary Log-log" was used because higher categories are more probable. The approach involved:

- First step - A full model containing all the variables identified was first constructed.
- Second step - A stepwise model was then employed manually using only the significant variables ($P<0.05$), based on the previous full model in the first analysis.
- Test of Parallel Lines was performed to assess if assumption of parallel lines was met ($P>0.05$). Random case selection at 30% and 20% was applied to test the parallel lines for both the full and stepwise models [small p-value <0.05 of assumption of parallel lines could be due to large sample size (Chinna, 2014b)].
- Result of the analyses was based on the full sample size models since it is more inferential to report using larger sample size.

Objective 3 used GLM Univariate to determine the extent of adherence to requirements for routine ANC. Backward elimination method was used by including all relevant variables in a model, then dropped the non-significant variables ($P>0.1$) one by one until all remaining variables are significant.

Descriptive analysis (frequency, min, max, and mean) was used to examine the extent of adherence for selected recommended practices (Objective 4). Lastly, binary logistic regression was used to determine the association between ANC adequacy (utilisation and content) as well as other factors and pregnancy outcomes (Objective 5). The analyses included both univariate analyses as well as multivariate analysis.

3.7.5 Regrouping of Categorical Variables

3.7.5.1 Objective 2: Association between adequacy of antenatal care utilisation among pregnant women and selected factors

The analysis in this aspect was first attempted using the original categories of the related variables—adequacy of ANC utilisation and socio-demographic, obstetric history and risk level variables—that contained more categories. However, all the outputs of these variables from chi-square test violated the chi-square assumption concerning the minimum expected cell frequency which requires at least 80% of the cells to have expected frequencies of 5 or more (Field, 2013; Pallant, 2010). Hence, the categories of the variable had to be regrouped (collapsed) into fewer categories. The results in Chapter 4 were based on the regrouped variables, in which the dependent variable, adequacy of ANC utilisation, was categorized from four categories into three categories by combining the “inadequate” and “intermediate” since “intermediate” should not be considered as “adequate.” In addition, some of the original categories of independent variables used during data collection were also collapsed into fewer categories.

3.7.5.2 Objective 3: Difference in extent of adherence to requirements of recommended routine antenatal care content and providers

There was no pregnant woman who scored “inadequate” content. Nevertheless, the analysis classified those with “intermediate” score as “inadequate.” There were, therefore, two ANC content categories: inadequate and adequate.

Originally, staff nurses without post-graduate qualification were classified as staff nurse with less than 3 years working experience, and staff nurse with more than 3 years working experience. Owing to the low frequency of attendance by staff nurse without postgraduate, the analysis collapsed these two variables into one variable: staff nurse without postgraduate qualification. Nevertheless, as the frequency of attendance by staff nurse without postgraduate remained low after combining all years of experience, this staff cadre variable was excluded from subsequent regression analysis.

3.7.5.3 Objective 5: Association between antenatal care adequacy (utilisation and content) as well as other factors and pregnancy outcome:

Pregnancy outcomes for gestational age at birth, birth weight, birth outcome and maternal outcome were collapsed into two categories for binary logistic regression. The dichotomous variables were preterm birth, low birth weight, stillbirth and maternal complications.

3.7.6 Effect Size of Correlation Coefficient

The association between content score (as measured by percentage of total ANC content score) and attendance by specific providers (as measured by percentage to total visits attended by specific providers) was investigated using Pearson product-moment correlation coefficient. The strength of the association is determined based on the following Cohen’s guidelines (Field, 2013):

Small effect	r = 0.10 to 0.29
Medium effect	r = 0.30 to 0.49
Large effect	r = 0.50 to 1.00

3.8 ETHICAL CONSIDERATION

The study protocol was reviewed and approved by the Research and Ethics Committee of University of Malaya on 22nd May 2013 (MEC Ref. No. 989.26). Ethical approval was also obtained from the Medical Research and Ethics Committee of Ministry of Health since this study involved the review of patient records at the health clinics (Approval reference: (2) dlm.KKM/NIHSEC/80Q-2/2/2 Jld2.P13-667, dated 18th July 2013).

There was no risk since this study only reviews the medical records for data extraction and did not involve any medical intervention. Confidentiality of patients was ensured since no personal information was used in data analysis. Patient records/information was anonymised and de-identified prior to analysis.

3.9 SUMMARY: METHODS

This retrospective cohort study involved the review of 522 ANC records from the public health facilities in the state of Selangor. Six primary health clinics were selected based on multi-stage random sampling. Sample-size estimate informed that 465 samples were required for this study. All the health clinics in Selangor were stratified into three strata using their expected daily workload as the stratification variable. Two clinics were selected from each stratum. The number of samples (women's ANC records) required from each of the stratum was estimated according to proportional allocation, taking into considerations the expected daily patient loads, required total sample size, and distribution of white-tag women versus colour-tag women in real life setting. The required number of ANC records was then systematically selected and screened using inclusion and exclusion criteria.

The dependent variables were pregnancy outcomes (preterm birth, LBW, stillbirth and maternal complications), adequacy of ANC utilisation and adequacy of ANC content. The independent variables included the pregnant women and provider characteristics, adequacy of utilisation and adequacy of content.

Adequacy of ANC was examined in terms of: (i) adequacy of utilisation that considered gestational age for first visit and observed-to-expected visits ratio, whereby the original APNCU Index was modified to match the lower recommended ANC schedule in Malaysia; and (ii) adequacy of content computed using the MOH guidelines in which the practices were grouped into the components of physical examination, health screening, case management, and health education. The weighting of scoring for each component was applied.

ANC utilisation and associated factors were analysed using ordinal regression, whereas ANC content was explored using GLM univariate. The association between utilisation and content adequacy with pregnancy outcomes—preterm birth, low birth weight, stillbirth and maternal complications—were examined using logistic regression, adjusted for associated factors.

Ethics approvals were obtained from the Research and Ethics Committee of University of Malaya, as well as from the Medical Research and Ethics Committee of Ministry of Health Malaysia. Patient records/information was anonymised and de-identified prior to analysis.

CHAPTER 4: RESULTS

For easy reading, the results are presented and arranged according to the listed objectives. The presentation of the study findings begins with the respondent characteristics, followed by the results in accordance to the study objectives - status of ANC adequacy; factors associated with adequacy of ANC; adherence to recommended ANC content and selected recommended practices; association of ANC utilisation, content, and other factors with pregnancy outcomes. Some of the relevant details of the results are provided in Appendix F. At the end of the chapter, the main results are summarised.

4.1 RESPONDENTS CHARACTERISTICS

4.1.1 Respondents Distribution

As shown in Table 4.1, there were a total of 522 respondents included in this data analysis. The distribution by clinic type and tagging colour were in accordance with the specification of sampling requirements described in Chapter 3.

Table 4.1: Distribution of Respondents by Clinic, Clinic Category, and Tagging

Health Clinic	District	Clinic by expected daily workload			Total	Tag colour		Total
		301-500	150-300	<150		white	colour	
1 Ampang	Hulu Langat	86 (16.5%)	-	-	86 (16.5%)	35 (6.7%)	51 (9.8%)	86 (16.5%)
2 Puchong	Petaling	91 (17.4%)	-	-	91 (17.4%)	27 (5.2%)	64 (12.3%)	91 (17.4%)
3 Section 19 SA	Petaling	-	128 (24.5%)	-	128 (24.5%)	40 (7.7%)	88 (16.9%)	128 (24.5%)
4 Batu 9 Cheras	Hulu Langat	-	119 (22.8%)	-	119 (22.8%)	35 (6.7%)	84 (16.1%)	119 (22.8%)
5 Bt. Changgang	Kuala Langat	-	-	50 (9.6%)	50 (9.6%)	16 (3.1%)	34 (6.5%)	50 (9.6%)
6 Sekinchan	Sabak Bernam	-	-	48 (9.2%)	48 (9.2%)	7 (1.3%)	41 (7.9%)	48 (9.2%)
Total		**177 (33.9%)**	**247 47.3%**	**98 (18.8%)**	**522 (100.0%)**	**160 (30.7%)**	**362 (69.3%)**	**522 (100.0%)**

In term of distribution by clinic type, 33.9%, 47.3%, and 18.8% were from clinic category of 301-500, 150-300, and <150 daily expected workload respectively. In total, 30.7% were white-tags and 69.3% colour-tags.

4.1.2 Respondents Characteristics

The detailed respondents characteristics by clinic category are tabulated in Appendix F. A brief description of their characteristics by socio-demographic factors, obstetric histories, and risk level of pregnancy is presented in the following sections.

4.1.2.1 Socio-demographic

(a) Maternal Age

The mean maternal age at first visit was relatively young at 28.7 years, the youngest being 16, and the oldest 46. Majority of the respondents, 84.1%, were from the age-group of 20-34. There were 2.1% (11) teenage pregnancies. Pregnant women aged 35 and above constituted 13.8% of the total 522 respondents.

(b) Ethnicity

Majority of the respondents, 75.9% were Malay, followed by 12.8% Chinese, 8.4% Indian, and 2.9% Indigenous people.

(c) Education Level

Over half (56.3%) of the pregnant women had secondary education. Over one-third (37%) had tertiary education in which 21.3% studied up to certificate or diploma level while 15.7% up to advanced diploma, degree or higher. There were 3.6% with primary education and only 0.8% (four women) without any formal education.

(d) Occupation (Pregnant Women)

The highest proportion, 38.1%, of the pregnant women fell under the occupation category of "Others," in which housewives constituted 37.0%, students 1.0%, and unemployed 0.2% (single mother status).

The most common formal occupation among the respondents was "Clerical workers" (16.7%), followed by "Technicians and associate professionals" at 12.8%. "Professional" and "Legislators, senior officials and managers" were 12.2%. In total, 25% of the pregnant women worked at the top-3 tiers of occupations (Legislators, senior officials and managers; professional; technicians and associate professionals). "Service workers, shop and market sales workers" constituted 12.1%. The remaining were factory operators, and fewer were elementary occupations (1.5%).

(e) Occupation (Spouses)

41.2% of the spouses worked in the top-3 tiers occupations, with "Technicians and associate professional" constituted 28.7%. Service workers and factory operators were around 18% each. Agriculture, fishery and craft workers were around 7%.

4.1.2.2 Obstetric Histories

(a) Gravidity

The mean gravidity was 2.4. Primigravidas were 33.3% and multigravidas were 66.7%. For multigravida, majority was in the range of gravida 2 to 4 (56.3%). Gravida 5 and above was 10.3%.

(b) Parity

The mean parity was 1.2. Nulliparous was 37.4%, and multipara 62.6% in which 56.9% and 5.7% were para 1 to 3 and Para 4 and above respectively.

(c) Miscarriage History

The difference in the figures for primigravida (33.3%) and nulliparous (37.4%) was due to past history of incomplete pregnancy (mainly miscarriage). In total, 19% of the women had at least one miscarriage (mean 0.2).

(d) History of complications during previous pregnancy (GDM, PIH, anaemia, PP, miscarriage)

Twenty-seven percent of pregnant women had a history of complications during previous pregnancy which included mainly history of GDM, PIH, anaemia, placenta praevia, and miscarriage, as compared to 39.7% without pregnancy complications in previous pregnancy. There were 33.3% primigravida who were not pregnant before therefore were not applicable to this assessment.

(e) History of complications during previous delivery (premature, caesarean, assisted delivery, PPH, stillbirth, NND)

The finding showed 18.8% of the pregnant women had complications during previous delivery; the complications included premature deliveries, caesarean, instrumental deliveries, PPH, stillbirth and neonatal death. Majority, 43.9%, did not have complications in previous delivery, while 37.4% were nulliparous who had not delivered before therefore were not applicable to the analysis.

4.1.2.3 Risk Level

The proportionate sampling required 30% white-tags and 70% coloured-tags. Accordingly 30.7% of the respondents had white-tags and 69.3% coloured-tags.

Table 4.2: Distribution of Risk Code at First and Last Visit

Risk Code (n=522)	First Visit (%)	Last Visit (%)
White	48.1	30.7
Green	46.6	41.2
Yellow	5.0	26.8
Red	0.4	1.3

The risk level and thus the colour of the women's tag changed when their pregnancy changed in risk. The changes of the risk code (tag colour), between the first visit and last visit, is presented in Table 4.2. During the first visits, 48.1% of the women were tagged as white, 46.6% as green and only 5.0% were yellow. Red-tag at first visit was 0.4% (two cases). By last visit, the proportion of white-tags was reduced to 30.7%, represented a 17.4% reduction. Meanwhile, the yellow-tags were increased from 5.0% to 26.8%. Red-tags at the last visit remained low at 1.3% (seven cases).

In total, 71.8% were considered low-risk pregnancies which consisted of white and green-tags, while 28.2% were high-risk pregnancies (yellow and red-tags).

a) Risk level and history of complications during previous delivery (premature, caesarean, assisted delivery, PPH, stillbirth, NND)

In the categorisation of women with previous delivery complications, 37.4% were nulliparous whom were not applicable to the variable related to "previous delivery history", 43.9% were multiparous without previous delivery complications, and 18.8% were multiparous with previous delivery complications (Table 4.3).

Table 4.3: Distribution by Risk Level and History of Complications in Previous Delivery*

History status		Risk Level		Total
		Low-risk	High-risk	
No hx of delivery complications (multiparous)	N	173	56	229
	% within history of previous delivery complications	75.5%	24.5%	100.0%
	% within risk level	46.1%	38.1%	43.9%
	% of Total	33.1%	10.7%	43.9%
Has hx of delivery complications (multiparous)	n	60	38	98
	% within history of previous delivery complications	61.2%	38.8%	100.0%
	% within risk level	16.0%	25.9%	18.8%
	% of Total	11.5%	7.3%	18.8%
Not applicable (nulliparous)	n	142	53	195
	% within history of previous delivery complications	72.8%	27.2%	100.0%
	% within risk level	37.9%	36.1%	37.4%
	% of Total	27.2%	10.2%	37.4%
Total	n	375	147	522
	% within history of previous delivery complications	71.8%	28.2%	100.0%
	% within risk level	100.0%	100.0%	100.0%
	% of Total	71.8%	28.2%	100.0%

* include premature, caesarean, assisted delivery, post-partum haemorrhage, stillbirth, neonatal death

However, 36.1% of the total high-risk cases (yellow and red-tags) were reported among the nulliparous, and the remaining 64% of the high-risk cases were among the multiparous.

4.1.2.4 User Utilisation Behaviours

(a) Defaulting of appointment

In total, 28.5% of the pregnant women had defaulted ANC appointment(s) during their pregnancy; either absence in between appointments or stopped coming before due date. The average default was 1.4 times. Among the defaulters (n=149), 73.2% defaulted one time, 18.8% defaulted two times, 5.4% three times, and 2.7% 4 times.

(b) Indication seen by other provider prior to first visit

Analysis by documented indication seen by other provider prior to the first visit at the health clinics showed 43.5% of the pregnant women had been seen by other provider prior. The distribution by ethnicity - Malay, Chinese, Indian and Indigenous were 70.9%, 18.1%, 9.7%, and 1.3% respectively, compared to those without indication seen by other provider prior at 79.7%, 8.8%, 7.5%, and 4.1% respectively (p=0.003).

The purpose of their prior consultation was mainly for pregnancy test (Table 4.4). There was also a large proportion that had early ultrasound done prior. Among these women, 12.8% (or 5.6% of total respondents) had the ANC check-up done by other provider prior to their first visit.

Table 4.4: Purpose of Prior Visit to Other Provider

Purpose for prior visit at other provider (n=227)	n	%
Pregnancy test	91	17.4
Early ultrasound	59	11.3
Pregnancy test and early ultrasound	48	9.2
ANC booking/check-up	29	5.6
Subtotal	227	43.5
No indication seen by other provider	295	56.5
Total	522	100.0

The distribution in each ethnic group that went for ANC check-up were 9.3%, 31.7%, 4.5%, and 0.0% respectively among the Malay, Chinese, Indian and Indigenous (p=0.006).

(c) POG of Initiation

Table 4.5 below provides an overview of descriptive statistics related to ANC utilisation. The average POG when the women sought for ANC at the clinics was around 13.7 weeks; the earliest being at the 4^{th} weeks and latest was at the 37^{th} weeks.

Table 4.5: Descriptive Statistics related to Antenatal Care Utilisation Data

ANC Utilisation Patterns	N	Min	Max	Mean	SD
1) POG at Visit-1 (at this clinic)	522	4	37	13.68	5.49
2) expected # of visits (based on recommended schedule adjusted for gestational age at birth)	522	2	11	6.98	1.74
3) number of visits for ANC/ consultation	522	1	23	10.22	2.99
4) number of visits for specific procedure(s) only	522	0	15	1.58	2.67
5) total # of visits (total of #3 and #4)	522	2	36	11.78	4.62
6) ratio observed-to-expected visits, adjusted for gestational age	522	40	625	176.02	78.84

In term of distribution of the pregnant women by the POG of initiation, 16.9% sought for ANC (at the clinics) at 8-week or earlier, while majority (64.8%) went for ANC check-up at 9 to 17 weeks. In total, 18.4% had late check-up at 18-week or later (Table 4.6).

Table 4.6: Distribution by Period of Gestation of Initiation (at the clinics)

POG of Initiation	n	%	Cumulative %
>=27 weeks	13	2.5	2.5
18-26 weeks	83	15.9	18.4
9-17 weeks	338	64.8	83.1
<=8 weeks	88	16.9	100.0
Total	522	100.0	

(d) Observed-to-Expected Visits Ratio

Table 4.5 earlier also shows that the average expected number of visits (based on standard recommended schedule of MOH, and adjusted for gestational age at birth) was around 7 visits (min = 2, max = 11). On the contrary, the average total number of visits irrespective of POG at first visit/booking was close to 12 visit (min = 2, max = 36), almost double the number of expected visits. The wide interval between the min and max value was due to extreme late booking, and colour-tag cases requiring frequent visits for specific procedures. The substantial difference between the observed and the expected visits results in a high mean O/E ratio of 176.0% (Table 4.5)

4.1.2.5 Revised Expected Date of Delivery

In total, 22.4% of the pregnant women have been given a revised expected date of delivery (REDD). Among the women with REDD, around 40% (47 cases) reported "unsure of date" (USOD).

4.1.2.6 Family Planning Practice before Pregnancy

Only 22.0% were recorded practicing family planning prior to the pregnancy. Among those practicing family planning (n=115), the most common method was oral contraceptive pill (OCP) at 60%, followed by condom at 12.2%, and injection at 11.3%. There was also 10.4% reported using non-modern method.

4.1.3 Providers Characteristics

The distribution of the type of personnel at each type of clinic based on expected workloads was tabulated in Appendix F. Clinics with expected daily workload of 301-500 and 150-300 assigned two medical officers to attend to maternal and child health users on a daily basis. These clinics also had in-house Family Medicine Specialist whom the medical officers could refer the high-risk pregnant women. Clinics with expected daily workload below 150 had one medical officer responsible for maternal and child health services. This type of smaller clinics also had access to Family Medicine Specialist on a scheduled visiting basis (around once every two weeks).

Total nursing staff for MCH services were around 40 for clinics with 301-500 expected daily workload and around 23-25 staff for clinics with 150-300 expected daily workload. The clinics with below 150 expected daily workload had less than 10 nursing staff. In general, majority of the nursing staff were community nurses, ranging from around 40-60% of total nursing staff. Staff nurses with postgraduate qualification constituted around 20-25% of total nursing staff.

4.1.4 Proportion of Pregnant Women by Pregnancy Outcomes

Table 4.7: Distribution of Pregnancy Outcomes

Pregnancy Outcomes	n	%
Gestational age at birth		
≥ 37 weeks	486	93.1
<37 weeks (preterm birth)	36	6.9
Total	522	100.0
Birth weight		
≥ 2,500g	455	87.2
<2,500g (LBW)	66	12.6
Total	521	99.8
Missing	1	0.2
Total	522	100.0
Birth outcomes		
Livebirth	506	96.9
Stillbirth	16	3.1
Total	522	100.0
Maternal complications		
No	489	93.7
Yes	33	6.3
Total	522	100.0

Table 4.7 shows that 6.9% of the total women delivered a live-birth before 37 weeks of pregnancy in this study. This translates to the preterm birth (<37 weeks of gestation) rate per 100 live-births of 7.1%, which is lower than the national rate of 12% (WHO, 2014b). The mean gestational age among the preterm birth was 34 gestational weeks (min 29, max 36).

LBW was 12.6%, about similar to the national rate of 11% (WHO, 2014b). As for stillbirth, the national rate was 6 per 1,000 total births (WHO, 2014b). This study found

3.1% of stillbirths out of the total samples (crudely translated to 31 per 1,000 total births) due to purposive sampling of death records as explained in the Methods chapter.

There was only one maternal death that met the eligibility criteria; the case was included in maternal complications outcome. Maternal complications outcome in this study consisted of women with any of this combination of conditions: retained placenta, PPH, impending eclampsia or pre-eclampsia, postnatal high BP, postnatal infection (wound or systemic infection e.g. fever), postnatal severe anaemia, unknown reason for admission or long hospital stay, maternal death.

For preterm birth, there was a significant association with the risk status (P=0.024), high-risk women were significantly associated with preterm birth (Table 4.8 below). Though LBW and maternal complications were not statistically associated with risk status of the women (possibly due to small sample size in the distribution of the frequency cells), it appeared that a larger proportion of high-risk women had LBW and maternal complications compared to low-risk women. The difference of stillbirth by risk status was not obvious.

Table 4.8: Distribution of Pregnancy Outcomes by Risk Level

Pregnancy Outcomes	All women (n=522), n(%)		Low-risk (n=375), n(%)		High-risk (n=147), n(%)		p
	No	Yes	No	Yes	No	Yes	
Preterm birth (n=36/522)	486 (93.1)	36 (6.9)	355 (94.7)	20 (5.3)	131 (89.1)	16 (10.9)	0.024
Low birth weight (n=66/521)	455 (87.3)	66 (12.7)	333 (89.0)	41 (11.0)	122 (83.0)	25 (17.0)	0.062
Stillbirth (n=16/522)	506 (96.9)	16 (3.1)	364 (97.1)	11 (2.9)	142 (96.6)	5 (3.4)	0.780
Maternal complications (n=33/522)	489 (93.7)	33 (6.3)	355 (94.7)	20 (5.3)	134 (91.2)	13 (8.8)	0.138
Adverse foetal outcomes (n=86/521)	435 (83.5)	86 (16.5)	321 (85.8)	53 (14.2)	114 (77.6)	33 (22.4)	0.022
Adverse pregnancy outcomes (all) (n=111/521)	410 (78.7)	111 (21.3)	304 (81.3)	70 (18.7)	106 (72.1)	41 (27.9)	0.021

When all the foetal outcomes (preterm birth, LBW and stillbirth) were combined as adverse foetal outcomes, the results showed that a larger proportion of high-risk women were significantly associated with adverse foetal outcomes (P=0.022). Likewise, when all outcomes were combined as one adverse pregnancy outcomes, the results showed that larger high-risk women were significantly associated with adverse pregnancy outcomes (P=0.021).

4.2 ASSESSING STATUS OF ANTENATAL CARE ADEQUACY (UTILISATION AND CONTENT)

Table 4.9: Distribution of Pregnant Women by Antenatal Care Adequacy Indexes

ANC Adequacy Index (N=522)	n	%	Cumulative %
Adequacy of utilisation (APNCU-Malaysia Index)			
Inadequate	97	18.6	18.6
Intermediate	10	1.9	20.5
Adequate	85	16.3	36.8
Adequate-plus	330	63.2	100.0
Adequacy of content			
Inadequate (<50%)	0	0.0	0.0
Intermediate (50-79%) – categorised as “inadequate” in analysis	270	51.7	51.7
Adequate (80-100%)	252	48.3	100.0
Adequacy of utilisation * Adequacy of content)			
Inadequate utilisation * Inadequate content	62	11.9	11.9
Inadequate utilisation * Adequate content	45	8.6	20.5
Adequate utilisation * Inadequate content	208	39.8	60.3
Adequate utilisation * Adequate content	207	39.7	100.0

4.2.1 Adequacy of Utilisation

Table 4.9 above revealed that in total, 18.6% of the pregnant women had “inadequate” utilisation, 1.9% had “intermediate,” 16.3% had “adequate,” and 63.2% had “adequate-plus” utilisation. Based on this tabulation, it appeared that there was a high proportion of pregnant women who had “adequate-plus” utilisation which meant that they had ANC utilisation which was higher than the recommended schedule.

Tabulation of utilisation adequacy and risk code showed that among the “adequate-plus,” around 28% were white-tags who could be managed according to the recommended schedule. Furthermore, in total, these 63.2% of women in “adequate-plus” category translated to 42.3% out of 71.8% of low-risk women and 20.9% out of 28.2% of high-risk women. 7.3% of high-risk did not have “adequate-plus” utilisation (total high-risk women were 28.2%). Among these high-risk women without “adequate-plus” utilisation, 42.1% (16/38) were ever referred to a hospital for additional consultation at 28 weeks onwards, 13.2% (5/38) were ever referred to a hospital before 28 weeks, and 44.7% (17/38) had no documented referral to a hospital.

Table 4.10: Visit Parameters (Type of Visits)

Visit Parameters (n=522)	Min	Max	Mean
number of expected visits	2	11	6.98
number of visits for ANC/ consultation	1	23	10.22
number of visits for specific procedure(s) only	0	15	1.58
total number of observed visits	2	36	11.78

Table 4.10 presents the statistic by type of visits. The mean number of expected visits was around 7. In reality, the mean total number of observed visits was close to 12. The mean number of visits for specific procedure(s) was 1.6. Overall, 53.6% of the pregnant women had made at least one visit for specific procedure (28.2% had one such visit, and 25.4% had 2 and above such visits).

4.2.2 Adequacy of Content

Distribution by ANC content adequacy showed that there was no pregnant woman who had less than 50% of the recommended routine ANC content documented. However, 51.7% of women had less than 80% of recommended routine ANC content documented which was categorised as inadequate level in the analysis. Accordingly, 48.3% had more than 80% (categorised as adequate level) of recommended routine ANC content documented (Table 4.9 earlier).

Table 4.11: Distribution of Weighted Content Scores (%) by Assessment Components

Assessment Components	N	Min	Max	Mean
% weighted PE score	522	43	100	84.59
% weighted HS score	522	44	89	84.67
% weighted CM score	522	43	100	84.13
% weighted HE score	522	7	71	35.26
% Total ANC content score	**522**	**49.2**	**90.8**	**77.07**

Table 4.11 above presents the mean of the weighted score by all the four assessment components. The average score for PE, HS and CM were similar at around 84% each. HE had the lowest score at only around 35% on average, with an equally lower min and max scores (7% and 71%). The average for the total score was around 77%, which fell under the inadequate category defined in this study.

The checklist for antenatal health advice, which was the basis for this assessment and which was supposed to guide the providers in ensuring the completeness of health advice topics provided, was found to be rarely used by the providers. Forty-five percent of the antenatal advice checklist pages in the women's record were not used at all by the providers. Instead, antenatal advice given was written in the treatment/ case management column. Thirty-seven percent of the checklists were used, in which the list of the topics was partially covered. Only 8% of the used checklists covered majority of the topics. The remaining 11% of the records used the old recording booklet without supplementing this checklist that was not included in the old format.

Analysis by the topics of the antenatal advice documented as given showed some of the topics were more frequently given while some of the topics were rarely given (Table 4.12 below). Antenatal dietary advice was given to almost all pregnant women (99.2%), the mean number of times given was 5.4. In comparison, some advice was seldom given. For example, advice on postnatal care was given to 5.2% of pregnant women, and advice on physical exercise was given to 3.3% of pregnant women only (Table

4.12). A common advice frequently given to most women "adequate rest and sleep" (mean 2.7) was actually not part of the health advice topics in the checklist.

Table 4.12: Documented Antenatal Advice provided - Mean of Number of Times Advised, and Percentage of Pregnant Women Advised

Antenatal advice topics assessed based on official checklist	Mean	All women (n=522) Given, %	Low-risk (n=375) Given, %	High-risk (n=147) Given, %
nutritional/dietary advice - antenatal	5.42	99.2	98.9	100.0
nutritional/dietary advice - postnatal/ breastfeeding	0.01	1.3	1.3	1.4
recommendations for family planning/ contraception	1.55	66.7	71.7	53.7
preparation for birth	1.44	73.9	81.1	55.8
birth process (S&S and related advice)	2.18	84.3	88.0	74.8
common discomfort during pregnancy and solutions	0.25	22.6	23.5	20.4
recommendations for breastfeeding	1.17	71.3	72.0	69.4
common disorders in pregnancy (at least 2 topics below)	-	26.1	20.5	40.1
PIH	0.03	-	-	-
PE/ IE	0.31	-	-	-
GDM/ hypo & hyper	0.18	-	-	-
anaemia	0.52	-	-	-
bleeding during pregnancy	0.47	-	-	-
early booking	0.06	6.1	6.7	4.8
foetal development	0.17	12.8	14.9	7.5
exercise antenatal/ postnatal	0.03	3.3	3.5	2.7
newborn care, baby bathing	0.00	0.4	0.3	0.7
jaundice baby care include S&S	0.20	19.7	21.6	15.0
postnatal care	0.06	5.2	5.6	4.1

Majority of the advice was less frequently provided to the high-risk women than the low-risk. This included family planning (53.7% versus 71.7%), preparation for birth (55.8% versus 81.1%) and birth process (74.8% versus 88.0%). On the other hand, advice on common disorders in pregnancy was more often provided to high-risk than low-risk women (40.1% versus 20.5%).

4.2.3 Adequacy of Utilisation and Content

Cross-tabulation of adequacy of utilisation and adequacy of content showed the following results for the following combinations:

- Inadequate utilisation and inadequate content 11.9%
- Inadequate utilisation and adequate content 8.6%
- Adequate utilisation and inadequate content 39.8%
- Adequate utilisation and adequate content 39.7%

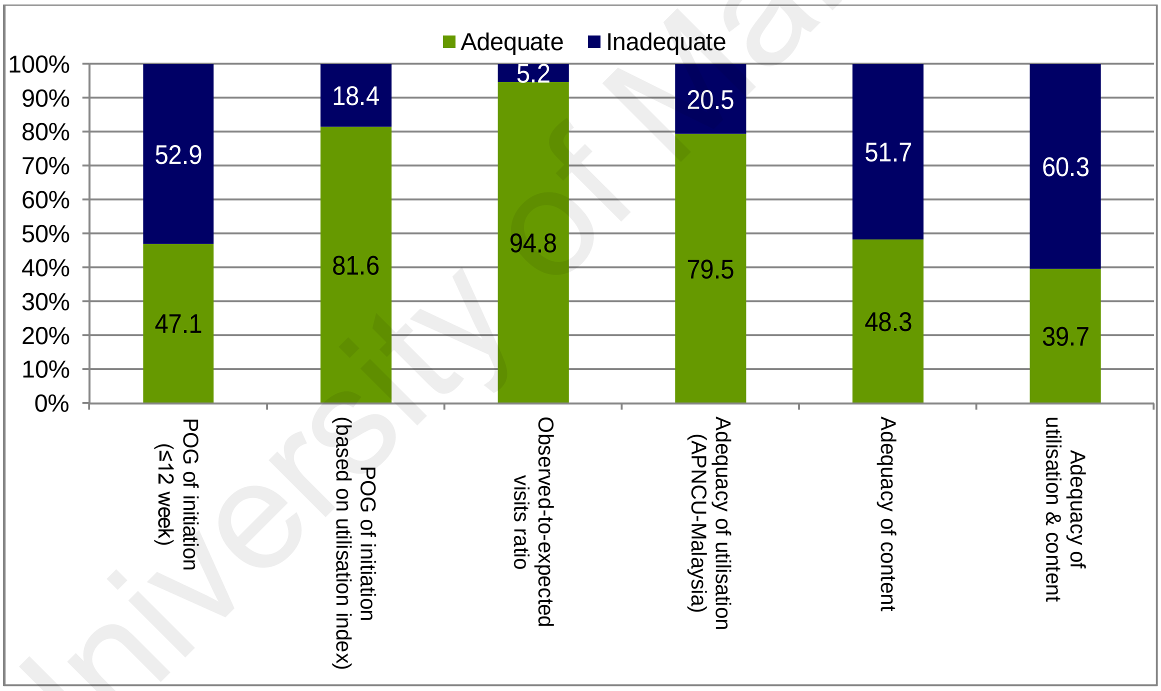
4.2.4 Adequacy of Antenatal Care by Different Indicators/ Index

Figure 4.1 tabulated the proportion of pregnant women with "Adequate" and "Inadequate" ANC using the different indicators discussed earlier. For easy comparison, the results were re-categorised into two categories, namely "adequate" and "inadequate." The indicators were explained below, providing the definition of "adequate" and "inadequate" that was used for the purpose of presenting the comparison in Figure 4.1:

- POG of initiation (≤ 12 weeks) - POG of first ANC visit by 12 weeks. In order to be consistent with the data collected by MOH, "Adequate" meant first ANC visit at or before 12 weeks, and "inadequate" covered those 13 weeks and above.
- POG of initiation (based on Utilisation Index) - POG of first ANC visit, based on the modified Adequacy of Utilisation Index (APNCU-Malaysia). In order to be in-line with the Adequacy of Utilisation Index (APNCU-Malaysia), "adequate" denoted first ANC visit at or before 17 weeks, and "inadequate" covered those 18 weeks and above.
- Observed-to-expected visits ratio.To be in-line with the modified Adequacy of Utilisation Index (APNCU-Malaysia), "adequate" included ratio of 90% and above, and "inadequate" was 89% and below.
- Adequacy of utilisation (based on APNCU-Malaysia considering POG of initiation and observed-to-expected visits ratio) - The original four categories

were combined, in which "adequate-plus" and "adequate" became "adequate," and "intermediate" and "inadequate" were combined as "inadequate."

- Adequacy of content (based on recommended routine ANC content documented) - The original three categories were combined, in which "adequate" remained as "adequate" (80-100%), and "intermediate" and "inadequate" were combined as "inadequate" (79% and below).
- Adequacy of utilisation and content in which "adequate" denoted adequate utilisation and adequate content, the remaining combinations was categorised as "inadequate."



Note: refer to the write-up above for definition of "adequate" and "inadequate" for each indicator/index.

