ASSOCIATION OF CHRONIC PAIN WITH PHYSICAL FUNCTION AND MORTALITY AMONG OLDER ADULTS IN RURAL MALAYSIA

CHAN YEE MANG

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CHAN YEE MANG

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ABSTRACT

Older adults are postulated to double in 2017 and 2050 worldwide, including Malaysia. Various challenges are related to ageing population, including poor physical functioning and increase number of chronic diseases. Chronic pain is often associated with chronic disease. Chronic pain affects almost one third of the world's adult population and higher prevalence reported among older adults. Evidence suggests that chronic pain has undesirable consequences on physical, mental health and premature mortality. In low- and middle-income countries, there are limited studies examining the consequences of chronic pain on physical function and premature mortality. The aim of this study is therefore to determine the association between chronic pain and physical disability, functional limitations and five-year mortality. The design of the study was a secondary analysis of existing cohort data in Kuala Pilah, Negeri Sembilan, Malaysia. Baseline assessments were conducted from November 2013 to February 2014. Twelve months follow-up data were collected from December 2014 to February 2015. The study population was older adults 60 years of age and above living in Kuala Pilah for a minimum period of 12 months prior to data collection. Respondents were excluded if they were not Malaysian citizens, living in nursing homes, admitted to hospital during the interview, refused to participate or had severe cognitive impairment. Logistic regression was used to examine cross-sectional associations between baseline chronic pain and outcomes of interest. Generalized Estimating Equation was used to examine longitudinal associations between baseline chronic pain and outcomes of interest. Cox Proportional Hazard model was used to examine the association between chronic pain and five-year mortality. The prevalence of chronic pain was 21.1% (95%CI 19.4, 22.8). Chronic pain was associated with higher risk of ADL disability (RR 2.14; 95%CI 1.38, 3.46) and IADL disability (RR 1.30; 95%CI 1.04, 1.62). However, chronic pain was not associated with higher risk of slow walking speed (RR 1.01, 95%CI 0.79, 1.29) and low handgrip strength

(RR 1.15; 95%CI 0.94, 1.40). The five-year mortality rate was higher in respondents with chronic pain (26.24%) compared to those with no chronic pain (18.51%). But, no significant association was observed (HR 1.09; 95%CI 0.84, 1.41). Early detection of chronic pain and appropriate pain management are important for the management of high chronic pain distribution among older adults in Malaysia. Effective interventions and preventive strategies are crucial to reduce the risk of ADL and IADL disabilities among older adults with chronic pain. Recommendation on adequate level of physical activity could be one of the preventive strategies to reduce the risk of ADL disability, IADL disability and five-year mortality. It is hoped that the findings of this study will be used to improve chronic pain management in the existing guidelines for pain management in local setting.

Keywords: *Older adults, chronic pain, physical disability, functional limitations, mortality*

ABSTRAK

Jumlah penduduk warga emas dijangka akan meningkat dua kali ganda daripada tahun 2017 ke 2050 di seluruh dunia. Di Malaysia, bilangan penduduk warga emas juga dijangka akan meningkat lebih daripada dua kali ganda dari 2015 ke 2050. Terdapat pelbagai isu-isu dan cabaran yang berkaitan dengan penuaan penduduk, termasuklah fungsi fizikal yang lemah dan peningkatan penyakit kronik. Sakit kronik sering dikaitkan dengan penyakit kronik. Di seluruh dunia, 30.3% populasi dewasa mengalami masalah sakit kronik. Prevalensi sakit kronik adalah lebih tinggi di kalangan warga emas. Statistik menunjukkan bahawa sakit kronik mempunyai pelbagai akibat kesihatan contohnya kesan kepada kesihatan fizikal, kesihatan mental dan risiko kematian pramatang. Kajian mengenai kesan sakit kronik terhadap fungsi fizikal dan kematian pramatang adalah terhad di kalangan negara-negara berpendapatan rendah dan sederhana. Oleh yang demikian, kajian ini bertujuan untuk mengenalpasti kaitan sakit kronik dengan ketidakmampuan fizikal, had fungsi dan kematian pra-matang. Reka bentuk kajian ini adalah dengan menganalisa data sekunder. Data sekunder dari kajian kohort yang dijalankan di daerah Kuala Pilah, Negeri Sembilan, Malaysia digunakan. Penilaian dasar telah dijalankan dari November 2013 hingga Februari 2014. Data susulan 12 bulan dikumpulkan daripada Disember 2014 hingga Februari 2015. Responden kajian adalah penduduk berusia 60 tahun ke atas dan tinggal di daerah Kuala Pilah sekurang-kurangnya selama 12 bulan sebelum pengumpulan data dijalankan. Responden dikecualikan jika mereka bukan warganegara Malaysia, tinggal di pusat jagaan, berada di hospital, enggan menyertai kajian atau mempunyai masalah kognitif yang teruk. Analisis regresi logistik digunakan untuk mengkaji hubungan antara sakit kronik dasar dengan hasil yang diingini pada peringkat kajian rentas. *Generalized Estimating Equation* digunakan untuk mengkaji hubungan longitudinal antara sakit kronik pada peringkat dasar dan hasil yang diingini. Model *Cox Proportional Hazard model* digunakan untuk mengkaji hubungan

antara sakit kronik dengan kematian lima-tahun. Keputusan kajian ini menunjukkan terdapat 21.1% (95%CI 19.4, 22.8) warga tua mengalami sakit kronik. Sakit kronik berkaitan dengan risiko ketidakmampuan aktiviti hidup harian (ADL) (RR 2.14; 95%CI 1.38, 3.46) dan ketidakmampuan aktiviti instrumental kehidupan harian (IADL) (RR 1.30; 95%CI 1.04, 1.62) yang lebih tinggi di kajian ini. Walaubagaimanapun, sakit kronik tidak dikaitkan dengan risiko kelajuan berjalan perlahan (RR 1.01, 95%CI 0.79, 1.29) dan kekuatan pegangan tangan rendah (RR 1.15; 95%CI 0.94, 1.40). Kadar kematian lima-tahun didapati lebih tinggi di kalangan responden yang mengalami sakit kronik (26.24%) berbanding mereka yang tidak mengalami sakit kronik (18.51%). Namun, tiada hubungan yang ketara di antara sakit kronik dan kematian lima-tahun (HR 1.09; 95%CI 0.84, 1.41). Pengesanan awal sakit kronik dan pengurusan sakit yang berpatutan adalah penting dalam pengurusan kadar sakit kronik yang tinggi di kalangan warga tua di Malaysia. Selain itu, intervensi berkesan untuk sakit kronik dan strategi pencegahan amatlah penting untuk mengurangkan risiko aktiviti kehidupan harian (ADL) dan aktiviti instrumental kehidupan harian (IADL). Pengesyoran jumlah aktiviti fizikal yang mencukupi boleh dijadikan salah satu strategi pencegahan untuk mengurangkan risiko ketidakmampuan aktiviti hidup harian (ADL), ketidakmampuan aktiviti instrumental kehidupan harian (IADL) dan kematian pra-matang. Diharapkan penemuan kajian ini dapat digunakan sebagai penambahbaikan garispanduan sakit kronik yang tersedia ada di Malaysia.

Kata kunci: *orang tua, sakit kronik, kecacatan fizikal, had fungsi, kematian*

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LIST OF SYMBOLS AND ABBREVIATIONS

ADL	:	Activity of Daily Living
AWGS	:	Asian Working Group for Sarcopenia
BMI	:	Body Mass Index
CLBP	:	Chronic Low Back Pain
CRC	:	Clinical Research Center
DSSI	:	Duke Social Support Index
GBD	:	Global Burden of Disease
GDS	:	Geriatric Depression Scale
GEE	:	Generalizing Estimating Equation
IADL	:	Instrumental Activity of Daily Living
IASP	:	International Association for the Study of Pain
ICD	:	International Classification of Diseases
ICF	:	The International Classification of Functioning, Disability and Health
LLSPS	:	Lower Limb Summary Performance Score
MAR	:	Missing at Random
MCAR	:	Missing Completely at Random
MMSE	:	Mini-Mental State Examination
MNAR	:	Missing Not at Random
MOH	:	Ministry of Health
MI	:	Multiple Imputation
NHMS	:	National Health and Morbidity Survey
NMRR	:	National Medical Research Registry Registration
NOS	:	Newcastle-Ottawa Scale
PASE	:	Physical Activity Scale for the Elderly

PRISMA	:	Preferred Reporting Items for Systematic Reviews and Meta-analyses
ROC	:	Receiver Operating Characteristic
UMREC	:	University of Malaya Research Ethics Committee
VIF	:	Variance Inflation Factor
YLDs	:	Years Lived with Disability

LIST OF APPENDICES

Author's Contributions

The dissertation presented in this thesis was the author's research done under the supervision of Professor Dr. Noran Naqiah Mohd Hairi and Dr. 'Abqariyah Binti Yahya@ahmad Noor, Department of Social and Preventive Medicine, University of Malaya, Kuala Lumpur.

The author carried out all aspects of the work addressed in this thesis, including preparation of literature review, data analysis, the writing of manuscript and the writing of the thesis. In addition, the author traced the mortality data from the National Registration Department and compared them to the existing dataset.

The paper published from this thesis was read and approved by all co-authors prior to publication. This thesis was read and approved by both supervisors before being submitted to the Institute of Graduate Studies (IGS).

CHAPTER 1: INTRODUCTION

This chapter provides an overview of the global ageing population scenario followed by ageing scenario in Malaysia. The next part discusses the issues and challenges of the ageing population. Subsequently, Malaysian's policies for pain management among older adults were addressed. The last part of this chapter describes the problem statement and study rationale of this study, research questions and study objectives.

1.1 Global ageing population scenario

Globally, the number of older adults is growing rapidly. The number of world's older adults is projected to double in 2017 and 2050. In the Asia region, older adults are also expected to double in 2017 and 2050. During the same period, the number of older adults is projected to increase more than twofold (9.7% to 23.1%) in Malaysia (United Nations, 2017).

In developing countries, population ages at a faster rate than in developed countries. Developing countries are expected to have more than 200% rise in older adults between 2015 and 2050. In contrast, developed countries are expected to have only about 70% increase in the number of older adults between 2015 and 2050 (Suzman & Beard, 2011).

In addition to the rapid increase of older adults, the population ageing speed is not the same in developed and developing countries. Population ageing at a faster speed in developing countries. For instance, developed countries such as France's older adults have taken more than 100 years to increase from seven to fourteen percent. On the contrary, many developing countries are anticipated to have similar demographic changes in just two decades (Suzman & Beard, 2011). The speed of ageing in Malaysia is

comparable to other developing countries. Malaysian older adults are estimated to increase from seven to fourteen percent in 23 years between 2020 and 2042 (Hamid, 2015). As a result, the preparation time for developing countries to become a healthy aged nation is comparatively shorter.