Figure 4.1: Measuring Antenatal Care Using Different Indicators and Indexes

As shown in Figure 4.1, 47.1% of the pregnant women had their first visit at the health clinics at or before 12 gestation weeks, while slightly over half (52.9%) had their first visit at 13 weeks or later. This was similar to the MOH data which recorded around 49% for Selangor state (Ministry of Health Malaysia, 2012a). The result excluded prior visit to other provider, if any.

Using the cut-off points for the first visit as defined in the APNCU-Malaysia Index, it was found that 81.6% of the pregnant women had their first visit at or before 17 gestation weeks which was acceptable according to the index. As for the observed-to-expected visit ratio, a very large proportion of pregnant women, 94.8%, had “adequate” ratio as compared to only 5.2% that had “inadequate” ratio.

Combining both the POG of initiation and visit ratio following the APNCU-Malaysia Index, there were 79.5% of pregnant women classified as having “adequate” utilisation, and 20.5% “inadequate”.

In term of the recommended routine ANC content documented in the pregnant women’s records, it was found slightly less than half (48.3%) had “adequate” (≥ 80%) recommended content, and 51.7% had “inadequate” (<80%) recommended standard care. Finally, combining both utilisation and content aspects, only 39.7% had “adequate” level in both, and over half (60.3%) had “inadequate” level in either utilisation or content.

The comparison above demonstrates different scenarios based on different indicators or indexes. In principal, while the adequacy status might appear excellent when a particular indicator or index was used, the adequacy status might look different when other aspect(s) of care was incorporated.

4.3 FACTORS ASSOCIATED WITH ADEQUACY OF ANTENATAL CARE UTILISATION

Table 4.13 provides an overview on the adequacy of utilisation and the association with selected socio-demographic and obstetric factors.

Table 4.13: Adequacy of Utilisation (APNCU-Malaysia Index) by Selected Factors

Variables	Total (n=522)	Inadequate (n=107)	Adequate (n=85)	Adequate-plus (n=330)	p
Socio-demographics					
Maternal age years, mean (SD)	28.7 (5.0)				
Maternal age, n(%)					
<=19	11 (2.1)	4 (3.7)	3 (3.5)	4 (1.2)	0.003
20-34	439 (84.1)	79 (73.8)	78 (91.8)	282 (85.5)	
35+	72 (13.8)	24 (22.4)	4 (4.7)	44 (13.3)	
Ethnicity, n(%)					
Malay	396 (75.9)	65 (60.7)	69 (81.2)	262 (79.4)	0.008
Chinese	67 (12.8)	23 (21.5)	9 (10.6)	35 (10.6)	
Indian	44 (8.4)	14 (13.1)	6 (7.1)	24 (7.3)	
Indigenous	15 (2.9)	5 (4.7)	1 (1.2)	9 (2.7)	
Education level, n(%)					
Primary or no formal education	23 (4.5)	11 (10.6)	1 (1.2)	11 (3.4)	0.012
Secondary	294 (57.6)	60 (57.7)	42 (50.6)	192 (59.4)	
Tertiary (cert. or dip.)	111 (21.8)	21 (20.2)	42 (26.5)	68 (21.1)	
Tertiary (adv. dip., degree or higher)	82 (16.1)	12 (11.5)	18 (21.7)	52 (16.1)	
Occupation, n(%)					
Legislators, senior officials and managers/ professional	64 (12.4)	9 (8.4)	13 (15.9)	42 (12.8)	NS 0.595
Technicians and associate professionals	67 (12.9)	16 (15.0)	12 (14.6)	39 (11.9)	
Clerical workers	87 (16.8)	20 (18.7)	14 (17.1)	53 (16.1)	
Service, shop, market sales workers; Plant, machine operators/assemblers; Craft and related trades workers; Elementary	101 (19.5)	18 (16.8)	19 (23.2)	64 (19.5)	
Others - HW, students, unemployed	199 (38.4)	44 (41.1)	24 (29.3)	131 (39.8)	
Obstetric Factor/ History					
Gravidity, mean (SD)	2.4 (1.5)				
Gravidity, n(%)					
Primigravida	174 (33.3)	29 (27.1)	67 (78.8)	78 (23.6)	<0.001
Multigravida	348 (66.7)	78 (72.9)	18 (21.2)	252 (76.4)	
Parity, mean (SD)	1.2 (1.3)				
Parity, n(%)					
Nulliparous	195 (37.4)	33 (30.8)	67 (78.8)	95 (28.8)	<0.001
Multiparous	327 (62.6)	74 (69.2)	18 (21.2)	235 (71.2)	
History of miscarriage, n(%)					
No	423 (81.0)	90 (84.1)	82 (96.5)	251 (76.1)	<0.001
Yes	99 (19.0)	17 (15.9)	3 (3.5)	79 (23.9)	
History of complications in previous pregnancy (GDM, PIH, anaemia, PP, miscarriage), n(%)					
No	207 (39.7)	49 (45.8)	11 (12.9)	147 (44.5)	<0.001
Yes	141 (27.0)	29 (27.1)	7 (8.2)	105 (31.8)	
Not applicable (primigravida)	174 (33.3)	29 (27.1)	67 (78.8)	78 (23.6)	
History of complications in previous delivery (Premature, caesarean, assisted del, PPH, stillbirth, NND), n(%)					
No	229 (43.9)	56 (52.3)	13 (15.3)	160 (48.5)	<0.001
Yes	98 (18.8)	18 (16.8)	5 (5.9)	75 (22.7)	
Not applicable (nulliparous)	195 (37.4)	33 (30.8)	67 (78.8)	95 (28.8)	

Table 4.13, continued

Variables	Total (n=522)	Inadequate (n=107)	Adequate (n=85)	Adequate-plus (n=330)	p
Risk Level					
Tag colour, n(%)					
White tag	160 (30.7)	28 (26.2)	41 (48.2)	91 (27.6)	0.001
Colour tag	362 (69.3)	79 (73.8)	44 (51.8)	239 (72.4)	
Risk level at last visit, n(%)					
Low-risk	375 (71.8)	75 (70.1)	79 (92.9)	221 (67.0)	<0.001
High-risk	147 (28.2)	32 (29.9)	6 (7.1)	109 (33.0)	
User Behaviour					
User default frequency, mean (SD)	1.4 (0.7)				
User behaviour, n(%)					
Not defaulted	373 (71.5)	76 (71.0)	44 (51.8)	253 (76.7)	<0.001
Defaulted	149 (28.5)	31 (29.0)	41 (48.2)	77 (23.3)	

4.3.1 Adequacy of Utilisation and Socio-demographic/-economic Factors

4.3.1.1 Age

As shown in Table 4.13, there was an association between age and adequacy of utilisation in which there was statistically significant difference in the pattern of utilisation adequacy among the three age-groups (p=0.003). Majority of the pregnant women in all the adequacy groupings were 20 to 34 years old; constituting 73.8%, 91.8% and 85.5% in the inadequate, adequate and adequate-plus categories, respectively. Women aged 35 years and above were seen in greater proportion in the inadequate group compared to the adequate and adequate-plus groups at 22.4%, 4.7% and 13.3% respectively. This has significant implication since pregnant women of this age group are often at higher risk of pregnancy problems.

Analysis of tagging (white versus coloured) by age-group showed that the proportion of colour-tags was 81.8% among women in the age-group ≤ 19 years, 65.6% among 20-34 years, and the highest (90.3%) among those aged ≥ 35 years. Colour-tag cases are expected to have higher number of ANC visits due to their risk factor, which might result in higher level of utilisation index since number of visits is one of the components of the index. Yet there were 33.3% of women aged ≥ 35 classified in the “inadequate” utilisation category.

4.3.1.2 Ethnicity

Ethnicity made a statistically significant difference in the pattern of utilisation adequacy (p=0.008). The proportion of Malays in the three adequacy categories—inadequate, adequate and adequate-plus—was 60.7%, 81.2% and 79.4% respectively. The proportion of Chinese in the same order of adequacy, was 21.5%, 10.6% and 10.6%, respectively. The proportion of Indian by the utilisation adequacy categories were 13.1%, 7.1% and 7.3% respectively for inadequate, adequate and adequate-plus.

Analysis by risk level showed that the distribution in the high-risk group among Malay, Chinese, Indian and Indigenous were 67.3%, 17.7%, 11.6%, and 3.4% respectively; and in the low-risk group 79.2%, 10.9%, 7.2%, and 2.7% respectively (p=0.040). Further analysis by documented indication seen by other provider prior to the first visit among the same order of ethnic groups were 70.9%, 18.1%, 9.7%, and 1.3% respectively, compared to those without indication seen by other provider prior at 79.7%, 8.8%, 7.5%, and 4.1% respectively (p=0.003). Moreover, among those who had been seen by other provider prior to the first visit, in term of the documented purpose for the prior visit to other provider before the first visit to the health clinics, the proportion in each ethnic group that went for ANC check-up were 9.3%, 31.7%, 4.5%, and 0.0% respectively among the Malay, Chinese, Indian and Indigenous (p=0.006).

In short, the Chinese had the largest proportion in inadequate utilisation category than the other two adequacy categories. The Chinese also had a higher distribution in the high-risk group than the low-risk group (17.7% versus 10.9%). At the same time, this ethnic group also had the largest proportion in terms of documented indication seen elsewhere prior to the first visit which represented 61.2% of Chinese pregnant women, as well as high proportion of documented ANC check-up elsewhere before visiting the health clinics. It was possible that the Chinese pregnant women, especially the high-risk women, have continued attending ANC check-up at the private clinics and did not inform the health clinics. Hence the higher proportion in the inadequate utilisation category compared to adequate and adequate-plus categories.

The Indian, on the other hand, also had the largest proportion in inadequate utilisation category than the other two adequacy categories. The Indian also had a higher distribution in the high-risk group than the low-risk group (11.6% versus 7.2%). Among the Indian, around 50.0% of the women had documented indication seen by other provider prior, but these Indian pregnant women had a low proportion of documented ANC check-up done elsewhere.

4.3.1.3 Education

There was a statistically significant association between education level and adequacy of utilisation (p=0.012). Pregnant women with primary or no education had a larger proportion of inadequate utilisation (10.6%), as compared to adequate (1.2%) and adequate-plus (3.4%). In turn, pregnant women with tertiary education (advance diploma and above) had a smaller proportion of inadequate utilisation (11.5%) as compared to adequate (21.7%), and adequate-plus (16.1%).

Those with secondary education constituted 57.7% of inadequate category, 50.6% adequate and 59.4% adequate-plus; while those with certificate or diploma education made up 20.2% of inadequate, 26.5% adequate, and 21.1% adequate-plus.

4.3.1.4 Occupation (Pregnant Women and Spouses)

Chi-Square test for independence indicated no significant association between occupation of pregnant women and utilisation adequacy (p=0.60). Likewise, there was no association between occupation of spouses and utilisation adequacy.

4.3.2 Adequacy of Utilisation and Obstetric Histories

4.3.2.1 Gravidity

There was statistically significant association between gravidity and adequacy of utilisation (p<0.001). The proportion of primigravida in inadequate utilisation was 27.1%, significantly less than the proportion in adequate utilisation (78.8%). The proportion of primigravida in adequate-plus utilisation was 23.9%.

The proportion of multigravida in the inadequate category was 72.9%, significantly more than those in adequate utilisation (21.2%); while the proportion of multigravida in adequate-plus was 76.1%.

(a) Analysis of tag colour by gravidity

Table 4.14: Tag Colour by Gravidity (Primigravida versus Multigravida)

Gravidity, n (%) (n=522)	Total	White tag	Colour tag	p
Primigravida	174 (33.3)	71 (44.4)	103 (28.5)	0.001
Multigravida	348 (66.7)	89 (55.6)	259 (71.5)	

Analysis of colour tagging by gravidity indicated there was a statistically significant association between gravidity and colour-tagged (P=0.001). Based on the odd ratio, the odds of pregnant women with colour-tags were 2 times higher among the multigravida than primigravida.

As showed in Table 4.14, the white-tags and colour-tags comprised of 44.4% and 28.5% of primigravida respectively. In comparison, the white-tags and colour-tags consisted of 55.6% and 71.5% of multigravida respectively. This would explain the higher proportion of multigravida with “adequate-plus” ANC utilisation, since colour-tagged often required additional visits for additional procedures specific to their conditions.

4.3.2.2 Parity

There was statistically significant association between parity and adequacy of utilisation ($p<0.001$). The proportion of nullipara in inadequate utilisation was 30.8%, significantly less than the proportion in adequate utilisation (78.8%). The proportion of nullipara in adequate-plus category was 28.8%, also significantly lower than adequate category.

The proportion of multipara in the inadequate category was 69.2%, significantly more than multipara in the adequate utilisation (21.2%). The proportion of multipara in adequate-plus category was 71.2%, also significantly higher than adequate category.

(b) Analysis of tag colour by parity

Table 4.15: Tag Colour by Parity (Nullipara versus Multipara)

Gravidity, n (%) (n=522)	Total %	White tag	Colour tag	p
Nullipara	195 (37.4)	81 (50.6)	114 (31.5)	<0.001
Multipara	327 (62.6)	79 (49.4)	248 (68.5)	

Analysis of colour tagging by parity indicated there was a significant association between parity and colour-tags ($P<0.001$).

As showed in Table 4.15, the white-tags and colour-tags consisted of 50.6% and 31.5% of nullipara respectively. In comparison, the white-tag and colour-tag consisted of 49.4% and 68.5% of multipara respectively. This would explain the higher proportion of multipara with “adequate-plus” ANC utilisation, since colour-tagged often required additional visits for additional procedures specific to their conditions.

4.3.2.3 History of Miscarriage

There was a significant association between miscarriage history and adequacy of ANC utilisation, $p < 0.001$.

The inadequate, adequate and adequate-plus categories consisted of 84.1%, 96.5%, and 76.1% of pregnant women without history of miscarriage; and 15.9%, 3.5%, and 23.9% of pregnant women with history of miscarriage, respectively.

4.3.2.4 History of Pregnancy Complications during Previous Pregnancy

There was statistically significant association between history of pregnancy complications and adequacy of utilisation ($p<0.001$). The inadequate, adequate and adequate-plus categories consisted of 27.1%, 8.2%, and 31.8% of pregnant women with history of pregnancy complications respectively.

4.3.2.5 History of Delivery Complications during Previous Birth

There was statistically significant association between history of delivery complications and adequacy of utilisation ($p<0.001$). The inadequate, adequate and adequate-plus categories consisted of 16.8%, 5.9%, and 22.7% of pregnant women with history of delivery complications respectively.

4.3.3 Adequacy of Utilisation and Risk Level

Colour of the tags (white-tag or colour-tag) made statistically significant difference to adequacy of ANC utilisation ($p=0.001$). The proportion of colour-tags in inadequate utilisation category was 73.8%, significantly more than the proportion in adequate utilisation (51.8%), but about the same in the adequate-plus category (72.4%).

The proportion of white-tags in inadequate utilisation was 26.2%, significantly less than the proportion in adequate utilisation (48.2%), but about the same with the proportion in adequate-plus category (27.6%).

Given that among the inadequate utilisation category, 73.8% was from the colour-tags who would often require additional visits for additional procedures specific to their risk factors, this indicated possible unmet utilisation need among the colour-tags.

It is expected to have higher proportion of colour-tags classified as “adequate-plus” since they often require additional visits for additional procedures specific to their conditions. However, close to 28% of adequate-plus utilisation category was from the white-tags, indicated possible over-utilisation of services among these white-tags.

Regrouping of risk level into low-risk (white and green-tags) versus high-risk (yellow and red-tags) indicated statistically significant difference. The low-risk women had a significantly larger proportion in the adequate utilisation category (92.9%), as compared to other categories of utilisation (inadequate 70.1%, adequate-plus 67.0%). In contrast, the high-risk women had a significantly lower proportion in adequate utilisation category (7.1%), but a higher proportion in adequate-plus (33.0%) and inadequate (29.9%). In summary, there was a sizeable proportion of low-risk women having adequate-plus utilisation, and the presence of high-risk women with inadequate utilisation.

4.3.4 Analysis of Factors Associated with Adequacy of Antenatal Care Utilisation

Ordinal regression was used to analyse factors associated with adequacy of ANC utilisation. In order to determine the link function suitable for the analysis, a frequency table for adequacy of utilisation was generated (Table 4.16).

Table 4.16: Distribution of Frequency by Adequacy of Utilisation Categories

ANC Utilisation Category	n	%	Cumulative %
Inadequate/Intermediate	107	20.5	20.5
Adequate	85	16.3	36.8
Adequate-plus	330	63.2	100.0
Total	**522**	**100.0**	

Based on the table above, it appears that the higher categories are more probable. Therefore, link function of “Complementary Log-log” was selected.

A full model containing all the variables identified in Chapter 3/Appendix E was first constructed. The model fitting information revealed the p-value of <0.001, indicating the level of ANC utilisation depends on at least one of the predictors. However, the p-value for Test of Parallel Lines was <0.001, indicating the assumption of parallel lines was not met.

As the small p-value (<0.001) of assumption of parallel lines could be due to large sample size (Chinna, 2014b), the same model was rerun with reduced sample size using the function of "Select Cases\Random sample of cases\Approximately 30% of all cases." However, random cases selection of 30% still yielded p-value of <0.001 for the test of parallel lines. The model was subsequently rerun using random cases selection of 20%, in which the assumption of parallel lines was met (P=0.115).

A stepwise backward selection model was subsequently employed manually using significant variables (P<0.05) from the first full model analysis. The p-value for model fitting was <0.001, but again, the p-value for Test of Parallel Lines was <0.001 (assumption of parallel lines was not met). The same stepwise model was rerun using reduced sample size through random cases selection of 30% and 20%. Likewise, the assumption of parallel lines was met using random cases selection of 20% (P=0.135).

Both the analyses (full model and stepwise model) confirmed the theory that large sample size could possibly cause the Test of Parallel Lines to be significant (i.e. large sample size may result in unmet assumption of parallel lines). Nevertheless, the analyses (Table 4.17) was still based on the full sample size model since it is more inferential to report using larger sample size.

Table 4.17: Factors Associated With Adequacy of Utilisation

Characteristics	Full Model		*Stepwise Model	
	P	OR (95% CI)	P	OR (95% CI)
Socio-demographic				
Age group:				
20-34	0.003	1.79 (1.21-2.65)	0.005	1.75 (1.19-2.57)
<=19 & 35+		1.00		1.00
Ethnicity:				
Malay	0.205	1.73 (0.74-4.02)		
Chinese	0.869	0.93 (0.38-2.28)		
Indian	0.859	1.09 (0.43-2.78)		
Indigenous people		1.00		
Education level:				
Primary or no education	0.049	0.49 (0.24-1.00)	0.008	0.43 (0.23-0.80)
Secondary	0.556	0.88 (0.58-1.35)	0.639	0.93 (0.68-1.27)
Tertiary		1.00		1.00
Socio-economic Status				
Occupation (women):				
Managers, professionals and technicians	0.568	0.87 (0.54-1.40)		
Clerical support, service/sales, skilled agricultural, forestry, fishery, craft, plant/machine, elementary workers	0.888	0.98 (0.69-1.38)		
Not working - HW, students, unemployed		1.00		
Obstetric Factor				
Parity:				
Multiparous	<0.001	2.17 (1.58-2.97)	<0.001	2.21 (1.63-3.00)
Nulliparous		1.00		1.00
Risk Level				
Risk level of pregnancy:				
Low-risk	0.001	0.53 (0.37-0.76)	0.002	0.56 (0.39-0.80)
High-risk		1.00		1.00

*stepwise backward selection model using significant variable (p<0.05) from the full model.

Table 4.17 shows the results of the full model and manual stepwise model examining the factors associated with ANC utilisation adequacy. In the initial full model analysis, maternal age (P=0.003), primary educated (P=0.049), parity (P<0.001) and risk level of pregnancy (P=0.001) made statistically significant contribution to ANC utilisation adequacy. Ethnicity and occupations of pregnant women had non-significant association with ANC utilisation adequacy.

A manual stepwise backward selection model using only the significant independent variables (P<0.05) from the initial full model was subsequently constructed. All these variables, maternal age, maternal education, parity and risk level, remained statistically significant in the stepwise model (Table 4.17).

Women aged 20-34 years old (low-risk age) were more likely to have higher ANC utilisation than women aged ≤ 19 and ≥ 35 years old. The odds of women 20-34 years of age having higher ANC utilisation were two times that of women aged ≤ 19 and ≥ 35 years (OR=1.75, 95%CI=1.19-2.57, P=0.005).

Primary educated women were less likely to have higher ANC utilisation than tertiary educated (OR=0.43, 95%CI=0.23-0.80, P=0.008). The odds of tertiary educated having higher ANC utilisation level were over two times that of primary educated. While primary educated was significantly differed from tertiary educated in ANC utilisation (P=0.008), there was no significant difference between secondary and tertiary educated (P=0.639). Likewise, there was no significant difference between primary and secondary educated (overlapping 95%CI of the coefficients).

Multiparous were more likely to have higher ANC utilisation than nulliparous. The odds of multiparous having higher ANC utilisation level were over twice the odds of nulliparous (OR=2.21, 95%CI=1.63-3.00, P<0.001).

Low-risk women were less likely to have higher ANC utilisation than high-risk women (OR=0.56, 95%CI=0.39-0.80, P=0.002). The odds of high-risk women having higher ANC utilisation level were around two times that of low-risk.

4.4 ADHERENCE TO RECOMMENDED ROUTINE ANTENATAL CARE CONTENT

Table 4.18 provides an overview on the adequacy of ANC content (categorical) and selected factors. None of the pregnant women fell under the “inadequate” category

(<50% of total score), 51.7% scored “intermediate” category (50-79%, categorised as inadequate in the analysis), and 48.3% scored “adequate” category (≥ 80%).

Table 4.18: Adequacy of Content (Categorical) by Selected Factors

Variables	Total (n=522)	Inadequate (≤ 79%) (n=270)	Adequate (≥ 80%) (n=252)	p
Obstetric Factors/ Histories				
Gravidity, n (%)				
Primigravida	174 (33.3)	89 (33.0)	85 (33.7)	NS (0.926)
multigravida	348 (66.7)	181 (67.0)	167 (66.3)	
Parity, n (%)				
Nulliparous	195 (37.4)	101 (37.4)	94 (37.3)	NS (1.000)
Multiparous	327 (62.6)	169 (62.6)	158 (62.7)	
History of complications during previous pregnancy (GDM, PIH, anaemia, PP, miscarriage), n (%)				
No	207 (39.7)	109 (40.4)	98 (38.9)	NS (0.942)
Yes	141 (27.0)	72 (26.7)	69 (27.4)	
NA (primigravida)	174 (33.3)	89 (33.0)	85 (33.7)	
History of complications during previous delivery (premature, caesarean, assisted del, PPH, stillbirth, NND), n (%)				
No	229 (43.9)	119 (44.1)	110 (43.7)	NS (0.988)
Yes	98 (18.8)	50 (18.5)	48 (19.0)	
NA (nulliparous)	195 (37.4)	101 (37.4)	94 (37.3)	
Risk tag colour at last visit, n (%)				
White tag	160 (30.7)	82 (30.4)	78 (31.0)	NS (0.961)
Colour tag	362 (69.3)	188 (69.6)	174 (69.0)	
Risk level, n (%)				
Low-risk	375 (71.8)	181 (67.0)	194 (77.0)	0.015
High-risk	147 (28.2)	89 (33.0)	58 (23.0)	
Provider Factors				
Clinic type (expected workload), n (%)				
301-500	177 (33.9)	92 (34.1)	85 (33.7)	<0.001
150-300	247 (47.3)	145 (53.7)	102 (40.5)	
Below 150	98 (18.8)	33 (12.1)	63 (25.8)	
Proportion of total visits attended by specific provider, mean (SD)				
CN<3 years’ experience	13.7 (19.6)	11.0 (16.7)	16.7 (22.0)	
CN>3 years’ experience	35.5 (24.2)	36.1 (24.3)	34.8 (24.1)	
CN of any experience (merged)	49.2 (26.2)	47.1 (26.6)	51.5 (25.6)	
SN without PG	3.93 (9.7)	2.6 (8.7)	5.3 (10.4)	
SN with PG	28.4 (24.7)	31.0 (25.8)	25.7 (23.1)	
MO<3 years’ experience	18.0 (18.3)	17.4 (18.6)	18.6 (18.0)	
MO>3 years’ experience	28.2 (24.8)	28.8 (24.9)	27.6 (24.9)	
MO of any experience (merged)	46.2 (19.0)	46.2 (19.8)	46.2 (18.2)	

4.4.1 Adequacy of Content and Obstetrics Factors/ Histories

4.4.1.1 Gravidity (Primigravida versus Multigravida)

As showed in Table 4.18, there was no significant association between gravidity and content adequacy (p=0.997). The distribution of the percentage of the total ANC content score by gravidity could be visualised in Figure 4.2 below. The distribution of scores on ANC content for primigravida and multigravida was rather similar; both groups had similar spread of middle 50% of scored (interquartile range, IQR), median value, and lower quartile value. It appeared that multigravida had an insignificant higher upper quartile and IQR. However, multigravida also contained more outliers that were below the lower quartile. The distribution was considerably symmetrical for both groups.

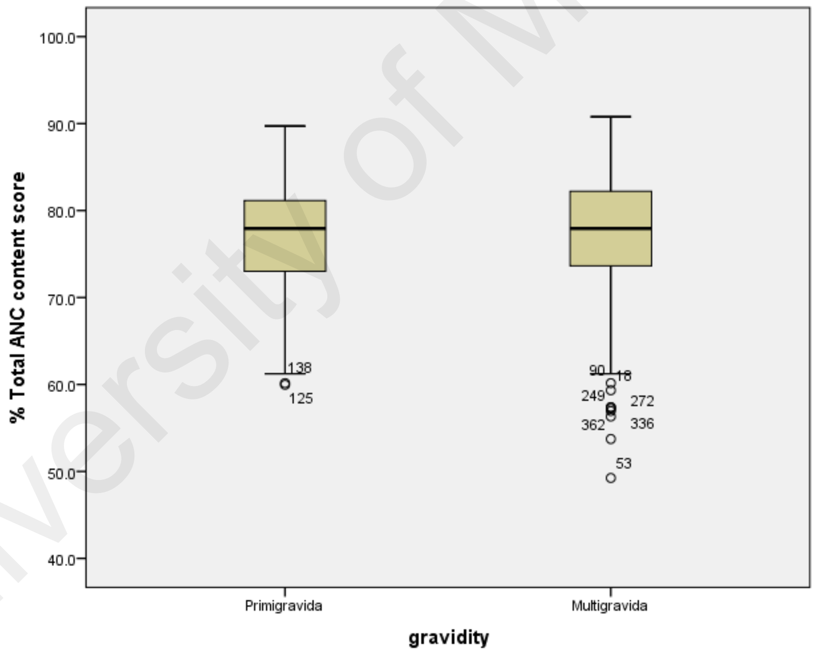


Figure 4.2: Boxplot – Percentage of Total Antenatal Care Content Score by Gravidity

4.4.1.2 Parity (Nulliparous versus Multiparous)

As showed in Table 4.18, there was no statistically significant association between parity and content adequacy (p=1.000).

4.4.1.3 Risk Tagging (White-tagged versus Colour-tagged)

There was also no significant association between tag colour (white-tagged versus colour tagged) and content adequacy, p=0.961 (Table 4.18).

The distribution of the percentage of the total ANC content score by tag colour is presented in the boxplot below (Figure 4.3). The distribution of scores on ANC content for white-tagged and colour-tagged was rather similar; both groups had similar interquartile range (IQR), median value, and upper quartile. It appeared that colour-tagged had an insignificant wider range of scores, mainly at the lower quartile, despite containing more outliers below the lower quartile. The distribution was considerably symmetrical for both groups.

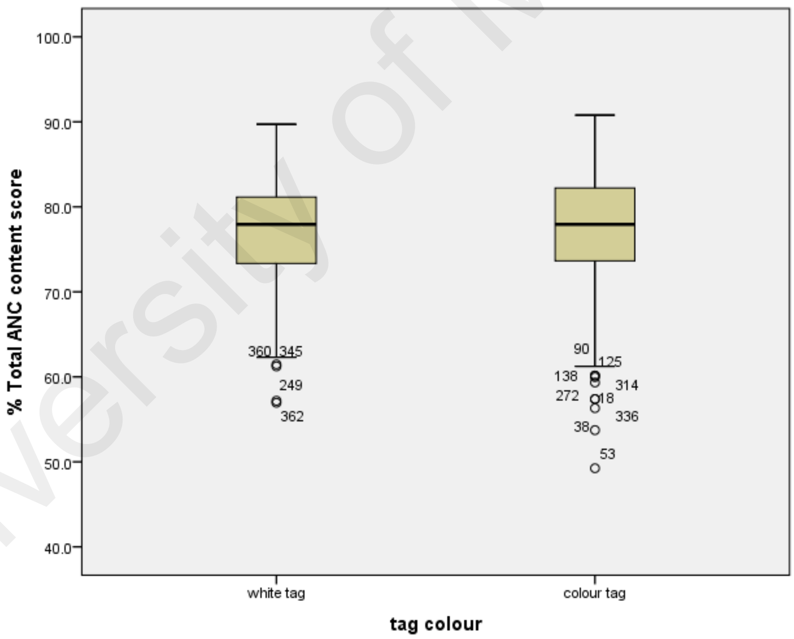


Figure 4.3: Boxplot – Percentage of Total Antenatal Care Content Score by Tag Colour

4.4.1.4 Low-Risk (White and Green-tag) versus High-Risk (Yellow and Red-tag)

However, when the women were re-categorised according to their risk tags into low-risk (white and green-tag) and high-risk (yellow and red-tag), there was statistically significant difference between the two risk groups and the pattern of content adequacy, p=0.015 (Table 4.18). The inadequate and adequate content categories consisted of 67.0% and 77.0% low-risk women respectively. As for high-risk, the composition for inadequate and adequate content categories was 33.0% and 23.0% respectively.

4.4.2 Adequacy of Content and Provider Factors

4.4.2.1 Clinic Type

There was statistically significant association between clinic type (as defined by expected daily workload) and adequacy of content, p<0.001. Among women attending clinics with 301-500 expected daily workload, 34.1% and 33.7% were in the inadequate and adequate content categories respectively. Among women attending clinics with 150-300 expected daily workload, 53.7% and 40.5% were in the inadequate and adequate content categories. And among women attending clinics with below 150 expected daily workload, 12.1% and 25.8% were in the inadequate and adequate content categories.

The proportion of "inadequate" content category was significantly smaller than the "adequate" category in the clinics with below 150 daily workloads. In comparison, the clinics with 150-300 and 301-500 expected daily workloads observed the reverse (larger inadequate category than adequate category).

4.4.2.2 Proportion of Total Visits Attended by Specific Providers

As shown in Table 4.18, among the nursing staff, attendance by community nurse (CN) with over 3 years' experience appeared to have the highest mean proportion, with an average of 35.5% of the total visits of a pregnant woman attended by CN with over 3 years' experience. This is followed by staff nurse with post-graduate qualification, who attended to an average of 28.4% of the total visits of a pregnant woman. Staff nurse without post-graduate had the least average attendance to pregnant women, at an average of 3.9% of the total visits of a pregnant women attended by them. Overall, 49.2% of a pregnant woman's total visits were attended by community nurses.

As for doctors, an average of 28.2% of a pregnant woman's total visits was seen by medical officers with over 3 years' experience, followed by average of 18.0% of total visit attended by medical officers with less than 3 years' experience. Overall, 46.2% of a pregnant woman's total visits were attended by medical officers.

Twenty-four pregnant women (4.6% of total) were seen by a FMS. The mean numbers of time seen by a FMS for white, green, yellow and red-tag were 0, 1.3, 2.1 and 1.5 times respectively. Among these twenty-four women, 0%, 3.3%, 10.7%, and 28.6% were white, green, yellow and red-tags respectively. This indicated 71.4% (5/7) of the red-tags were not seen by a FMS however, all red-tags had ever been referred to a hospital for medical consultation.

Sixty-three pregnant women (12.1% of total) were seen by a dietician or nutritionist. The mean numbers of time seen by a dietician or nutritionist were 1.1 times. Among these sixty-three women, 0.6%, 2.3%, 40.7%, and 0.0% were white, green, yellow and red-tags respectively.

4.4.2.3 Association between Percentage of Content Score and Percentage of Total Visits Attended By Specific Providers

Matrix scatter plot was produced to examine the association of percentage of content score and percentage of total visit attended by different health professional qualification or experience. The different nursing qualification was categorised into:

- community nurse (CN) with <3 years' experience;
- community nurse (CN) with >3 years' experience;
- staff nurse (SN) without post-graduate qualification;

- staff nurse (SN) with post-graduate qualification.

The doctors were categorised into:

- medical officer (MO) with <3 years' experience;
- medical officer (MO) with >3 years' experience;
- family medicine specialist (FMS).