1.2 Issues and challenges associated to ageing population

Population ageing is a desirable accomplishment, nevertheless, there are issues and challenges associated with ageing population. These challenges include increasing number of chronic diseases, poorer physical functioning leading to dependency, increasing per capita health care expenditure and increasing percentage of non-working population (Christensen, Doblhammer, Rau, & Vaupel, 2009; "Global Health and Aging," 2011). As age increases, evidence suggests that the prevalence of chronic pain diseases and the cost of healthcare expenditure on chronic diseases will also increase (Bodenheimer, Chen, & Bennett, 2009; Christensen et al., 2009; Marešová, Mohelská, & Kuča, 2015).

The definition of chronic pain is pain that has persisted for a minimum duration of three months, or continues after a typical healing period of three months (Merskey, 1994; Treede et al., 2015). Chronic pain is frequently related to chronic disease and pain specialists suggest that chronic pain may be considered as a chronic disease (SIP, 2012). The president of European Federation of the International Association of the Study of Pain (IASP) said chronic pain is one of the most underrated healthcare issues, creating a major burden on the healthcare system in the Western world and chronic pain is considered to be a disease of its own (WHO, 2004).

Chronic pain may affect the neurological and physiological experiences of all populations. Older adults are more likely to experience pain than younger counterparts. Chronic pain is one of the major healthcare problems that has not received adequate attention. Therefore, we need to pay more attention to chronic pain in order to understand the distribution and consequences of chronic pain.

1.2.1 Chronic pain prevalence

1.2.1.1 Global prevalence of chronic pain

Globally, chronic pain prevalence is high and affecting nearly one-third (30.3%) of the adult population (Elzahaf, Tashani, Unsworth, & Johnson, 2012). Among European adults, chronic pain prevalence varies from 12% to 30% (Breivik, Collett, Ventafridda, Cohen, & Gallacher, 2006). In Asia, a systematic review of 16 Asian country studies found that chronic pain prevalence in the adult population ranged from 7.1% to 61%. Among older adults in Asian countries, chronic pain prevalence ranges from 42% to 90.8% (Zaki & Hairi, 2015).

1.2.1.2 National prevalence of chronic pain

Older adults have a higher chronic pain prevalence compared to adult population. In developed countries, 38.5% older Swedish adults (Larsson, Hansson, Sundquist, & Jakobsson, 2017) and 42.0% of older Poland adults reported chronic pain (Kozak-Szkopek et al., 2017). Chronic pain prevalence among older Malaysians was 15.2% (Zaki & Hairi, 2014).

1.2.2 Health consequences of chronic pain

Without proper treatment, chronic pain can have very harmful effects. There is evidence that chronic pain has several adverse health effects on older adult, including consequences on physical, mental health and increase the risk of premature mortality. The Global Burden of Disease study shows that chronic low back pain is responsible for more than 146 million "years lived with disability (YLDs) in 2013. It was the single largest source of YLDs recorded in 2013 (Rice, Smith, & Blyth, 2016). In addition, chronic neck pain was the fourth main cause of YLDs (Rice et al., 2016). The ageing population is postulated to be one of the major contributors to the rise in YLDs.

In several studies, chronic pain in older adults has been found to have negative effects on physical health (Bryant, Grigsby, Swenson, Scarbro, & Baxter, 2007; Hairi, Cumming, Blyth, & Naganathan, 2013; Leveille et al., 2009; Satghare et al., 2016). On top of that, chronic pain sufferers have reported poorer mental well-being (Cabak et al., 2015), lower health-related quality of life and increased costs to society (Bernfort, Gerdle, Rahmqvist, Husberg, & Levin, 2015; Willman, Petzäll, Östberg, & Hall‐Lord, 2013). In comparison, a Cochrane review found that protective factors, such as physical activity and exercise may improve pain severity, physical function and quality of life among chronic pain sufferers (Geneen et al., 2014).

Increased risk of premature mortality is another undesired result of chronic pain. A systematic review of ten studies from developed countries showed a mildly increased mortality risk among respondents with chronic pain (Smith, Wilkie, Uthman, Jordan, & McBeth, 2014). Nonetheless, the pooled estimate of the ten included studies using the same outcome measure was small and not significant (Smith et al., 2014). Subsequently, another study found an increased mortality risk among adults suffering from chronic pain (Patel & Turk, 2015).

1.3 Malaysian pain management policy

In Malaysia, a few guidelines and handbooks on pain management are available as guidance to healthcare providers. First, the Pain Management Handbook was published in 2013 ("Pain Management Handbook," 2013). The aim of this handbook is to provide an overview of treatment principles for both acute and chronic pain. Second, the 3rd edition of Pain as The 5th Vital Sign Guideline was published in 2018 ("Pain as The 5th Vital Sign Guideline: 3rd Edition," 2018). This guideline provides adult pain management guidelines for both paramedics and doctors. Third, the first edition of Guidelines for Pain Management in The Elderly was published in 2018 ("Guidelines For Pain Management In The Elderly: 1st Edition," 2018). The guidelines provide approaches to pain management, factors affecting pain management, pain assessment and modes of pain management for older adults.

The above mentioned guidelines and handbook of pain management in Malaysia primarily focused on acute pharmacological pain management in clinical settings. In healthcare systems, chronic pain in pain treatment has a low priority. This is largely due to lack of knowledge if the mechanisms behind the transition from acute to chronic pain. Nevertheless, optimal chronic pain management requires a holistic multidisciplinary team approach with adequate behavioral therapy. To date, there are no clear guidelines or defined treatment pathways available for chronic pain management in Malaysia.

National health and morbidity survey (NHMS) Malaysia have started data collection on chronic pain since 2006. NHMS 2006 found that 7.1% of Malaysian aged 18 and over had chronic pain, with 15.2% chronic pain prevalence among older adults (IPH, 2008; Zaki & Hairi, 2014). In addition, NHMS found a significant association between chronic pain with the hospitalization frequency (Zaki & Hairi, 2014). Nonetheless, there is still no policy on chronic pain. This shows that chronic pain policy is not at the same pace as

ageing. At present, the pain management services in Malaysia are only available at tertiary care services. Hence, there is a gap of pain services at the primary care level.

1.4 Health status among urban and rural older adults

Studies have found that older rural adults are more vulnerable than their urban counterparts and have poorer health (Fogelholm et al., 2006; Zare, Kokiwar, & Ramesh, 2018). A study conducted in Finland to examine whether living in urban, semi-urban or rural communities are related with chronic diseases and functional disabilities among older adults found that elevated serum cholesterol, obesity, disability, sedentary lifestyle and high fat intake were more prevalent in rural communities (Fogelholm et al., 2006). The differences seemed to be explained by socio-economic background and health behaviour. A cross-sectional study comparing older adults from urban and rural areas in India reported that rural older adults are more likely to suffer from chronic diseases than their urban counterparts (Zare et al., 2018). In addition, rural older adults were also reported to have poorer quality of life (Usha & Lalitha, 2016). In short, older adults from rural areas have lower health status than older adults from urban areas.

1.5 Problem statement and study rationale

1.5.1 Problem statement

Chronic pain affects almost a third of the adult population worldwide and older adults have reported a greater chronic pain prevalence (Elzahaf et al., 2012; Kozak-Szkopek et al., 2017; Larsson et al., 2017). In addition, the number of older adults is growing rapidly worldwide. As a consequence, chronic pain prevalence may increase with the rising number of older adults. Evidence indicates that chronic pain has a number of adverse health effects on older adults, including physical health consequences and increased risk of premature mortality (Bryant et al., 2007; Hairi et al., 2013; Leveille et al., 2009; Smith et al., 2014).

The first Asia Pacific Declaration for Chronic Pain Relief was established in 2006 to recognize chronic pain as a priority concern for health and improve the management of chronic pain ("First Asia Pacific Declaration for Chronic Pain Relief," 2006). The declaration has identified eight issues. The objective of this study was to partially address the call to action on the first issue, which is to identify the burden of chronic pain on personal, public and economic aspects, and to set chronic pain as a priority public health issue in Asia Pacific.

1.5.2 Study rationale

Chronic pain is an underestimated healthcare problem, and the ageing population is a public health concern. Studies have found that older rural adults are more vulnerable than their urban counterparts and have poorer health (Fogelholm et al., 2006; Zare et al., 2018). Furthermore, rural older adults have also been reported to have poorer quality of life (Usha & Lalitha, 2016). In developing countries, there are limited studies examining the association between chronic pain and physical function, and risk of premature mortality with chronic pain. More specifically, the evidence on chronic pain health consequences is underexplored among rural older population in Malaysia. Thus, this study intended to explore the consequences of chronic pain on physical function and mortality among rural older adults.

Several previous studies have identified possible modifiable factors that could possibly improve physical function and mortality among respondents with chronic pain (Geneen et al., 2014; Patel & Turk, 2015). The aim of this study was also to identify potential modifiable protective factors and risk factors of chronic pain on physical function and mortality.

This study allows us to explore the consequences of chronic pain on physical function and mortality among rural older adults in Malaysia. This enables us to develop appropriate prevention and intervention strategies by better understanding the relationships. Identification of rural older adults at risk provides valuable information to the healthcare professionals.

1.6 Research questions

1. What are the associations between chronic pain and physical function among older adults from existing literature?
2. Does chronic pain increase the risk of physical disability among older adults with chronic pain in rural Malaysia?
3. Does chronic pain increase the risk of functional limitations among older adults with chronic pain in rural Malaysia?
4. Does chronic pain increase the risk of five-year mortality among older adults in rural Malaysia?

1.7 Study objectives

1.7.1 General objectives

To determine the association of chronic pain with physical disability, functional limitations and five-year mortality among older adults in rural Malaysia.

1.7.2 Specific objectives

1. To determine the association between chronic pain and physical function among older adults from existing literature.
2. To determine the cross-sectional and longitudinal associations between chronic pain and physical disability among older adults in rural Malaysia.
3. To determine the cross-sectional and longitudinal associations between chronic pain and functional limitations among older adults in rural Malaysia.
4. To determine whether chronic pain increases the risk of five-year mortality among older adults in rural Malaysia.

CHAPTER 2: LITERATURE REVIEW

This chapter describes literature reviews on several important topics of this research. These topics are definition of chronic pain, definition of physical disability, definition of functional limitations, chronic pain prevalence, consequences of chronic pain on morbidity and mortality among older adults. This chapter also explains the comprehensive review conducted to determine the consequences of chronic pain on physical function among older adults from the existing literature. The last part of this chapter discusses about the theories and models of chronic pain, theories and models of disablement and this study's conceptual framework.

2.1 Definitions

2.1.1 Definition of older adults

The definition of older adults differs across countries. Most developed countries have defined older adults as being aged 65 years and over (Kowal & Dowd, 2001). In contrast, the United Nations has described older adults as 60 years and over (United Nations, 2017). Similarly, in Malaysia, older adults are described as 60 years of age and over (Zawawi, 2013).

2.1.2 Definition of chronic pain

Pain can be categorised based on pathophysiological, etiological, anatomical and duration of pain. Pain classification according to duration of pain generally divided into acute and chronic pain (Abd-Elsayed & Deer, 2019). Table 2.1 illustrates the comparison between acute and chronic pain.

Table 2.1: Comparison between acute and chronic pain

	Acute	Chronic
Duration	Pain that last less than three months.	Pain that extends three months beyond onset.
Pathology	A complex, unpleasant experience with emotional and cognitive, as well as sensory, features that occur as a reaction to tissue trauma.	Pain that persists beyond the period of normal healing, which is usually three months.
Onset	Acute pain occurs all of a sudden, usually because of injury.	Chronic pain may have been caused by an initial trauma, injury or infection. Nonetheless, the progression may be gradual and without any prior injury or body damage.

2.1.2.1 Chronic pain

The definition of chronic pain is pain that has persisted for a minimum duration of three months, or continues after a typical healing period of three months (Merskey, 1994; Treede et al., 2015). Many countries have used three months as cut off for chronic pain definition and are consistent with the definition by the IASP (Zaki & Hairi, 2015). It is without sufficient recognised pathology to explain the extent of the pain (Berry et al., 2001). In addition, chronic pain does not have the neurovegetative warning symptoms as seen in acute pain cases (Sallum, Garcia, & Sanches, 2012). The International classification of Diseases (ICD) 11 categorised chronic pain into seven most clinically relevant disorders (Treede et al., 2015). Appendix A illustrates ICD 11 classification of chronic pain.

2.1.3 Definition of physical disability

Physical disability in this study was assessed using Katz Index of Independence of Activities of Daily Living (ADL) (Katz, Ford, Moskowitz, Jackson, & Jaffe, 1963) and the Lawton Instrumental Activities of Daily Living (IADL) scales (Lawton & Brody, 1969).

2.1.3.1 Katz ADL scale

The Katz ADL scale is a widely used graded instrument used for assessing six primary and psychosocial functions. These functions are bathing, dressing, toileting, transferring, feeding and continence. The Katz ADL scale is one of the early examples developed to measure functionality in chronically ill and ageing populations (Katz et al., 1963). Katz ADL scale is one of the commonly used questionnaires to evaluate disability among older

adults (Yang, Ding, & Dong, 2014). Previous studies conducted among older adults in Malaysia used Katz ADL scale to assess disability in their studies (Choo et al., 2016; N. I. Ibrahim et al., 2018; Kumar, Hasan, Wong, Chong, & Kairuz, 2019; Sharkawi et al., 2016).

2.1.3.2 Lawton IADL scale

IADL assesses the higher level of functioning compared to ADL. IADLs diminish earlier in the phases of illness compared to ADL. The Lawton IADL scale is developed to measure the independent living skills of the population (Lawton & Brody, 1969). Lawton IADL measures the domestic functions and there are eight items: ability to use telephone, shopping, food preparation, housekeeping, laundry, mode of transportation, responsibilities for own medications and ability to handle finances. The validity and reliability of Lawton IADL scale was evaluated among Malay speaking older adults in Malaysia. The Content Validity Index percentages for four criteria ranged from 88.89 to 100.0. The Cronbach alpha coefficient for internal consistency was 0.838. Intra-class Correlation Coefficient of inter-rater reliability and test-retest reliability was 0.957 and 0.950 respectively (Kadar, Ibrahim, Razaob, Chai, & Harun, 2018).

2.1.4 Definition of functional limitations

Functional limitations are restrictions in the performance of basic physical and mental activities that are used in daily life. Basic physical actions include general mobility, discrete movements and powers, difficulty seeing, hearing problems and communication difficulties (Verbrugge & Jette, 1994). This study assessed functional limitations using walking speed and handgrip strength.

2.1.4.1 Walking speed

Walking speed is a tool used for assessing functional status and overall health of population (Middleton, Fritz, & Lusardi, 2015). It is a valid reliable and sensitive tool. Older adults are likely to be in poorer health if their walking speed is 0.8 m/s and below (Van Kan et al., 2009). Evidence in epidemiology research supports the use of walking speed tests as adverse health outcomes predictors for older adults (Muñoz-Mendoza, Cabrero-García, Reig-Ferrer, & Cabañero-Martínez, 2010).

2.1.4.2 Handgrip strength

Muscle strength is a significant element of healthy ageing. The handgrip strength test in an easy to use muscle strength measurement test. Asian Working Group for Sarcopenia (AWGS) categorised male with handgrip strength of less than 26kg and female handgrip strength of less than 18kg were categorised as having low handgrip strength (Chen et al., 2014). Poor baseline handgrip strength has a longitudinally association with the risk having functional limitations among older adults (Wang et al., 2019).

2.2 Prevalence of chronic pain

2.2.1 Older adults in low- and middle-income countries

Chronic pain prevalence among older adults residing in China was 41.1% (Si et al., 2019). In Iran, nearly one third of (31.7%) older adult population experienced chronic pain (Salman Roghani, Delbari, Asadi-Lari, Rashedi, & Lökk, 2019). Taiwanese older adults reported 42% prevalence of chronic pain (Yu, Tang, Kuo, & Yu, 2006). Nearly half (47.6%) of the South Indian older adults suffer from chronic pain (Kirubakaran & Dongre, 2019). The prevalence of chronic pain among older adults from low- and middle-

income countries varies from 31.7% to 47.6%. Nearly all studies were conducted in urban areas or urban-rural areas other than the study conducted in India. Most of the prevalence studies were representative of community dwelling older adults (sample sizes varying from 850 to 5326), with the exception of the study conducted in Taiwan with only 219 older adults interviewed (Yu, Tang, Kuo, & Yu, 2006). Majority of the prevalence studies defined chronic pain as having pain for the past three months, with the exception of Kirubakaran (2019) considered chronic pain as having pain for past six months (Kirubakaran & Dongre, 2019).

2.2.2 Older adults in developed countries

In a study of 1141 older Swedish adults, 38.5% of chronic pain was reported (Larsson et al., 2017). A systematic review of seven studies conducted in the United Kingdom reported chronic pain prevalence ranged from 35% to 51.3% (Fayaz, Croft, Langford, Donaldson, & Jones, 2016). An epidemiology study conducted among older adults in Santa Catarina, Brazil stated 29.3% of chronic pain (Santos, Souza, Antes, & d'Orsi, 2015). Chronic pain prevalence among older adults in Poland was reported at 42% (Kozak-Szkopek et al., 2017). The prevalence of chronic pain among older adults in developed countries varies from 29.3% to 51.3%. All studies were conducted using a population-based survey sampling frame with sample sizes ranging from 1141 to 7601. Larsson (2017) and Kozak-Szkopek (2017) defined chronic pain as having at least three months of pain (Larsson et al., 2017; Kozak-Szkopek et al., 2017). On the other hand, Santos (2015) defined chronic pain as having pain for six months or more (Santos, Souza, Antes, & d'Orsi, 2015). Table 2.2 illustrates chronic pain prevalence among older adults.

Table 2.2: Chronic pain prevalence among older adults

Author, year	Country	Prevalence of chronic pain (%)
Low- and middle-income countries		
Si H et al., 2019	China	41.1
Salman Roghani et al., 2019	Iran	31.7
Yu et al., 2006	Taiwan	42
Kirubakaran and Dongre, 2019	India	47.6
Developed countries		
Larsson et al., 2017	Sweden	38.5
Fayaz et al., 2016	United Kingdom	35-51.3
Santos et al., 2015	Brazil	29.3
Kozak-Szkopek et al., 2017	Poland	42

2.3 Consequences of chronic pain on physical health and mortality

2.3.1 Consequences of chronic pain on physical health

Chronic pain can result in numerous undesirable health consequences in older adults, especially on physical health. The health consequences of chronic pain are affecting individual from different perspectives including individual level, social and family related consequences and increase economic burden of health system (Dueñas, Ojeda, Salazar, Mico, & Failde, 2016). Family members of older adults suffering from chronic pain are affected by older adults' chronic pain issues. They are at risk of negative psychological effects and raised stress level (Riffin, Fried, & Pillemer, 2016). In addition, the presence of chronic pain among older adults has also been related to increased costs to society and lower quality of life (Bernfort et al., 2015).

A community-based study in southern Colorado found an association between pain and deterioration of physical function among older adults, independent of ethnicity. After adjusted for presence of multiple comorbidities, the independent effect of chronic pain remains (Bryant et al., 2007). Another population-based survey reported chronic pain and pain interferes with activities were associated with physical disability among older adults (Hairi et al., 2013). Satghare P (2016) reported that older adults who experienced more than 2-3 days pain in a week had significant association with disability as compared to those who never experienced pain (Satghare et al., 2016).

A research conducted in hospitalised rehabilitation units reported that chronic pain was associated with impaired physical function (Pereira et al., 2014). Older adults with two or more locations of musculoskeletal pain, experienced severe pain and pain affected their daily activities were reported with higher risk for falls (Leveille et al., 2009). A Cochrane review found that physical activity and exercise have been shown to reduce pain severity and improve physical function among adults experienced pain (Geneen et al., 2017). The

Cochrane review reported that physical activity is mostly acceptable among people with pain and unlikely to cause harm. In summary, chronic pain was found to be associated with deterioration of physical function, physical disability, higher risk for falls, lower quality of life and increased cost to the society.

2.3.2 Comprehensive review on the association between chronic pain and physical function among older adults

A systematic search was carried out to obtain a comprehensive literature review on the association between chronic pain and physical function among older adults. The search was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines (Moher et al., 2015). The systematic search was aimed at answering the research question: "What are the associations between chronic pain and physical function among older adults?"

PICO method was used to identify the population (P), intervention (I), comparison (C) and outcomes (O). Two levels of screening were done, followed by data extraction and quality appraisal. Inclusion criteria were: a) studies with primary data collection; b) written in English; c) respondents 60 years and older; d) published between 1990 and 2019 and; e) definition of chronic pain as having pain for a minimum period of three months. Exclusion criteria were: a) abstracts and incomplete reports; b) duplicate studies and; c) qualitative studies.

2.3.2.1 Search strategy

Electronic search was done using the six databases from 1990 till 2019. These databases are Pubmed, ScienceDirect, Psychology and Behavioral Science, CINAHL, SCOPUS and EBScohost–SocINDEX. The search tools of these databases were used where possible and appropriate. We conducted the search in English using terms “old”, "older", "elder", "elderly", "geriatric", "geriatrics", “chronic pain”, “chronic pains”, “widespread chronic pain”, “widespread chronic pains”, “persistent pain”, "impacts", "outcome" and “outcomes". These search terms were used either singly or in combinations. Grey literature for instance thesis and dissertations from universities was search using ProQuest Dissertations & Theses Global.

2.3.2.2 Data collection and analysis

(a) ***Screening Process***

Title and abstracts of studies retrieved using search keywords were screened by two independent reviewers for relevance. Studies included in the screening of title and abstracts underwent screening of full text by two independent reviewers. Disagreements during the screening process between the two reviewers were resolved by consensus.

(b) ***Data extraction and quality appraisal***

Two reviewers independently carried out the data extraction using a pre-specified data extraction form (Appendix B). Disagreements on the data extraction by two independent reviewers were resolved by consensus.

The modified Newcastle-Ottawa Scale (NOS) was used for quality assessment of selected studies (Dahlhamer et al., 2018). An adapted version of the NOS with slight modification was used for cross-sectional studies (Appendix C). The quality was assessed based on three criteria. The first criterion was Selection. The parameters measured were the representativeness of the sample, sample size, non-respondents and exposure ascertainty. The second criterion was Comparability. The respondents in different outcome groups were compared according to study design or analysis. The third criterion was Outcome. The parameters measured were the assessment of the outcome and statistical test used. The score system was categorised as follows: under 6 (low), 6-7 (medium) and 8-9 (high).