(a) Association between content score and attendance by nurses

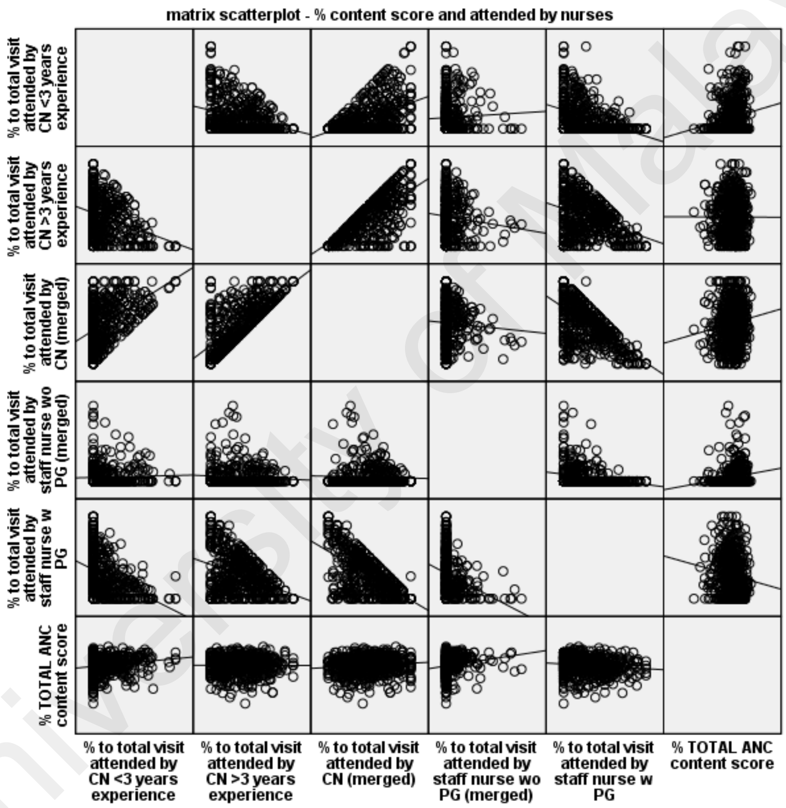


Figure 4.4: Matrix Scatter Plot - Percentage of Antenatal Care Content Score by Percentage of Total Visits Attended by Specific Nurses

From the output of scatter plot (Figure 4.4), there appeared to be a moderate, positive correlation between percentage of content score and percentage of total visit attended by CN with less than 3 years' experience. Pregnant women who had higher proportion of total visits attended by CN with less than 3 years' experience were found to have higher content score. In contrast, there appeared to be a very small, negative correlation between content score and total visit attended by CN with more than 3 years' experience. When both categories of CN (less than and more than 3 years' experience) were merged, it appeared there was a slightly stronger positive correlation than when it was analysed separately.

As for the SN without post-graduate qualification, there appeared to be a small, positive correlation with regards to content score and total visit attended by SN without post-graduate qualification. Interestingly, there appeared to be a moderate, negative correlation between percentage of content score and percentage of total visit attended by SN with post-graduate qualification. This meant pregnant women with higher proportion of total visits attended by SN with post-graduate qualification had lower content score. On the other hand, pregnant women with lower proportion of total visits attended by SN with post-graduate qualification had higher content score. The strength of the association between content score and attendance by specific nursing professional (percentage to total visits attended by specific nurses) could be seen in Table 4.19.

Table 4.19: Correlation of Antenatal Care Content Score and Attendance by Specific Nurses

Attendance by specific nurses	% to total visit attended by CN <3 years' experience	% to total visit attended by CN >3 years' experience	% to total visit attended by CN (merged)	% to total visit attended by staff nurse without PG	% to total visit attended by staff nurse with PG	% TOTAL ANC content score
% to total visit attended by CN <3 years' experience	1	-.30***	.47***	.04 ns	-.40***	.17***
% to total visit attended by CN >3 years' experience	522	1	.70***	-.084 ns	-.36***	-.00 ns
% to total visit attended by CN (merged)	522	522	1	-.05 ns	-.63***	.12**
% to total visit attended by staff nurse wo PG (merged)	522	522	522	1	-.26***	.17***
% to total visit attended by staff nurse w PG	522	522	522	522	1	-.13**
% TOTAL ANC content score	522	522	522	522	522	1

ns = not significant (p > .05); *p<0.05; **p<0.01; ***p<0.001

In brief, the strength of the association between content score and attendance by specific nursing professional was:

- There was a small, positive association between content score and total visits attended by CN with less than 3 years' experience, r=0.17, n=522, p<0.001.
- There was no significant association between content score and total visits attended by CN with more than 3 years' experience, r= -0.002, n=522, p=0.962.
- There was a small, positive correlation between content score and total visits attended by CN (merged all experiences), r=0.12, n=522, p=0.005, with higher content score associated with higher total visits attended by CN.
- There was a small, positive correlation between content score and total visits attended by SN without postgraduate, r=0.17, n=522, p<0.001.
- There was a small, negative correlation between content score and total visits attended by SN with postgraduate, r= -0.13, n=522, p=0.004, with lower content score associated with higher total visits attended by SN with postgraduate.

(b) Association between content score and attendance by doctors

For MO with less than or more than 3 years' experience, there appeared to be a small, positive correlation with regards to content score and total visit attended by either MO (Figure 4.5). This meant that pregnant women with higher proportion of total visits attended by either MO, had slightly higher content scores. Similar to the analysis of CN, when both categories of MO (with less than and more than 3 years' experience) were merged, it appeared there was a slightly stronger correlation than when it was analysed separately. There appeared to be almost no correlation with the proportion of total visits attended by FMS. Higher or lower proportion of total visits attended by FMS had no effect on content scores. Worthy of note, there was only 24 pregnant women required to be referred to FMS (N=24).

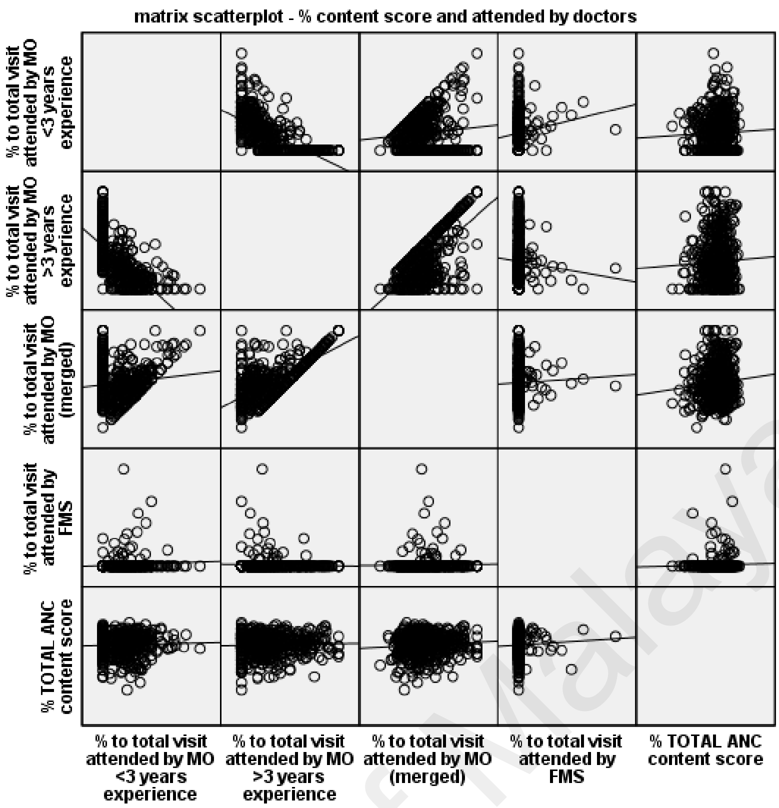


Figure 4.5: Matrix Scatter Plot - Percentage of Antenatal Care Content Score by Percentage of Total Visits Attended by Specific Doctors

The strength of the association between content score (percentage of total ANC content score) and attendance by specific medical professional (percentage to total visits attended by specific medical professional) is presented in Table 4.20 below.

Table 4.20: Correlation of Antenatal Care Content Score and Attendance by Specific Doctors

Attendance by specific doctors	% to total visit attended by MO <3 years' experience	% to total visit attended by MO >3 years' experience	% to total visit attended by MO (merged)	% to total visit attended by FMS	% TOTAL ANC content score
% to total visit attended by MO <3 years' experience	1	-.65***	.11**	.10*	.04 ns
% to total visit attended by MO >3 years' experience	522	1	.68***	-.05 ns	.04 ns
% to total visit attended by MO (merged)	522	522	1	.03 ns	.09**
% to total visit attended by FMS	522	522	522	1	.04 ns
% TOTAL ANC content score	522	522	522	522	1
ns = not significant (p > .05); *p<0.05; **p<0.01; ***p<0.001					

In brief, the strength of the association between content score and attendance by specific medical professional was:

- There was no significant association between content score and total visits attended by MO with less than 3 years' experience, r=0.04, n=522, p=0.363.
- There was no significant association between content score and total visits attended by MO with more than 3 years' experience, r=0.04, n=522, p=0.383.
- There was a very small, positive correlation between content score and total visits attended by MO (merged all experiences), r=0.09, n=522, p=0.043.
- There was no significant association between content score and total visits attended by FMS, r=0.04, n=522, p=0.358.

4.4.3 Analysis of Factors Associated with Antenatal Care Content Score

In order to determine the factors associated with ANC content score, GLM Univariate analysis model was constructed using the variables outlined in Chapter 3/ Appendix E. Backward elimination method was applied in which all identified variables were first included in a full model, and then dropped the variable with p-value >0.10 one-by-one, until all remaining variables were significant (P<0.05).

Table 4.21: Analysis Model (GLM Univariate): Initial Full Model Containing All Possible Factors Associated with Content Adequacy & Final Model After Backward Elimination for Factors Associated with Content Adequacy

Variables	Initial Full Model P	Final Model P
Parity	.418	
Risk level	.004	.001
Clinic type	.000	.000
% total visits attended by SN with PG	.130	
% total visits attended by MO	.367	
% total visits attended by CN	.865	

The result of the initial full model analysis included all the variables as planned (Table 4.21), in which it demonstrated that among the variables concerned, only risk level and clinic type had p-value of <0.05. Thus, at least one pair of means for ANC content score among women with different risk level and attending different clinics differed significantly. As for the rest of the variables, there was non-significant difference in mean ANC content score among these variables (P>0.05).

These non-significant predictors were then manually removed one-by-one to assess the effect on the model using backward elimination method until the final model contained only significant predictors (P<0.05). The final model in Table 4.21 above showed that risk level (P=0.001) and clinic type (P<0.001) had statistically significant association with the pregnant women's ANC content score.

Based on the Bonferroni pair wise comparisons and the plot (Table 4.22, Table 4.23), the mean ANC content score among the low-risk women was significantly higher compared to the mean score among the high-risk women, statistically (P=0.001).

Table 4.22: Difference of Mean for Antenatal CareContent Score (%) by Risk Level and Clinic Type

Variables (n=522)	Mean ANC content score, %	p
Risk level:		0.001
Low-risk	78.4	
High-risk	76.4	
Clinic type:		<0.001
<150	80.0	
150-300	75.0	
301-500	77.0	

Note: GLM Univariate, backward elimination of P>0.10 one-by-one till all P<0.05. Initial variables - parity, risk level, clinic type, % attendance by CN, SN and MO.

Likewise, based on the Bonferroni pair wise comparisons and the plot (Table 4.22, Table 4.23), the mean ANC content score among the clinic below 150 expected daily workload was significantly higher compared to the mean score among the clinic with 150-300 daily workload (P<0.001) and clinic with 301-500 daily workload (P=0.001).

The mean ANC content score between clinic with 150-300 daily workload and clinic with 301-500 daily workload had statistically significant difference (P=0.005), clinic with 150-300 daily workload had lower mean score compared to clinic with 301-500 daily workload.

Table 4.23: Difference of Mean for Antenatal Care Content Score among Clinic Type

Pairwise Comparisons				
Dependent Variable: % TOTAL ANC content score				
(I) risk level	(J) risk level	Mean Difference (I-J)	Std. Error	P [b]
Low	High	1.997*	.618	.001
High	Low	-1.997*	.618	.001
Based on estimated marginal means				
*. The mean difference is significant at the .05 level.				
b. Adjustment for multiple comparisons: Bonferroni.				

Pairwise Comparisons				
Dependent Variable: % TOTAL ANC content score				
(I) clinic type	(J) clinic type	Mean Difference (I-J)	Std. Error	P [b]
<150	150-300	4.987*	.758	.000
	301-500	3.008*	.799	.001
150-300	<150	-4.987*	.758	.000
	301-500	-1.979*	.625	.005
301-500	<150	-3.008*	.799	.001
	150-300	1.979*	.625	.005
Based on estimated marginal means				
*. The mean difference is significant at the .05 level.				
b. Adjustment for multiple comparisons: Bonferroni.				

4.5 ADHERENCE TO SELECTED RECOMMENDED PRACTICES

4.5.1 Routine Medical Examination

Table 4.24: Descriptive Statistics related to Routine Medical Examination

	N	Min	Max	Mean
Total RME	522	0	3	2.01
RME1 POG	521	4	37	14.96
RME2 POG	486	18	40	34.13
RME3 POG	42	26	37	34.45

As shown in Table 4.24, the total number of routine medical examination (RME) the pregnant women had ranged from 0 to 3. The standard recommended practice for Malaysia was two RME; however, there was a clinic practised three RME for each pregnancy. The POG for RME1 started as early as 4 weeks to as late as 37 weeks, with an average POG of around 15 weeks. For RME2, it was from POG 18 to 40 weeks, with an average POG of around 34 weeks.

Table 4.25: Data Related To Routine medical Examination

	N (%)
Total RME per woman	
0	1 (0.2)
1	35 (6.7)
2	444 (85.1)
3	42 (8.0)
Total	522 (100.0)
RME1 at or before V3	
RME1 at Visit-1	392 (75.1)
RME1 at Visit-2 or Visit-3	118 (22.6)
RME1 at Visit-4 or onwards	12 (2.3)
No RME	1 (0.2)
Total	522 (*100.0)
compliance - RME1 at booking or by POG 24 weeks	
Not complied	12 (2.3)
Complied	510 (97.7)
Total	522 (100.0)
compliance - RME2 at 31-36 weeks (adjusted for POG at birth)	
Not complied	42 (8.0)
Complied	480 (92.0)
Total	522 (100.0)

*Note – due to rounding, the total percentage appeared to have extra 0.2%

A very large proportion of pregnant women (93.1%) had at least two RME, 6.7% had one RME, and only one woman was recorded not having any RME (Table 4.25). Majority had the RME1 during the first visit (75.1%), while 22.6% had the RME1 at the second or third visits. Twelve pregnant women (2.3%) had the RME1 at the forth visit and onwards.

Overall, 97.7% of the pregnant women were provided the first RME1 at booking or by POG 24 weeks; and only 2.3% failed to be seen during this period. As for RME2, 92% of the pregnant women were seen for RME2 during 31-36 weeks, while 8% were not seen during the period.

4.5.2 Haematinic Supplement (Folic Acid)

Majority (90.2%) of the pregnant women were given haematinic supplement (including folic acid) or advised to take the supplement during their first visit to the clinics. 9.8% of the pregnant women were not given or advised.

Table 4.26: Descriptive Statistics related to Haematinic/Supplement

	N	Min	Max	Mean	Mode
POG when haematinic/supplement was first documented as given/ advised	522	4	37	14.14	10
total number of times haematinic/supplement advice was given	522	0	16	6.72	5

The POG when haematinic supplement was first documented as given or advised ranged from 4 weeks to 37 weeks (though there was only one case which was given/ advised at 37 weeks). Pregnant women were often given or advised at 10 weeks (mode=10, Table 4.26).

Out of the 9.8% of the pregnant women who had not been given or advised to consume folic acid, around half of them had their first visit at or before 12 weeks gestation. Yet they were not given/ advised to consume folic acid.

4.5.3 Abdominal Ultrasound

The POG when the first abdominal ultrasound was done ranged from as early as 5 weeks (two cases) to as late as 40 weeks (four cases), with an average POG of 18 weeks. However, 13.8% of pregnant women had their first ultrasound done elsewhere prior to the first visit whereby the POG was not recorded (Table 4.27).

Table 4.27: Descriptive Statistics related to Abdominal Ultrasound

	N	Min	Max	Mean
POG of first US, in week	522	5	40	18.1
total US done at this health clinic	522	0	9	2.1
total US done by other provider	522	0	4	0.5
total US done (all providers)	522	0	9	2.6

In total, the average number of ultrasounds done per woman including ultrasounds done by other providers was around 2.6. Around 52% had two to three ultrasounds (mode=2). The minimum and maximum of total ultrasounds recorded were zero (29 cases, 5.6%) and nice (3 cases, 0.6%; Table 4.27).

Table 4.28: Selected Data related to Abdominal Ultrasound

Ultrasound (US)	N (%)
US done at first visit	
No	346 (66.3)
Yes	176 (33.7)
Total	522 (100.0)
US ≥2 times	
No	113 (21.6)
Yes	409 (78.4)
Total	522 (100.0)
First US by 24 weeks gestation	
No	93 (17.8)
Yes	429 (82.2)
Total	522 (100.0)

One-third (33.7%) of the pregnant women had an ultrasound on their first visit at the health clinics. In term of compliance to minimum requirement for ultrasound, 78.4% of the women met the requirement of having two ultrasounds (adjusted for timing of first visit), as compared to 21.6% who had not (Table 4.28).

There was a total of 82.2% who complied with the requirement of performing an ultrasound by 24 gestation weeks (adjusted for timing of first visit), as compared to 17.8% who did not (Table 4.28).

4.5.4 POG when selected Physical Examinations were initiated

The MOH's ANC guidelines recommend examining: (i) symphysis-fundal height from 22 gestational weeks onwards, (ii) foetal lie and presentation from 32 gestational weeks onwards, and (iii) foetal heart auscultation from 24 gestational weeks onwards (if using Pinards foetoscope) or 14 weeks (if using electronic device).

Table 4.29: Period of Gestation When Selected Physical Examinations Were Initiated, Week

POG examination initiated, week (n=522)	Min.	Max.	Mean	Median	SD
Symphysis-fundal height	8	37	18.26	18.00	4.184
Foetal lie/ presentation	8	37	18.63	18.00	4.009
Foetal heart auscultation	11	37	19.62	19.00	3.673

As seen from Table 4.29, on average, assessment for symphysis-fundal height, foetal lie and presentation, and foetal heart auscultation were commenced at around 18-19 gestation weeks. Half of the pregnant women were examined on these parameters by 18 weeks and earlier.

In addition, 75.1% of the pregnant women had their first symphysis-fundal height examined at 20 weeks or earlier, as compared to the recommendation to include this parameter in the examination from 22 gestational weeks onwards.

Foetal lie and presentation assessment was initiated among almost all pregnant women (98.9%) by 30 weeks or earlier, as compared to the recommendation to perform this from 32 weeks onwards.

Majority (84.1%) of the pregnant women had their first foetal heart auscultation at 22 weeks or earlier, while the recommendation was from 24 or 14 weeks onwards depending on the type of device used.

4.5.5 Haemoglobin Screening

Haemoglobin (Hb) was routinely tested for most visits in actual practice, the mean for Hb or FBC screening was around seven tests per pregnant woman (median=7).

4.5.6 Hepatitis B Screening

Although Malaysia guideline recommends hepatitis B screening at booking, none of the clinics surveyed performed the screening test or asked women's hepatitis B status, or advised women to seek testing elsewhere.

4.5.7 Additional Assessment/ Screening for Specific Conditions (Not Included in Recommended Routine Antenatal Care)

4.5.7.1 Additional Laboratory Tests/ Monitoring

The proportion of pregnant women with documented common additional tests is presented in Table 4.30. FBC was considered additional test as the ANC guidelines only specifies the requirements of Hb test. Five out of the six studied health clinics included FBC as their standard screening tests during booking visit. As a result, 88.7% of pregnant women had at least one FBC.

Table 4.30: Distribution Related To Documented Additional Tests (Not Included In Recommended Routine Antenatal Care)

Additional tests (n=522)	Tested (%)	Not tested (%)	Total (%)
FBC*	88.7	11.3	100.0
MGTT	72.0	28.0	100.0
urine FEME	29.9	70.1	100.0
BSP	16.5	83.5	100.0
HbA1C	9.8	90.2	100.0
RBS (random blood sugar)	8.4	91.6	100.0
FBP (full blood picture)	6.3	93.7	100.0
iron studies	5.4	94.6	100.0
Hb analysis	3.6	96.4	100.0

* 5 health clinics included FBC as one of the standard screening during booking visit.

MGTT was the second most frequently done additional test, constituted a large proportion (72%) of the pregnant women since MGTT is a standard confirmatory test for Gravidadum Diabetes Mellitus (GDM) for pregnant women with risk factors. Around 17% of the pregnant women required Blood Sugar Profile (BSP) monitoring, which is used for monitoring of GDM. Close to 10% of the pregnant women were prescribed HbA1c test, and 8.4% required random blood sugar testing.

FBP, iron studies, and Hb analysis, which are screening tests for anaemia, represented 6.3%, 5.4% and 3.6% respectively for pregnant women who had been tested. The samples for these tests are all sent to referral hospitals affiliated with the health clinics.

Around 30% of the pregnant women required urine FEME which was prescribed when urine dipstick test was positive or when the women complaints of urinary tract related symptoms.

4.5.7.2 Additional Prescription for Specific Conditions

(a) Documented prescription for UTI/ UTI-like symptoms

Table 4.31: Distribution related to Documented Prescription for Urinary Tract Infection

Frequency of documented UTI treatment	n	%	Valid %	Cumulative %
1	59	11.3	69.4	69.4
2	12	2.3	14.1	83.5
3	10	1.9	11.8	95.3
4	3	0.6	3.5	98.8
5	1	0.2	1.2	100.0
Subtotal	85	16.3	100.0	
No UTI documented	437	83.7		
Total	**522**	**100.0**		

The finding revealed that 16.3% of the pregnant women were ever prescribed for UTI or UTI-like symptoms (Table 4.31); the total UTI related prescription documented was 130. The figure was only for UTI prescription provided, and did not include women who sought medical consultation for complaint related to UTI symptoms such as abdominal pain or dysuria, but was not documented for UTI prescription. Therefore, the figure for UTI could be higher; especially some of the cases could be asymptomatic.

(b) Documented prescription for vaginal infection

Table 4.32: Distribution related to Documented Prescription for Vaginal Infection

Frequency of documented vaginal infection treatment	n	%	Valid %	Cumulative %
1	37	7.1	86.0	86.0
2	5	1.0	11.6	97.7
4	1	0.2	2.3	100.0
Subtotal	43	8.2	100.0	
No vaginal infection documented	479	91.8		
Total	522	100.0		

Around 8% of the pregnant women were ever prescribed treatment for vaginal infection (Table 4.32); the total related prescription documented were 51. The figure was only for vaginal infection prescription provided, and did not include women who sought medical consultation for complaint related to vaginal infection such as vaginal discharge, but was not documented for vaginal infection prescription.

4.6 ADEQUACY OF ANTENATAL CARE UTILISATION, CONTENT AND FACTORS ASSOCIATED WITH PREGNANCY OUTCOMES

4.6.1 Antenatal Care Utilisation, Content and Pregnancy Outcomes

Table 4.33 presents the association of ANC adequacy with pregnancy outcomes, in which the odd ratios were adjusted for maternal age, ethnicity, maternal education, maternal occupation, risk status, parity, clinic type, and utilisation or content.

Table 4.33: Adequacy of Antenatal Care and Pregnancy Outcomes Models

ANC Adequacy	Adjusted OR* (95% CI)				
(n=522)	Preterm birth (n=36)	LBW (n=66)	Stillbirth (n=16)	Combined foetal outcomes (n=86)	Mat complication (n=33)
ANC Utilisation:					
Inadequate	4.54 (0.50-40.94)	1.06 (0.34 – 3.31)	0.43 (0.05 – 4.02)	1.24 (0.44-3.46)	2.30 (0.48 – 10.93)
Adequate	1.00	1.00	1.00	1.00	1.00
Adequate-plus	5.90 (0.73-47.48)	1.82 (0.71 – 4.67)	0.90 (0.15 – 5.34)	1.99 (0.83-4.75)	2.21 (0.57 – 8.51)
ANC Content:					
Inadequate	3.72 (1.58-8.72)	1.18 (0.67 – 2.08)	0.65 (0.22 – 1.94)	1.41 (0.85-2.34)	0.50 (0.22 – 1.14)
Adequate	1.00	1.00	1.00	1.00	1.00

*odds ratios adjusted for maternal age, ethnicity, maternal education, maternal occupation, risk status, parity, clinic type, and utilisation or content.

4.6.1.1 Antenatal Care Utilisation and Pregnancy Outcomes

As showed in Table 4.33, though statistically non-significant, given the odds ratio of around two and above which is quite a sizeable effect size, this is suggestive of evidence concerning association of utilisation and some of the pregnancy outcomes assessed. The odds for preterm birth, LBW, combined foetal outcomes, and maternal complications in the adequate-plus category were 5.90, 1.82, 1.99, and 2.21 times respectively that of adequate category. The odds for preterm birth and maternal complications in the inadequate category were 4.54 and 2.30 times that of the adequate category. Though non-significant statistically, having adequate utilisation appeared to be associated with lower odds of preterm birth and maternal complications outcome compared to inadequate utilisation. The results might also imply that intensive utilisation appeared to be associated with higher prevalence of preterm birth, LBW, adverse foetal outcomes and maternal complications in general. Distribution of pregnancy outcomes by risk level, which might explain the association of intensive utilisation and pregnancy outcomes, has been presented in Table 4.8 in earlier section.

The odds for stillbirth in the inadequate category were 0.43, compared to the adequate category. This implied that the odds of stillbirths for women with adequate ANC utilisation appeared to be over two times higher than women with inadequate utilisation.

4.6.1.2 Antenatal Care Content and Pregnancy Outcomes

Based on the observed significance level, ANC content adequacy was associated with preterm birth statistically. The odds of preterm birth in the inadequate category were over three times that of the inadequate category. ANC content did not appear to influence LBW. As for stillbirth and maternal complications outcomes, ANC content categorisation appeared to be not internally consistent in which the adequate category had poorer outcomes than the inadequate category. The odds for stillbirth and maternal complications in the inadequate category were lower (0.65 and 0.50 respectively), compared to adequate category.

4.6.2 Associated Factors of Pregnancy Outcomes

4.6.2.1 Preterm Birth

Table 4.34 shows the results of univariate and multivariate analyses examining the factors associated with pre-term birth.

Table 4.34: Factors Associated With Preterm Birth

Characteristic	Preterm	Univariate		Multivariate	
	n/total (%)	Crude OR (95%CI)	P	aOR (95%CI)	P
ANC Adequacy					
ANC Utilisation:					
Inadequate	7/107 (6.5)	2.91 (0.59-14.36)	0.191	2.43 (0.44-13.27)	0.306
Adequate	2/85 (2.4)	1.00		1.00	
Adequate-plus	27/330 (8.2)	3.70 (0.86-15.87)	0.078	3.12 (0.65-15.12)	0.157
ANC Content:					
Inadequate	28/270 (10.4)	3.53 (1.58-7.90)	0.002	3.43 (1.46-8.03)	0.005
Adequate	8/252 (3.2)	1.00		1.00	
ANC content score, %:					
Percentage total content score	-	0.90 (0.86-0.95)	<0.001	Use categorical	
Utilisation * Content Score %					
Inadequate utilisation * content score		1.00 (0.99-1.01)	0.504		
Adequate utilisation * content score		0.98 (0.96-1.00)	0.078		
Adequate-plus utilisation * content score		1.00			
Socio-demographic					
Age group:					
20-34	27/439 (6.2)	1.00			
<=19 & 35+	9/83 (10.8)	1.86 (0.84-4.11)	0.127		
Ethnicity:					
Malay	32/396 (8.1)	1.00			
Chinese	2/67 (3.0)	0.35 (0.08-1.50)	0.157		
Indian	1/44 (2.3)	0.30 (0.04-1.99)	0.196		
Indigenous people	1/15 (2.8)	0.81 (0.10-6.40)	0.843		
Education level:					
Primary or no formal education	3/23 (13.0)	2.08 (0.55-7.91)	0.284		
Secondary	20/294 (6.8)	1.01 (0.49-2.08)	0.977		
Tertiary	13/193 (6.7)	1.00			
Socio-economic Status					
Occupation (women):					
Managers, professionals and technicians	11/131 (8.4)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, elementary workers	11/188 (5.9)	1.31 (0.57-3.02)	0.524		
Not working - HW, students, unemployed	13/199 (6.5)	0.89 (0.39-2.04)	0.781		
Occupation (spouse):					
Managers, professionals and technicians	13/215 (6.0)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, armed forces, others	22/293 (7.5)	1.26 (0.62-2.56)	0.521		

Table 4.34, continued

Characteristic	Preterm n/total (%)	Univariate Crude OR (95%CI)	Univariate P	Multivariate aOR (95%CI)	Multivariate P
Obstetric Factors/ Histories					
Parity:					
Nulliparous	10/195 (5.1)	0.63 (0.30-1.33)	0.222		
Multiparous	26/327 (8.0)	1.00			
Risk level:					
Low-risk	20/375 (5.3)	1.00		1.00	
High-risk	16/147 (10.9)	2.17 (1.09-4.31)	0.027	1.64 (0.79-3.40)	0.189
Risk code:					
White	9/160 (5.6)	1.00			
Green	11/215 (5.1)	0.91 (0.37-2.24)	0.828		
Yellow	15/140 (10.7)	2.01 (0.85-4.76)	0.111		
Red	1/7 (14.3)	2.80 (0.30-25.78)	0.364		
History of miscarriage:				included in the	
No	25/423 (5.9)	1.00		list of pregnancy	
Yes	11/99 (11.1)	1.99 (0.94-4.20)	0.071	complications	
History of complications in previous pregnancy					
No	14/207 (6.8)	1.00		1.00	
Yes	15/141 (10.6)	1.64 (0.77-3.52)	0.203	1.85 (0.83-4.10)	0.132
NA (primigravida)	7/174 (4.0)	0.58 (2.23-1.47)	0.248	0.82 (0.32-2.32)	0.759
History of complications in previous delivery					
No	16/229 (7.0)	1.00			
Yes	10/98 (10.2)	1.51 (0.66-3.46)	0.327		
NA (nulliparous)	10/195 (5.1)	0.72 (0.32-1.63)	0.428		
Default History					
User pattern:					
Not defaulted	21/373 (5.6)	1.00		1.00	
Ever defaulted	15/149 (10.1)	1.88 (0.94-3.75)	0.075	1.81 (0.86-3.80)	0.120
Provider Factors					
Clinic type (expected daily workload):					
Below 150	8/98 (8.2)	1.00		1.00	
150-300	22/247 (8.9)	1.10 (0.47-2.56)	0.825	0.84 (0.34-2.06)	0.697
301-500	6/177 (3.4)	0.40 (0.13-1.17)	0.094	0.32 (0.10-0.99)	0.048
% of total visits attended by CN		0.99 (0.98-1.01)	0.232		
% of total visits attended by SN w post-graduate		0.99 (0.98-1.01)	0.326		
% of total visits attended by MO		1.00 (0.99-1.02)	0.675		

In the univariate analyses, having inadequate ANC content (P=0.005) or lower percentage of ANC content score (P<0.001, B= -0.101), and high-risk pregnancy (P=0.027) had statistically significant association with preterm birth. ANC utilisation; socio-demographic factors such as maternal age, ethnicity, maternal education; socio-economic status (SES) factors like maternal and spouse' occupation; parity; risk code, history of complications in previous pregnancy and delivery; history of default; and provider factors (clinic type and percentage of total visits attended by specific providers) had no significant association with preterm birth statistically (Table 4.34).

A multivariate model using all independent variables with p<0.10 in the univariate analysis models was constructed. The categorical ANC content variable was used instead of the total ANC content score because the categorical variable provides more tangible interpretation of adequacy.

Risk level, although statistically significant in the univariate analyses, was no longer significantly associated with preterm birth in the multivariate model. In contrast, the types of clinic attended by the pregnant women became significantly associated with preterm birth statistically in the multivariate model. The odds of preterm birth for women attended clinics with expected daily workload of 301-500 were three times lower than women attended clinics with expected daily workload of <150 (OR=0.32, 95% CI=0.10-0.99, P=0.048).

Having inadequate ANC content remained statistically significantly associated with preterm birth. The odds of preterm birth for women with inadequate ANC content were over three times higher than women with adequate content (OR=3.43, 95% CI=1.46-8.03, P=0.005).

Although the p-value was non-significant at >0.05, the odds for preterm birth among women in the adequate-plus and inadequate utilisation categories appeared to be three times and over two times higher respectively compared with adequate utilisation category. The non-significant p-value was possibly due to small sample size. Given the odd ratios of 3.43 (adequate-plus utilisation) and 2.43 (inadequate category) which are sizeable effect size, these are suggestive of some evidences on the association of preterm birth with adequacy of ANC utilisation.

Likewise, though statistically non-significant, the odds for preterm birth among women with history of pregnancy complications in previous pregnancy appeared to be almost two times higher compared with those without history of complications. The non-significant p-value was possibly due to the “not applicable” category assigned for primigravida, and thus resulting in smaller sample size assessed. Given the odds ratio of 1.85 which is a sizeable effect size, this is suggestive of evidence on the association of preterm birth with history of complications in previous pregnancy.

4.6.2.2 Low Birth Weight

Table 4.35 below shows the univariate and multivariate analyses examining the factors associated with LBW.

In the univariate analyses, being secondary educated (P=0.025), having spouse that worked in lower SES job (P=0.016), red-tags (P=0.001), and had history of previous delivery complications (P=0.003) were significantly associated with LBW statistically. ANC utilisation and content adequacy, and other factors as presented in the table had no statistical significant association with LBW.

A multivariate model including all independent variables with P<0.10 in the univariate analyses was constructed. The variable “risk level (two categories - low versus high-risk)” which was collapsed from the risk code was not included in the multivariate analysis due to redundancies with “risk code” variable. The four-category “risk code” was chosen instead in the multivariate model because it provides more comprehensive information concerning risk tagging as compared to the aggregated two-category “risk level” variable.

Table 4.35: Factors Associated With LBW

Characteristic	LBW n/total (%)	Univariate Crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
ANC Adequacy					
ANC Utilisation:					
Inadequate	9/107 (8.4)	0.88 (0.33-2.40)	0.809	1.10 (0.35-3.47)	0.877
Adequate	8/85 (9.4)	1.00		1.00	
Adequate-plus	49/329 (14.9)	1.68 (0.77-3.71)	0.195	1.69 (0.66-4.32)	0.277
ANC Content:					
Inadequate	37/270 (13.7)	1.22 (0.72-2.04)	0.461		
Adequate	29/251 (11.6)	1.00			
ANC content score, %:					
Percentage total content score	-	0.97 (0.94-1.01)	0.140		
Utilisation * Content Score %					
Inadequate utilisation * content score		0.99 (0.98-1.00)	0.094		
Adequate utilisation * content score		0.99 (0.98-1.11)	0.202		
Adequate-plus utilisation * content score		1.00			
Socio-demographic					
Age group:					
20-34	55/438 (12.6)	1.00			
<=19 & 35+	11/83 (13.3)	1.06 (0.53-2.13)	0.861		
Ethnicity:					
Malay	54/395 (13.7)	1.00		1.00	
Chinese	4/67 (6.0)	0.40 (0.14-1.15)	0.088	0.37 (0.11-1.28)	0.117
Indian	4/44 (9.1)	0.63 (0.22-1.84)	0.399	0.55 (0.17-1.74)	0.310
Indigenous people	4/15 (26.7)	2.30 (0.71-7.48)	0.167	2.38 (0.63-9.01)	0.203
Education level:					
Primary or no formal education	1/23 (4.3)	0.47 (0.06-3.69)	0.471	0.43 (0.05-3.85)	0.449
Secondary	47/294 (16.0)	1.96 (1.09-3.53)	0.025	1.70 (0.86-3.36)	0.128
Tertiary	17/192 (8.9)	1.00		1.00	
Socio-economic Status					
Occupation (women):					
Managers, professionals and technicians	11/130 (8.5)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, elementary workers	26/188 (13.8)	1.74 (0.83-3.65)	0.146		
Not working - HW, students, unemployed	28/199 (14.1)	1.77 (0.85-3.70)	0.128		
Occupation (spouse):					
Managers, professionals and technicians	18/214 (8.4)	1.00		1.00	
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, armed forces, others	46/293 (15.7)	2.03 (1.14-3.61)	0.016	1.62 (0.85-3.08)	0.145

Table 4.35, continued

Characteristic	LBW n/total (%)	Univariate Crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
Obstetric Factors/ Histories					
Parity:					
Nulliparous	24/194 (12.4)	0.96 (0.56-1.64)	0.875		
Multiparous	42/327 (12.8)	1.00			
Risk level:					
Low-risk	41/374 (11.0)	1.00		Not included -	
High-risk	25/147 (17.0)	1.66 (0.97-2.85)	0.064	use risk code	
Risk code:					
White	14/159 (8.8)	1.00		1.00	
Green	27/215 (12.6)	1.49 (0.75-2.94)	0.253	1.35 (0.63-2.87)	0.440
Yellow	21/140 (15.0)	1.83 (0.89-3.75)	0.100	1.48 (0.66-3.34)	0.344
Red	4/7 (57.1)	13.81 (2.80-68.01)	0.001	8.41 (1.41-50.01)	0.019
History of miscarriage:				included in the	
No	54/423 (12.8)	1.00		list of pregnancy	
Yes	12/98 (12.2)	0.95 (0.49-1.86)	0.889	complications	
History of complications in previous pregnancy					
No	22/207 (10.6)	1.00			
Yes	21/140 (15.0)	1.48 (0.78-2.82)	0.227		
NA (primigravida)	23/174 (13.2)	1.28 (0.69-2.39)	0.436		
History of complications in previous delivery					
No	21/229 (9.2)	1.00		1.00	
Yes	21/98 (21.4)	2.70 (1.40-5.22)	0.003	2.40 (1.14-5.03)	0.021
NA (nulliparous)	24/194 (12.4)	1.40 (0.75-2.60)	0.289	1.80 (0.88-3.68)	0.106
Default History					
User pattern:					
Not defaulted	48/372 (12.9)	1			
Ever defaulted	18/149 (12.1)	0.93 (0.52-1.65)	0.799		
Provider Factors					
Clinic type (expected daily workload):					
Below 150	12/98 (12.2)	1.00			
150-300	38/246 (15.4)	1.31 (0.65-2.63)	0.448		
301-500	16/177 (9.0)	0.71 (0.32-1.57)	0.402		
% of total visits attended by CN		1.00 (0.99-1.01)	0.652		
% of total visits attended by SN w post-graduate		1.00 (0.99-1.01)	0.608		
% of total visits attended by MO		1.01 (1.00-1.02)	0.241		

Education and spouse's SES although significant in the univariate analyses, were no longer significant in the multivariate model. Being red-tagged and having history of previous delivery complications remained associated with LBW. The odds of LBW were over eight times higher for red-tag women compared with white-tag women (OR=8.41, 95%CI=1.41-50.01, P=0.019). There were no significant differences between other risk codes and the odds of LBW.

The odds for LBW were over two times higher for women with previous delivery complications compared with women without previous delivery complications (OR=2.40, 95%CI=1.14-5.03, P=0.021). Though the difference was non-statistically significant (P=0.106), the odds for LBW among the nulliparous were around 2 times higher than multiparous without history of delivery complications.

The odds for LBW among indigenous people appeared to be two times higher than Malay, although the p-value was >0.05. The non-significant p-value was possibly due to small sample size (N=15) since the proportion of indigenous people is small in Malaysia, particularly in the study areas. Given the OR of 2.38 which is a sizeable effect size, this is suggestive of evidence on association of LBW with the indigenous people.

4.6.2.3 Stillbirth

Table 4.36 shows the results of univariate and multivariate analyses for factors associated with stillbirth. In the univariate analyses, being Indian (P=0.039), having history of previous delivery complications (P=0.018), and percentage of attendance by Medical Officer (MO) were significantly associated with stillbirth. ANC utilisation and content adequacy, and other factors were not significantly associated with stillbirth.

Table 4.36: Factors Associated With Stillbirth

Characteristic	Stillbirth n/total (%)	Univariate crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
ANC Adequacy					
ANC Utilisation:					
Inadequate	2/107 (1.9)	0.79 (0.11-5.73)	0.816		
Adequate	2/85 (2.4)	1.00			
Adequate-plus	12/330 (3.6)	1.57 (0.34-7.13)	0.562		
ANC Content:					
Inadequate	7/270 (2.6)	0.72 (0.26-1.96)	0.519		
Adequate	9/252 (3.6)	1.00			
ANC content score, %:					
Percentage total content score	-	1.03 (0.95-1.12)	0.438		
Utilisation * Content Score %					
Inadequate utilisation * content score		0.99 (0.97-1.01)	0.367		
Adequate utilisation * content score		0.99 (0.97-1.01)	0.535		
Adequate-plus utilisation * content score		1.00			
Socio-demographic					
Age group:					
20-34	14/439 (3.2)	1.00			
<=19 & 35+	2/83 (2.4)	0.75 (0.17-3.36)	0.707		
Ethnicity:					
Malay	11/396 (2.8)	1.00		1.00	
Chinese	0/67 (0.0)	0.00	0.997	0.00	0.997
Indian	4/44 (9.1)	3.50 (1.07-11.50)	0.039	2.99 (0.81-11.03)	0.100
Indigenous people	1/15 (6.7)	2.50 (0.30-20.73)	0.396	1.80 (0.15-21.07)	0.641
Education level:					
Primary or no formal education	0/23 (0)	0.00	0.998		
Secondary	11/294 (3.7)	1.46 (0.50-4.27)	0.488		
Tertiary	5/193 (2.6)	1.00			
Socio-economic Status					
Occupation (women):					
Managers, professionals and technicians	3/131 (2.3)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, elementary workers	7/188 (3.7)	1.65 (0.42-6.50)	0.474		
Not working - HW, students, unemployed	6/199 (3.0)	1.33 (0.33-5.40)	0.693		
Occupation (spouse):					
Managers, professionals and technicians	6/215 (2.8)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, armed forces, others	10/293 (3.4)	1.23 (0.44-3.44)	0.692		

Table 4.36, continued

Characteristic	Stillbirth n/total (%)	Univariate crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
Obstetric Factors/ Histories					
Parity:					
Nulliparous	3/195 (1.5)	0.38 (0.11-1.34)	0.132	0.65 (0.15-2.91)	0.577
Multiparous	13/327 (4.0)	1.00		1.00	
Risk level:					
Low-risk	11/375 (2.9)	1.00			
High-risk	5/147 (3.4)	1.17 (0.40-3.41)	0.780		
Risk code:					
White	3/160 (1.9)	1.00		1.00	
Green	8/215 (3.7)	2.02 (0.53-7.75)	0.304	0.83 (0.18-3.78)	0.813
Yellow	3/140 (2.1)	1.15 (0.23-5.77)	0.869	0.32 (0.05-2.13)	0.237
Red	2/7 (28.6)	20.93 (2.84-154.45)	0.003	3.38 (0.26-44.65)	0.355
History of miscarriage:				included in the	
No	12/423 (2.8)	1.00		list of pregnancy	
Yes	4/99 (4.0)	1.44 (0.46-4.57)	0.534	complications	
History of complications in previous pregnancy					
No	5/207 (2.4)	1.00			
Yes	8/141 (5.7)	2.43 (0.78-7.59)	0.126		
NA (primigravida)	3/174 (1.7)	0.71 (0.17-3.01)	0.641		
History of complications in previous delivery					
No	5/229 (2.2)	1.00		1.00	
Yes	8/98 (8.2)	3.98 (1.27-12.50)	0.018	3.37 (0.98-14.17)	0.053
NA (nulliparous)	3/195 (1.5)	0.70 (0.17-2.97)	0.628		
Default History					
User pattern:					
Not defaulted	12/373 (3.2)	1.00			
Ever defaulted	4/149 (2.7)	0.83 (0.26-2.62)	0.747		
Provider Factors					
Clinic type (expected daily workload):					
Below 150	1/98 (1.0)	1.00			
150-300	8/247 (3.2)	3.25 (0.40-26.31)	0.270		
301-500	7/177 (4.0)	3.99 (0.48-32.95)	0.198		
% of total visits attended by CN		1.02 (1.00-1.04)	0.116		
% of total visits attended by SN w post-graduate		0.99 (0.97-1.01)	0.494		
% of total visits attended by MO		1.03 (1.00-1.05)	0.039	1.03 (1.01-1.06)	0.020

A multivariate model containing all independent variables with P<0.10 in the univariate analyses was constructed. Ethnicity, although significant in the univariate analyses, was no longer significant in the multivariate model (P=0.428). However, the odds for stillbirth among Indian women were three times higher compared with Malay women, although the p-value was >0.05. The non-significant p-value was possibly due to small sample size (4/44). Given the OR of 2.99 which is a sizeable effect, there is some evidence concerning the association of stillbirth among the Indian women.

Likewise, although the p-value for red-tag was >0.05, possibly due to small sample size (N=7) since there is not many red-tag cases at the health clinics. Given the OR of 3.38 which is a sizeable effect size, this is suggestive of evidence on association of stillbirth with red-tag.

History of previous delivery complications appeared to be associated with stillbirth although the p-value was >0.05. The odds were over three times higher (OR=3.37, 95%CI=0.98-14.17, P=0.053) for women with previous delivery complications compared with women without previous delivery complications. Though not statistically significant, there is clinical importance of this suggestive evidence of association.

Percentage of total visits attended by MO though statistical significant (P=0.020), the effect size was small. The OR value was 1.03 (95% CI=1.01-1.06).

4.6.2.4 Maternal Complications

Table 4.37 shows the results of univariate and multivariate analyses examining the factors associated with maternal complications. In the univariate analyses, having a spouse with lower SES (P=0.005), history of previous delivery complications (P<0.001), and percentage of total attendance by MO (P=0.033) were significantly associated with maternal complications. ANC utilisation and content adequacy and other factors had no statistically significant influence on maternal complications.

Table 4.37: Factors Associated With Maternal Complications

Characteristic	Mat. Complication n/total (%)	Univariate crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
ANC Adequacy					
ANC Utilisation:					
Inadequate	7/107 (6.5)	1.91 (0.48-7.63)	0.358		
Adequate	3/85 (3.5)	1.00			
Adequate-plus	23/330 (7.0)	2.05 (0.60-6.99)	0.252		
ANC Content:					
Inadequate	12/270 (4.4)	0.51 (0.25-1.06)	0.072	0.45 (0.20-1.05)	0.064
Adequate	21/252 (8.3)	1.00		1.00	
ANC content score, %:					
Percentage total content score	-	1.04 (0.98-1.11)	0.159		
Utilisation * Content Score %					
Inadequate utilisation * content score		1.00 (0.99-1.01)	0.985		
Adequate utilisation * content score		0.99 (0.98-1.01)	0.270		
Adequate-plus utilisation * content score		1.00			
Socio-demographic					
Age group:					
20-34	30/439 (6.8)	1.00			
<=19 & 35+	3/83 (3.6)	0.51 (0.15-1.72)	0.277		
Ethnicity:					
Malay	24/396 (6.1)	1.00		1.00	
Chinese	1/67 (1.5)	0.24 (0.03-1.77)	0.159	0.17 (0.02-1.48)	0.108
Indian	6/44 (13.6)	2.45 (0.94-6.36)	0.066	1.72 (0.54-5.49)	0.361
Indigenous people	2/15 (13.3)	2.39 (0.51-11.18)	0.270	3.76 (0.51-27.79)	0.195
Education level:					
Primary or no formal education	4/23 (17.4)	4.87 (1.34-17.68)	0.016	4.32 (0.83-22.38)	0.082
Secondary	21/294 (7.1)	1.78 (0.77-4.10)	0.177	1.10 (0.42-2.90)	0.850
Tertiary	8/193 (4.1)	1.00		1.00	
Socio-economic Status					
Occupation (women):					
Managers, professionals and technicians	6/131 (4.6)	1.00			
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, elementary workers	13/188 (6.9)	1.55 (0.57-4.18)	0.389		
Not working - HW, students, unemployed	14/199 (7.0)	1.58 (0.59-4.21)	0.364		
Occupation (spouse):					
Managers, professionals and technicians	5/215 (2.3)	1.00		1.00	
Clerical, service, skilled agricultural, forestry, fishery, craft, plant, armed forces, others	26/293 (8.9)	4.09 (1.54-10.83)	0.005	3.54 (1.22-10.25)	0.020

Table 4.37, continued

Characteristic	Mat. Complication n/total (%)	Univariate crude OR (95%CI)	P	Multivariate aOR (95%CI)	P
Obstetric Factors/ Histories					
Parity:					
Nulliparous	15/195 (7.7)	1.43 (0.70-2.91)	0.323		
Multiparous	18/327 (5.5)	1.00			
Risk level:					
Low-risk	20/375 (5.3)	1.00			
High-risk	13/147 (8.8)	1.72 (0.83-3.56)	0.142		
Risk level:					
White	9/160 (5.6)	1.00			
Green	11/215 (5.1)	0.91 (0.37-2.24)	0.828		
Yellow	11/140 (7.9)	1.43 (0.58-3.56)	0.441		
Red	2/7 (28.6)	6.71 (1.14-39.49)	0.035		
History of miscarriage:				included in the	
No	26/423 (6.1)	1.00		list of pregnancy	
Yes	7/99 (7.1)	1.16 (0.49-2.76)	0.734	complications	
History of complications in previous pregnancy					
No	8/207 (3.9)	1.00			
Yes	13/141 (9.2)	2.53 (1.02-6.27)	0.046		
NA (primigravida)	12/174 (6.9)	1.84 (0.74-4.62)	0.192		
History of complications in previous delivery					
No	5/229 (2.2)	1.00		1.00	
Yes	13/98 (13.3)	6.85 (2.37-19.80)	<0.001	11.34 (3.28-39.23)	<0.001
NA (nulliparous)	15/195 (7.7)	3.73 (1.33-10.47)	0.012	7.47 (2.11-26.45)	0.002
Default History					
User pattern:					
Not defaulted	25/373 (6.7)	1.00			
Ever defaulted	8/149 (5.4)	0.79 (0.35-1.79)	0.573		
Provider Factors					
Clinic type (expected daily workload):					
Below 150	10/98 (10.2)	1.00			
150-300	11/247 (4.5)	0.41 (0.17-1.00)	0.050		
301-500	12/177 (6.8)	0.64 (0.27-1.54)	0.319		
% of total visits attended by CN		0.99 (0.98-1.00)	0.116		
% of total visits attended by SN w post-graduate		1.01 (1.00-1.02)	0.149		
% of total visits attended by MO		1.02 (1.00-1.04)	0.033	1.02 (1.00-1.04)	0.026

A multivariate model containing all independent variables with P<0.10 in the univariate analyses was constructed. All the three variables (SES of spouse, history of previous delivery complications, and percentage of total attendance by MO) remained associated with maternal complications. The odds for maternal complications were 3.5 times higher (OR=3.54, 95%CI=1.22-10.25, P=0.020) for women with spouse of lower SES compared with women with spouse of higher SES.

The odds for maternal complications among multiparous who had previous delivery complications were over 11 times higher (OR=11.34, 95%CI=3.28-39.23, P<0.001) as compared with multiparous without previous delivery complications. In addition, the odds for maternal complications among the nulliparous were around 7.5 times higher than multiparous without history of delivery complications (OR=7.47, 95%CI=2.11-26.45, P=0.002). Further analysis on these 15 nulliparous with maternal complications was done to examine if they had any previous pregnancy that was problematic. The analysis showed that among these 15 nulliparous with maternal complications, 3/15 of the nulliparous was actually multigravida who had been pregnant and had complications in their previous incomplete pregnancy. But majority (12/15) of these nulliparous were primigravida that had not been pregnant previously. This showed that women who were gravida 1 and para 0 (G1P0) were likely to have maternal complications.

Percentage of total visits attended by MO is statistically significant (P=0.026). The OR value was 1.02 (95% CI=1.00-1.04), indicating a small effect size.

The odds for maternal complications among indigenous women appear to be around four times higher compared with Malay women, although the p-value was >0.05. The non-significant p-value was possibly due to small sample size (N=15) since the proportion of indigenous people is low in Malaysia. Given the OR of 3.76 which is a sizeable effect size, this is suggestive of association of maternal complications among the indigenous women.

Similarly, primary educated women appeared to have the odds of more than four time higher compared to tertiary, although the p-value was 0.082 which was possibly due to small sample size (N=23) since there was lower proportion of primary educated population. The OR of 4.32 is a sizeable effect size that is suggestive of association of maternal complications with primary educated women.

4.7 SUMMARY: RESULTS

4.7.1 Respondents Characteristics – Users of Health Clinics for Antenatal Care

The pregnant women (users of ANC at the health clinics) were relatively young, the mean maternal age at first visit was 28.7 years. Majority (75.9%) were Malay, followed by 12.8% Chinese, 8.4% Indian, and 2.9% Indigenous people. Compared to overall ethnic composition of Malaysia, there are a larger proportion of Malay uses ANC services at the health clinics.

Over half (56.3%) of the users for ANC (pregnant women) had secondary education and over one-third (37%) had tertiary education. Only 3.6% were primary educated and 0.8% (four women) without any education.

The highest proportion, 38.1%, of the pregnant women fell under the occupation category of "Others" in which housewives constituted 37.0%, students 1.0%, and unemployed 0.2% (single mother status). In total, 25% of the pregnant women worked at the top-3 tiers of occupations (Legislators, senior officials and managers; professional; technicians and associate professionals). "Clerical workers" were 16.7%; "Service workers, shop and market sales workers" were 12.1%. The remaining were craft, factory operators, and elementary workers (7.3%). As for the spouses, 41.2% of the spouses worked in the top-3 tiers occupations, with "technicians and associate professional" constituted 28.7%. Service workers and factory operators were around 18% each. Agriculture, fishery, craft and elementary workers were 28.3%.

Mean gravidity and parity were 2.4 and 1.2 respectively. 33.3% were primigravida and 66.7% were multigravida. Nulliparous was 37.4%, and multiparous 62.6%.

Nineteen percent of the pregnant women had at least one miscarriage. Twenty-seven percent of the pregnant women had a history of complications during previous pregnancy (mainly GDM, PIH, anaemia, placenta praevia, and miscarriage), compared to 39.7% without complications in previous pregnancy. Thirty-three percent were primigravida who were not applicable to this assessment since a primigravida was pregnant for the first time and thus did not have any previous pregnancy.

Around 19% of the pregnant women had complications in previous delivery (premature deliveries, caesarean, instrumental deliveries, PPH, stillbirth and neonatal death) compared to 43.9% without complications in previous delivery. Thirty-seven percent were nulliparous who were not applicable to this assessment since a nulliparous did not have any previous delivery.

The proportionate sampling required 30% white-tags and 70% colour-tags. As a result, 30.7% of the respondents were white-tags and 69.3% colour-tags. In total, 71.8% were considered low-risk pregnancies (white and green-tags), and 28.2% were high-risk pregnancies (yellow and red-tags).

The average POG when the pregnant women sought for ANC at the surveyed clinics was around 13.7 weeks; the earliest at the 4th weeks and latest was the 37th weeks. The average expected number of visits (based on standard recommended schedule of MOH, adjusted for gestational age at birth) was around 7 visits. In contrast, the average total observed number of visits irrespective of POG at first visit/booking was close to 12 visits, almost double the number of expected visits.

In total, 28.5% of the pregnant women have defaulted at least one ANC appointment; either absence in between appointments or stopped coming before due date. The mean was 1.4.

There were 22.4% of the women given a REDD (revised expected date of delivery). Among these women, around 40% (47 cases) reported “unsure of date” (USOD).

Twenty-two percent were recorded as practicing family planning. Among those practicing family planning (n=115), the most common method was oral contraceptive pill at 60.0%, followed by condom at 12.2%, and hormonal injection at 11.3%. There were also 10.4% reported as using non-modern method.

4.7.2 Assessing Status of Antenatal Care Adequacy (Utilisation and Content)

Achievements concerning adequacy in ANC varied, depending on the type of indicators or indexes adopted. In terms of adequacy of utilisation, in total, 18.6% of the pregnant women had “inadequate” utilisation, 1.9% had “intermediate,” 16.3% were “adequate,” and 63.2% had “adequate-plus” utilisation. Based on this tabulation, it appears that there were a significantly high proportion of pregnant women who had “adequate-plus” utilisation which meant they had intensive ANC utilisation that was higher than the recommended schedule.

Distribution by content adequacy index showed that there was no woman who had “inadequate” ANC content (services) provided to them. In total, 51.7% of the women had “intermediate” content (which was classified as “inadequate” in analysis), and 48.3% had “adequate” content provided to them.

In terms of the mean of the weighted score by all the four assessment components, the average score for PE, HS and CM were similar at around 84% each. HE had the lowest score at only around 35% on average.

Cross-tabulation of adequacy of utilisation and adequacy of content showed the proportion of the following combinations:

- Inadequate utilisation and inadequate content 11.9%
- Inadequate utilisation and adequate content 8.6%
- Adequate utilisation and inadequate content 39.8%
- Adequate utilisation and adequate content 39.7%

4.7.3 Factors Associated with Adequacy of Antenatal Care Utilisation

- Pregnant women aged ≤ 19 and ≥ 35 had lower level of ANC utilisation compared to those in the 20-34 age-groups.
- Chinese, Indian, and indigenous people had higher proportions of inadequate ANC utilisation compared to Malay.
- Pregnant women with primary or no education had lower level of ANC utilisation. In turn, pregnant women with tertiary (advance diploma and above) education had a smaller proportion of inadequate utilisation.
- There was no statistically significant association between occupation of pregnant women or their spouse and ANC utilisation adequacy.
- Nulliparous had significantly higher proportion of adequate utilisation (79%), and lower proportion of inadequate (31%) and adequate-plus category (29%). Multiparous have significantly lower proportion of adequate utilisation (21%), but higher proportion of inadequate (69%) and adequate-plus category (71%).
- There was a sizeable proportion of low-risk women having adequate-plus utilisation (67% of total adequate-plus category) and the presence of high-risk women with inadequate utilisation (30% of total category).
- Ordinal regression - Age, education, parity and risk level are all related to the utilisation ranking. Women aged 20-34 are more likely to have higher

utilisation than women aged ≤ 19 and ≥ 35. Primary educated were less likely to have higher utilisation than tertiary educated (negative coefficients). Multiparous are more likely to have higher utilisation than nulliparous. Low-risk women were less likely to have higher utilisation than high-risk (P=0.002).

4.7.4 Adherence to Recommended Routine Antenatal Care Content

- There was no significant association statistically between parity and content adequacy by category of score.
- High-risk women with inadequate ANC content score was significantly more than adequate content score (33.0% versus 23.0%, P=0.015).
- Clinic type <150 had significantly lower proportion of inadequate content score and higher proportion of adequate content score (12.1% versus 25.8%) than larger clinics (53.7% versus 40.5%; 34.1% versus 33.7%; P<0.001).
- The percentage of total visits attended by SN with postgraduate has a small negative correlation with ANC content score (P<0.01); while increasing the percentage of total visits attended by SN without postgraduate, CN and MO were predicted to slightly increase the ANC content score (P<0.05).
- The mean content score among low-risk was significantly higher than the high-risk (P=0.001), and the mean content score among clinic <150 was significantly higher than bigger clinics (P ≤ 0.001).

4.7.5 Adherence to Selected Recommended Practices

- Overall, 97.7% of the pregnant women were provided the first RME1 at booking or by POG 24 weeks; and only 2.3% failed to be seen during this period. As for RME2, 92% of the women were seen for RME2 during 31-36 weeks, while 8% were not seen during the period.

- Over 90% of the pregnant women were given haematinic supplement (including folic acid) or advised to take the supplement during their first visit to the clinics. Out of the 9.8% of the pregnant women who had not been given or advised to consume folic acid, around half of them had their first visit at or before 12 weeks gestation, yet they had not been given or advised.
- Around 82% had their first ultrasound by 24 weeks POG, while 17.8% did not.
- Symphysis-fundal height, foetal lie and presentation, and foetal heart auscultation were commenced at around 18-19 gestation weeks, earlier than recommended schedules of initiation.
- None of the clinics surveyed performed screening test or asked pregnant women's hepatitis B status, or advised the women to seek testing elsewhere.
- Approximately 16% of the pregnant women were ever documented for prescription for UTI or UTI-like symptoms.
- Around 8% of the women had documented prescription for vaginal infection.

4.7.6 Adequacy of Antenatal Care Utilisation, Content and Other Factors Associated with Pregnancy Outcomes

ANC utilisation and pregnancy outcomes: The odds for preterm birth and maternal complications appeared to be higher in the adequate-plus and inadequate categories, as compared to adequate category. The results also suggest that intensive utilisation is associated with higher prevalence of LBW. The odds for stillbirth were higher in adequate category than inadequate category.

ANC content and pregnancy outcomes: preterm birth was significantly associated with ANC content statistically. The odds for preterm birth were higher in inadequate category than adequate category. The odds for stillbirth and maternal complications appeared to be higher in adequate category than inadequate category. ANC content did not appear to influence LBW.

Preterm birth: Having inadequate ANC content score (OR=3.43, 95%CI=1.46-8.03) and attended clinics with daily expected workload of 301-500 (OR=0.32, 95%CI=0.10-0.99) were significantly associated with preterm birth statistically. Women with adequate-plus utilisation (OR=3.43) and inadequate utilisation (OR=2.43), as well as history of pregnancy complications in previous pregnancy (OR=1.85) also appeared to have higher odds of preterm birth.

LBW: Being red-tagged (OR=8.41, 95%CI=1.41-50.01) and having history of previous delivery complications (OR=2.40, 95%CI=1.14-5.03) were significantly associated with LBW statistically. Nulliparous also appeared to have higher odds for LBW than multiparous without history of delivery complications (OR=1.80). The odds for LBW among indigenous people also appeared to be higher (OR=2.38).

Stillbirth: History of previous delivery complications (OR=3.37, 95%CI=0.98-14.17) and increase percentage of total visits attended by MO (OR=1.03, 95%CI=1.01-1.06) were significantly associated with stillbirth statistically. Being Indian (OR=2.99) and red-tagged (OR=3.38) also appeared to have higher odds for stillbirth.

Maternal complications: Having spouse with lower SES (OR=3.54, 95%CI=1.22-10.25), history of previous delivery complications (OR=11.34, 95%CI=3.28-39.23), and increase percentage of total visits attended by MO (OR=1.02, 95%CI=1.00-1.04) were significantly associated with maternal complications statistically. Indigenous people (OR=3.76) and primary educated women (OR=4.32) also appeared to have higher odds for maternal complications.

CHAPTER 5: DISCUSSION

In this chapter, the results obtained from the study will be discussed to understand better and explain the significance of the findings. The findings will be compared with the findings of other relevant studies, to justify how the findings could be related and generalised to other populations. The discussion starts with an overview of the sampled population, followed by commenting on the status of ANC adequacy in terms of both utilisation and content, before moving on to discussing the factors associated with ANC utilisation and content, bearing in mind that factors influencing health services utilisation may be associated with user characteristics, while the content of the care provided may be influenced by provider factors. Adequacy of ANC and other factors are also examined to determine their association with pregnancy outcomes. The discussion also draws on the findings from literature review, in particular when assessing the national ANC guidelines of Malaysia and in addressing the observation in current practice.

5.1 OVERVIEW OF RESPONDENTS

Discussing the characteristics of the respondents of this study who were the ANC users of the public-funded health clinics need to consider the two known features of these clinics: highly affordable since the fee schedule is only MYR1.00 (USD0.30) and long waiting times (Jaafar, et al., 2013). The overview of the respondents appears to fit the profile of population who might use the ANC services of the health clinics due to high affordability and who could bear the long waiting times – i.e. they were relatively young, majority did not have tertiary education, either did not have formal employment or had less demanding occupation, and have lower social-economic status.

The respondents were generally young; the mean maternal age of the pregnant women at the first visit was around 28 years old. More than half (56%) of the users for

ANC at the health clinics had secondary education and around one-third (37%) had tertiary education. Majority of the pregnant women (30%) had no formal employment, 36% worked as clerical, service or factory workers. Only 25% worked at the top-3 tiers of occupation. In addition, close to 60% of the women's spouse were services, factory, agriculture, fishery, craft or elementary workers.

Majority of the respondents were Malay (76%), followed by Chinese (13%), Indian (8%), and Indigenous people (3%). The official ethnic composition of Selangor showed Bumiputera which included both Malay and Indigenous people was 57.1% of total population, Chinese (28.5%), Indians (13.5%) and Others [0.8%, (Department of Statistics, 2011)]. This implies that a higher proportion of the Malays use the ANC services provided by the public-funded health clinics, while a large proportion of the Chinese do not use the ANC services of the public-funded health clinics. This matches the general knowledge that majority of the Chinese pregnant women use private health care (personal communication with MOH and health clinic officers, Appendix A). This findings further confirmed this statement by showing that the Chinese women were the largest proportion of respondents who had documented indication seen elsewhere prior to the first visit (61.2% of Chinese pregnant women), as well as high proportion of documented ANC check-up elsewhere before visiting the health clinics.

Majority of the respondents were low-risk women (white and green-tags, 72%) and only 28% were high-risk (yellow and red-tags). Though there was no official data on the distribution of pregnant women by risk level for comparison, it was widely known that majority of the pregnant women attending ANC at the health clinics were low-risk cases.

The average POG when the pregnant women sought for ANC at the surveyed clinics was around 13.7 weeks. Forty-seven percent of the women had their first visit at the health clinics at or before 12 gestation weeks. This was similar to the MOH data which recorded around 49% for Selangor state (Ministry of Health Malaysia, 2012a).

The mean number of expected visits (based on standard recommended schedule of MOH, adjusted for gestational age at birth) was around 7 visits. In contrast, the mean total number of observed visits was close to 12 visits including visits for specific single procedure. The mean for total ANC visits excluding visits for specific single procedure was over 10 visits. More than half (54%) had at least one visit for single procedure. The figure was higher than the MOH data which recorded around 11 visits for Malaysia and 9 visits for Selangor (Ministry of Health Malaysia, 2012a). However, it is assumed that the MOH statistics might not include additional visits for single procedure or special appointments.

Twenty-two percent of women reported practicing family planning. Among those practicing family planning (n=115), the most common method was oral contraceptive pill (60.0%), followed by condom (12.2%), and hormonal injection (11.3%). There were also 10.4% reported using non-modern method. The proportion of women practising family planning in this study was lower than the official contraceptive prevalence rate of 52% based on year 2004 data [Note: the Malaysian Population Family Survey is conducted every 10 year (Jaafar, 2014)]. The lower rate documented might be because this information was not actively pursued at the clinic level. Also, there might be differences in the understanding of family planning in which non-modern might not be reported or recorded.

The preterm birth (<37 weeks of gestation) rate per 100 live births was around 7% in this study, which is lower than the national rate of 12% (WHO, 2014b). This is because as the first level primary health care clinics, there is a limit to the type of complicated pregnancy that could be handled at this level of care. The extreme high-risk cases that might prompt preterm birth are often referred to hospitals and managed at hospital level. For example, in-vitro fertilisation cases which have a tendency to deliver preterm are managed by specialist at the specialised hospitals or clinics.

LBW was below 13%, about similar to the national rate of 11% (WHO, 2014b). As for stillbirth, the national rate was 6 per 1,000 total births (WHO, 2014b), while this study found 3.1% stillbirths out of the total samples (31 per 1,000 total births) due to purposive sampling of death records.

In essence, it is apt to say that the characteristics of the respondents were similar to the expected characteristics of the users of ANC services at the public-funded health clinics. The findings would be expected to be similar if the methods were applied in other populations.

5.2 ASSESSING STATUS OF ANTENATAL CARE ADEQUACY (UTILISATION AND CONTENT)

Indicators such as crude coverage and POG of initiation in ANC are not able to provide useful feedback on the performance of health system. For example, striving for early initiation of care will have little benefit if the subsequent utilisation pattern were too few or too many. Likewise, this particular achievement in early initiation or other single indicators may have little effect on pregnancy outcomes if the overall quality of ANC was poor. Therefore, what is utmost important is the ability of the indicators to incorporate the quality dimension of care.

5.2.1 Antenatal Care Utilisation

In Malaysia, indicators for ANC utilisation rely on period of gestation of the first visit and average number of total ANC visits, as separate indicators. The cut-off points for gestation of first visit are set at 0-12 weeks, 13-24 weeks and ≥ 25 weeks. These cut-off points are contentious. For example, initiating ANC at 13 or 15 weeks is substantially different from having the first visit at 20-24 weeks in terms of the opportunity to benefit from screening tests, antenatal education and health advice, yet these are being grouped in the same category. As had already been discussed in Section 2.2.1, there is limited evidence to determine exactly when the first antenatal visit should take place (Villar, et al., 2001). However, late booking means that women may not have the opportunity to benefit from screening tests, antenatal education and health advice, or supported decision making regarding the place and choice of delivery (Baker & Rajasingam, 2012). On the other hand, the latest CEMD of UK revealed that among the women who died who had received any ANC, 43% had their ANC booking at ≤ 10 weeks of gestation, 31% at 11-12 weeks, and only 20% at >12 weeks [missing data was 6% (Knight, et al., 2015)]. In total, over 70% of the women who died had their booking by 12 weeks of gestation and only 20% had their booking after 12 weeks of gestation.