2.3.2.3 Results

(a) ***Outcome of search and screening process***

Selection was based on the inclusion criteria listed above. The six databases produced 5747 potentially relevant studies. Out of 5747 potentially relevant studies, 1346 duplicates were excluded. Two independent reviewers screened the title and abstract of 4401 studies, which produced 25 studies. Subsequently, two independent reviewers screened these 25 full studies. The screening of full text excluded 21 studies due to unfulfilled definition of chronic pain, outcome did not measure physical function and existed only as abstracts. Five studies were included through screening of full text. Of these five studies, one full text could not be obtained despite the effort made to contact the corresponding author. Therefore, only four studies were included in data analysis (Figure 2.1). Grey literature search was conducted using similar keywords in ProQuest Dissertations & Theses Global database. The search yielded 85 papers, but none were included because the subjects of interest was not applicable to these studies.

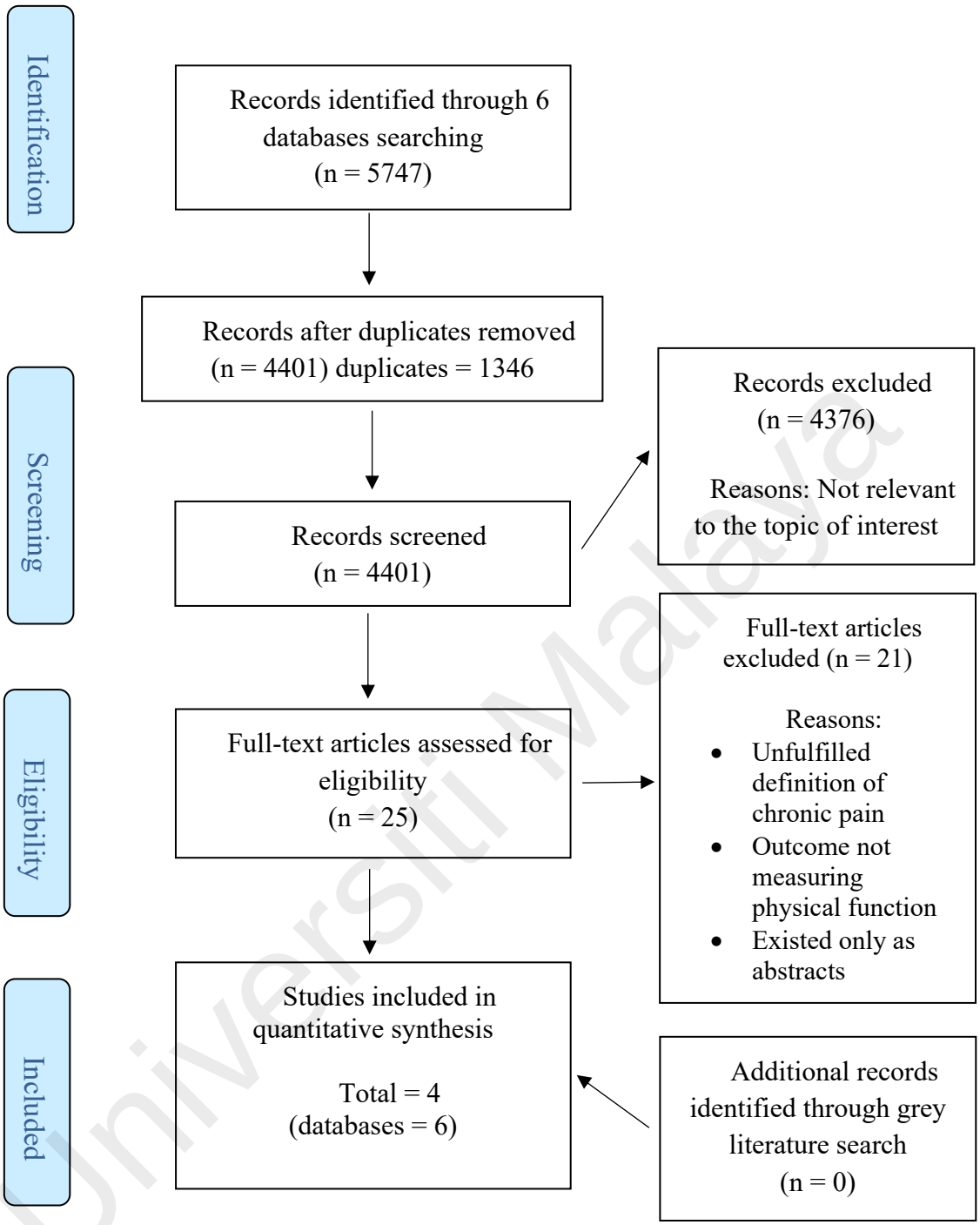

Figure 2.1: PRISMA flow diagram

Extracted data (results) from the four studies selected are summarized and presented in Table 2.3. We did not carry out meta-analysis following narrative synthesis due to the heterogeneity of the data in the selected studies (Haidich, 2010). Table 2.3 illustrates consequences of chronic pain on physical function according to the evidence strength.

Table 2.3: Consequences of chronic pain on physical function according to the evidence strength

Author, year	Study design	Sample size	Outcome category	Effect size(s)/Finding(s)	Quality
Hairi NN, 2013	Cross-sectional	8881	ADL disability	Men: PR 1.31 (95%CI 1.19, 1.43) Women: PR 1.34 (95%CI 1.28, 1.42)	Medium
Morone NE, 2014	Cross-sectional	79	Gait speed Stair climbing	Gait speed: β -0.002, p=0.043 Stair climbing: β=0.012, p=0.014	Medium
Pereira LSM, 2014	Cross-sectional	420	Lower Limb Summary Performance Score	B: -1.78, p=0.001	Medium
Si H, 2019	Cross-sectional	1219	ADL disability IADL disability Short Physical Performance Battery Handgrip strength	ADL: OR 1.85 (95%CI 1.29, 2.64) IADL: OR 1.44 (95%CI 1.03, 2.01) Low SBBP: OR 1.83 (95%CI 1.21, 2.78) Weak grip strength: OR 1.07 (95%CI 0.83, 1.37)	Medium

(b) ***Description of studies (study characteristics)***

Among the four studies, three were conducted in developed countries (75%); one in the United States and two in Australia. Only one study (25%) was conducted in developing countries; China. There is an under-representation from low- and middle-income regions. All four studies were cross-sectional study design, and hence we could not establish the causal relationship between chronic pain and physical function.

For exposure variable, Morone (2014) evaluated chronic pain using McGill Pain Questionnaire (MPQ) (Morone, Abebe, Morrow, & Weiner, 2014). Hairi (2013), Pereira (2014) and Si et al (2019) assessed the exposure variable by asking if the respondents experienced pain for at least three months (Hairi et al., 2013; Pereira et al., 2014; Si et al., 2019).

In these studies, various measurements for outcome variable were adopted. Hairi (2013) evaluated physical disability by asking six ADL questions (Hairi et al., 2013). Morone (2014) conducted the evaluation of physical function by assessing the gait speed and stair climbing (Morone et al., 2014). Pereira (2014) assessed the Lower Limb Summary Performance Score (LLSPS), which represents the combined performance of three tests: standing balance, sit to stand ability and gait speed (Pereira et al., 2014). Si H (2019) measured (i) the Katz Index for ADL disability, (ii) the Lawton Scale for IADL disability, (iii) handgrip strength and (iv) short physical performance battery, which represents the combination of three tests: standing balance, gait speed and chair stands (Si et al., 2019).

(c) Findings of studies

Findings from the selected studies have shown that chronic pain was associated with poorer physical function among older adults. Chronic pain was found to be significantly associated with ADL disability (Hairi et al., 2013; Si et al., 2019) and IADL disability (Si et al., 2019). According to Hairi (2013), ADL disability was more common among respondents who reported chronic pain, pain that interferes with activities, moderate and strong to severe pain (Hairi et al., 2013). Si H (2019) also identified older adults experienced chronic pain were at an increased risk of ADL and IAD disabilities (Si et al., 2019).

Besides, chronic pain has been shown to have significant associations with physical function measured by objective tests. Morone (2014) found that the gait speed and stair climbing of the respondents deteriorates as the pain scores increases (Morone et al., 2014). Pereira (2014) reported chronic pain was associated with a lower LLSPP score (Pereira et al., 2014). In addition, respondents with chronic pain were found to have association with poor lower extremity physical performance (Si et al., 2019). Nonetheless, chronic pain has not been reported to have association with poor grip strength because common chronic pain locations among older Chinese adults were lower extremity and lower back (Si et al., 2019).

(d) ***Conclusion***

In a nutshell, chronic pain was found to be associated with poorer physical function among older adults in all selected studies. However, we were not able to establish the causal relationship due to the cross-sectional study design of all selected studies. In addition, majority of the selected studies were carried out in developed countries. Therefore, future longitudinal research is needed to determine the causal relationship between chronic pain and physical function, particularly in low- and middle-income countries.

2.3.3 Consequences of chronic pain on mortality

A systematic review of ten studies from developed countries revealed a slightly higher mortality risk among respondents with chronic pain (Smith et al., 2014). Of the ten studies, seven reported significant associations between chronic pain and mortality. The three remaining studies did not show significant associations. However, the pooled estimate from studies using the same outcome measure was small and not significant (Smith et al., 2014). A study carried out in the United States reported higher mortality risk among adults suffering from chronic pain. However, the association lost significance after adjusted for limitations in physical function (Patel & Turk, 2015). Smith (2018) conducted a study using two large United Kingdom population cohorts reported that widespread pain was not associated with mortality among older adults (Smith, Wilkie, Croft, & McBeth, 2018).

In contrast, a 15-year follow-up Taiwan nationwide population-based study found that older participants with chronic pain had an increased rate of mortality than their counterparts after adjusting for the underlying comorbidities and the causes of chronic pain. The study identified 17568 older participants with chronic pain and matched with 17568 older adults by age and sex as comparison group (Tsai et al., 2019). Evidence shows inconsistent findings in the relationship between chronic pain and mortality among older adults. Table 2.4 presents mortality risk of chronic pain.

Table 2.4: Mortality risk of chronic pain

Author, year	Study design	Location	Years of follow up	Risk of mortality
Smith D, 2014	Systematic review	• England • Finland • Sweden • England • Denmark • Scotland • Norway • Denmark • US • UK	• 8 • 14-16 • 14 • 8.2 • 8 • 10 • 18 • 15 • 35 • 6	Studies were heterogeneous. Mortality Rate Ratios 1.14 (95%CI 0.95–1.37) (p = 0.162)
Patel K, 2015	Cohort	United States	7.7	Increased risk of mortality
Smith D, 2018	Cohort	United Kingdom	10	Not associated with increased mortality risk
Tsai M-H 2019	Cohort	Taiwan	15	Increased risk of mortality

2.4 Study gap and rationale

All selected studies in the comprehensive review found that chronic pain among older adults was associated with poorer physical function. Nonetheless, all selected studies were cross-sectional studies and majority of the selected have been conducted in developed countries. Evidence suggests that Caucasian populations have higher grip strength (Woo et al., 2014) and more skeletal muscle mass (Silva et al., 2010) compared to Asian populations. The findings from developed countries cannot be generalised to all populations. We found an evidence gap in the longitudinal relationship between chronic pain and physical function, especially in developing countries. Existing literature on the risk of premature mortality among chronic pain sufferers comes primarily from developed countries. Again, we could not generalise these findings to all populations. We have also found an evidence gap in the premature mortality risk among older chronic pain sufferers in developing countries.