Likewise, the average number of total ANC provides little benefit in assessing adequacy of ANC utilisation when the initiation period is not known. For example, a multiparous could be seen seven times throughout her 40-week pregnancy which is considered adequate according to the recommended number of ANC visits for multipara. However, if it was not known that this particular woman initiated her first ANC visit at 20 weeks gestation which is considered late, was it right to conclude that this woman had adequate ANC utilisation because she had seven ANC visits? The scenario highlights the limitation in using these two indicators separately.

The concept of APNCU Index that is widely used in developed countries incorporated both the adequacy of initiation and adequacy of visits. This long researched index categorised initiation later than 12 weeks under the "adequate" category, and adequacy of visits is based on observed-to-expected visit ratio. The index overall provides a more meaningful analysis concerning ANC utilisation.

The finding from this present study revealed that 47% of the pregnant women had their first visit at the health clinics at or before 12 gestation weeks, while slightly over half (53%) had their first visit at 13 weeks or later. This was similar to the MOH data which was recorded at around 49% in year 2010 for Selangor state (Ministry of Health Malaysia, 2012a). The mean for the POG of first visit was around 14 weeks.

The mean for total number of total ANC visits was close to 12 visits (including visits for specific single procedure). The mean for total ANC visits excluding visits for specific single procedure was over 10 visits. More than half (54%) had at least one visit for single procedure. If the data were to include visits made solely for blood pressure monitoring, this figure would become even higher. The average visits per pregnant women recorded by MOH was around 11 visits for Malaysia and 9 visits for Selangor (Ministry of Health Malaysia, 2012a), whereby it was not certain if the MOH statistics include additional visits for single procedure or special appointment. It is inaccurate to exclude visits for single procedure or special appointment from the total ANC visits, because the visit for single procedure such as blood tests, dietary counselling, or ultrasounds and etc. are crucial for ANC; and have financial and economic implications for both the providers and users. This also relates to efficiency of services considering that some of these single procedures could have been scheduled together with a routine ANC visit.

Given the high average number of visits in relation to Malaysia's recommended ANC schedule, the observed-to-expected visit ratio naturally was impressive, with a very large proportion of pregnant women (94.8%) had "adequate" ratio as compared to only 5.2% that had "inadequate" ratio.

Combining both the POG of initiation and observed-to-expected visit ratio according to the modified APNCU Index, this present study found that there were 80% of the pregnant women classified as having "adequate" utilisation, and 20% "inadequate." This result is similar to a study using a modified APNCU Index in Canada, in which it was found that 75% of the insured pregnant women had adequate ANC utilisation (included both "adequate" and "adequate-plus" categories), and 25% had inadequate ANC utilisation [included both intermediate and inadequate categories, (Jarvis, et al., 2011)]. The comparison in this Canadian study used the finding for the insured pregnant women only because ANC services offered at the Malaysian health clinics are literally provided free to the population, whereby the user is only required to pay a token of USD0.30. The finding was also similar to the finding in the USA based on the APNCU index and a modified variant in which around 74-76% had adequate ANC utilisation which included both "adequate" and "adequate-plus" categories, and around 23% had inadequate ANC utilisation which included both intermediate and inadequate categories (VanderWeele, et al., 2009).

However, using the categories of "adequate" and "adequate-plus" to further refine the adequate level of utilisation, this present study reveals high proportion of "adequate-plus" category (63%) in which the utilisation level was above the standard visits, and the presence of inadequate ANC utilisation category (21%); while those classified as "adequate" was only 16%.

The proportion of "adequate-plus" category is higher than the findings of a study in the USA. The US study had around 30% classified as "adequate-plus" and around 45% had adequate utilisation (VanderWeele, et al., 2009). Because the recommended ANC schedule of the USA is much higher than the Malaysian Government guidelines, it might be argued that if applying the US standard, "adequate-plus" might be lower. The researcher argues however, that national standards are based on the country setting—specific availability of technical, human and financial resources and affordability. Adequacy of ANC therefore needs to be defined using national standards. It cannot be evaluated on the base of other countries' standards which operate with a substantially different resource envelope.

Sixty-three percent of total pregnant women were classified in "adequate-plus" category. Among this "adequate-plus" category, 67% were low-risk women and 33% were high-risk women. The finding is similar to the finding in the USA in which 64% of the "adequate-plus" category were women without maternal medical risk factors and 36% were women with risk factors (Koroukian & Rimm, 2002). This indicates the presence of over-utilisation among low-risk women who were not expected to have ANC visits higher than recommended.

These 63% of women in "adequate-plus" category translated to 42% out of 72% of low-risk women and 21% out of 28% of high-risk women, in total. This indicated 42% of total women or 59% of low-risk women had inappropriate high utilisation since the low-risk was not expected to have utilisation above recommended. On the other hand, 7% of total women or 26% of the high-risk women had inappropriate low utilisation since it was expected that high-risk would have intensive utilisation (total high-risk were 28.2%). Among these high-risk women without intensive utilisation, 13% (5/38) were ever referred to a hospital for additional consultation before 28 weeks, 42% (16/38) were ever referred to a hospital at 28 weeks onwards, and 45% (17/38) had no documented referral to a hospital. While it could be argued that around half of these high-risk women without intensive utilisation might receive subsequent ANC at the hospital after their referral, a referral at the third trimester onwards might not result in many more ANC visits. Moreover, there was around half of these high-risk women that had no documented referral to a hospital. This could partly due to possible non-documentation of the referrals. Some of the women might also have, out of their own initiative, attended private clinics parallel to receiving ANC at the public clinics which was not reported to the public clinics.

At this juncture, it could be said that there are two issues related to ANC utilisation: first, there was a large proportion (63%) of intensive utilisation in which over-utilisation was noted among more than half (nearly 60%) of the low-risk women, while there was still 26% of high-risk women not having intensive utilisation as expected. Second, among the 21% of the pregnant women who had inadequate ANC utilisation, the inadequacy was mainly due to late initiation as evidenced by the fact that 18% of the pregnant women had their first visit at 18 gestational weeks or later. The inappropriate over-utilisation of ANC implies the need to consider a more efficient resource scheduling practice, while late initiation of ANC suggests the need for educating reproductive age women on this subject.

5.2.2 Antenatal Care Content

This present study found that 52% of the pregnant women had less than 80% of recommended routine ANC content documented in their antenatal records; and 48% had ≥ 80% of the recommended ANC content. This indicates that around half of the pregnant women did not receive the minimal level of recommended routine care. This finding is similar to a study in USA in which the majority of the pregnant women (70%) also had less than 80% of the recommended ANC content documented; and there was only 30% of pregnant women had ≥ 80% of the recommended ANC content (Handler, et al., 2012).

The results from this present study appear to indicate better adherence to recommended ANC practice than the American study in terms of proportion of pregnant women with ≥80% of ANC content (48% versus 30%). This is due to differences in assessment criteria whereby the approach had been more stringent in the American study. For example, the assessment criteria for maternal weight in the American study required that maternal weight is to be taken at every visit; whereas the assessment criteria for maternal weight in this present study according to the Malaysian practice considered the recommended schedule, i.e. 10 times for primigravida, and 7 times for multigravida, adjusted for gestational age at birth. If the total visits is less than 10 or 7 visits respectively for a 40 weeks pregnancy, evidence of being done at each visit is accepted as meeting the scoring criteria. Therefore, should similar approach be adopted, the achievement in ANC content in Malaysia would be lower.

In Malaysia, indicators for ANC content measure single procedure such as crude coverage of anti-tetanus toxoid (ATT) for pregnant women, Hb status at ±36 weeks gestation (non-exhaustive, most clinics are not reporting for all pregnant women), medical referral (to MO, FMS, or hospital). While it is necessary to monitor the coverage of ATT among the pregnant women, routine surveillance of the other two indicators might be less useful. For example, what can the number of medical referrals reveal in terms of health services and system performance? Is it necessary to conduct routine surveillance of Hb status every month, quarter, or year? What could this reflect on the quality of services? Instead, assessing or monitoring/evaluation quality of services necessitates broader aspects of care. For example, the coverage of ATT in this study has been excellent (96%). However, this is not able to reflect overall quality of ANC, as evidenced by the large proportion of pregnant women (52%) that had less than 80% of basic recommended ANC content documented.

This study also revealed interesting finding in terms of the scores by different components of the ANC content assessed. The average for the total score was around

77%. The average score for PE, HS and CM were similar at around 84-85% each. HE had the lowest percentage of score at only around 35%.

The substantially lower score in health education echoed the finding of other studies in which health education is frequently less performed as compared to physical examination, screening, or prescription (Dhar, et al., 2010; Majrooh, et al., 2014; Victora, et al., 2010). Other studies found 42% of the pregnant women were not informed of any pregnancy danger signs (Pembe, et al., 2010), and 30% to 55% of pregnant women did not receive 11 out of 22 recommended health education topics (White, 2006).

Further analysis of this present study showed that the checklist for antenatal health advice, which was supposed to guide the providers in ensuring the completeness of health advice topics provided, was rarely used. Majority (45%) of the antenatal advice checklist page in the women's records were not used by the providers; antenatal advice given was written in the treatment/ case management column instead. When the checklist was used (37%), it was found that the list of the topics was only partially covered. Provision of predefined antenatal advice topics was not fully adhered to.

Pregnant women were also often given the same antenatal advice during visits. For example, the mean number of times antenatal dietary advice given was 5.4. Another common advice given to pregnant women was to have adequate rest and sleep (mean 2.7), which was not part of the health advice topics in the checklist. In contrast, advice on physical exercise which is part of the checklist was rarely given to pregnant women (3%). Advice related to postnatal care was also seldom given (5%). Repeated advice could be due to low compliance or persistent conditions that warranted similar advice. Overall, it appears that different topics are attached with different importance by the nurses, but reasons for that were not investigated in this study and should be explored further.

In addition, the observation validated the orientation towards risk management in the care of high-risk women, majority of the general/ non-risk focused advice was less frequently provided to the high-risk women. The healthcare professional prioritised the need for information according to the risk-factors of the women and overlooked other needs. This finding could be explained by the focus on a risk-oriented approach rather than a more comprehensive package of care that often results in reduced opportunities for discussion and responding to women's need for additional information (Hanson, VandeVusse, Roberts, & Forristal, 2009; Lee, Ayers, & Holden, 2014; Wennberg, Lundqvist, Högberg, Sandström, & Hamberg, 2013).

Health education is considered essential for influencing health-related attitudes and practice of pregnant women. Its comparatively limited application raises concerns about the implications for maternal and newborn health outcomes. Further research is required to analyse how the technical performance of ANC content can be improved, reviewing both the attitudes of health personnel and pregnant women. Research is also needed on the effectiveness of care and the constraints of provider.

5.2.3 Antenatal Care Content and Utilisation

Combining both utilisation and content aspects, only 40% had "adequate" category in both utilisation and content. Over half (60%) had "inadequate" category in either utilisation or content. A large proportion (40%) had adequate utilisation but inadequate content, 12% had inadequate utilisation and content, while around 9% had inadequate utilisation but adequate content.

As earlier discussed in literature review, considering the definitions of quality care (Donabedian, 1966; Pittrof, et al., 2002), assessing “adequacy of ANC” should incorporate both the elements of utilisation of services by the pregnant women as well as the ANC content provided to the women. ANC content should refer to the requirements of routine care based on the local recommended standards. Yet when both elements were assessed, there were only around 40% of the women that had adequate level for both. Though direct comparison with other study is not viable due to differences in the scope of ANC content studied, other study showed that when both utilisation and content were considered, proportion of pregnant women with adequate utilisation and adequate content was also low (Trinh, et al., 2006). In spite of the similar observation, quality maternal services delivery should still strive to fulfil a balance in both utilisation and content.

5.3 FACTORS ASSOCIATED WITH ADEQUACY OF ANTENATAL CARE UTILISATION

In the univariate cross-tabulation analysis to examine the utilisation pattern, maternal age, ethnicity, maternal education, parity, history of complications in previous pregnancy, history of complications in previous delivery, and risk level had statistically significant influence on the level of ANC utilisation, individually. Using Ordinal regression as the model of analysis, maternal age, maternal education, parity, and risk level of pregnancy made statistically significant contribution to the model for factors associated with adequacy level of ANC utilisation. Ethnicity and occupation of pregnant women were found to have no statistically significant influence in the adequacy level of ANC utilisation ($p>0.05$) when controlled for other factors.

This present study found that pregnant women aged 20-34 years old were more likely to have higher level of ANC utilisation than pregnant women aged ≤ 19 and ≥ 35 years old. This is partly consistent with the finding of a study that reported younger pregnant women received more ANC than pregnant women aged 35 years and older (Kishowar Hossain, 2010), but that same study also reported pregnant women younger than 20 years old receiving more ANC than those aged 20-34 year, contradicts to this present study in this aspect.

In general, there have been contradictory findings concerning maternal age and ANC utilisation. Some reported higher use among the younger pregnant women overall (Kishowar Hossain, 2010), while some reported higher use among the older pregnant women (Chen, et al., 2007; Vecino-Ortiz, 2008), and there has been studies reported that maternal age had no significant effect on ANC utilisation (Celik & Hotchkiss, 2000). These differences underline that the influence of maternal age depends on the study setting. In the case of the present study, women aged 19 and below may be less educated and thus less informed about the importance of ANC utilisation. As for pregnant women aged 35 and above, these women may attend ANC check-up less often due to self-perceived experience in pregnancy.

The results shows that less educated pregnant women were less likely to have higher ANC utilisation than tertiary educated pregnant women, consistent with that in many studies. Pregnant women's education level was a strong predisposing factor and the best predictor of ANC utilisation in many studies. Pregnant women with higher education were more likely to use antenatal care from trained providers (Fan & Habibov, 2009; Kishowar Hossain, 2010; Raatikainen, et al., 2007; Ren, 2011; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008), and there is significant positive association between maternal education and frequency of ANC utilisation; higher education attainment increased the frequency of ANC utilisation (Fan & Habibov, 2009; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010).

This present study found that multipara was more likely to have higher ANC utilisation than nullipara. Other studies reported high parity tend to be associated with no and/ or low utilisation of ANC (Celik & Hotchkiss, 2000; Kishowar Hossain, 2010; Sepehri, et al., 2008; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008). High parity women were more likely to rely on their past pregnancy experiences and therefore might not feel the need for ANC (Celik & Hotchkiss, 2000; Kishowar Hossain, 2010; Titaley, Dibley, et al., 2010; Vecino-Ortiz, 2008). It is not feasible to compare the result of this present study with other studies because while the analysis of this study used the category of nullipara versus multipara which means a pregnant woman with one previous birth will be classified as "multiparous", other studies reported using high parity which definitely means higher number of previous births.

Instead, the higher level of ANC utilisation reported in this study could be explained by the significantly higher proportion of colour-tags among the multipara compared to nullipara. As a result, there were higher proportions of multipara with "adequate-plus" ANC utilisation since colour-tags often required additional visits for additional procedures specific to their conditions.

Low-risk women (white and green-tags) were found to be less likely to have higher ANC utilisation than high-risk women (yellow and red-tags). The odds for high-risk women of having higher ANC utilisation level were around twice the odds for low-risk. This is consistent with other studies which reported complication-free pregnancy was associated with low utilisation, as the women might not perceive that ANC visits were necessary (Ren, 2011; Titaley, Dibley, et al., 2010). This also provides evidence that service delivery was individualised according to needs. For example, in Malaysia, a pregnant woman is "instructed' or dictated on the frequency of visits once they are tagged red.

5.4 ADHERENCE TO RECOMMENDED ROUTINE ANTENATAL CARE CONTENT

5.4.1 Adequacy of Content and Providers

Analysis by matrix scatter plot and bivariate correlations to assess the association of percentage of total attendance by specific providers with percentage of content score showed that there was a small, positive correlation between content score and total visits attended by CN (r=0.12, n=522, p=0.005), with higher content score associated with higher total visits attended by CN. In contrast, there was a small, negative correlation between content score and total visits attended by SN with postgraduate (r= -0.13, n=522, p=0.004) with lower content score associated with higher total visits attended by SN with postgraduate. While there was a positive correlation between content score and total visits attended by MO, the effect size was very small (r=0.09, n=522, p=0.043).

Other studies had found that adherence to ANC content differed among provider sites, including difference in private versus public provider (Boller, et al., 2003; Dhar, et al., 2010; Handler, et al., 2012; Victora, et al., 2010). However, when study was conducted within the same level and same setting of care, it demonstrated that nursing professional with higher qualification was less likely to deliver the ANC component studied than the lower qualified nursing staff (Pembe, et al., 2010).

The finding of this present study in which higher attendance by higher qualified nursing staff was found to be associated with lower content score might also be explained by the risk management protocol of the Malaysian ANC guidelines. The risk management protocol dictates that low-risk (white and green-tags) women are to be followed-up by the CN, while the high-risk (yellow and red-tags) are seen and monitored by the staff nurse because of their high-risk conditions. During the review of the records, the researcher found that in general, the ANC check-up and medical consultation sessions of these high-risk cases appeared to focus on the high-risk condition that the pregnant women had and less on other aspects of care. For example, the care and advice given to a woman with GDM would focus heavily on BSP monitoring only, and lesser overall care and advice were provided to the woman. This is supported by the lower mean ANC content score among the high-risk compared to low-risk in the GLM Univariate model which will be discussed in the followings.

5.4.2 Factors Associated with Antenatal Care Content Score

In this study, risk level and clinic type are factors significantly associated with the pregnant women's ANC content score statistically. As for the percentage of attendance by specific providers, further analysis showed no difference in mean content score, when controlled for clinic type and risk level.

The mean ANC content score among the low-risk women was significantly higher than the mean ANC content score among the high-risk women, although there was only a small difference, at 78% and 76%, respectively. There has been not much comparison on the extent of adherence to ANC content by the risk level of pregnant women. In a study conducted in developed setting, it appeared that a higher proportion of high-risk women received ANC content in which the documented adherence was ≥ 80% [34% versus 24%, (Handler, et al., 2012)]. This is different from the finding of this present study that recorded a lower proportion of high-risk women received ≥ 80% of recommended ANC content than the low-risk (40% versus 52%). During the review of records, we found that ANC check-up and medical consultation of high-risk cases appeared to focus on the high-risk condition, and less on other aspects of care. For example, the care and advice given to a pregnant woman with severe anaemia or gestational diabetes mellitus would focus heavily on Hb or blood sugar monitoring, but lesser attention on other aspects. While it is understandable to focus on a particular risk condition, it is however not desirable to forgo other general aspects of care a pregnant woman would need. This reflects the notion of treating a patient (pregnant woman with medical condition) as “a sum of the parts,” as opposed to the call for a more holistic approach that should be concerned with the multidimensional needs of the women and not only with their biological care (Chalmers, Mangiaterra, & Porter, 2001; Graham & Campbell, 1991; Lindmark, 1992).

Other studies had found adherence to ANC content differed among provider sites (Boller, et al., 2003; Dhar, et al., 2010; Handler, et al., 2012; Victora, et al., 2010). Similarly, this present study found that the mean ANC content score among clinic below daily capacity of 150 patients was 80%, significantly higher than the mean ANC content score among bigger clinics with daily capacity of 150-300 patients (75%, $P<0.001$) and 301-500 daily capacity (77%, $P=0.001$). Clinics with 150-300 daily capacity were found to have lower mean ANC content score compared to clinics with 301-500 daily capacity. The finding is consistent with other studies that found adherence to ANC content differed among provider sites (Boller, et al., 2003; Dhar, et al., 2010; Handler, et al., 2012; Victora, et al., 2010). In the context of this study, the staffing norm of a clinic is proportional to the planned daily capacity of the clinic. Both the clinics for the below 150 patients strata were located in less populated districts. Based on the number of clinics and total population in the districts (Department of Statistics, 2011), the average population coverage for these two smaller clinics ranged from around 20,000 to 30,000 per clinic. In contrast, the other four bigger clinics were located in the most populated districts. Average population coverage per clinic was proportionally much higher, ranged from about 130,000 to 300,000 people, much higher than the planned target ratio of 1:20,000 (Jaafar, et al., 2013). In comparison, the population coverage for the four bigger clinics was approximately 5 to 10 times higher than the two smallest clinics. Despite the much higher population coverage among the four bigger clinics, the nurse ratio between the clinics in the 301-500 patients strata and the smallest clinics in the <150 patients strata was around 4 times higher; and the nurse ratio between the clinics in the 150-300 patients strata and the smallest clinics <150 patients strata was only around 3 times higher. This implies a higher actual user load than planned capacity, which resulted in higher provider-user ratio, and thus reduced provider-user interaction time. It had been acknowledged that there is a shortage of health clinics in densely populated areas such as the Klang Valley which include two of these densely populated study districts where the four bigger clinics were located. The overall population ratio for MOH health clinics of 1:33 600 has not met the target of 1:20 000 (Jaafar, et al., 2013).

5.5 ADHERENCE TO SELECTED RECOMMENDED PRACTICES

5.5.1 Routine Medical Examination

The Malaysian ANC guidelines require pregnant women to be seen by medical doctor at least twice per pregnancy. The first routine medical examination (RME1) is to be conducted at booking or by 24 weeks gestation and the second routine medical examination (RME2) at 32-36 weeks gestation. The achievement in RME is good. Only 2% of pregnant women did not fulfil of the requirement of RME1 and 8% of the pregnant women did not fulfil the requirement of RME2. Almost all, 98%, were seen by a doctor by the third ANC visit, of which 75% was seen at the first visit.

5.5.2 Haematinic Supplement (including Folic Acid)

Though over 90% of the pregnant women were given or advised to take haematinic supplement (including folic acid) during their first visit to the clinic, there was around 10% of the pregnant women not given or advised.

Folic acid is advised to be consumed before 12 weeks due to its obvious benefit in preventing neural tube defect of the foetus. Out of the 10% of the pregnant women who had not been given or advised to consume folic acid, around half of them had their first visit at or before 12 weeks gestation, yet they had not been documented as being given or advised to take folic acid at or before 12 weeks gestation. As such, it seems there may be missed-opportunities in prevention of neural tube defect.

5.5.3 Abdominal Ultrasound

MOH Malaysia recommends performing abdominal ultrasound before 24 weeks (Ministry of Health, 2010). This study found that 18% of the women did not have their first ultrasound at or before 24 weeks. The mean period of gestation for the first ultrasound was around 18 weeks. The mean number of ultrasound (including those done by other providers) was 2.6. Twenty-two percent of pregnant women had less than 2 ultrasounds.

The United Kingdom ([NICE] National Institute for Health and Clinical Excellence, 2008), the USA ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012), and Australia ([AHMAC] Australian Health Ministers' Advisory Council, 2012) offer early ultrasound for gestational age assessment (before 14 weeks). These three guidelines again offer ultrasound scanning between 18-20 weeks to detect structural anomalies. UK and Australian guidelines also offer at 32 weeks to those with placenta extended over the internal cervical os (per vaginal ultrasound) during the 18-20 week scan. In comparison, the Malaysian guidelines for gestational ultrasound was less specific and late (Ministry of Health, 2010).

5.5.4 Period of Gestation when Selected Time-appropriate Examinations were initiated

On average, this present study found that assessments for symphysis-fundal height, foetal presentation, and foetal heart auscultation were commenced at around 18-19 gestation weeks. Half of the women were examined on these parameters by 18 weeks and earlier.

5.5.4.1 Symphysis-Fundal Height

In comparison, the Malaysian guidelines (Ministry of Health, 2010) recommend examining symphysis-fundal height at 22 weeks onwards, while the UK ([NICE] National Institute for Health and Clinical Excellence, 2008) recommends starting later at 24 weeks. Though earlier examination as found in this study does not have harmful effect, earlier initiation has no proven benefit to ANC, but has economic implication on provider side since the staff will spend more time on the women unnecessarily.

5.5.4.2 Foetal Presentation

The Malaysian guidelines (Ministry of Health, 2010) recommend examining foetal presentation from 32 weeks, whereas the UK ([NICE] National Institute for Health and Clinical Excellence, 2008) and Australia ([AHMAC] Australian Health Ministers' Advisory Council, 2012) recommend starting later at 36 weeks. A much early start as found in this study will have substantial economic implication on provider side without the due benefit, and may cause unnecessary worry to the women.

5.5.4.3 Foetal Heart Auscultation

Malaysian guidelines (Ministry of Health, 2010) recommend foetal heart auscultation from 24 weeks (if using Pinards foetoscope), or 14 weeks (if using electronic device). In contrast, UK ([NICE] National Institute for Health and Clinical Excellence, 2008) does not recommend routine listening, unless requested by pregnant women for reassurance only. This current practice in Malaysia will need further review considering the lack of evidence as highlighted in other guidelines ([NICE] National Institute for Health and Clinical Excellence, 2008).

5.5.5 Haemoglobin/ Full Blood Count Screening

Though Malaysia did not specify the frequency of subsequent testing in their guidelines, Hb was routinely tested for most visits in actual practice, the mean number of Hb or FBC tests was around seven tests per pregnant woman (median=7). Malaysia also routinely checked all pregnant women at around 36 weeks, as evidenced by the national M&E indicator – antenatal mother by three categories of Hb level at 36 weeks (Ministry of Health Malaysia, 2012a). In comparison, NICE, ACOG and AHMAC offered Hb screening at booking and repeat testing at 28 weeks.

Comparing with the recommended guidelines of these three other developed countries which are evidenced-based, Malaysian practice in Hb screening appears to be over-investigated and should be reviewed.

5.5.6 Hepatitis B Screening

Although Malaysia guideline recommends hepatitis B screening at booking, none of the clinics surveyed performed the test or asked the pregnant women's hepatitis status. Though it was reported that antenatal hepatitis B screening is effective in reducing the risk of mother-to-child transmission, meeting the need of screening might be challenging for many health clinics which are currently without the equipment and financial allocation to conduct this particular test. The cost benefit and screening strategy will need to be reviewed within the current health system context and epidemiology profile.

5.5.7 Additional Medical Consultation for Specific Conditions

5.5.7.1 Urinary Tract Infection

Malaysia guidelines does not offer routine urine test early in pregnancy to detect asymptomatic bacteriuria. This study found that 16% of the pregnant women were ever prescribed treatment for urinary tract infection (UTI) or UTI-like symptoms during their pregnancy. Diagnosis was only based on detection of white blood cells and protein in the urine but not urine culture. This figure was only for UTI related treatment documented. The incidence for actual UTI therefore could be higher since some of the cases could be asymptomatic. Incidence of asymptomatic bacteriuria (ASB) was found in 2-10% of women in the USA, and in 2-5% of pregnant women in UK ([AHMAC] Australian Health Ministers' Advisory Council, 2012; [NICE] National Institute for Health and Clinical Excellence, 2008).

The United Kingdom ([NICE] National Institute for Health and Clinical Excellence, 2008), the USA ([AAP/ACOG] American Academy of Pediatrics and American College of Obstetricians and Gynecologists, 2012), and Australia ([AHMAC] Australian Health Ministers' Advisory Council, 2012) recommends to routinely offer urine culture test early in pregnancy to detect asymptomatic bacteriuria. The UK guidelines substantiate its decision based on studies that showed: (i) increased risk between untreated ASB and maternal and foetal outcomes, such as preterm birth and pyelonephritis. (ii) healthcare resource consequences of antenatal ASB screening associated with reduction of maternal and infant morbidity, i.e. future cost saving of treating pyelonephritis and preterm birth as well as the possible resulting lifetime costs of disability associated with preterm birth ([NICE] National Institute for Health and Clinical Excellence, 2008). Furthermore, screening and treating pregnant women can lead to healthier mothers and infants and does not lead to a choice to end a pregnancy. Therefore, screening and consequent treatment has only positive benefits for pregnant women and their children.

Based on economic analysis, NICE concluded that a policy of either of the screening strategies (leukocyte esterase-nitrite dipstick versus culture test) is more cost-effective than no screening. Though the culture test is relatively more expensive, it has a higher sensitivity and specificity. NICE recommended culture test in view of cost-effectiveness. The Australia guidelines also recommend routine urine culture screening for ASB, and refer closely to the findings and recommendation quoted by NICE UK ([AHMAC] Australian Health Ministers' Advisory Council, 2012). AHMAC added that in Australia, available estimates suggest that asymptomatic bacteriuria during pregnancy may be more common among Aboriginal and Torres Strait Islander women (who have lower SES in general).

Considering the evidence of benefit for routine screening for asymptomatic bacteriuria, the current guidelines should be reviewed to consider incorporation of routine urine screening for asymptomatic bacteriuria early in pregnancy.

5.5.7.2 Vaginal Infection

Over 8% of the pregnant women ever treated for vaginal infection. The figure was only for vaginal infection treatment provided and did not include pregnant women who sought medical consultation for complaint related to vaginal infection such as PV discharge, but was not treated for vaginal infection. However, the cause of the vaginal infection was not investigated in this study, and might not relate to sexually transmitted infection.

However, elsewhere in United Kingdom, Australia and United States, Chlamydia testing is routinely offered to pregnant women below 25 years old only. NICE's 2008 review included 19 studies, prevalence of genital Chlamydia ranged from 7% to over 14%, with high prevalent among younger women. NICE asserted that a causal link between the organism and adverse outcomes of pregnancy have not been established, therefore the evidence remains difficult to evaluate in relation to neonatal morbidities. Where a causal link between organism and outcome has been established, rapid identification and good management of affected neonates is thought to be a clinical and cost-effective alternative to screening. Therefore, thus far it has not been recommended to routinely offer Chlamydia testing to all women as part of antenatal care.

In Malaysia, there was a retrospective study conducted from 2001 to 2005 to establish the prevalence of Chlamydia trachomatis infection in symptomatic patients attending the clinic in Kuala Lumpur General Hospital (Norashikin, Gangaram, & Hussein, 2007). The prevalence rate in that study was expectedly high since that study only screened symptomatic patients. The prevalence of Chlamydia trachomatis infection was 24% (n=86) for male patients and 18% (n=32) for female patients with the highest prevalence in the group aged 15-19 years in both sexes. The study concluded that the need for routine screening in the sexually active population aged less than 30 years should also be considered to assess the prevalence of C. trachomatis infection in the general population in this country.

Taking into account of the recommended practice of NICE, ACOG and AHMAC to routinely offered Chlamydia screening test to pregnant women below 25 years old as well as the finding of the Chlamydia trachomatis study in Malaysia, it is advisable to consider screening pregnant women below 25 years old during the ANC visit.

5.6 ADEQUACY OF ANTENATAL CARE UTILISATION, CONTENT AND OTHER FACTORS ASSOCIATED WITH PREGNANCY OUTCOMES

This present study analysed the factors associated with pregnancy outcomes using separate indicators: preterm birth, LBW, stillbirth, and maternal complications. The three foetal outcomes were also combined in the analysis (combined foetal outcomes). But it was decided not to combine both foetal and maternal outcomes into a general "combined pregnancy outcomes" since this might not be useful in assessing the association of pregnancy outcomes with ANC adequacy.

5.6.1 Proportion of Women by Pregnancy Outcomes

The preterm birth rate per 100 live births in this present study was 7%, lower than the official rate of 12% (WHO, 2014b). The lower rate is due to the role and scope of the first level health facilities in which the extreme high-risk cases which might prompt preterm birth are referred and solely managed at hospital level. LBW was 13%, about similar to the official rate of 11% (WHO, 2014b).

As for stillbirth, the official rate reported by WHO was 6 per 1,000 total births in Malaysia (WHO, 2012). This study however found 3.1% (31 per 1,000 total births) due to the purposive sampling of death records as explained in the Methodology chapter.

There was only one maternal death that met the eligibility criteria; the case was included in maternal complications outcome. Maternal complications outcome in this study consisted of women with any combination of these conditions: retained placenta, PPH, IE/PE, postnatal high BP, postnatal infection (infected wound or systemic e.g. fever), postnatal severe anaemia, unknown reason for admission or long hospital stay, maternal death.

5.6.2 Antenatal Care Utilisation, Content and Pregnancy Outcomes

5.6.2.1 Antenatal Care Utilisation and Pregnancy Outcomes

The two steps (univariate followed by multivariate) analysis shows that adequacy of utilisation was not significantly associated with pregnancy outcomes statistically, possibly due to the distribution of samples in the frequency table cells. Though statistically non-significant, the results of the ANC adequacy and pregnancy outcomes models in which the odd ratios were adjusted for maternal age, ethnicity, maternal education, maternal occupation, risk status, parity, clinic type, and utilisation or content are suggestive of some evidences concerning association of utilisation and some of the pregnancy outcomes assessed. The odds for preterm birth, LBW, combined foetal outcomes and maternal complications in the adequate-plus category were 5.90, 1.82, 1.99, and 2.21 times of adequate category, respectively. The odds for preterm birth and maternal complications in the inadequate category were 4.54 and 2.30 times of the adequate category, respectively.

In general, though non-significant statistically, there is sizeable effect size which is suggestive that having adequate utilisation appears to be associated with lower odds of preterm birth and maternal complications compared to inadequate and intensive utilisation. Intensive utilisation appears to be associated with higher prevalence of preterm birth, LBW, adverse foetal outcomes and maternal complications in general. Further analysis of pregnancy outcomes by risk level revealed that high-risk women were significantly associated with preterm birth (p=0.024). Though the association of LBW and maternal complications with risk level was not statistically significant, there was generally a higher proportion of LBW and maternal complications among the high-risk women. In essence, preterm birth, LBW and maternal complications were more prevalent among high-risk who in general were scheduled to come for more frequent monitoring visits than the standard schedule. This explained the association between intensive utilisation and adverse pregnancy outcomes that were known to be higher among high-risk, i.e. preterm birth, LBW, adverse foetal outcomes and maternal complications. While it is justified for the high-risk women to have more frequent visits for additional care associated with their condition, there is no reason for low-risk women to have higher number of ANC visits than the standard schedule.

The suggestive results for the preterm birth outcomes were similar to a study conducted in the USA using APNCU Index and two variants of this index, which was based on the recommended schedule of ACOG. It was found that there were poorer outcomes in the adequate-plus and inadequate categories, compared with the adequate category (VanderWeele, et al., 2009). In that study in the USA, based the original APNCU Index, the odds of preterm birth in the adequate-plus category was 8.51, and the odds in the inadequate category was 3.69, compared to the adequate level. Using two variants of the modified index, the odds in the adequate-plus category was lower at 4.51-5.15, and the odds in the inadequate category were 2.13-2.17. Though the differences in the odds were smaller, the direction was essentially the same.