Evidence shows that older rural adults are more vulnerable than their urban counterparts and have poorer health (Fogelholm et al., 2006; Zare et al., 2018). In addition, rural older adults were also reported to have poorer quality of life (Usha & Lalitha, 2016). Therefore, the aim of this study is to determine the cross-sectional and longitudinal associations between chronic pain and physical function among older adults in rural Malaysia. This study also aims to determine the premature mortality risk among older adults with chronic pain in rural Malaysia.

2.5 Theories and models

2.5.1 Biopsychosocial model

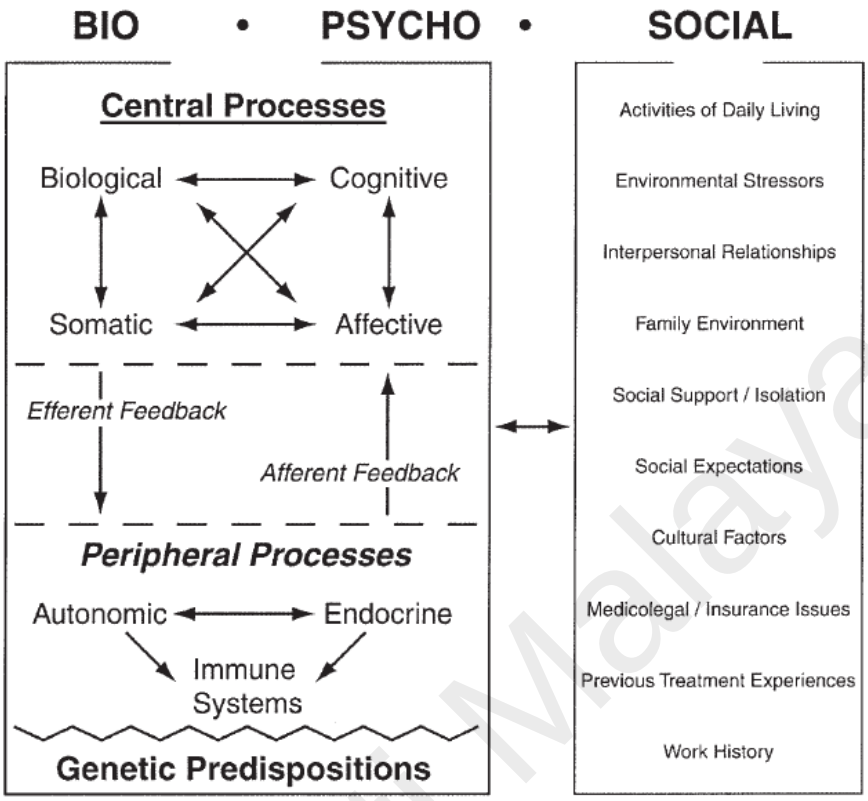

Figure 2.2: The biopsychosocial model

The biopsychosocial model is commonly used by researchers and clinician to explain chronic pain conditions (Gatchel, 2004). This model describes how the dynamic interaction between physiological, psychological and social factors causes chronic pain. The model focuses on both disease and illness. Diseases is characterised as "an objective biological phenomenon", involving either anatomical, pathological or physiological destruction of particular body structure or organ systems. In general, illness refers to a "subjective experience or self-attribute" present in the disease.

The biopsychosocial model uses physiological, psychological and social factors as their interplay to explain chronic pain. Therefore, everyone has different experiences of pain. A wide variety of psychological and socioeconomic factors may have interaction

with physical pathology to cause symptoms of pain. In this study, relevant physiological, psychological and social factors were taken into consideration in exploration the relationship of chronic pain with disability and mortality.

2.5.2 Disability theories and models

2.5.2.1 Nagi's disablement model

Nagi's disablement model is built according to four distinct but interrelated principles. These principles are (i) active pathology, (ii) impairment, (iii) functional limitation and (iv) disability (NAGI, 1991).

(a) ***Active pathology***

Active pathology can be the result of infection, trauma, metabolic imbalance, degenerative disease or other etiology (NAGI, 1991). It involves interrupting or interfering with normal processes and the organism's ongoing attempt to restore a normal state.

(b) ***Impairment***

Impairment implies an anatomical, physiological, mental or emotional loss or abnormality (NAGI, 1991). The concept consists of three categories: (i) all pathological conditions which are impairment by definition, as these conditions include anatomical, physiological, mental or emotional deviation, (iii) residual losses or abnormalities that persist after the active condition of pathology has been controlled or eliminated and (iii) abnormalities not associated with pathology, for example congenital formations.

(c) ***Functional limitations***

Functional limitations mean manifestations at the level of the entire organism (NAGI, 1991). The difference in functional limitations and impairments is the point at which limitations appear. For example, many tissues may have a modified structure or function without constraining the ability of the entire organism.

(d) ***Disability***

Disability applies more to social than to organisms functioning (NAGI, 1991). It I the inability or limitation of an individual to execute socially defined roles and tasks. The example of such roles and tasks are family or other relations, job, education, recreation and self-care.

2.5.2.2 Model of disablement process

Verbrugge and Jetta developed the model of the disablement process with its main foundation in the Nagi's disablement mode (Figure 2.3). The disablement process if an extension and expansion of the Nagi's disablement model. It stresses predisposition and introduces factors which accelerate and slow down the pathway (Verbrugge & Jette, 1994). The Nagi's disablement model focused primarily on delineating the pathway from pathology to different types of functional outcomes. The disablement process model takes into account social, psychological, environment factors that work to alter it.

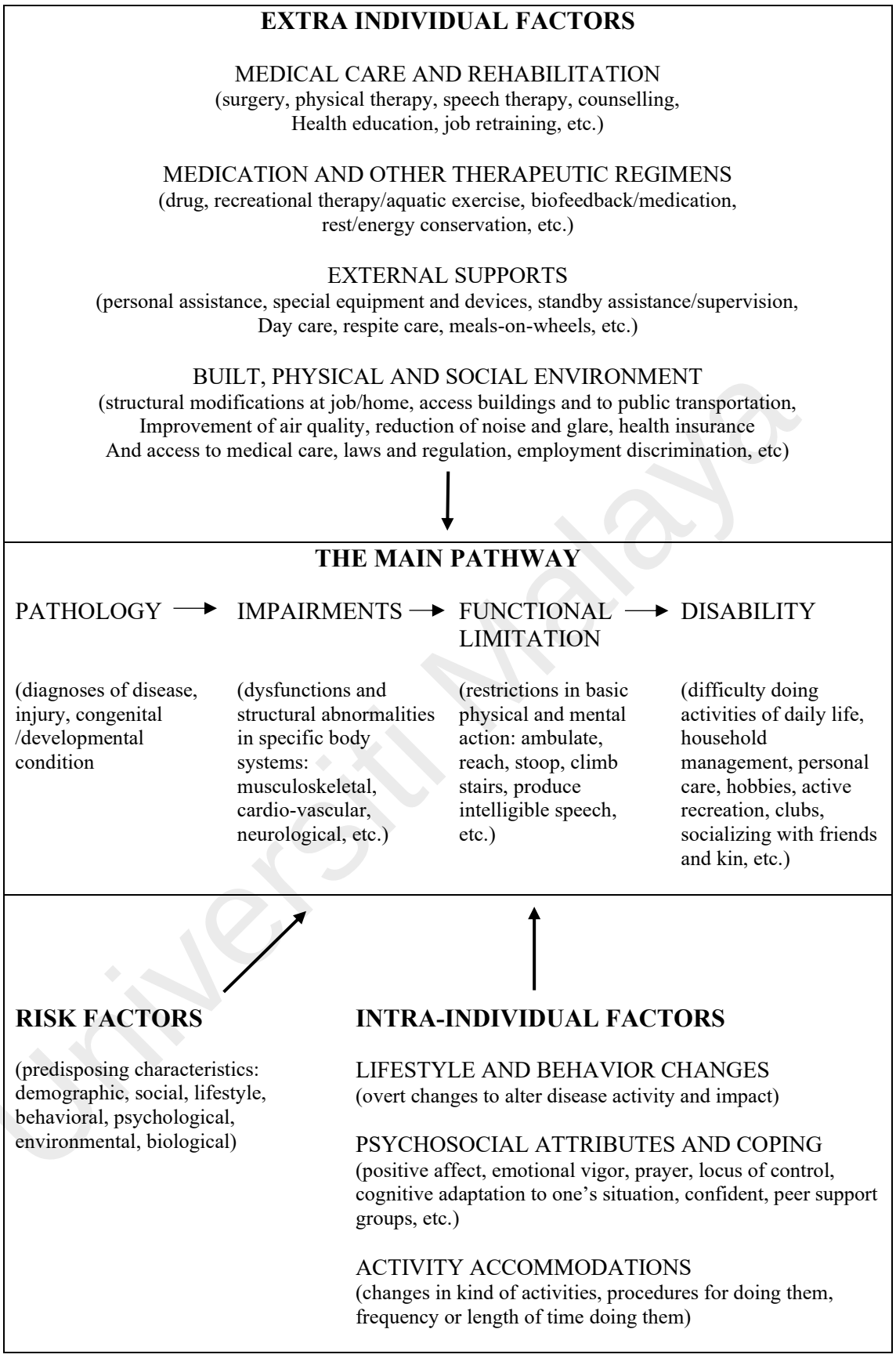

Figure 2.3: The disablement process model

(Source: Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. Social science & medicine, 38(1), 1-14.)

2.5.2.3 International Classification of Functioning, Disability and Health (ICF)

ICF was officially endorsed in the World Health Assembly in May 2001 (WHO, 2001). It is a framework to describe and organise information on functioning and disability. The development of this framework was guided by four general principles. These four general principles are:

i. Universality: Can be applied to everyone from all physical, social and cultural backgrounds regardless of their health
ii. Parity and etiological neutrality: Disability is not differentiated by etiology
iii. Neutrality: Domain definitions are set in neutral language whenever possible
iv. Environmental influence: Environmental factors were included, considering the importance of the functioning of people

ICF has two parts, each consisting of two components. Part 1 concerns Functioning and Disability. Part 2 concerns Contextual Factors. The Body and Structures are the first component of Part 1. The second component of Part 1 is the Activities and Participation component. Environmental factors are the first component of Part 2. The second component of Part 2 is the Personal factors.

The ICF is embedded in the biopsychosocial model, based on an integration of the social and medical models of disability ("The ICF: an overview," 2012). The functioning and disability of the ICF framework are multi-dimensional concepts. Figure 2.4 illustrated the ICF framework.

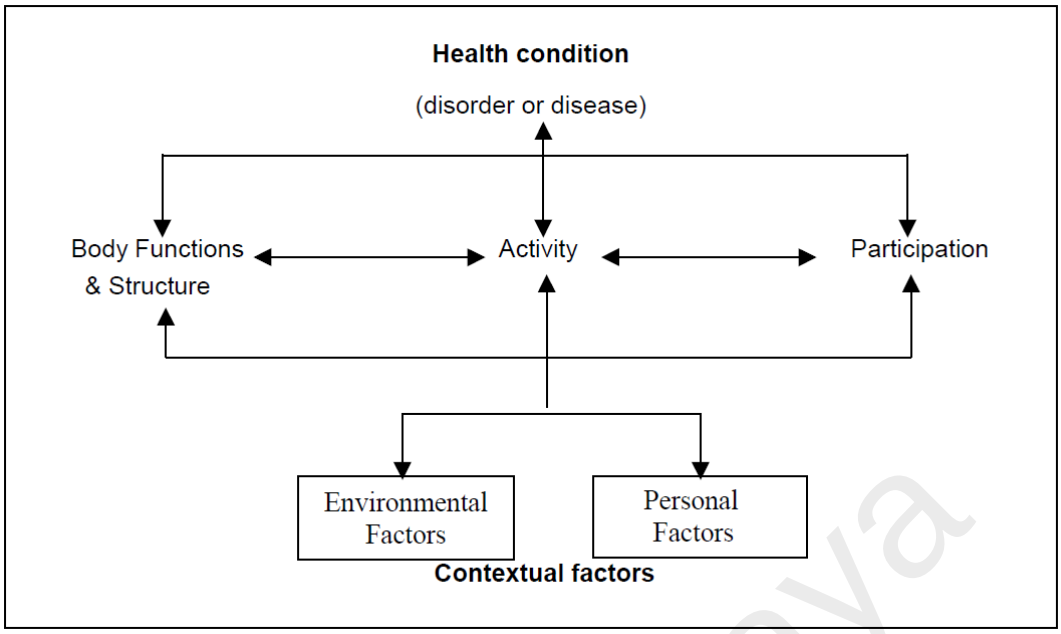

Figure 2.4: The International Classification of Functioning, Disability and Health

2.6 Conceptual framework of this study

The conceptual framework of this study is based on biopsychosocial model of chronic pain for older adults. The biopsychosocial model of chronic pain for older adults explains how different diseases are interrelated taking into consideration the biological, psychological and social factors. The biopsychosocial model, considered essential in pain, provides a framework for understanding how different diseases are related through an assessment of sensorial, cognitive, and interpersonal factors (Miaskowski et al., 2020).

The conceptual framework of this study also incorporated components the disablement process model and ICF framework. The disablement process model includes active pathology, impairment, functional limitation and disability. It also takes into account social, psychological, environment factors that work to alter it (Verbrugge & Jette, 1994). On the other hand, the ICF framework uses multi-dimensional concepts to describe the functioning and disability based on interactions between chronic pain and contextual factors. The bio-psychosocial model embedded in the ICF broadens the perspective of disability and allows medical, individual, social and environmental influences on functioning and disability to be examined (WHO, 2001).

The conceptual framework of this study explains the associations of chronic pain with physical function and mortality. Potential factors affecting the associations are also included in the conceptual framework. Factors associated with chronic pain and physical function are age, sex, education, comorbidities, depressive symptoms, cognitive status, social activity and physical activity. Factors associated with chronic pain and mortality are age, sex, BMI, education, living status, alcohol, comorbidities, sleep problems, anxiety and physical function. The conceptual framework of this study focused mainly on intrapersonal factors (biological and psychological) and social factors. This is because

the existing pain guidelines and policies in Malaysia focus on intrapersonal factors affecting pain experience and management.

This study is designed to assess the hypothesis that older adult with chronic pain will have higher risk of physical disability, functional limitations and five-year mortality than older adults with no chronic pain in rural Malaysia. The conceptual framework of this study is shown in Figure 2.5.

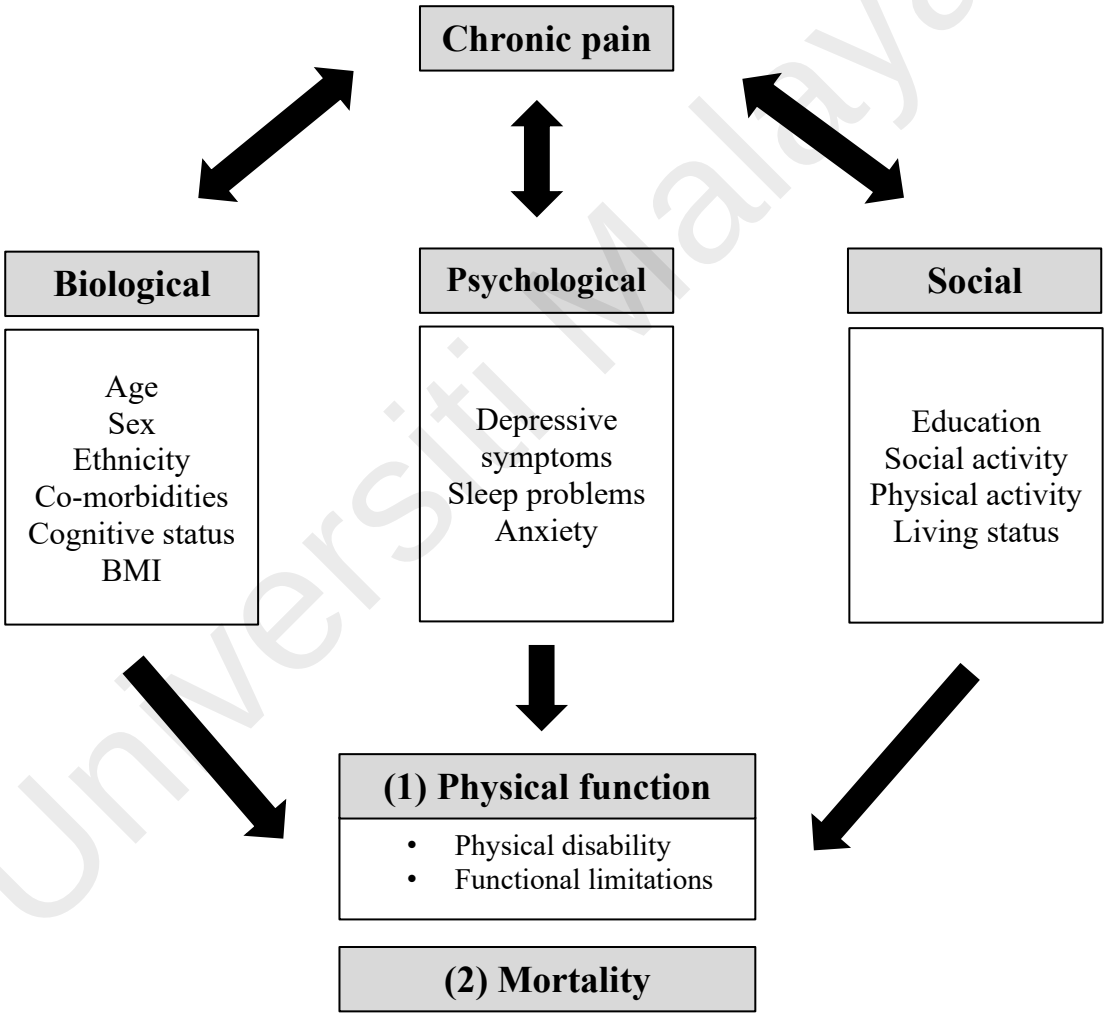

Figure 2.5: Conceptual framework for chronic pain and its associations with physical function and mortality

(Source: Dueñas M, Ojeda B, Salazar A, Mico JA, Failde I. A review of chronic pain impact on patients, their social environment and the health care system. Journal of pain research. 2016;9:457)

CHAPTER 3: MATERIALS AND METHODS

Chapter 3 discusses the methods used in this study. The first part describes the study design, followed by describing the background and sampled population of existing cohort study used for secondary data analysis, data collection of mortality data, justification for utilizing existing cohort data, study variables and instruments, statistical analysis and ethics of this study.

3.1 Overall study design

The overall design of this study involves secondary data analysis of an existing cohort data.

3.2 Existing cohort study

3.2.1 Permission to utilise existing data set

Prior to analysing the data set, we obtained permission from the principal investigator to utilise the existing data set. Personal correspondence with principal investigator and research team members was carried out to obtain details pertaining to the design, implementation and essential details of the study.

3.2.2 Study design of existing cohort study

The existing study is a prospective cohort study. The study analysed the baseline and first twelve months follow-up data to answer the research objectives of this study. Baseline assessments were conducted from November 2013 to February 2014. Twelve months follow-up data were collected from December 2014 to February 2015.

3.2.3 Background, study setting and study area of the existing cohort

The existing cohort study was conducted in Negeri Sembilan to assess the state of health and health needs of the older rural population. The study was initiated in 2013 in collaboration with the Negeri Sembilan State Health Office (Ismail, 2016). Negeri Sembilan is located on Peninsular Malaysia's western coast. Negeri Sembilan has seven districts. The seven districts include Kuala Pilah, Jelebu, Rembau, Tampin, Jempol, Port Dickson and Seremban. Kuala Pilah district was selected due to its highest percentage of older adults in all districts of Negeri Sembilan (DOS, 2010).

The population of Malaysia is generally divided into two separate localities: urban and rural, based on population density. Urban is a gazetted area and its adjoining built-up areas which had a combined population of at least 10,000 during the census, or a specific development area having a population of 10,000 people or more where at least 60 per cent of them (aged 15 years and above) are engaged in non-agricultural activities. In contrast, rural is an area with a population of fewer than 10,000 people with predominantly agriculture and natural resources (DOS, 2010). Kuala Pilah is classified as a rural area as defined above.

The population distributions of Kuala Pilah district resemble the demographics of any rural areas in Malaysia (DOS, 2010). Malay ethnicity is the majority of Kuala Pilah's population, followed by Chinese, Indians and others. Older adults aged 60 and over who have been living in the Kuala Pilah district for at least twelve months before data collection have been recruited as respondents to this study. Respondents were omitted if they were non-Malaysian citizens, stayed in nursing homes, hospitalised during data collection or declined to take part in the study.