As for the LBW, the results were also similar to another study in the USA using the APNCU Index (Koroukian & Rimm, 2002). The result of this American study showed the odds for LBW in the adequate-plus categories were 1.89, and in adequate category were 0.60, compared to the reference inadequate category at 1.00 (Koroukian & Rimm, 2002).

The odds for stillbirth in the inadequate category were 0.43, compared to the adequate category. This means that the odds of stillbirths for women with adequate ANC utilisation appear to be over two times higher than women with inadequate utilisation. Stillbirth does not seem to be reduced by adequate utilisation. Interpreting this result have to take into the account that stillbirth outcome is also substantially influenced by the care received during labour and delivery (Bhutta et al., 2014; Mason, et al., 2014; WHO & UNICEF, 2014). Worldwide, there are 2.6 million stillbirths every year, of which nearly half occur during labour (Mason, et al., 2014), implying the influence of intra-partum care.

The suggestive results for stillbirth is different from the results of a study in Germany in which the odds of stillbirth in the inadequate category was higher (1.14 times), compared to adequate category (Reime, et al., 2009). Though the utilisation index used in the German study was also based on the principles of the APNCU Index, the index was modified and has only two categories: adequate care versus inadequate care. Adequate care was defined as having initiated prenatal care before 13 weeks of gestation and having utilised at least half of the visits recommended until birth which means the initiation cut-off point was earlier than the original APNCU Index, and intermediate category as well as adequate-plus category was grouped as "adequate care". Therefore, comparison with this German study is not viable since the adequacy categorisation and timing of initiation differed.

Searching for comparable studies on ANC utilisation and maternal complications is difficult due to differences in measuring maternal complications. Some studies related to maternal aspect used maternal mortality as the outcomes, while several used a mix of mode of delivery, foetal outcomes, and maternal outcomes (Petrou, et al., 2003; Wahid, 2001), different from the maternal outcome of this present study.

In short, though statistically non-significant, having adequate ANC utilisation appears to be associated with lower odds of preterm birth and maternal complications, compared to inadequate and intensive utilisation. Intensive utilisation does not seem to lower the odds for preterm birth, LBW, combined adverse foetal outcomes and maternal complications in general. Stillbirth does not appear to be reduced by having adequate utilisation, implying the influence of other aspect of care such as intra-partum care.

5.6.2.2 Antenatal Care Content and Pregnancy Outcomes

Based on the observed significance level, ANC content adequacy was significantly associated with preterm birth, statistically. The odds of preterm birth in the inadequate category were over three times that of the adequate category. One explanation is that having adequate routine ANC content provided to the women contributes to early detection and timely management of risk for preterm birth. Study had found that lack of educating pregnant women on the signs and symptoms of preterm labour as well as advice to call the health provider was associated with around three times higher risk of preterm birth (Libbus & Sable, 1991). The knowledge on recognising preterm risk, possible causes, and action to take will better prepare the pregnant women to seek medical care promptly should the situation arise. Also, routine ANC consultation or screening might help to detect and promptly manage risk conditions such as bacteriuria or placenta praevia. Adequacy of ANC content does not appear to have an influence on LBW outcome.

The finding is consistent with the study by Handler et al. on preterm birth and LBW, which reported that low adherence to routine ANC content (<80% of recommended routine practice) was associated with overall increase odds of preterm birth among the pregnant women (aOR=1.8, 95%CI=1.0-3.4), but had no effect on the odds of LBW [aOR=1.0, 95%CI=0.5-1.9; (Handler, et al., 2012)].

It might be argued that preterm birth presents a shorter pregnancy period and thus reduces the opportunity for the complete ANC content to be provided to the pregnant women. However, the scoring criteria for the ANC content included in this present study considered the gestational age of birth, where relevant. Only health education component has not considered the gestational age of birth. Furthermore, the mean gestational age among the preterm births was 34 gestational weeks (min 29, max 36); and the health education topics assessed in this present study consisted of topics that could have already been provided by this period.

In contrast, having adequate ANC content appears to have higher odds for stillbirth and maternal complications, though non-significant statistically. This again supports the recognition that stillbirth outcomes is also influenced by the care provided during labour and delivery (Bhutta, et al., 2014; Mason, et al., 2014; WHO & UNICEF, 2014), besides having adequate ANC utilisation and content. For example, delay in detecting foetal distress when the woman is in labour may result in stillbirth; a break in infection prevention and control practice during delivery may cause postnatal infection, or retained placenta will result in postpartum haemorrhage. These largely relate to the care received during labour and delivery. Investing in care around the time of birth saves mothers and their newborn babies and prevents stillbirths and disability (Bhutta, et al., 2014; Mason, et al., 2014).

On the contrary, having adequate ANC content but poorer maternal outcomes as compared to those in the inadequate category may hint at the need to review the current ANC content provided to the pregnant women. The list of maternal complications used in this study was based on the respondents' conditions. These include retained placenta, postpartum haemorrhage, impending eclampsia/ preeclampsia, postnatal high blood pressure, postnatal infection (infected wound or systemic e.g. fever), postnatal severe anaemia, unknown reason for admission or long hospital stay and maternal death. While the aetiology of some of these conditions may not be easy to control and may relate to other aspect of care such as intra-partum care, some of these may be preventable through effective ANC. In short, adequate ANC content is significantly associated with lower odds for preterm birth statistically. However, adequate ANC content also appears to be associated with higher odds for stillbirth and maternal complications. While this may indicate the importance of other aspect of care, this may hint at the need to review the current routine ANC content provided.

5.6.3 Other Factors Associated with Pregnancy Outcomes

As mentioned in the literature review, few studies on ANC adequacy and pregnancy outcomes presented or discussed the effect of other independent variables or associated factors on pregnancy outcomes in recent years. Even when these factors were discussed, these were often limited to only a few factors. Moreover, because many study settings may differ, the findings may therefore differ among the studies, and interpretation of the results will need to consider this particular attribute.

5.6.3.1 Preterm Birth

Women attended clinics with daily expected workload of 301-500 were significantly associated with lower preterm birth statistically. The odds of preterm birth among these women were three times lower than those attended clinics <150 daily workload (P=0.048). This is expected given that these clinics (type 301-500) are located in the urban districts/ towns (Hulu Langat/ Ampang and Puchong/ Petaling) which are within close proximity to many private and public hospitals as well as private specialist clinics. These type 301-500 daily workload health clinics also have in-house Family Medicine Specialist. Women with high-risk pregnancy from these urban districts are thus having the choice to seek ANC at these health facilities and also have easier geographical access to specialists. In comparison, the clinics type <150 expected daily workload are located in rural districts (Kuala Langar/ Bukit Changgang and Sabak Bernam/ Sekichan) which are only served by the district hospital within close proximity. In general, the specialist referral hospitals and private facilities are located at urban areas (Jaafar, et al., 2013). These type <150 daily workload health clinics also do not have in-house Family Medicine Specialist; the visiting in-house Family Medicine Specialist are often scheduled to serve the smaller clinics once every two weeks. In short, women with high-risk pregnancy from these rural districts have lesser choice to seek ANC at other health facilities and also have lesser geographical access to specialists.

The odds for preterm birth among women with history of pregnancy complications in previous pregnancy appeared to be almost two times higher compared with women without history of complications in previous pregnancy. The list of complications in previous pregnancy used in this study was derived from the respondents' previous pregnancy-related histories, and mainly consists of GDM, PIH, anaemia, placenta praevia, and miscarriage. Among this list, history of GDM, PIH, placenta praevia, and previous miscarriages of at least three times are part of the current risk assessment in which pregnant women will be colour-coded should they have one of these histories.

5.6.3.2 Low Birth Weight

The odds of LBW were over eight times higher for red-tag women compared with white-tag women (OR=8.41). The result is consistent with other study which found the odds of LBW were higher among women with maternal medical risk factors e.g. pregnancy associated hypertension, incompetent cervix, uterine bleeding, eclampsia, which are compatible to the risk factors for red tag; the odds for these risk ranged from 2.49 to 3.78 (Koroukian & Rimm, 2002).

The odds for LBW were over two times higher for women with previous delivery complications compared with women without previous delivery complications (OR=2.40, 95%CI=1.14-5.03; P=0.021). There is no other study that used the same list for history of previous delivery complications (which included previous histories of premature, caesarean, assisted delivery, PPH, stillbirth, neonatal death) to assess the associated factors of LBW. However, one study found the odds of LBW among the women with previous premature birth was 3.06 (Koroukian & Rimm, 2002).

Also, it appeared that the odds for LBW among nulliparous compared to multiparous without previous delivery complications were higher by around 2 times. In the categorisation of women with previous delivery complications, 37% were nulliparous whom were not applicable to “previous delivery history”, 44% were multiparous without previous delivery complications, and 19% were multiparous with previous delivery complications. However, 36% of the total high-risk cases (yellow and red-tags) were also reported among these nulliparous, and the remaining 64% were among the multiparous. The results is in line with another study which reported higher LBW prevalence among the high-risk primiparae (Petrou, et al., 2003).

The odds for LBW among indigenous people appeared to be over two times higher compared with the Malay (OR=2.38). This is consistent with another study which reported higher odds (OR=1.89) of LBW among the non-white in USA (Koroukian & Rimm, 2002). Both of these groups are generally regarded as less socio-economically developed.

5.6.3.3 Stillbirth

Among the similar variables studied, Reime et al. reported that nulliparous, teenage pregnancy, advanced maternal age and not employed during pregnancy were risk factors for stillbirth (Reime, et al., 2009). This present study did not find similar association because, one, the German study included migrants which was excluded from this present study since migrants were known to have different health seeking behaviour and other characteristics that would influent the results (Zulkifli, et al., 1994), and two, there was only 16 stillbirth reported in this present study.

The odds for stillbirth among Indian women appeared to be three times higher compared with the Malay women (OR=2.99). This is consistent with other study that shows differences among different ethnic background (Reime, et al., 2009).

Stillbirth appeared to be associated with red-tagged women (OR=3.38), compared to the white-tagged. This is expected given the high risk status of red-tags.

History of previous delivery complications seemed to be associated with stillbirth. The odds were over three times higher (OR=3.37, P=0.053) for women with previous delivery complications compared with women without previous delivery complications.

Percentage of total visits attended by MO is also significant whereby the OR value was 1.03 (95% CI=1.01-1.06). Though this is statistically significant, the effect is very small.

5.6.3.4 Maternal Complications

The odds were over three times higher (OR=3.54, 95%CI=1.22-10.25; P=0.020) for women with spouse of lower SES compared with women with spouse of higher SES. The odds for maternal complications among indigenous women seemed to be close to four times higher compared with the Malay women (OR=3.76). Primary educated women appeared to have the odds of more than four time higher compared to tertiary (OR=4.32).

Being primary educated and being indigenous people are also generally equated as less social-economically developed. It appears that women with lower SES have higher odds of maternal complications. Being primary educated may also subject the women to be less informed about self-care and health practice, which may aggravate their risk for adverse maternal outcomes.

The odds for maternal complications among women who had previous delivery complications were over 11 times higher (OR 11.34, 95%CI 3.28-39.23, P<0.001) as compared with women without previous delivery complications. In addition, the odds for maternal complications among the nulliparous were around 7.5 times higher than multiparous without history of delivery complications. Women who were gravida 1 and para 0 (G1P0) were likely to have maternal complications as defined by this study which encompassed care related to labour and delivery and antenatal period.

Percentage of total visits attended by MO is also significant with the OR value of 1.02 (95% CI=1.00-1.04). Though this is statistically significant, the effect is very small and thus not significant clinically.

5.7 STRENGTHS AND LIMITATIONS OF THE STUDY

5.7.1 Strengths of Study

This study is the first study in Malaysia that assessed ANC utilisation using a modified composite index that combined both the adequacy of initiation and observed-to-expected number of visits, based on the APNCU Index (Kotelchuck, 1994) that is frequently used in developed setting. Previous ANC utilisation studies and indicators used in Malaysia frequently relied on the single aspect of number of total ANC visits and gestational age at first visit, which had disclosed excellent achievements considering the average number of visits of around 11 visits and 60% of the pregnant women had their first ANC visit by 12 weeks gestation (Ministry of Health Malaysia, 2012a).

This is also the first study in Malaysia to look objectively at compliance of all components of the existing national ANC guidelines including health education topics used by the clinics. Although the district health offices conducted ANC records audit regularly based on random sampling of records, the current ANC records audit focuses on the correct assignment and recording of colour coding and risk factor as well as case management of selected high-risk case such as pregnant women with anaemia and pregnant women with GDM according to certain aspects of care protocols. It appears that the current audit focuses on risk coding and management of high-risk cases; monitoring on unnecessary procedures or timing of time-sensitive procedures etc. are not evidenced. In addition, the current audit does not link to any outcomes; as such it is purely a care protocol monitoring tool that has limited use. In comparison, the methods applied in this study allows for more effective monitoring and evaluation of current ANC practices, especially within the context of rational use of resources and effectiveness of ANC in preventing adverse pregnancy outcomes.

As Malaysia is moving towards a more developed nation and the on-going reform that will require MOH to take on a stronger stewardship, comprehensive monitoring and evaluation of health services are therefore crucial for policy-formulation and continuous improvement of services delivery and outcomes as well as appropriate use of resources. The methods used in this study can be applied to this end, in particular, within the context of UHC that calls for quality services.

The data was collected by the researcher who has the qualification and experience in nursing and health sector project surveys. As such, consistency in data review and extraction was ensured. Misinterpretation or overlooking of care rendered was also minimised since the researcher understands and has experience in ANC. In addition, the data were solely collected by the researcher and did not rely on the nursing staff of the clinics. This avoided information biases associated with data collection by in-service clinic staff. For example, the in-service clinic staff might feel compelled to withhold certain information or cases which exposed the providers' non-compliance to ANC guidelines.

With regards to the setting of ANC in Selangor, this state is among the few states that have the ethnic composition that are closest to the national composition. Overall, the states in Malaysia shares similarity in the organisation of health services delivery due to the considerably centralised and uniform health system, in particular among Peninsular Malaysia. Thus, it could be said that these setting is considerably similar to the overall setting of Peninsular Malaysia. And thus, the study findings might be applicable to overall national strategy.

Lastly, the assessment was made at individual population level, utilising the ANC records of each woman. Other studies usually tend to use aggregate population data, utilising the clinic's reports that do not allow for data disaggregation. It is not, however, until the data are disaggregated that patterns, trends and other important information could be uncovered. Data collection at individual population level, as has been adopted in this study, allows for data disaggregation by specific subgroups of respondents.

5.7.2 Limitations of Study

This study has several limitations. First, the study encountered limitations associated with retrospective study using medical records, i.e. evidence of care rendered and quality of data. The evidence of care rendered and the quality of data collected are based on the quality of medical documentation. It is assumed that all elements of care rendered are fully documented in the women's record booklet. However this might not be necessarily true. Since for the purposes of data analysis, no entries will be interpreted as "care/intervention not rendered." This may result in a slight under-estimation of the proportion of pregnant women on whom each of the intervention was performed since the resulting estimate does not include those on whom the interventions were actually performed but not documented in the medical records. Nevertheless, essential events are generally documented. In addition, each record was carefully examined for evidence of care rendered but not documented in the care notes, for example, the result slips of investigations which were not mentioned in the care notes.

Second, the modification to the observed-to-expected visit ratio range as explained in Methods has circumvented the bias of classifying as "adequate-plus" when the actual number of visits exceeds the expected visits by just one visit. Given the exploratory nature of this present study, it uses only one variant of the index which is considered appropriate. Subsequent studies might consider examining another variant of this modified index.

Third, the ANC content assessment conducted by this study was based on the current national ANC guidelines, while comparison was made with the recommended guidelines from other developed countries (UK, Australia and USA) which have better maternal and child health indicators, in particular UK and Australia. Therefore, there seems to be gaps in the comparison made. Nevertheless, on the positive side, the Malaysia guidelines might have some rooms for improvement that could be carefully examined and addressed. Future study might consider assessing the ANC content using an "improved" guideline that would address the gaps identified.

The study did not assess the ANC utilisation and content of the private sector. This was because the private sector did not necessarily use the recommended guidelines of the MOH and the characteristics of the key care providers and users were different in the two settings. Inclusion of private sector in the study would therefore confound the association between the predictors and outcomes. Furthermore, not all private clinics offered complete antenatal services up to third trimester. Considering that this was the first time such study/analysis was conducted, the aim was to assess adequacy of ANC at the public sector and was not intended to compare the two sectors. Most importantly, majority of the maternal deaths had delivered at the public hospitals. Though the data on the providers of the women's ANC were not available, based on the requirement of the referral system, it could be assumed that majority of the maternal death cases had attended ANC at a public clinic. As such, a study that was conducted solely at the public clinics would still be deemed important.

5.8 SUMMARY: DISCUSSION

In relation to ANC utilisation, the issues could be broadly summarised as: One, the presence of inappropriate intensive utilisation among nearly 60% of the low-risk women, while there were still 26% of high-risk women not having intensive utilisation as expected. Two, inadequacy due to late initiation in which almost all the 20% of the pregnant women who had inadequate utilisation had late initiation (18% of this group had their first visit at 18 weeks and above). Inappropriate over-utilisation of ANC implies the need to consider a more efficient resource scheduling practice, while late initiation of ANC suggests the need for educating reproductive age women on this subject.

This study reveals that about half of the pregnant women had less than 80% of the recommended routine ANC content documented in their ANC records. While the mean of the weighted score for PE, HS, and CM were similar at around 84% each, the mean of the weighted score for HE was only around 35%. Delivery of health advices that scored the lowest is a concern considering the importance of health education.

The proportion of pregnant women with adequate utilisation and adequate content was only around 40%. Quality maternal health services delivery should strive for a balance in both utilisation and content.

Maternal age, maternal education, parity, and risk level of pregnancy were significantly associated with adequacy level of ANC utilisation statistically. Ethnicity and occupation of the pregnant women were found to have no significant influence in adequacy level of ANC utilisation.

Risk level and clinic type were significantly associated with the pregnant women's ANC content score. The percentage of attendance by specific providers was found to have no influence in the mean content score when controlled for other provider factors.

Examining the extent of adherence to selected recommended practices reveals interesting results, and underscores areas for improvement. Particularly when these practices were assessed in terms of the initiation period, frequency, and common health problems encountered. In essence, the current practice of ANC and the assessment conducted by this study on ANC content delivered to pregnant women are based on the current national ANC guidelines. In comparison with the recommended guidelines from other developed countries (UK, Australia and USA) with better maternal and childbirth indicators, in particular UK and Australia, the Malaysian guidelines reveals some rooms for improvement that should be carefully examined and addressed.

Adequate ANC utilisation appeared to be associated with lower odds of preterm birth and maternal complications compared to inadequate utilisation, though non-significant statistically. This study indicates that intensive utilisation does not seem to lower the odds for preterm birth, LBW, combined foetal outcomes, and maternal complications in general. Stillbirth did not seem to be reduced by having adequate utilisation, implying the influence of other aspect of care such as intra-partum care.

Adequate ANC content was significantly associated with lower odds for preterm birth statistically, but having adequate ANC content appeared to have higher odds for stillbirth and maternal complications though non-significant statistically. While this may indicate the importance of other aspect of care such as intra-partum care, this may hint at the need to review the current ANC content provided to the pregnant women.

Overall, history of complications in previous pregnancy or delivery is the common factors associated with preterm birth, LBW, stillbirths and maternal complications. Red-tags appeared to have higher odds for LBW and stillbirth than white-tags. Clinic type was associated with preterm birth, possibly associated with geographical access to specialist services for high-risk cases. The odds for preterm birth, among women with history of pregnancy complications in previous pregnancy seemed higher compared with women without history of complications. The odds for LBW and stillbirth among women with history of delivery complications in previous pregnancy were higher compared with women without history of delivery complications.

Ethnicity appeared to be an associated factor for LBW and stillbirths. The odds for LBW among indigenous people appeared to be higher than the Malay. The odds for stillbirth among Indian women seemed to be higher compared with the Malay women.

Spouse's occupation and history of previous delivery complications were significantly associated with maternal complications statistically. Maternal education and ethnicity also appeared to have an influence on maternal complications, though non-significant statistically. The odds for maternal complications were significantly higher for women with spouse of lower SES occupation compared with women with spouse of higher SES occupation. The odds for maternal complications among women who had previous delivery complications were significantly higher compared with women without previous delivery complications. Primary educated women appeared to have higher odds of maternal complications than tertiary education, though non-significant statistically. The odds for maternal complications among indigenous women appeared to be higher than the Malay.

CHAPTER 6: RECOMMENDATION

This study examined adequacy of ANC in Malaysia, considered adequacy in both the perspectives of utilisation and content. Assessing adequacy of utilisation alone might disclose user patterns on utilisation, however, the quality of care would not be known. Likewise, assessing adequacy of content would be less meaningful without understanding the utilisation pattern. It is imminent to consider both perspectives. It is also crucial that pregnancy outcomes be evaluated in relation to ANC adequacy. This is particularly relevant when increased utilisation is no longer the goal of health reform but effectiveness and efficiency. The following recommendations are derived from the gaps identified in the study. Where relevant, the recommendations also incorporate the direction of current global initiative, as well as consider the relevant contextual issues and their possible implications in health services delivery.

6.1 ANTENATAL CARE UTILISATION

6.1.1 Rationale Use of Antenatal Care

Finding from association of ANC utilisation and pregnancy outcomes, as demonstrated in this present study, revealed that adequate ANC utilisation appeared to be associated with lower odds of preterm birth and maternal complications than inadequate and intensive utilisation. Intensive utilisation however did not seem to lower the odds for preterm birth, LBW, combined foetal outcomes and maternal complications. The finding implies that intensive utilisation does not seem to improve pregnancy outcomes in general. While it is justified for the high-risk women to have more frequent visits for additional care, there is no reason for low-risk women to have high number of ANC visits than the standard schedule.

This study showed a high proportion (63%) of "adequate-plus" utilisation, that is, intensive utilisation above the standard visits. There was also an observed inappropriate utilisation of ANC by risk level of pregnancy. Nearly 60% of the low-risk women, who were not expected to, had intensive utilisation. On the other hand, 26% of the high-risk women, who were expected to, did not have intensive utilisation. Rational use of ANC according to risk status has to be encouraged to avoid over-utilisation among low-risk women and under-utilisation among high-risk women. Inappropriate intensive utilisation of ANC among the low-risk women implies the need to consider a more efficient resource scheduling practice. The health clinics could aim to improve the efficiency of appointment scheduling and to avoid making appointment solely for specific single procedures. Unnecessary additional visit has economic and financial implications for both the users and providers. Where applicable, some of these procedures could be scheduled together with the routine ANC visit; for example, ultrasound, dietary advice, and specific laboratory tests.

6.2 ANTENATAL CARE CONTENT

6.2.1 Provision of Routine Antenatal Care to All Women

The present study showed that half of the women had less than 80% of the recommended routine ANC content provided to them, indicating inadequacy of routine ANC provided. Provision of health advice that scored the lowest is a concern considering the importance of health education in influencing the health-related practice of women. The predefined antenatal health advice topics were not adhered to. Overall, it appeared that different antenatal health advice topics are attached with different importance by the nurses, but reasons for that were not investigated in this study and should be explored further. Provision of the antenatal health advice needs to be monitored and enforced to ensure each woman receiving essential antenatal health education.

All pregnant women should be given the complete scope of routine ANC regardless of their risk level. This study observed that the care and consultation given to high-risk women had a tendency to focus on their high risk condition; lesser attention was given on standard routine care. While it is understandable to focus on a particular risk condition, it is however not desirable to forgo other general aspects of care a pregnant woman would need. Delivery of ANC should be concerned with the multidimensional needs of the women and not only their biological care.

This study also showed that the completeness of routine ANC content provided was associated with population coverage. Clinics with high population coverage tended to have lower mean ANC content score than clinics with much lower population coverage. Examining the ratio of nursing staff among the different clinic strata showed the staff ratio has not been aligned with the population coverage. This implies a higher actual user load than planned capacity which resulted in higher provider-user ratio, and thus reduced provider-user interaction time. It is essential to ensure adequate provider-user ratio in highly populated areas. It is also crucial to ensure efficient resource scheduling to optimize the provider-users interactions.

6.2.2 Antenatal Care Guidelines: Evidence-Based Practices

While it is imperative to ensure that all pregnant women are given the complete routine ANC, it is even more important to encourage evidence-based practices. There have been enormous studies and trials on the effectiveness of ANC practices; the use of these findings should be encouraged. In addition, local studies related to ANC practices and maternal health should be promoted to examine the local situation that could be used as the basis to aid in policy formulation. For example, this study observed that there were a sizeable proportion of women who had been prescribed treatment for UTI/ UTI-like symptoms and vaginal infections. The documented treatment frequency warrants consideration for routine asymptomatic bacteriuria screening and Chlamydia screening which had been found to be effective in preventing adverse pregnancy outcomes. This may also necessitate a multicentre study to determine the prevalence of Chlamydia among the pregnant women before deciding on the benefit of introducing Chlamydia screening as standard ANC or study on routine ASB screening which has already been included as the recommended practice in Australia, the United Kingdom, and the United States.

Examining the extent of adherence to selected recommended practices underscores areas for improvement. This is apparent when these practices are assessed in terms of initiation period and frequency. For example, this study revealed that some of the procedures such as examination of symphysis-fundal height, foetal presentation and foetal heart auscultation were initiated earlier than recommended. Unnecessary earlier initiation of intervention should be avoided since this has economic implication and may cause unnecessary worry to the women.

Overall, as compared to the evidence-based guidelines from countries with better and well developed maternal and child health indicators, in particular United Kingdom and Australia, the Malaysian guidelines reveal spaces for improvement. This is especially relevant within the context of possible changes in morbidity patterns, emergence of non-communicable diseases, and resource constraints that warrant stringent preventive measure. It is recommended to review the current guidelines with a strong focus on evidence-based practices. This is also apparent taking into the account of the finding on the association of ANC content and pregnancy outcomes. This study showed that women with adequate ANC content had lower odds of preterm birth than women with inadequate ANC content. However, adequate ANC content did not seem to improve the outcomes of stillbirth and maternal complications. While these outcomes may also depend on the quality of labour and birthing care, this may hint at the need to review the current ANC guidelines to ensure the provision of effective evidence-based care.

6.2.3 Risk Assessment

The risk-oriented ANC strategy involves: (i) routine care to all women, (ii) additional care for women with moderately severe diseases and complications, (iii) specialised obstetrical and neonatal care for women with severe diseases and complications (WHO, 2009). At the same time, the perinatal care principles called for de-medicalisation of care for normal pregnancy and birth (WHO Regional Office for Europe, 1998). This implies that risk assessment is still required to ensure appropriate care is given to women.

Malaysia adopts similar risk-oriented approach, referring to the British model of care (Ministry of Health, 2010). The current risk assessment and coding system consists of an extensive list of conditions. While this risk assessment system has been useful as a management tool in that it enables the nursing staff to refer or admit a pregnant woman with problem smoothly and swiftly, the risk assessment system has not been assessed in terms of the time spent on coding and its possible effect on patient care. It is of the opinion that the current assessment system may be reviewed to aim for streamlining and focusing on risk factors that are proven and important in tackling the problem recognised in maternal and child health; for example, maternal morbidity and mortality, preterm birth and stillbirth outcomes. It will be useful to assess the current risk factors included in the assessment system in terms of their benefit and influence in the delivery of ANC. It is also worthwhile to continue assessing the profile of women who passed the risk assessment and classified as no- or low-risk, but had adverse pregnancy outcomes. This may shed some lights concerning the aetiologies of these outcomes, particularly preterm birth and stillbirth, that are known to differ by gestational age, genetics, and environmental factors (Gravett, Rubens, & Nunes, 2010).

6.3 MIDWIFERY/NURSING EDUCATION AND ANTENATAL CARE

Overall, ANC in the public sector of Malaysia is delivered through interdisciplinary teamwork and integration across facility and community settings. The categories of nursing professionals involve in ANC roughly consist of:

- Nursing/midwifery professionals with a 3-year general nursing training and additional post-graduate midwifery qualification (nurse-midwives),
- Nursing professionals with a 3-year general nursing training who has no midwifery qualification (staff nurses), and
- Associate nursing/midwifery professionals who received a 2-year basic training with some focus on midwifery (community nurses).

The staff nurses without post-graduate training and community nurses provide care to pregnancy women who have no or low-risk (white and green-tags). According to the national ANC guidelines of MOH Malaysia, every pregnancy regardless of risk status, needs to be reviewed by medical doctor at least twice throughout the pregnancy including uncomplicated pregnancy (Ministry of Health, 2010). Pregnant women are also referred to dentist, dietician or other providers based on needs.

Findings of other studies examining several providers active in provision of midwifery care identified few benefits when reliance was solely on low-skilled health-care workers. Midwifery was associated with improved efficient use of resources and outcomes when provided by midwives who were educated, trained, licensed, and regulated; and midwives were most effective when integrated into the health system in the context of effective teamwork, referral mechanisms, and sufficient resources

(Renfrew et al., 2014). It can be said that there is effective teamwork, referral mechanisms, and reasonable resources in the delivery of ANC in the public sector of Malaysia. However, certain findings of this study may imply the need for additional continuous medical education for healthcare professionals involve in the delivery of ANC. For example, over-utilisation of ANC may indicate the lack of awareness on the importance of efficient resource scheduling. Having half of the women with less than 80% of the routine ANC content score, and inappropriate timing for initiation of care may disclose the need for additional training to reinforce adherence to ANC guidelines. In particular, where it appears that different health advice topics are attached with different importance by the nurses, the reason for lack of adherence should be investigated. Moreover, as earlier mentioned, this study showed that women with adequate ANC content appeared to have higher odds of stillbirth and maternal complications than women with inadequate ANC content. Though it is acknowledged that these outcomes are also depend on the quality of labour and birthing care as well as the current content of care, this may also imply the need to review the current in-service training programme.

On average, nearly half of the total visits of the pregnant women were attended by community nurses, compared to 28% of their total visits that were attended by staff nurse with post-graduate qualification. This implies that the community nurses play a significant role in caring for pregnant women; hence, the need to pay attention to this cadre. At present, training programme for the community nurses is a two-year programme. The entry requirement is lower than the training programme for staff nurses. A community nurse is an associate nursing/midwifery professional and is assigned to attend to low-risk pregnancies. While such shorter training programme may help to expedite the production of a large quantity of skilled health workforce, the quality implication of such training programme may need to be reviewed in the long run. As Malaysia is moving towards achieving the status of a developed nation, it is necessary to question if the current calibre of the health workforce is in tandem with those of developed nations. Are they prepared to meet the need of the developed communities who are becoming better informed? Are they able to keep abreast with the development in evidence-based practices? What are the mechanisms in place that ensure their continuous education while in service?

In comparison, the midwives-managed care model of the developed countries, for example Australia, United Kingdom and some other European countries, is run by midwifery professionals who have undergone comprehensive training programme or specialisation. These countries also have an integrated professional licensing system that ensures the continuous medical education of the health workforce.

One of the action agenda identified for improvement of maternal and newborn care is to increase health worker numbers and skills with attention to quality (Mason, et al., 2014). In essence, the major challenge in every context is building and maintaining a health workforce with the skills to provide quality maternal and newborn care (Mason, et al., 2014; UNFPA, (ICM), & (WHO), 2014). Health workers need evidence-based skills derived from pre-service and in-service training. To address the shortage in human resources, countries need specific human resource plans to increase the numbers and autonomy of midwives, as well as to include nurses with specific neonatal care skills and to ensure that all health workers are competent and confident in newborn care.

6.4 MONITORING AND EVALUATION

6.4.1 Monitoring the Progress towards Universal Health Coverage

Monitoring the progress towards UHC has profound implications both at the national and subnational (state) levels. Besides, in order to advance further, middle income countries like Malaysia should do more than monitoring and evaluating the global indicators set forth for all countries which include the least developed countries. In the case of pregnancy care, measuring effective coverage of ANC may not yield much value in situation like Malaysia where there is a high proportion of pregnant women who had high utilisation level of ANC. This metric, while may be important for global comparison, is not useful to pinpoint the gaps in delivery of ANC services. Instead, quality indicators that incorporate the content and expected quantity of services provided will be more useful. The methods used in this study can be applied to this end.

This study demonstrates the gap between availability of routinely recorded data and their use for monitoring and evaluating the quality of ANC and informing the formulation of policies and strategies concerning intervention coverage, adequacy, and effectiveness of ANC. It provides insights for the improvement of rational use of resources (ANC utilisation) and the quality of ANC content delivered.

The monitoring and evaluation framework for Malaysia has to move beyond counting the crude quantity, but to drill deeper into the quality dimension dealing with the content of the services provided using facility data at state level, and allows for disaggregation by key variables. A monitoring and evaluating framework that includes ANC adequacy (utilisation and content) should be considered as a complementary tool to analyse association of ANC and pregnancy outcomes. The result as demonstrated in this present study may shed some light on the gaps of current services. This may help to explain the stagnating progress in pregnancy outcomes despite excellent performance of the tracer indicators.

6.4.2 Incorporating the Complementary Tool into the Current Monitoring Framework

Fiscella (1995) discussed how could the effectiveness of ANC be further evaluated in the USA. Some of the key points raised including improvement to the utilisation index, linking computerised point-of-care ANC records to regional and national database for prospective collection of multiple risk factors and minimising incomplete data, selected use of bioassays of urine to improve reliability of measurements of smoking and drug use, use of appropriate measures of socioeconomic status could help to minimise potential bias, and etc. Though these were discussed in 1995, some of the points remain relevant to current Malaysian context, in particular, the discussions on improving measurement of utilisation, linkage of point-of-care records to centralised database, measures of socioeconomic status. The relevance of these points is supported by the recent attentions on monitoring within the context of UHC (Boerma, AbouZahr, et al., 2014; Ng, et al., 2014).