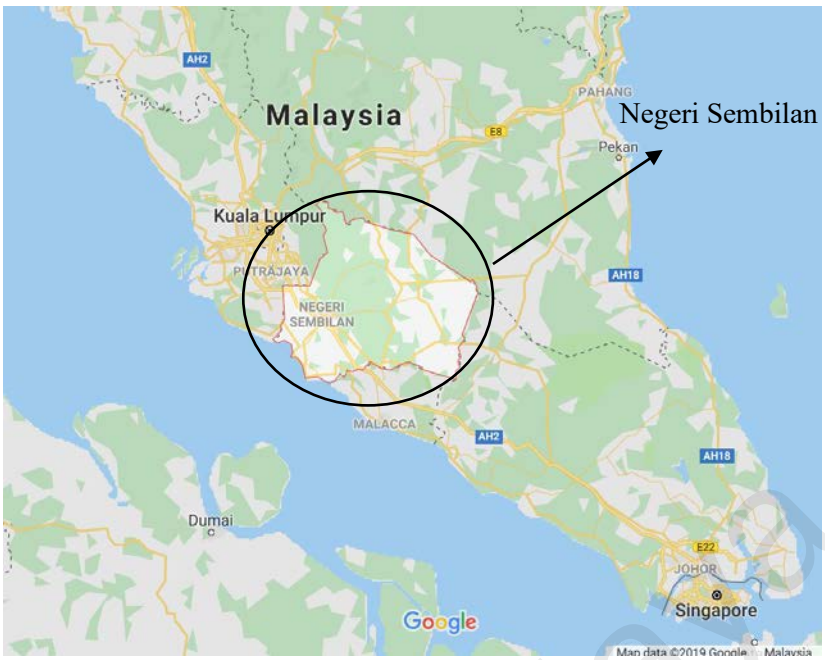

Figure 3.1: Map of Negeri Sembilan, Malaysia
(Source: google map)

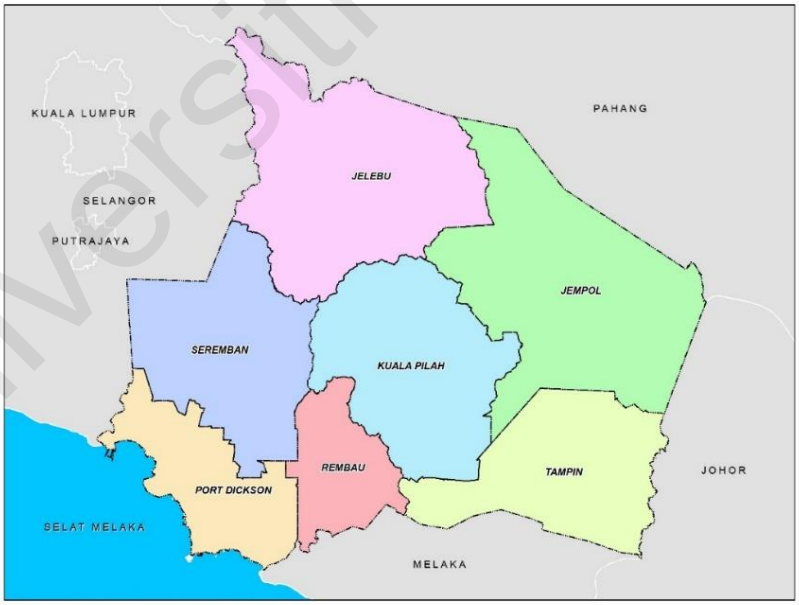

Figure 3.2: Map of Kuala Pilah district of Negeri Sembilan
(Source: Portal rasmi Kerajaan Negeri Sembilan, http://www.ns.gov.my/my/kerajaan/info-negeri/pengenalan)

3.2.4 Sampled population of the existing cohort study

In the existing cohort study, Department of Statistics assisted in the sampling carried out in two stages. Kuala Pilah district was divided into 254 enumeration blocks (EBs). A total of 156 EBs were selected at random to meet the sample size needed for the cohort study, n = 2500. Each EB has 80-120 living quarters (LQs) and 16 LQs were chosen at random from each EB. The older adult respondents in the selected LQ were approached and the permission to take part in the study was requested from each of the respondents. The trained data collectors performed face-to face data collection after receiving written consent. Figure 3.3 presents the sampling flow chart of the existing cohort study.

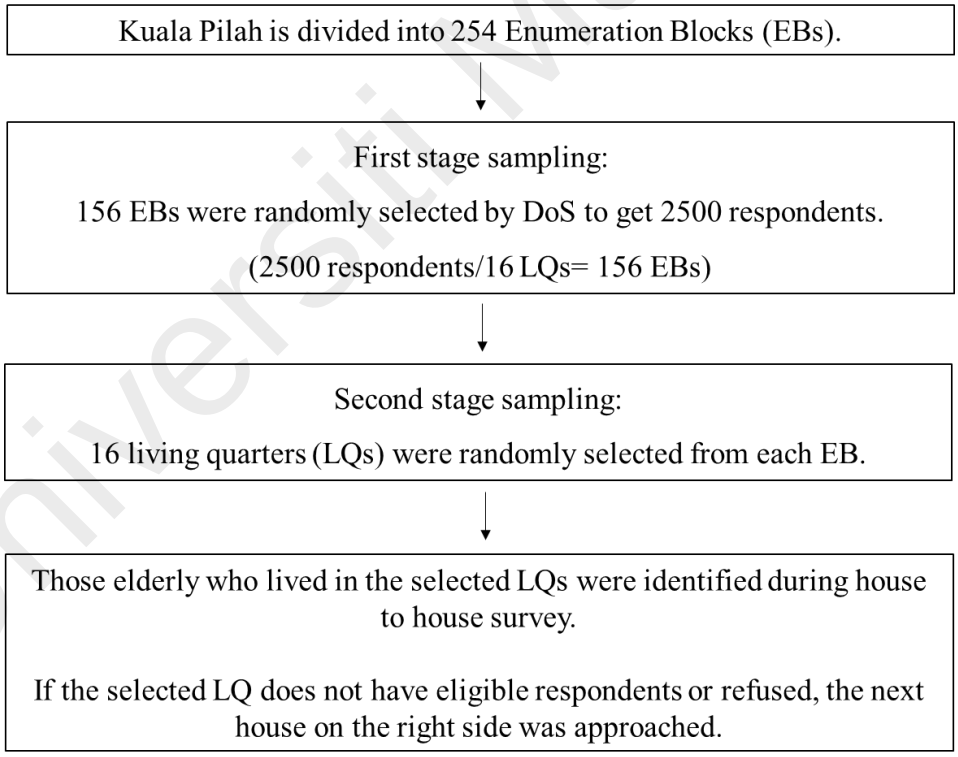

Figure 3.3: Sampling flow chart of the existing cohort study

3.3 Data collection of mortality data

Mortality data was obtained in order to answer one of the specific objectives. Mortality data was requested from the Malaysian Clinical Research Center (CRC) via the Patient Information Department of the University of Malay Medical Centre. CRC Malaysia obtained mortality data from National Registration Department Malaysia. The national identification number of respondents from the original study was used to identify the mortality status of respondents.

3.4 Justification for utilising existing data for this study

Secondary analysis of existing data was selected to answer research questions in this study because it is an effective research approach in terms of time, effort and cost (Cheng et al., 2014; Greenhoot & Dowsett, 2012; Johnston, 2017). Low cost is the key advantage of secondary analysis of existing data. Minimal cost may be needed to obtain datasets, but the amount is miniscule compared to the amount needed for primary data collection. In addition, the secondary analysis of existing data is also time and effort efficient. There were a few reasons of choosing this existing data set for this study. The reasons are as stated below:

i. The existing data set has suitable variables to address the research objectives and this component has not been further analysed or reported in the existing cohort study.
ii. We have confidence in data quality as instruments utilised were validated instruments in the Malaysian setting, data collectors were trained, data collection was conducted face-to-face and the principal investigator examined the collected data from time to time to minimise missing data and also illogical data.

iii. The proportion of duplicates as reported in the original analysis of the baseline data for the cohort study was small (0.8%), thus we remain optimistic that the available data in the existing dataset will fulfil the required sample size needed for this current study.

iv. The original study is a closed cohort study. Repeated data has been collected from the same population, this fulfil the research objectives and allows looking at trends and changes of phenomena over time.

Previous studies have reported that rural older adults tend to be more disadvantaged and have poorer health (Fogelholm et al., 2006; Zare et al., 2018). Furthermore, rural older adults also have a lower quality of life than their urban counterparts (Usha & Lalitha, 2016). Therefore, the existing cohort study conducted in rural area was selected to answer research questions of this study.

3.5 Power calculation

The power calculation was conducted for the existing data set. The aim of power calculation is to know whether the available data can provide sufficient power to examine all research questions. The estimated power was calculated at baseline, followed by twelve months follow-up. Estimated power was calculated for four outcome variables: ADL disability, IADL disability, walking speed and handgrip strength. The power calculation included sample size, estimated means, estimated standard deviation (SD) of each group and α-level of the hypothesis test.

In the baseline estimate, the result was 0.9882 for ADL disability, 1.000 for IADL disability, 1.000 for walking speed and 1.000 for handgrip strength. All results were higher than the desired power of 80% (Suresh & Chandrashekara, 2012). However, the

twelve months follow-up power calculation resulted in result of 0.9326 for ADL disability, 0.5593 for IADL disability, 0.0981 for walking speed and 0.6301 for handgrip strength. Lower estimated power at twelve-month follow-up was observed at IADL disability, walking speed and handgrip strength. It may be attributed to the large number of respondents with outcome of interest at baseline who were omitted from twelve months follow-up power calculation. We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. As a result, outcome variables with large number of respondents with outcome of interest at baseline had lower estimated power at twelve months follow-up. Table 3.1 presents baseline and twelve months follow-up power calculation.

Table 3.1: Baseline and twelve months follow-up power calculation

Variable	**Estimated power at baseline**	**Estimated power at twelve months follow-up**
ADL disability	0.9882	0.9316
IADL disability	1.000	0.5593
Walking speed	1.000	0.0981
Handgrip strength	1.000	0.6301

3.6 Inclusion and exclusion criteria

3.6.1 Inclusion criteria

- Aged 60 and older
- Lived in Kuala Pilah district for at least 12 months before data collection

3.6.2 Exclusion criteria

- Non-Malaysian citizens
- Stayed in nursing homes
- Hospitalised during data collection period
- Declined to take part in the study
- Severe cognitive impairment (MMSE<10)

3.7 Study instruments

The following are the questionnaires and tools used in the existing cohort study (Appendix D):

- Socio-demographic and medical history questionnaire
- Physical disability: Katz ADL and Lawton IADL scales
- Functional Limitations: Walking speed and Handgrip strength
- Depressive symptoms: Geriatric Depression Scale (GDS)
- Cognitive function: Mini-mental status examination (MMSE)
- Social support: Duke Social Support Index (DSSI)
- Physical activity: Physical Activity Scale of the Elderly (PASE)
- Self-rated health

3.7.1 Socio-demographic and medical history questionnaires

The variables used in socio-demographic and medical history questionnaires include age group, sex, ethnicity, education level, marital status, living arrangements, monthly household income and medical history. In order to obtain medical history, respondents were asked whether they were suffered from diabetes, hypertension, hyperlipidemia, myocardial infarction, chronic lung disease, stroke or arthritis. Comorbidities was measured by the number of medical illnesses that the respondents had. Obesity was grouped into obese (BMI≥27.5) and not obese (BMI<27.5) based on the Malaysian guideline (Zainudin, Daud, Mohamad, Boon, & Mohamed, 2014).