The public sector of Malaysian health care was one of the firsts in the world to embark on electronic medical records, starting at tertiary hospital sector since the mid-90s. There was also a pilot project on computerisation of maternal and child health services at the primary health care sector around the end-90s, and another pilot on tele-primary care around the mid-2000. Besides, there was an ambitious initiative to implement a nationwide electronic personalised healthcare plan for each population since the mid-90s. It remains positive that the nationwide electronic records will be implemented at all levels of care in the country.

At present, the public sector in Malaysia has a functioning health information and management system, collecting utilisation data from all levels of care. The health facilities submit the data in electronic format in a bottom-up approach. However, these are aggregated reporting for single indicator whereby useful personal data of each individual is lost. As such it is not able to associate user characteristics with care pattern or outcomes. To be able to evaluate the effectiveness of ANC, reporting format has to be revised to allow for case reporting instead of aggregated reporting. To monitor ANC, it is necessary to define both the intervention (e.g. ANC utilisation related data – ANC initiation data, number of visits, birth date, EDD, and selected ANC content, etc), and pregnancy outcomes (e.g. preterm birth, LBW or etc). Dataset for case reporting should be streamlined to contain only key data that will enable useful monitoring and evaluation on effectiveness of ANC. Beside the interventions and outcomes related datasets, depending on the depth of evaluation envisaged, ideally the minimal datasets shall also contain some standardised socio-demographic data, and key risk factors that will help to determine the factors associated with the outcomes to be evaluated. Admittedly, this type of evaluation will be extremely challenging without a national electronic medical records system at the point-of-care (Boerma, AbouZahr, et al., 2014; Ng, et al., 2014).

Incorporating ANC content into the monitoring and evaluation of ANC interventions and pregnancy outcomes will be easy in an electronic medical records environment. What needs to be done is to define specific ANC content to be evaluated. However, in non-electronic operations, selected ANC content and its real-life practice could still be incorporated into the current ANC records audit conducted regularly by the district health offices. The current ANC records audit review the correct assignment and coding of the risk assessment system, as well as case management of selected high risk cases such as pregnant women with anaemia and pregnant women with GDM according to certain aspects of care protocols. It appears that the current audit focuses only on risk coding and management of high risk cases. Monitoring on unnecessary procedures or timing of time-sensitive procedures etc. is not evidenced. In addition, the current audit does not link to any outcomes; as such it is purely a care protocol monitoring tool with limited use.

Until the introduction of electronic medical records is materialised, paper-based manual data extraction for comprehensive analysis should be systematically implemented in all states as soon as possible. This will allow for validation of the methods and results. A working group consisting of experts in ANC, monitoring and evaluation, statistical and software, health information system, trainers and field supervision for data collection should be established and tasked to validate the methods and results.

6.4.3 Confidential Enquiries into Maternal Deaths and Severe Maternal Morbidity

Although Confidential Enquires into Maternal Deaths (CEMD) is regularly carried out for every maternal death reported in Malaysia, the last published CEMD report of Malaysia was for the period 2001-2005, more than a decade ago. Dissemination of the findings was limited to mainly public sector providers, and not made accessible to the lay public. In comparison, the practice of the founding model of CEMD UK which has been started since 1952, regularly publishes the death cases in a book for easy access and broad dissemination to the professional and lay people (S. Alexander, et al., 2003), at shorter interval. The CEMD UK's compilation also discusses specific topics or guidelines related to the results of the enquiries.

In view of the success of CEMD United Kingdom which has since been adopted by other European countries (S. Alexander, et al., 2003), it is advisable for Malaysia to improve on the interval of the publication and dissemination strategy. Improvement on maternal mortality data should be the priority.

Besides, monitoring of severe maternal morbidity is desirable. Severe maternal morbidity is seen as indicators of the quality of obstetric care. It widens the scope of inquiry to include the ‘‘near-miss’’ cases where a maternal death was narrowly averted.

The main rationale for measuring severe maternal morbidity is to gain better understanding of differences in mortality ratios. In effect, these are related both to the prevalence of the morbid condition and to the likelihood of dying from the condition when it occurs (S. Alexander, et al., 2003). The definition and indicators used by the EURO-PERISTAT group are operational in Malaysia. The four indicators are: eclampsia, hysterectomy or embolisation, blood transfusion, and ICU admission >24 hours (S. Alexander, et al., 2003; EURO-PERISTAT, 2012).

6.5 FUTURE STUDIES

There are potential areas for future researches that will be useful to complement the finding of this study. As has already been mentioned in previous chapters, further research is required to assess how the technical performance of routine ANC can be improved. In particular, the issue concerning low compliance to the provision of antenatal health education, reviewing both the attitudes of health personnel and pregnant women. The lack of compliance to the antenatal health education checklist should be investigated to determine the root cause and possible solution.

In addition, future studies should include qualitative study involving in-depth interviews with the key personnel and stakeholders responsible for ANC related policy or guidelines. The study will look into issues related to ANC guidelines and policy implications, especially on the rationale why certain proven practices are not included; for example, BMI assessment, routine urine culture to detect ASB, Chlamydia screening, and certain genetic screening. Likewise, the study could look into the reason why certain practices that were found to be ineffective elsewhere but are still maintained in Malaysia; for example, foetal heart auscultation, breast examination, urine sugar screening at every scheduled visit, frequent Hb/FBC screening. Depending on the findings of the qualitative assessment, an effectiveness studies such as cost-outcome analysis will be valuable to convince the policymakers to consider certain revision to the current policy or guidelines.

6.6 THE WAY FORWARD

For the next steps, this could start with sharing the study through a briefing to the Department of Health of Selangor state where this study was conducted. The briefing shall focus on the methods and the findings related to utilisation pattern and actual content of care delivered. Where feasible, further assessment will be encouraged to examine the weaknesses observed in the study. The current ANC records audit review conducted by the district health offices could be encouraged to incorporate more in-depth assessment of ANC provided as had been mentioned earlier.

At the national level, it is planned to share the finding with the Ministry of Health's Family Health Development Department. It is hoping that data extraction for comprehensive analysis could be systematically implemented in some of the states. This will allow for validation of the methods and results for continuous improvement. The recommendation at the national level will be the establishment of a working group consisting of experts in ANC, monitoring and evaluation, biostatistics and software, trainers and field supervision for data collection to explore the incorporation of the methods presented in this study into the current monitoring and evaluation framework.

CHAPTER 7: CONCLUSION

Since its introduction nearly a century ago, ANC continues to be an effective preventive measure for foeto-maternal-newborn health. Recent strategic papers on monitoring of health services affirmed that while ANC is an effective preventive measure, quality is still a problem that requires additional monitoring and evaluation to capture the quality dimension.

On the whole, the study provided insights on the use of resources vis-à-vis ANC utilisation and quality of ANC content delivered. Above all, the study presented several contributions to research on antenatal care adequacy. One, intensive utilisation does not seem to improve pregnancy outcomes. While it is justified for high-risk to have more frequent visits for additional care, there is no reason for low-risk to have higher number of visits than standard schedule. Over-utilisation of ANC among low-risk women, as demonstrated in this study, implies the need to consider a more efficient resource scheduling. Rational use of ANC according to risk status should be encouraged to avoid over-utilisation among low-risk women and under-utilisation among high-risk women.

Two, the fact that over half of women had <80% of the recommended routine content indicates the need to improve technical performance of care to ensure completeness of routine care provided. All women should be given complete routine care regardless of their risk level. Delivery of ANC should be concerned with the multidimensional needs of the women and not only with their biological care.

Three, the study has resulted in an accompanying insight on the need to review the current guidelines, spinning from reviewing guidelines from countries with better maternal and child health outcomes. As compared to the evidence-based guidelines from these countries, in particular UK and Australia, the Malaysian guidelines reveal spaces for improvement. Moreover, this present study showed that adequate ANC content did not seem to reduce stillbirth and maternal complications. While these outcomes may also depend on the care received during labour and birthing, this may hint at the need to review the current ANC guidelines, to ensure the inclusion of effective evidence-based care.

Lastly, the methods used could be reviewed as to their utility in expanding monitoring and evaluation framework for improving quality and informing policy formulation. This study demonstrates a disconnect between availability of routinely recorded data and their use for improving quality of antenatal care and informing the formulation of policies and strategies concerning coverage, quality, and economics of antenatal care. This is the first study in Malaysia that assessed ANC utilisation using a composite index combining adequacy of initiation and observed-to-expected visits ratio based on the APNCU Index that is frequently used in developed setting. This is also the first study in Malaysia to look and analyse objectively compliance to existing national ANC guidelines. This study demonstrates the need to systematically monitor and evaluate ANC. Additional studies which confirm the accuracy of the facility-based indexes and streamline data extraction will be useful.

Further researches are required to analyse how the technical performance of routine antenatal care can be improved, in particular, delivery of antenatal health advice, reviewing both the attitudes of health personnel and pregnant women. Future studies may also consider involving stakeholders responsible for guidelines and policy formulation, examining the rationale of why certain effective practices are excluded, and vice-versa, why certain ineffective practices are maintained.

7.1 SELF REFLECTION OF CONDUCTING THIS STUDY

The journey associated with the conduct of the study and development of this thesis has been a rewarding experience. In all previous studies undertaken, the brain has never been that challenged. The researcher has learned much by going through the complete process of the study personally. The data collection tool could never be perfected before applying in real-life situation, no matter how much experience or background knowledge a researcher might have. There could be user or provider behaviour or practice that were not known prior and might necessitate additional data fields. For example, users that might seek healthcare elsewhere prior and providers who might provide health education topics that was not in the standard checklist and etc.

Involving in the primary data collection itself has helped the researcher to gain a better understanding on the context and system, providing an insight for subsequent handling of data and analysis. The researcher is grateful that this study has pushed the researcher to use SPSS finally and rather thoroughly. This has been a skill that the researcher had not appreciated previously. There had been no necessity to master the statistical software because a data processing person would always be engaged in project surveys. From dealing with the nitty-gritty of data analysis, the researcher has come to appreciate the advantage of acquiring this skill which will add value to future surveys and in designing dummy tables.

Through this study, the researcher has gained better knowledge in a number of statistical procedures and approaches in testing association. The application of analysis models is generally more common in academic studies and less applicable in project related researches. Descriptive statistics and cross-tabulation are commonly more useful in project researches. Another useful advice learned from the statisticians is the shift away from over-reliance on “p-value”. Traditionally, “p-value” has been equated as the ultimate authority to confirm the association between predictors and outcome. What had been learned and advised was that "p-value" is linked to the sample size: the same effect will have different p-values in different sized samples. Small differences can be deemed "significant" in large samples, and large effects might be deemed "non-significant" in small samples. If the "p-value" was non-significant but the odds ratio had a sizeable effect size, it is still important to mention the suggestive evidence of an association between the variables.

The development of the thesis itself has been nurturing and a great learning, though at times frustrating. There were so much that could be included, yet the researcher has to be careful not to side-track. When the data started to "talk", then the researcher has to be careful of not being bias in reading the data; additional analysis was needed to rule out possible confounders. When writing the thesis, one frustration was the requirement for references to support every single opinion formed. It was upsetting when one could remember reading those points earlier in some articles but have to dig through heaps of articles to find that particular piece of intellectual evidence! The upkeep of an organised referencing library with detailed folders therefore was crucial in minimising the pain. Life will be hard to imagine without the reference management software. All in all, this study was one of the most fulfilling quests in life.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

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APPENDIXES

Appendix A: Key Informant Interviews - Summary of Main Points

Appendix B: Comparison of ANC Guidelines

Appendix C: Data Collection Forms

Appendix D: Routine Antenatal Care Content for All Women and Compliance Criteria for Scoring

Appendix E: Statistical Procedures and Approaches for Testing Association

Appendix F: Respondents Characteristics

Appendix A: Key Informant Interviews - Summary of Main Points

Deputy Directors of Family Health Development, MOH Malaysia, from April to August, 2012, research proposal development stage:

- The problem faced in the provision of antenatal care is the increasing antenatal visit which is fast approaching 11 visits per pregnancy, higher than the recommended schedule. It will be useful to find out the reason that warrants such high number of visits.
- In general, the pregnancy outcomes of the Chinese women are better than other ethnic groups. This group also has higher proportion of family planning practice/ birth spacing.
- Majority of the users of the health clinics are Malay women; Chinese women often use private antenatal care.
- The freshly graduated nursing staffs often were not yet able to step into their roles right after completion of training programme; additional on-the-job training was still required. It is expected that they could fulfil their role competently upon completion of training.

Nursing officers of health clinics (Ampang, Bukit Changgang, Batu 9 Cheras, Puchong), district matrons (Hulu Langat, Bukit Changgang and Petaling) from June to November 2013, data collection tools pre-testing and finalisation, as well as finalisation of portional sample allocation according to risk level:

- Distribution of pregnant women by colour coding: Around 70% of the pregnant women attended the public health clinics are colour-tagged (green, yellow or red), and only 25%-30% are white tagged. Among the colour-tagged, majority are green-tagged (~50%), followed by yellow-tagged (~20%) and red-tagged (~5%).
- Records for stillbirths and maternal deaths: Health policy at district level requires that all stillbirths and maternal deaths are to be reported to the health

clinic that serves the residential address of the deceased. These include un-booked cases and antenatal cases solely seen by private sector (not seen by public clinic at all), which means there will be no antenatal care records available for these cases at the health clinic.

Family medicine specialist (Ampang health clinic), July 2013, data collection stage:

- The clinic has lesser proportion of Chinese women because majority of the Chinese women use antenatal care of the private clinics.
- There is an increase in the number of patients seen at this clinic due to the poorer economic performance of the country.

Family Health Development Unit, Selangor State Health Department, 2012-2014, research proposal development and data analysis stages:

- Discussions on the routine antenatal care content according to national guidelines, among others, the discussion on use of ultrasound which is commonly used for dating in Malaysia to estimate the expected date of delivery.
- Discussions on weighting of care components, among others, the statement of the Unit on assignment of weighting factor – "*…we are looking at standard of ANC whereby as stakeholder, we feel that the physical examination and case management is the most important part, while screening is compulsory for safety reason. Health education - yes it is important however to measure the impact as standard of ANC in this study, is not that accurate*".

Appendix B: Comparison of ANC Guidelines

RECOMMENDED ANC PRACTICES FOR HEALTHY PREGNANT WOMEN AND UNCOMPLICATED PREGNANCY OF SELECTED COUNTRIES (TIMING & FREQUENCY)

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
	MMR in 2013 (per 100,000 live births) [g]	**World 210**	**29**	**8**	**28**	**6**	**ranging from 3 to 14**
	Frequency of visits and initiation (uncomplicated pregnancy up to 40 weeks of gestation)	4	10 (primi), 7 (multi) Initiate by 12 weeks	10 (primi), 7 (multi) booking by 10 weeks	13 Initiate at 1st trimester, first pregnancy is examined every 4 weeks for the first 28 weeks of gestation, every 2 weeks until 36 weeks of gestation, and weekly thereafter.	10 (primi), 7 (multi) booking within the first 10 weeks (note: traditional schedule was 14 visits before the national guidelines was developed)	
A	**PHYSICAL EXAMINATION (PE)**						
A1	oral hygiene/ dental care (or referral for oral health services)	not mentioned	at booking refer for oral health services	not mentioned	at booking, advise oral health checks and treatment, if required	at booking, advise oral health checks and treatment, if required	not mentioned
A2	general condition - pallor, cyanosis, varicose veins, etc	4, all visits	at booking and specific condition	assumed part of PE to identify women who may need additional care	at booking	assumed part of clinical assessment and screening to identify women who may need additional care	not mentioned

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
A3	cardiovascular system	assumed part of "clinical examination" at 1st visit	at booking and during RME		at booking		not mentioned
A4	respiratory	assumed part of "clinical examination" at 1st visit	at booking and during RME		at booking		not mentioned
A5	thyroid	assumed part of "clinical examination" at 1st visit	at booking and during RME		at booking		not mentioned
A6	abdomen - previous scar/ other masses	assumed part of "clinical examination" at 1st visit	at booking and during RME		at booking		not mentioned
A7	gynaecological/ vaginal examination	1 (at 1st or 2nd visit)	only if indicated	routine pelvic examination is not recommended	at booking	routine antenatal pelvic examination is not recommended.	4, mean
A8	spine	assumed part of "clinical examination" at 1st visit	at booking	assumed part of PE to identify women who may need additional care	at booking	assumed part of clinical assessment	not mentioned
A9	height	1 at 1st visit	at booking	at booking for calculation of BMI	at booking for calculation of BMI	at booking	taken for body mass index calculation
A10	weight	1, and all 4 visits for women with low weight at first visit	every scheduled visit	at booking, repeated weighing if clinical management is likely to be influenced	every scheduled visit Estimate pre-pregnancy weight/ BMI.	at booking, repeated weighing should be confined to circumstances that are likely to influence clinical management.	6, mean

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
						Estimate pre-pregnancy weight/ BMI based on self-reported weight.	
A11	blood pressure	4, all visits	every scheduled visit	every scheduled visit	every scheduled visit	at booking, not clearly stated if done for every visit and women, but stated insufficient new evidence to justify changing the NICE recommendations which recommends BP monitoring for every visit – assumed routinely done for all women (Module II)	8, mean
A12	breast	assumed part of "clinical examination" at 1st visit	at booking	routine examination is not recommended for promotion of postnatal breastfeeding	at booking	Routine breast examination during antenatal care is not recommended	not mentioned
A13	Foetal growth - symphysis-fundal height (SFH) and/ or abdominal palpitation	4, all visits	SFH from 22 weeks onwards	SFH from 24 weeks onwards	serial SFH assessment, initiation gestation not indicated	every scheduled visit, either or both method – but did not specify initiation gestation (under Module II)	7, mean
A14	foetal lie and presentation	4th/last visit	from 32 weeks onwards	36 weeks or later Suspected mal-	not mentioned, assumed done since form has this field	36 weeks or later; Suspected non-	4, mean

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
				presentation should be confirmed by ultrasound		cephalic presentation should be confirmed by ultrasound	
A15	foetal heart auscultation	3	from 24 weeks onwards if using Pinard Foetoscope; and can be as early as 14 weeks if Daptone available	routine listening is not recommended, unless requested by mother for reassurance	at appropriate gestational ages	If auscultation of the foetal heart rate is performed, a Doppler may be used from 12 weeks and a Pinard stethoscope from 26 weeks (Module II)	6, mean
A16	oedema	assumed part of "clinical examination" at 1st visit	every visit	assumed part of PE to identify women who may need additional care	not mentioned, assumed done since form has this field	assumed part of clinical assessment	not mentioned
A17	body mass index	only height and weight, no BMI	only height and weight, no BMI	at booking, and repeated if clinical management is likely to be influenced	at booking	at booking	3, mean
B	**HEALTH SCREENING (HS)**						
B1	urine protein	1, and all 4 visits for nulliparous/ women with previous eclampsia	every scheduled visit	every scheduled visit	Obtain baseline screening (dipstick) to assess renal status. But, in the absence of risk factors or symptoms, there has not been shown to be a benefit in routine urine dip-stick testing during ANC for women at low risk.	at booking Offer testing for proteinuria if a woman has risk factors for, or clinical indications of pre-eclampsia; in particular raised blood pressure. For point-of-care testing, use an automated dipstick	7, mean

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
						analyser if available, as visual inspection of a urinary dipstick is the least accurate method to detect true proteinuria.	
B2	urine sugar	1 at 1st visit	every scheduled visit	not recommended for screening of gestational diabetes, instead risk factors screening is recommended for healthy population, and women with one or more risk factors will be offered testing for gestational diabetes	not routinely done, but all women screened for GDM whether by patient history, clinical risk factors, or laboratory screening test to determine blood glucose level. In most women, blood glucose screening should be performed at 24–28 weeks gestation	not routinely done, but all women assessed for risk of hyperglycaemia at booking, and offer testing for hyperglycaemia to all women between 24 and 28 weeks.	7, mean
B3	Hb or FBC	1 at 3rd visit, and 2 times for clinically severe anaemia at 1st visit	at booking, and regularly for subsequent visits (frequency not indicated)	at booking and at 28 weeks	FBC, early in pregnancy Hb repeated in early 3rd trimester	at booking and at 28 weeks	3, mean
B4	ABO	1 at 1st visit	at booking	at booking or earlier	early in pregnancy	at booking	1, mean
B5	Rhesus type	1 at 1st visit	at booking	at booking or earlier	early in pregnancy, also antibody screen	at booking	1, mean
B6	VDRL (Syphilis)	1 at 1st visit	at booking	at booking or earlier	at booking (early in pregnancy);	at booking	not mentioned
B7	HIV	not mentioned	at booking	at booking or earlier	at booking (early in pregnancy)	at booking	2, mean

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
B8	Ultrasound, abdominal	not mentioned	recommended at booking for dating, before 24 weeks (if facility is available). For foetal growth assessment, serial scan should be done every 2-3 weeks	offer early for gestational age assessment (10-13 weeks); offer at 18-20 weeks to detect structural anomalies; routine use not recommended after 24 weeks; offer repeat ultrasound at 32 weeks to those placenta extended over the internal cervical os during 18–20 week scan.	1st trimester ultrasound is performed before 14 weeks. optimal timing for a single ultrasound in the absence of specific indications for first-trimester examinations is at 18–20 weeks of gestation.	at booking offer ultrasound for gestational age assessment to be carried out between 8 and 14 weeks of pregnancy, also to determine, detect multiple pregnancies and accurately time foetal anomaly screening. Repeated ultrasound assessments should only be used when clinically indicated. Offer ultrasound to assess foetal development and anatomy between 18 and 20 weeks. Offer repeat ultrasound at 32 weeks to those placenta extended over the internal cervical os during 18–20 week scan.	3, mean
B9	Ultrasound, transvaginal	not mentioned	not offered	not differentiated	As above, either abdominal or transvaginal for 1st trimester ultrasound	not differentiated	2, mean

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
B10	Hepatitis B	not mentioned	at booking	at booking or earlier	at booking (early in pregnancy)	at booking	1.5, mean
B11	Other screening tests	no	various, routinely ordered according to maternal risk factors (e.g. MGTT)	urine test for asymptomatic bacteriuria; blood test for sickle cell diseases and thalassemia, Down's syndrome (combined test or triple/quadruple test), rubella susceptibility; inform chlamydia testing at booking to women younger than 25 years.	urine culture early in pregnancy to detect asymptomatic bacteriuria; chlamydial (early in pregnancy); Group B streptococcal (at 35-37 weeks); Genetic screening tests recommended based on ethnicity, Screening and invasive diagnostic testing for aneuploidy offered to all 20 weeks regardless of maternal age.	urine culture at booking to detect asymptomatic bacteriuria; rubella non-immunity at booking, offer screening for chromosomal abnormalities to be carried out between 11 and 14 weeks; chlamydia testing at booking to PWs younger than 25 years or all women in areas of high prevalent; Hepatitis C, bacterial vaginosis, Vitamin D deficiency at booking for high risk groups only; Group B streptococcal (at 35-37 weeks).	urinalysis for bacteria (5, mean), Lues (2, mean), Alpha-Feto-Proteine or Triple (2, mean), Atypical red cell antibodies (2, mean), rubella titer (1, mean), gestational diabetes OGTT (1, mean)

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
C	**CASE MANAGEMENT (CM)**						
C1	immunisation - anti-tetanus vaccination (in dose)	2 doses, 1st dose at 1st visit, 2nd dose at 3rd visit	primi = at quickening and repeated 4 weeks later; multi = single dose in 3rd trimester before 37 weeks	not mentioned	routine assessment of immunization status is recommended, with appropriate immunisation if indicated.		not mentioned
C2	haematinic supplement (include folic acid or multivitamins supplements)	4, all visits	at booking (folic acid before/at POG 12 weeks; haematinics/multivitamin supplement after POG 12 weeks. Some HC only prescribed multivitamin [e.g. Obimin] which content folic acid)	information on benefit of folic acid supplementation at first contact with healthcare professional; iron supplement considered only if indicated	1st trimester health education	information on benefit of folic acid supplementation; Advise women that taking vitamins A, C or E supplements is not of benefit in pregnancy and may cause harm; Advise women to take iodine supplement of 150 micrograms each day. Women with pre-existing thyroid conditions should seek advice before taking supplement; Do not routinely offer iron supplementation during pregnancy.	not mentioned

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
C3	routine medical examination (RME) by doctor	not mentioned	two times = RME1 at booking or by POG 24 weeks; RME2 at 36 weeks.	not necessary, midwife-led model of care should be offered to uncomplicated pregnancy	not necessary as basic level of ANC could be delivered by certified nurse-midwives, certified midwives, and other advanced-practice nurses with experience, training, and competence.	not necessary, depending on the models of care whereby midwife care model will have midwives as the primary providers of care for the women	
C4	risk assessment	not mentioned	at booking and at the followings: 13-20 weeks; 21-28 weeks; 29-32 weeks; 33-36 weeks. (risk assessment based on standard checklist and schedule in which medical conditions include psychiatrics and physical disability; risk for depression is not assessed)	At booking - risk factors screening for gestational diabetes, pre-eclampsia. Also assess to identify possible depression and women with genital mutilation	Begin at booking and ongoing include psychosocial risk screening and counselling, screening for depression, domestic violence	At booking – screen for risk factors, including psychosocial risk factors for mental health, domestic violence etc., also screening for depression and anxiety assess risk of hyperglycaemia - including age, BMI, previous gestational diabetes, previous high birth weight baby, family history of diabetes, and family origin.	2, mean
C5	colour coding of risk	not mentioned	yes	no	no	No	not mentioned

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
D	**HEALTH EDUCATION (HE)**						
D1	nutritional/dietary advice - antenatal	not mentioned	yes	"give information" is emphasized at every visit	1st trimester	yes	not mentioned
D2	nutritional/dietary advice - postnatal/ breastfeeding		yes	not mentioned in antenatal module	included in dietary advice	not mentioned in antenatal modules	
D3	recommendations for family planning/ contraception	1, at 3rd visit	yes	not mentioned	2nd or 3rd trimester		not mentioned
D4	preparation for birth	1, at 3rd visit	yes	at 34 weeks	2nd or 3rd trimester	yes	not mentioned
D5	birth process (S&S and related advice)		yes	before or at 36 weeks	2nd or 3rd trimester	yes	
D6	common discomfort during pregnancy and solutions		yes	1st trimester, various conditions (nausea and vomiting, constipation, heartburn, haemorrhoids, varicose vein, vaginal discharge, backache etc.)	1st trimester health education (nausea and vomiting)	1st trimester, various conditions (nausea and vomiting, constipation, heartburn, haemorrhoids, varicose vein, pelvic girdle pain etc.)	
D7	breastfeeding	1, at 3rd visit	yes	before or at 36 weeks	2nd or 3rd trimester	yes	not mentioned
D8	disorders in pregnancy	recommendation for emergencies - 4, all visits	yes (include PIH, PE/IE, DM, anaemia, bleeding)	assumed part of patient education	assumed part of patient education	yes (include PE, DM, anaemia,	
D9	early booking		yes	not mentioned	not mentioned, but discussed anticipated schedule of visits	not mentioned, but discussed anticipated schedule of visits and schedule for booking visit	
D10	foetal development		yes	at booking	not mentioned	not mentioned	

	Recommended ANC practices	WHO [a]	Malaysia [b]	UK [c]	US [d]	Australia [e]	EU Survey [f]
D11	exercise/ physical activity		yes	at booking	1st trimester	yes	
D12	newborn care		yes	before or at 36 weeks	2nd or 3rd trimester	yes	
D13	jaundice baby care		yes	not mentioned	not mentioned	not mentioned	
D14	postnatal care	not mentioned	yes	before or at 36 weeks	offered under postnatal care	not mentioned	not mentioned
D15	foetal movement monitoring		from 28 weeks onwards, all women instructed to record foetal movement chart daily (Cardiff "count-to-ten"), and told to report if movement less than 10 in 12 hours.	routine formal foetal-movement counting should not be offered.	foetal movement monitoring by women using "10 movements in 2 hours" using focused counting. After 10 movements have been perceived, the count can be discontinued for that day. In the absence of 10 movements in 2 hours, additional foetal evaluation is warranted.	from 20 weeks onward, discuss foetal movements - timing, normal patterns etc.; advise women to be aware of the normal pattern of foetal movement and to contact their health care professional promptly if concerns about decreased or absent movements.	

[a] Villar J, Ba'aqeel H, Piaggio G, Lumbiganon P, Belizán JM, Farnot U, et al. WHO antenatal care randomised trial for the evaluation of a new model of routine antenatal care. The Lancet. 2001;357(9268):1551-64.
[b] Malaysia MoH. Perinatal care manual: Section 2 Antenatal care (2nd edition). 2010.
[c] National Institute for Health and Clinical Excellence (NICE). Antenatal care: routine care for the health pregnant woman. London: National Institute for Health and Clinical Excellence; 2008.
[d] American Academy of Pediatrics (AAP) and American College of Obstetricians and Gynecologists (ACOG). Guidelines for Perinatal Care, 7th edition. Washington, DC: American College of Obstetricians and Gynecologists; 2012.
[e] Australian Health Ministers' Advisory Council. Clinical Practice Guidelines: Antenatal Care – Module 1. Canberra: Australian Government Department of Health and Ageing 2012. Available from: http://www.health.gov.au/antenatal.; and Australian Health Ministers' Advisory Council. Clinical Practice Guidelines: Antenatal Care – Module 2. Canberra: Australian Government Department of Health and Ageing; 2014. Available from: http://www.health.gov.au/antenatal.
[f] Bernloehr A, Smith P, Vydelingum V. Antenatal care in the European Union: A survey on guidelines in all 25 member states of the Community. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2005;122(1):22-32.
[g] 36. WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division,. Trends in Maternal Mortality: 1990-2013. Estimates by WHO, UNICEF, UNFPA, The World Bank and the United Nations Population Division. Geneva: WHO; 2014.

DATA COLLECTION FORM: CLINIC PROFILE

District name ______________________________

Clinic name ______________________________

SECTION: PROVIDER PROFILE				
0A: QUALIFICATION & EXPERIENCE OF HEALTHCARE WORKERS				
#	**Name**	**Position**	**Educational Qualification**	**Years of working experience**
1				
2				
3				
4				
5				

DATA COLLECTION FORM: ANC RECORDS

District name	______________________		
Clinic name	______________________		
No. Pendaftaran:	______________________	Malaysian (please mark x if yes, must be Malaysian)	☐
No. telephone ANC patient:	Housephone: Handphone: ______________________		
Date recorded:	______________________		
Date entered:	______________________		

SECTION 1: DATA COLLECTION CATEGORY ASSESSMENT (please mark x)

101	Has patient defaulted ANC at this clinic? (stopped coming before due date, or absence in between) Reason, if known, when missed: ______________________	Yes	☐
		No	☐
102	**If YES (defaulter), please note that some of the items may not applicable**		
103	**If NO (not defaulter), complete all items**		

SECTION 2: SOCIO-DEMOGRAPHIC

201	Month and year woman was born	Month	☐
		Year	☐
202	Woman's ethnicity (please mark x)	Malay	☐
		Chinese	☐
		Indian	☐
		Indigenous/ orang asli	☐
		Others (please specify)	☐

203	Woman's education level (please mark x)	No formal education	
		Primary	
		Secondary	
		Tertiary - diploma, degree, higher	
204	Woman’s occupation (please specify and mark x): ________________	Legislators, senior officials and managers (Penggubal undang undang, pegawai kanan and pengurus)	
		Professionals (Profesional)	
		Technicians and associate professionals (Juruteknik dan professional bersekutu)	
		Clerical workers (Pekerja perkeranian)	
		Service workers and shop and market sales workers (Pekerja perkhitmatan, pekerja kedai dan jurujual)	
		Skilled agricultural and fishery workers (Pekerja mahir pertanian dan perikanan)	
		Craft and related trades workers (Pekerja pertukangan dan yang berkaitan)	
		Plant and machine operators and assemblers (Operator loji dan mesin serta pemasang)	
		Elementary occupations (Pekerjaan asas)	
		Others (please specify)	
205	Spouse’s occupation (please specify and mark x):	Legislators, senior officials and managers (Penggubal undang undang, pegawai kanan and pengurus)	
		Professionals (Profesional)	
		Technicians and associate professionals (Juruteknik dan professional bersekutu)	

Clerical workers (Pekerja perkeranian)	
Service workers and shop and market sales workers (Pekerja perkhitmatan, pekerja kedai dan jurujual)	
Skilled agricultural and fishery workers (Pekerja mahir pertanian dan perikanan)	
Craft and related trades workers (Pekerja pertukangan dan yang berkaitan)	
Plant and machine operators and assemblers (Operator loji dan mesin serta pemasang)	
Elementary occupations (Pekerjaan asas)	
Others (please specify)	

SECTION 3: ANC UTILISATION, RISK LEVEL, DELIVERY ROUTE & PREGNANCY OUTCOMES

3A: ANC UTILISATION (for this pregnancy)

301 Gestational age at first visit/ booking (in weeks), based on estimate at booking

Booking date (at this clinic)

Indication seen/booked at other provider prior to this booking visit, if any (gestation, purpose) gestation: purpose:

LMP (last menstruation period)

EDD

REDD (if any)

302 Total number of ANC visits for this pregnancy **(to be counted from Section 5A)**

total	**single procedure**	**> single proc.**

3B: RISK LEVEL (risk factor & colour tag at first and last visit)

		Risk factor (please describe)	**Colour code**
303	First visit		

		Risk factor (please describe)	**Colour code**
304	Last visit when re-tagged:		

3C: PLACE OF DELIVERY (not applicable for defaulter)

305	Hospital (please specify name of hospital)	name of hospital: ______________	
306	Home		

3D: ROUTE OF DELIVERY (not applicable for defaulter)

307	vaginal delivery	
308	caesarean section	

3E: PREGNANCY OUTCOMES (not applicable for defaulter)

309	gestational age at birth (in weeks)	date:	
310	birth weight (in g)		
311	birth outcome - livebirth or stillbirth (Please mark x, and indicate any other info below) ______________	livebirth	
		stillbirth	

312	maternal outcome	no complication	☐
		has complication but alive, please specify type of complication below:	☐
		______________________	
		maternal death	☐

SECTION 4: HISTORY TAKING

Past obstetric history

401	Total number of pregnancies the woman ever had, including this pregnancy (gravidity)	☐
402	Total number of births (livebirth and stillbirth) the woman ever has at 22 gestational weeks or more, excluding this pregnancy (parity)	☐

403	**Please fill in the information of all pregnancy history before this pregnancy (404-411) - please use another piece of paper if the space is not adequate.**

Birth/ proce-dure	**404 Year delivered or procedure done**	**405 Hasil kandungan (pre-term, term, post-term)**	**406 Jenis kelahiran**	**407 Tempat dan disambut oleh**	**408 Berat lahir (in g)**	**409 Komplikasi ibu**	**410 Komplikasi anak**	**411 Keadaan anak sekarang (pada waktu booking untuk pregnancy ini)**
1								
2								
3								
4								
5								

	Menstrual history & FP:		
412	regularity of cycles (pusingan/regularity, # days)	-day cycle regular/ irregular	days
413	FP method (please circle "Yes or No", if yes, please indicate method)	Method:	Yes / No
	Medical history, family history or socio-economic background (e.g. smoking, drugs & alcohol consumption) etc:		
414	(please indicate if any)		

SECTION 5: ANC PROVIDED

	ANC	VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	date seen (dd/mm)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
	gestational weeks (jangka masa)	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
5A: ANC PROVIDED - ROUTINE CARE & MANAGEMENT																		
	PHYSICAL EXAMINATION																	
501	referral for dental check-up																	
502	general condition - pallor, cyanosis, varicose veins																	
503	cardiovascular system																	
504	respiratory																	
505	Thyroid																	
506	abdomen - previous scars, uterine size/other masses																	
507	vaginal examination when indicated																	
508	spine																	
509	height																	
510	weight																	
511	blood pressure																	
512	breast																	

SECTION 5: ANC PROVIDED

	ANC	VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	date seen (dd/mm)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
	gestational weeks (jangka masa)	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
513	symphysio-fundal height (tinggi rahim)																	
514	foetal lie and presentation (kedudukan janin)																	
515	foetal heart auscultation/ movement (jantung janin/ gerak janin)																	
516	oedema																	
	INVESTIGATIONS																	
521	urine protein																	
522	urine sugar																	
523	Hb																	
524	ABO (kumpulan darah)																	
525	Rhesus																	
526	VDRL																	
527	HIV rapid test																	
528	Ultrasound, abdominal																	
	Ultrasound done at other provider (#, when)																	

SECTION 5: ANC PROVIDED

ANC		VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	date seen (dd/mm)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
	gestational weeks (jangka masa)	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
529	Hepatitis B																	
	CASE MANAGEMENT/ HEALTH EDUCATION																	
541	immunisation - anti-tetanus vaccination (1^{st} , 2^{nd} or booster dose)																	
542	haematinic supplement (iron & folic acid)																	
543	advice to rest																	
544	Makanan seimbang: Antenatal or dietary advice																	
545	Makanan seimbang: Postnatal/ menyusukan babi																	
546	Perancang keluarga																	
547	orientate on the use of foetal movement chart/ FM monitoring																	
548	Persiapan bersalin di rumah/ hospital																	
549	S&S of labour and advice to seek immediate care																	
550	Masalah ringan semasa hamil dan cara mengatasinya, incl. S&S small complications & advice for stat care																	

SECTION 5: ANC PROVIDED

ANC		VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
date seen (dd/mm)		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
gestational weeks (jangka masa)		week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
551	Susu ibu:																	
a	- recommendation for breastfeeding in general only																	
b	- Faedah penyusuan ibu -																	
c	- Pentingnya penyusuan ibu sejurus selepas kelahiran																	
d	- Meletakkan bayi sentiasa bersama ibu -																	
e	- Posisi bayi dan pelekapan semasa penyusuan																	
f	- Pentingnya penyusuan mengikut kehendak bayi																	
g	- Pastikan susu dihasilkan dengan secukupnya -																	
h	- Beri hanya susu ibu -																	
i	- Teknik memerah dan menyimpan susu bagi ibu yang bekerja																	
552	Keadaan luar biasa masa mengandung:																	
a	- PIH -																	
b	- Pre Eclampsia/ Impending Eclampsia -																	
c	- Diabetes -																	
d	- Anaemia -																	
e	- Perdarahan semasa mengandung -																	
553	Kepentingan dating awal ke klinik																	
554	TCA compliance reminder/ advice																	

SECTION 5: ANC PROVIDED

ANC		VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	date seen (dd/mm)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
	gestational weeks (jangka masa)	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
555	report birth to HC																	
556	give information on antenatal screening test (benefits & limitations)																	
557	Perkembangan janin dalam kandungan																	
558	Senaman: ibu antenatal/ postnatal																	
559	Proses kelahiran																	
560	Penjagaan baby baru lahir																	
561	Cara mandi bayi																	
562	Jagaan bayi jaundis																	
563	Jagaan postnatal																	
564	Others health education topic, please indicate																	
565	Reason for internal doctor referral:																	
a	RME (1st, 2nd)																	
b	Problem/ complaint (please specify: PV discharge, UTI symptoms etc)																	
566	External referral:																	
a	Specialty/ services (please specify)																	
b	Reason (please specify)																	

SECTION 5: ANC PROVIDED

	ANC	VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
	date seen (dd/mm)	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
	gestational weeks (jangka masa)	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
567	please indicate other important care given (treatment prescribed etc)																	
	RISK ASSESSMENT																	
571	risk assessment based on standard checklist and schedule																	
	Total number of procedures complied with (sum of all entries with a compliance score of "1")																	
	Content adequacy score (%)																	
SECTION 5B: ANC PROVIDED - ADDITIONAL ASSESSMENT FOR SPECIFIC CONDITION OR OPTIONAL ASSESSMENT																		
581	blood sugar profile (BSP)																	
582	modified glucose tolerance test (MGTT)																	
583	full blood counts (FBC)																	
584	oral glucose tolerance test (OGTT)																	
585	urine FEME																	
586	others, please specify																	

SECTION 5: ANC PROVIDED

ANC		VISIT NUMBER & GESTATIONAL WEEK OF THE VISIT (1 = procedure was done/recorded; 0= procedure not done or not recorded)															Total number of times pro-cedure was done	Compliance Score (0=not complied; 1=complied)
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**		
date seen (dd/mm)		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		
gestational weeks (jangka masa)		week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )	week ( )		
SECTION 6: ATTENDING PROVIDER (please mark 1 to indicate the attending provider; refer to information obtain in Providers Section):																		
601	community nurse (0-3 years' working experience)																	
602	community nurse (more than 3 years' working experience)																	
603	staff nurse **without** post-graduate (0-3 years' working experience)																	
604	staff nurse **without** post-graduate (more than 3 years' experience)																	
605	staff nurse with post-graduate (midwifery or public health)																	
606	medical officer (0-3 years' working experience)																	
607	medical officer (more than 3 years' working experience)																	
608	family medicine specialist																	
609	other, please specify:																	

SECTION 7: ANTENATAL HOME VISIT OR PHONE REMINDER

701	Has antenatal home visit or phone reminder been conducted for this pregnancy? (Please circle "Yes or No")	home visit	Yes / No
		phone reminder	Yes / No
702	If yes, what is the reason(s) for the antenatal home visit or phone reminder? (Please mark x)	missed antenatal appointment/ did not come to clinic for antenatal follow-up Reason:___________________	
		evaluation/preparation for home delivery	
		Others (please specify the reason): _________________________	

SECTION 8: QUALITY OF ANTENATAL RECORDS (please mark x)

801	Health education page is recorded/ filled		Yes / No
802	Information for previous pregnancy(ies) is complete (Perihal Kandungan Lalu is complete)		
803	Other observations		

Appendix D: Routine Antenatal Care Content for All Women and Compliance Criteria for Scoring

ROUTINE ANTENATAL CARE CONTENT FOR ALL WOMEN AND COMPLIANCE CRITERIA FOR SCORING

#	ANC interventions listed in MOH ANC Guidelines [3]	Compliance criteria for scoring	score
I)	**PHYSICAL EXAMINATION (PE)**		
1	oral hygiene (or referral for oral health services)	at least once	1
2	general condition - pallor, cyanosis, varicose veins, etc.	at booking and subsequent visits	1
3	cardiovascular system	at least 2 times; adjusted for POG at birth.	1
4	respiratory	at least 2 times; adjusted for POG at birth.	1
5	thyroid	at least 2 times; adjusted for POG at birth.	1
6	abdomen - previous scar/ other masses	at booking and during RME	1
7	height	indicated done (value found)	1
8	weight	as per recommended visits - 10 times for primigravida, 7 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is less than 10 or 7, evidence of being done at each visit is accepted.	1
9	blood pressure	as per recommended visits - 10 times for primigravida, 7 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is less than 10 or 7, evidence of being done at each visit is accepted.	1
10	breast	at least once	1
11	symphysis-fundal height	from 22 weeks onwards (include those done 1 week earlier) - 8 times for primigravida, 5 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is lesser than this number, evidence of being done at each visit is accepted.	1
12	foetal lie and presentation	from 32 weeks onwards (include those done 1 week earlier) - 6 times for primigravida, 4 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is lesser than this number, evidence of being done at each visit is accepted.	1
13	foetal heart auscultation	from 24 weeks onwards (include those done 1 week earlier) - 8 times for primigravida, 5 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is lesser than this number, evidence of being done at each visit is accepted.	1
14	oedema	as per recommended visits - 10 times for primigravida, 7 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is less than 10 or 7, evidence of being done at each visit is accepted.	1
		Physical Examination (PE)	**14**
II)	**HEALTH**		

#	ANC interventions listed in MOH ANC Guidelines [3]	Compliance criteria for scoring	score
	SCREENING (HS)		
1	urine protein	as per recommended visits - 10 times for primigravida, 7 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is less than 10 or 7, evidence of being done at each visit is accepted.	1
2	urine sugar	as per recommended visits - 10 times for primigravida, 7 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits is less than 10 or 7, evidence of being done at each visit is accepted.	1
3	Hb	50% of recommended visits - 5 times for primigravida, 4 times for multigravida at POG 40 weeks; adjusted for POG at birth. If total visits less than 5 or 4, evidence of being done at each visit is accepted.	1
4	ABO	once	1
5	Rhesus	once	1
6	VDRL	once	1
7	HIV	once	1
8	Ultrasound, abdominal	at least two times, including ultrasound done by other provider; acceptable if POG of 1st visit was >24 weeks, and only 1 ultrasound done after 24 weeks.	1
10	Hepatitis B	once	1
		Health Screening (HS)	**9**
III)	**CASE MANAGEMENT (CM)**		
1	immunisation - anti-tetanus vaccination (in dose)	two doses for primigravida, one booster dose for multigravida (if completed 2 doses at Gravidity 1).	1
2	haematinic supplement (include folic acid or multivitamins supplements)	must be prescribed at booking to avoid missed-opportunity of taking folic acid before POG 12 weeks.	1
3	routine medical examination (RME) by doctor - 1^{st} RME	RME1 at booking or by POG 24 weeks (plus 1 week acceptable).	1
4	routine medical examination (RME) by doctor – 2^{nd} RME	RME2 at 31-36 weeks (□ 1 week is acceptable); adjusted for POG at birth.	1
5	ultrasound performed routine before or at 24 weeks of pregnancy	at least once before or at POG 24 weeks (plus 1 week is acceptable), including U/S done by other provider; Acceptable if 1st visit >24 weeks in which no previous U/S done by other provider and HC did U/S at 1st visit or later; Acceptable if 1st visit >24 weeks in which U/S done by other provider previously regardless of POG. Not acceptable if 1st visit >24 weeks and no U/S done throughout.	1
6	risk assessment	at 1-12 weeks; ±1 week; adjusted for initiation and POG at birth.	1
		at 13-20 weeks; ±1 week; adjusted for initiation and POG	

#	ANC interventions listed in MOH ANC Guidelines [3]	Compliance criteria for scoring	score
		at birth.	
		at 21-28 weeks; ±1 week; adjusted for initiation and POG at birth.	
		at 29-32 weeks; ±1 week; adjusted for initiation and POG at birth.	
		at 33-36 weeks or 33 weeks onwards; ±1 week; adjusted for initiation and POG at birth.	
7	colour coding of risk	appropriate risk tagging, compared against known risk factors/ past history	1
		Case Management (CM)	**7**
IV)	**HEALTH EDUCATION (HE)** (based on listing in ANC pink booklet)		
1	nutritional/dietary advice - antenatal	at least once	1
2	nutritional/dietary advice - postnatal/ breastfeeding	at least once	1
3	recommendations for family planning/ contraception	at least once	1
4	preparation for birth	at least once	1
5	birth process (S&S and related advice)	at least once	1
6	common discomfort during pregnancy and solutions	at least once	1
7	recommendations for breastfeeding	at least once	1
8	common disorders in pregnancy	at least 2 out of 5 listed topics (pregnancy induced hypertension, preeclampsia/ impending eclampsia, gestational diabetes mellitus, anaemia, bleeding)	1
9	early booking	at least once	1
10	foetal development	at least once	1
11	exercise antenatal/ postnatal	at least once	1
12	newborn care, baby bathing	at least once	1
13	jaundice baby care	at least once	1
14	postnatal care	at least once	1
		Health Education (HE)	**14**
		MAXIMUM COMPLIANCE SCORE	**44**

Appendix E: Statistical Procedures and Approaches For Testing Association

Study objectives	Dependent variables	Independent variables	Procedures and approaches
Objective 1: **To estimate the proportion of pregnant women who have adequate or inadequate:** **a) ANC utilisation based on an utilisation index that includes both the gestational age at first ANC visit; and observed-to-expected ANC visits ratio;** **b) ANC content based on weighted scores for physical examination, health screening, case management, and health education;** **c) ANC adequacy which considers both adequacy of utilisation and content.**			Cross tabulation/ chi-square
Objective 2: **To determine if there is an association between the adequacy of ANC utilisation among pregnant women and the following:** **a) socio-demographic and socio-economic factors;** **b) obstetric factors and histories;**	Adequacy of ANC utilisation Inadequate (included intermediate and inadequate); Adequate; Adequate-plus.	a) Socio-demographic & SES factors: Maternal age (20-34, ≤ 19 and ≥ 35); Ethnicity (Malay, Chinese, Indian, Indigenous people); Education (primary or no formal education, secondary, tertiary and above); *(Employment status - excluded in Ordinal Regression due to multicollinearity, VIF>5);*	a) Cross tabulation/ chi-square (significant association/ difference at $p<0.05$). b) Ordinal regression – predict cumulative probabilities, e.g. more or less likely to have higher ranking; could be presented as OR. (significant association/ difference at $p<0.05$) Link function of "Complementary Log-log" was used as the higher categories are more probable.

Study objectives	Dependent variables	Independent variables	Procedures and approaches
c) risk level of pregnancy.		Occupation (SES). b) Obstetric factors and histories; *(Gravidity (primi, multi) - excluded in Ordinal regression due to multicollinearity, VIF>5);* Parity (nulliparous, multiparous); History of complications during previous pregnancy (although collinearity test showed high correlation value of more than 0.85 due to obvious high association with parity, this variable was still included due to its importance); *- excluded in Ordinal regression due to multicollinearity, VIF>5);* History of complications during previous delivery (although collinearity test showed high correlation value of more than 0.85 due to obvious high association with parity, this variable was still included due to its importance). *– excluded in Ordinal regression due to multicollinearity, VIF>5);* c) Risk level of pregnancy: Low risk (white, green) and high risk (yellow, red).	The assumption that there is no or low multicollinearity of the independents (i.e. the variables are independent of each other) was tested using the collinearity test from the regression\linear\statistics\collinearity diagnostics function. The independent variables with VIF>5 and had correlation value of more than 0.85 among the independent variable were dropped from the model, and indicated in previous column (because this can lead to the problem of multicollinearity). Analysis approach: 1st step – a full model containing all the variables identified was first constructed; 2nd step - A stepwise model was then employed manually using only the significant variables (P<0.05), based on the previous full model in the first analysis. Test of Parallel Lines Assumption (Proportional of Odds Assumption) was performed to assess if assumption of parallel lines was met (P>0.05). Random case selection at 30% and 20% was applied to test the parallel lines. Result of the analyses was based on the full sample size models since it is more inferential to report using larger sample size.

Study objectives	Dependent variables	Independent variables	Procedures and approaches
Objective 3: **To determine and compare the extent of adherence to requirements for routine ANC set by MOH in term of ANC content score, among the following:** **a) parity (nulliparous versus multipara) or gravidity (primigravida versus multigravida);** **b) risk level of pregnancy;** **c) providers by qualification (in term of proportion of total visits attended by specific providers);** **d) pregnant women seeking ANC in different type of health clinics as determined by expected daily workload.**	Adequacy of ANC content: Inadequate, Adequate.	a) Obstetric Factors/ History: Gravidity (pimigravida, multigravida); Parity (nulliparous, multiparous); History of complications during previous pregnancy; History of complications during previous delivery; b) Risk level of pregnancy: Low risk (white, green) and high risk (yellow, red); Tag colour at last visit prior to delivery (white, green, yellow and red). c) Provider factor Clinic type by expected daily workload (301-500, 150-300, below 150);	Cross tabulation/ chi-square (significant association/ difference at p<0.05) boxplot
	Total ANC content score (%)	d) Percentage of total visits attended by specific provider; nurses: Community nurse (CN) with <3 years' experience; Community nurse (CN) with >3 years' experience;	Matrix scatterplot, Correlation (content score and attendance by specific provider), effect size of correlation coefficient based on Cohen's guideline.

Study objectives	Dependent variables	Independent variables	Procedures and approaches
		Staff nurse (SN) without post-graduate qualification; Staff nurse (SN) with post-graduate qualification. doctors: Medical officer (MO) with <3 years' experience; Medical officer (MO) with >3 years' experience; Family medicine specialist (FMS).	
	Total ANC content score (%)	a) Parity (nulliparous and multiparous); b) Risk levels of pregnancy (low and high risk); c) Clinic type by expected daily workload: (i) 301-500, (ii) 150-300, (iii) below 150; d) Percentage of total visits attended by specific providers: (i) CN, (ii) staff with post-graduate, (iii) MO.	GLM Univariate (Significant association/ difference at p<0.05) Used backward elimination method by including all relevant variables in a model, then drop non-significant variables (P>0.1) one by one in the model, until all remaining variables are significant. The assumption that there is no or low multicollinearity of the independents (i.e. the variables are independent of each other) was tested using the collinearity test from the regression\linear\statistics\collinearity diagnostics function. All the independent variables tested had VIF<5 and the correlation values were less than 0.85, therefore all were retained (no violation of collinearity).

Study objectives	Dependent variables	Independent variables	Procedures and approaches
Objective 4: **To examine the extent of adherence for selected recommended practices and to compare the national ANC guideline with recommended guidelines from other countries.**	NA	Various selected recommended practices: a) routine medical examination (RME), b) haematinic supplement, c) abdominal ultrasound, d) physical examination: SFH, foetal presentation, foetal heart auscultation, e) additional assessment/ screening for specific conditions.	Descriptive (frequency, min, max, mean)
Objective 5: **To determine if there is an association between ANC adequacy (utilisation and content) as well as other factors and pregnancy outcome, based on the following indicators:** **a) Preterm birth (≤ 36 weeks gestation at birth);** **b) Low birth weight (birth weight <2,500g);** **c) Stillbirth;** **d) Maternal complications (intra- or**	a) preterm birth (<37 weeks gestation at birth); b) LBW (< 2,500g); c) Stillbirth; d) maternal complications (maternal intra- or postpartum complications including maternal death).	ANC utilisation adequacy: inadequate, adequate. ANC content adequacy: inadequate, adequate. Percentage of total ANC content score. Interaction of ANC utilisation and percentage of total ANC content score. Other risk factors/ mediators: a) Socio-demographic factors:	**Testing of model coefficients:** A full model single block binary logistic regression was first performed for testing of model coefficients (adequacy of ANC and pregnancy outcomes model). This is more for examining the overall internal consistency of the model. The odds ratios for ANC adequacy (utilisation and content) were adjusted for maternal age, ethnicity, maternal education, maternal occupation, risk status, parity, and clinic type. **Testing of association:** Binary logistic regression (Significant association/ difference at $p<0.05$) 1^{st} step - univariate analyses;

Study objectives	Dependent variables	Independent variables	Procedures and approaches
postpartum complications including maternal death).		Maternal age (20-34, ≤ 19 and ≥ 35); Ethnicity, Education, *(Working status – excluded due to multicollinearity, VIF>5).* b) Socio-economic status: Occupation (pregnant women); Occupation (spouse). c) Obstetric factors and histories: *(Gravidity – excluded due to multicollinearity, VIF>5).* Parity (nulliparous, multiparous); Risk level by tagging (low and high risk) – excluded in multivariate analysis due to redundancies; Tag colour at last visit prior to delivery (white, green, yellow and red); History of miscarriage; History of complications during previous pregnancy	2nd step - multivariate analysis using the variables with P<0.10 in the 1st step analysis. The assumption that there is no or low multicollinearity of the independents (i.e. the variables are independent of each other) was tested using the collinearity test from the regression\linear\statistics\collinearity diagnostics function. The independent variables with VIF>5 and had correlation value of more than 0.85 among the independent variable were dropped from the model, and indicated in previous column (because this can lead to the problem of multicollinearity). Hosmer & Lemeshow test (chi-square test of goodness of fit) – p>0.05 = chi-square value is small = model fits. Interpretation of results considered odd ratios with sizeable effect, even when it was statistically not significant. This is because the p-value is possibly influenced by sample size, in which large sample size will result in significant p-value although the effect could be small.

Study objectives	Dependent variables	Independent variables	Procedures and approaches
		(although collinearity test showed VIF>5 due to obvious high association with parity, this variable was still included due to its importance); History of complications during previous delivery (although collinearity test showed VIF>5 due to obvious high association with parity, this variable was still included due to its importance). d) Default history e) Provider factors: Clinic type by expected daily workload (301-500, 150-300, below 150); Percentage of total visits attended by specific providers: (i) CN, (ii) staff with post-graduate, (iii) MO.	

References: (Chinna, 2014a, 2014b; Field, 2013; Pallant, 2010)

Appendix F: Respondents Characteristics (Pregnant Women and Providers)

I) Pregnant Women

Characteristics		Unit	Clinic category by expected daily workload			Total
			301-500	150-300	below 150	
age-group at Visit-1	<=19	n (%)	3 (0.6%)	4 (0.8%)	4 (0.8%)	11 (2.1%)
	20-34	n (%)	151 (28.9%)	210 (40.2%)	78 (14.9%)	439 (84.1%)
	>=35	n (%)	23 (4.4%)	33 (6.3%)	16 (3.1%)	72 (13.8%)
	Total	n (%)	177 (33.9%	247 (47.3%)	98 (18.8%)	522 (100.0%)
	Mean (SD)					28.7 (5.0)
ethnicity	Malay	n (%)	121 (23.2%)	198 (37.9%)	77 (14.8%)	396 (75.9%)
	Chinese	n (%)	26 (5.0%)	22 (4.2%)	19 (3.6%)	67 (12.8%)
	Indian	n (%)	25 (4.8%)	18 (3.4%)	1 (0.2%)	44 (8.4%)
	Indigenous/ Orang Asli	n (%)	5 (1.0%)	9 (1.7%)	1 (0.2%)	15 (2.9%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
education level	No formal education	n (%)	3 (0.6%)	1 (0.2%)	0 (0.0%)	4 (0.8%)
	Primary	n (%)	6 (1.1%)	7 (1.3%)	6 (1.1%)	19 (3.6%)
	Secondary	n (%)	91 (17.4%)	139 (26.6%)	64 (12.3%)	294 (56.3%)
	Tertiary (certificate or diploma)	n (%)	39 (7.5%)	54 (10.3%)	18 (3.4%)	111 (21.3%)
	Tertiary (advanced diploma, degree or higher)	n (%)	31 (5.9%)	42 (8.0%)	9 (1.7%)	82 (15.7%)
	unknown	n (%)	7 (1.3%)	4 (0.8%)	1 (0.2%)	12 (2.3%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
occupation (women)	1 Legislators, senior officials and managers	n (%)	4 (0.8%)	3 (0.6%)	0 (0.0%)	7 (1.3%)
	2 Professional	n (%)	19 (3.6%)	28 (5.4%)	10 (1.9%)	57 (10.9%)
	3 Technicians and associate professionals	n (%)	23 (4.4%)	33 (6.3%)	11 (2.1%)	67 (12.8%)
	4 Clerical workers	n (%)	35 (6.7%)	41 (7.9%)	11 (2.1%)	87 (16.7%)
	5 Service workers, shop and market sales workers	n (%)	22 (4.2%)	23 (4.4%)	18 (3.4%)	63 (12.1%)
	7 Craft and related trades workers	n (%)	2 (0.4%)	0 (0.0%)	0 (0.0%)	2 (0.4%)
	8 Plant and machine operators and assemblers	n (%)	5 (1.0%)	21 (4.0%)	2 (0.4%)	28 (5.4%)
	9 Elementary occupations	n (%)	5 (1.0%)	2 (0.4%)	1 (0.2%)	8 (1.5%)
	11 Others - HW, students, unemployed	n (%)	60 (11.5%)	94 (18.0%)	45 (8.6%)	199 (38.1%)
	unknown	n (%)	2 (0.4%)	2 (0.4%)	0 (0.0%)	4 (0.8%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)

Characteristics		Unit	Clinic category by expected daily workload			Total
			301-500	150-300	below 150	
occupation (spouses)	1 Legislators, senior officials and managers	n (%)	5 (1.0%)	7 (1.3%)	3 (0.6%)	15 (2.9%)
	2 Professional	n (%)	17 (3.3%)	26 (5.0%)	7 (1.3%)	50 (9.6%)
	3 Technicians and associate professionals	n (%)	53 (10.2%)	73 (14.0%)	24 (4.6%)	150 (28.7%)
	4 Clerical workers	n (%)	14 (2.7%)	17 (3.3%)	4 (0.8%)	35 (6.7%)
	5 Service workers, shop and market sales workers	n (%)	28 (5.4%)	50 (9.6%)	19 (3.6%)	97 (18.6%)
	6 Skilled agricultural and fishery workers	n (%)	0 (0.0%)	0 (0.0%)	16 (3.1%)	16 (3.1%)
	7 Craft and related trades workers	n (%)	7 (1.3%)	5 (1.0%)	9 (1.7%)	21 (4.0%)
	8 Plant and machine operators and assemblers	n (%)	31 (5.9%)	53 (10.2%)	12 (2.3%)	96 (18.4%)
	9 Elementary occupations	n (%)	9 (1.7%)	4 (0.8%)	2 (0.4%)	15 (2.9%)
	10 Armed forces	n (%)	3 (0.6%)	7 (1.3%)	1 (0.2%)	11 (2.1%)
	11 Others	n (%)	0 (0.0%)	1 (0.2%)	1 (0.2%)	2 (0.4%)
	unknown	n (%)	10 (1.9%)	4 (0.8%)	0 (0.0%)	14 (2.7%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
gravidity (3 group)	1	n (%)	69 (13.2%)	72 (13.8%)	33 (6.3%)	174 (33.3%)
	2-4	n (%)	93 (17.8%)	152 (29.1%)	49 (9.4%)	294 (56.3%)
	=>5	n (%)	15 (2.9%)	23 (4.4%)	16 (3.1%)	54 (10.3%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
	Mean (SD)					2.4 (1.5)
gravidity (2 group)	Primigravida (1)	n (%)	69 (13.2%)	72 (13.8%)	33 (6.3%)	174 (33.3%)
	Multigravida (=>2)	n (%)	108 (20.7%)	175 (33.5%)	65 (12.5%)	348 (66.7%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
	Mean (SD)					2.4 (1.5)
parity (3 group)	0	n (%)	77 (14.8%)	82 (15.7%)	36 (6.9%)	195 (37.4%)
	1-3	n (%)	91 (17.4%)	154 (29.5%)	52 (10.0%)	297 (56.9%)
	=>4	n (%)	9 (1.7%)	11 (2.1%)	10 (1.9%)	30 (5.7%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
	Mean (SD)					1.2 (1.3)
parity (2 group)	Nulliparous (0)	n (%)	77 (14.8%)	82 (15.7%)	36 (6.9%)	195 (37.4%)
	Multiparous (=>1)	n (%)	100 (19.1%)	165 (31.6%)	62 (11.9%)	327 (62.6%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
	Mean (SD)					1.2 (1.3)
history of miscarriage in previous pregnancy	No hx miscarriage	n (%)	144 (27.6%)	202 (38.7%)	77 (14.8%)	423 (81.0%)
	Had hx miscarriage	n (%)	33 (6.3%)	45 (8.6%)	21 (4.0%)	99 (19.0%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)

Characteristics		Unit	Clinic category by expected daily workload			Total
			301-500	150-300	below 150	
(dichotomous)	Mean (SD)					0.2 (0.5)
history of complications during previous pregnancy (GDM, PIH, anaemia, PP, miscarriage)	No	n (%)	59 (11.3%)	110 (21.1%)	38 (7.3%)	207 (39.7%)
	Yes	n (%)	49 (9.4%)	65 (12.5%)	27 (5.2%)	141 (27.0%)
	NA (primigravida)	n (%)	69 (13.2%)	72 (13.8%)	33 (6.3%)	174 (33.3%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
history of complications during previous delivery (premature, caesarean, assisted del, PPH, stillbirth, NND)	No	n (%)	69 (13.2%)	116 (22.2%)	44 (8.4%)	229 (43.9%)
	Yes	n (%)	31 (5.9%)	49 (9.4%)	18 (3.4%)	98 (18.8%)
	NA (nulliparous)	n (%)	77 (14.8%)	82 (15.7%)	36 (6.9%)	195 (37.4%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
tag colour	white tag	n (%)	62 (11.9%)	75 (14.4%)	23 (4.4%)	160 (30.7%)
	coloured tag	n (%)	115 (22.0%)	172 (33.0%)	75 (14.4%)	362 (69.3%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
risk code at Visit-1	white	n (%)	88 (16.9%)	112 (21.5%)	51 (9.8%)	251 (48.1%)
	green	n (%)	79 (15.1%)	121 (23.2%)	43 (8.2%)	243 (46.6%)
	yellow	n (%)	10 (1.9%)	13 (2.5%)	3 (0.6%)	26 (5.0%)
	red	n (%)	0 (0.0%)	1 (0.2%)	1 (0.2%)	2 (0.4%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
risk code at last Visit	white	n (%)	62 (11.9%)	75 (14.4%)	23 (4.4%)	160 (30.7%)
	green	n (%)	62 (11.9%)	107 (20.5%)	46 (8.8%)	215 (41.2%)
	yellow	n (%)	51 (9.8%)	62 (11.9%)	27 (5.2%)	140 (26.8%)
	red	n (%)	2 (0.4%)	3 (0.6%)	2 (0.4%)	7 (1.3%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
appointment defaulting behaviour	not defaulted	n (%)	125 (23.9%)	175 (33.5%)	73 (14.0%)	373 (71.5%)
	defaulted (absence in between appointments, or stopped coming before due date,)	n (%)	52 (10.0%)	72 (13.8%)	25 (4.8%)	149 (28.5%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
appointment defaulting frequency	1	n (%)	39 (26.2%)	54 (36.2%)	16 (10.7%)	109 (73.2%)
	2	n (%)	9 (6.0%)	13 (8.7%)	6 (4.0%)	28 (18.8%)
	3	n (%)	3 (2.0%)	3 (2.0%)	2 (1.3%)	8 (5.4%)
	4	n (%)	1 (0.7%)	2 (1.3%)	1 (0.7%)	4 (2.7%)
	Total	n (%)	52 (34.9%)	72 (48.3%)	25 (16.8%)	149 (100.0%)
	Mean (SD)					1.4 (0.7)
indication seen by other provider prior to Visit-1	no	n (%)	100 (19.2%)	120 (23.0%)	75 (14.4%)	295 (56.5%)
	yes	n (%)	77 (14.8%)	127 (24.3%)	23 (4.4%)	227 (43.5%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)

Characteristics		Unit	Clinic category by expected daily workload			Total
			301-500	150-300	below 150	
REDD	no	n (%)	138 (26.4%)	198 (37.9%)	69 (13.2%)	405 (77.6%)
	yes	n (%)	39 (7.5%)	49 (9.4%)	29 (5.6%)	117 (22.4%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
family planning practice	not using any FP	n (%)	137 (26.2%)	182 (34.9%)	64 (12.3%)	383 (73.4%)
	using FP	n (%)	32 (6.1%)	49 (9.4%)	34 (6.5%)	115 (22.0%)
	unknown	n (%)	8 (1.5%)	16 (3.1%)	0 (0.0%)	24 (4.6%)
	Total	n (%)	177 (33.9%)	247 (47.3%)	98 (18.8%)	522 (100.0%)
family planning method	condom	n (%)	4 (3.5%)	3 (2.6%)	7 (6.1%)	14 (12.2%)
	OCP	n (%)	16 (13.9%)	30 (26.1%)	23 (20.0%)	69 (60.0%)
	injection	n (%)	6 (5.2%)	5 (4.3%)	2 (1.7%)	13 (11.3%)
	implant	n (%)	0 (0.0%)	1 (0.9%)	0 (0.0%)	1 (0.9%)
	IUCD	n (%)	1 (0.9%)	1 (0.9%)	0 (0.0%)	2 (1.7%)
	non-modern method	n (%)	4 (3.5%)	7 (6.1%)	1 (0.9%)	12 (10.4%)
	unknown method	n (%)	1 (0.9%)	2 (1.7%)	1 (0.9%)	4 (3.5%)
	Total	n (%)	32 (27.8%)	49 (42.6%)	34 (29.6%)	115 (100.0%)

II) Providers (at the time of data collection and related to MCH)

Providers	Unit	Health Clinic					
		1 Ampang (301-500)	2 Puchong (301-500)	3 Section 19 SA (150-300)	4 Batu 9 Cheras (150-300)	5 Bt. Changgang (<150)	6 Sekinchan (<150)
CN <3 years' experience	n	2	3	4	0	0	2
CN >3 years' experience	n	13	17	6	14	5	2
SN without postgraduate	n	1	10	8	5	1	3
SN with postgraduate (include nursing officers)	n	6	7	5	6	2	2
TOTAL Nursing Staff		***22**	**37**	**23**	**25**	**8**	**9**
MO	n	2	2	2	2	1	1
FMS	n	1	1	1	1	Visiting	Visiting

* nursing staff for ANC services only