3.7.2 Measurement for chronic pain and pain interference

Chronic pain was defined by asking respondents: "In the past six months, have you experienced persistent pain in any part of the body for three months or more?". The answers were "yes" or "no". The most widely accepted chronic definition in Asian countries in three months, which is in line with the definition of IASP (Zaki & Hairi, 2015). On the other hand, pain interference was assessed by asking the question: "Did the pain interfere with your ability to work or manage your day to day activities?". The responses are "not at all", "little interference", "moderate interference", "frequent interference" or "very frequent interference". The responses of pain interference was collapsed into two categories: "pain with interference" and "pain without interference"

3.7.3 Physical disability

Physical disability is assessed using two instruments: Katz ADL scale and Lawton IADL scale. Those two methods are amongst the most used questionnaires for evaluating disability in older adults (Yang et al., 2014).

3.7.3.1 Katz activities of daily living (ADL)

Katz ADL scale evaluated physical performance using six functions: bathing, dressing, toileting, transferring, continence and feeding. Each function had three choices: without assistance, partial assistance and complete assistance. Respondents were classified as having ADL disability if they required partial or complete assistance in at least one of the six functions. Respondents were classified as ADL independent if they could execute all six functions without assistance.

3.7.3.2 Lawton Instrumental Activity of Daily Living (IADL)

IADL assesses the higher level of functioning compared to ADL. IADLs diminish earlier in the phases of illness compared to ADL. Lawton IADL scale is an instrument established to evaluate community independent living skills (Lawton & Brody, 1969). The scale included eight items: ability to use telephone, food preparation, housekeeping, laundry, mode transportation, responsibilities for own medications and ability to handle finances. Each function had three options: without assistance, partial assistance and complete assistance. Respondents were classified as having an IADL disability of they required partial or complete assistance in at least one of the eight functions. Respondents were classified as IADL independent if they could execute all eight functions without assistance.

3.7.4 Functional limitations

3.7.4.1 Walking speed

Walking speed is a measurement used for assessing functional status and overall health of population (Middleton et al., 2015). Walking speed is a valid reliable and sensitive measurement. If older adults have walking speed 0.8m/s and slower, they tend to have poorer health (Van Kan et al., 2009). Walking speed was reported to be associated with survival among older adults (Studenski et al., 2011). During data collection, respondents were requested to walk at their normal pace for four meters, with a start-up of one meter prior to timing. The test was performed twice for each of the respondents, with the shortest time in seconds needed to complete the distance was selected. In this study, walking speed pf 0.8m/s and below was categorised as having slow walking speed.

3.7.4.2 Handgrip strength

The handgrip strength measurement was carried out using hydraulic hand dynamometer with seated respondents. During the measurement, the elbow of the respondents was placed sideways and flexed at right angles in a neutral wrist position with support below the dynamometer. The Asian Working Group for Sarcopenia (AWGS) has recommended low handgrip strength for men as less than 26 kg and women as less than 18 kg (Chen et al., 2014). Handgrip strength was shown to have significant correlation with the quality of life among older adults (Wiraguna & Setiati, 2018) and increasing ADL dependency among the oldest old (Taekema, Gussekloo, Maier, Westendorp, & de Craen, 2010). Poor handgrip strength and low physical activity has been observed in frail older adults (Lenardt et al., 2016). In the analysis, an average of three measurements of dominant hand handgrip strength were taken. Male respondents

with handgrip strength below 26kg and female respondents with handgrip strength below 18kg were considered to have low handgrip strength (Chen et al., 2014).

3.7.5 Depressive symptoms: Geriatric Depression Scale (GDS)

GDS was first developed as 30 questions screening instrument to detect geriatric depression (Yesavage et al., 1982). Later, a shorter version of the GDS, consisting of 15 questions was developed taking into consideration of factors such as fatigue and poor concentration of older adults (Sheikh & Yesavage, 1986). The short version GDS is shown to be an effective screening tool as its longer predecessor (Burke, Roccaforte, & Wengel, 1991). Short version GDS was used to assess the depressive symptoms of study respondents. The Malay short version GDS was validated with satisfactory reliability and validity values in Malaysia (Teh & Hasanah, 2004). No depressive symptoms were identified in scores of zero to four, while scores more than four suggested mild to severe depression (Greenberg, 2012).

3.7.6 Cognitive function: Mini-mental status examination (MMSE)

MMSE is a cognitive mental status examination consisting of 11 questions. MMSE requires five to ten minutes to administer (Folstein, Folstein, & McHugh, 1975). It covers items of cognitive function include orientation, registration, recall, calculation and attention, naming repetition, comprehension, reading, writing and drawing. Zarina et al., in 2007 translated MMSE into Malay language and validated with a high reliability value (Zarina, Zahiruddin, & AH, 2007). Subsequently, MMSE was validated in other Malay speaking older adults in Malaysia (Ibrahim et al., 2009). The Malaysian guideline on dementia management has classified the severity of cognitive impairment into four

groups as shown in in Table 3.2. For this study, respondents with severely impaired cognitive function (MMSE 0-9) were excluded from analysis. In addition, mild cognitive impairment (MMSE 21-26), moderate cognitive impairment (MMSE 15-20) and moderately severe cognitive impairment (MMSE 10-14) were grouped into impaired cognitive function in the analysis of this study. For this study, cognitive status was re-categorised into two groups in this study; (i) Normal: MMSE score 27-30 and (ii) Impaired: MMSE score 10-26.

Table 3.2: Severity of cognitive impairment

Severity	Score
Normal	27 – 30
Mild	21-26
Moderate	15-20
Moderately severe	10-14
Severe	0-9

(Source: Clinical Practice Guidelines: Management of Dementia 2nd Edition, 2009)

3.7.7 Social support: Duke Social Support Index (DSSI)

DSSI evaluates numerous dimensions of social support. It consists all items on two subscales of social interaction and subjective support. The 11-item Duke Score Social Support was shown to have strong evidence of reliability and validity, with Cronbach's alpha as 0.77 and test-retest reliability scores ranging from 0.70 to 0.81 (Goodger, Byles, Higganbotham, & Mishra, 1999).

3.7.8 Physical activity: Physical Activity Scale of the Elderly (PASE)

PASE is a physical activity measurement developed for older adults that is brief, easily scored. The data can be collected via telephone, mail or face-to-face (Washburn, Smith, Jette, & Janney, 1993). PASE questionnaire was translated into Malay language and validated with acceptable validity and reliability to evaluate the physical activity level of older adults in Malaysia (Ismail et al., 2015).

3.7.9 Self-rated health

Self-rated health is evaluated by asking the respondents: "How would you evaluate your present health?". The answers were either "extremely good", "very good", "good", "fair" or "bad". The responses of self-rated health were collapsed into "good" and "poor".

3.8 Study variables

3.8.1 Independent variables

a) Chronic pain

3.8.2 Dependent variables

a) Katz ADL

b) Lawton IADL

c) Walking Speed

d) Handgrip strength

e) Five-year mortality

3.8.3 Covariates

a) Socio-demographic characteristics: Age group, sex, education level, ethnicity, marital status, type of living arrangement and monthly household income.

b) Health related variables and other variables: Chronic pain interference, comorbidities, depressive symptoms, cognitive status, physical activity, social support and obesity.

3.9 Operational definitions of study variables

3.9.1 Independent variable

Table 3.3: Operational definition of independent variable

Variables	Operational definition
Chronic pain	Chronic pain was measure by asking whether the respondents experienced pain every day or in most days for three months or more over the past six months before the data was collected (Merskey, 1994). This question was validated among older adults in Malaysia and has been used in a number of major epidemiological research (Ismail, 2016; Rafidah & Zaki, 2016).

3.9.2 Dependent variables

Table 3.4: Operational definition of dependent variables

Variable	Operational definition
Katz Index of Independence in Activity of Daily Living	Six domains were being assessed: bathing, dressing, toileting, continence and feeding. The scoring for each domain is divided to 0, 1 or 2. Respondents were classified as having ADL disability if they required partial or complete assistance in at least one of the six functions. Respondents were classified as ADL dependent if they could execute all six functions without assistance.
Lawton Instrumental Activity of Daily Living	Eight domains were being assessed: ability to use telephone, shopping, mode of transportation, responsibilities for own medications and ability to handle finances. The scoring for each domain is divided into 0, 1, or 2. Respondents were classified as having IADL disability if they required partial or complete assistance in at least one of the eight functions. Respondents were classified as IADL independent if they could execute all eight functions without assistance.

'Table 3.4, continued'

Variable	Operational Definition
Walking speed	Respondents were evaluated for time needed to walk at their usual pace for four meters. The test was performed twice in each of the respondents. The shortest time needed to complete the test was taken. Respondents were categorised with walking speed 0.8m/s and below were categorised as having slow walking speed (Chen et al., 2014).
Handgrip strength	Hydraulic hand dynamometer was used to measure handgrip strength. Respondents were required to be seated, place their elbow by their side and wrist at neutral position. The average of three measurements of dominant hand handgrip strength were taken. Asian Working Group for Sarcopenia (AWGS) cut-off was adopted (Chen et al., 2014). Male respondents with handgrip strength less than 26kg were categorised as having low handgrip strength. Female respondents with handgrip strength less than 18kg were categorised as having low handgrip strength.
Mortality status	The mortality data was collected from Malaysian Clinical Research Centre (Source: National Registration Department Malaysia).

3.9.3 Covariates

Table 3.5: Operation definition of socio-demographic factors

Variable	Operational Definition
Older adults	Older adults in Malaysia is defined as 60 years of age or older (Zawawi, 2013).
Pain interference	Pain interference was assessed by asking: Does persistent pain interfere with your work or daily activities? It was categorised into five responses: Not at all, mildly interfere, moderately interfere, frequently interfere and very frequently interfere. The responses of pain interference were collapsed into two categories: pain with interference and pain without interference.
Education level	Education level has three categories: no formal education, primary education, and secondary or tertiary education
Type of living arrangement	Type of living arrangement was grouped into either living with spouse and/or children, living alone or living with others.
Monthly household income	Monthly household income has three groups: Low (<RM500), medium (RM500-999) and High (≥RM1000).

Table 3.6: Operational definition of health related variables and other variables

Variable	Operational definition
Comorbidities	Respondents were asked if they were told by doctor or medical staff if they have diseases as below: • Diabetes • Hypertension • Hyperlipidaemia • Myocardial infarction • Chronic lung disease • Stroke • arthritis Responses are recorded as yes or no. Comorbidities was measured by the number of diseases that the respondents had.
Depressive symptoms	Depressive symptoms were assessed using GDS and responses were grouped as yes or no.
Cognitive status	Cognitive status was assessed using MMSE. Respondents with severely impaired cognitive function (MMSE score 0-9) were excluded from the analysis. Cognitive status has two categories: Normal (MMSE score 27-30) and Impaired (MMSE score 10-26)
Physical activity	The PASE scale was used to evaluate physical activity. The higher PASE scores show a higher level of physical activity.

'Table 3.6, continued'

Variable	Operational definition
Physical activity	The PASE scale was used to evaluate physical activity. The higher PASE scores show a higher level of physical activity.
Social support	Higher DSSI scores suggests higher levels of social support. Respondents in the first quartile were classified as low social support.
Obesity	Obesity were grouped into obese (BMI≥27.5) and not obese (BMI<27.5).

3.10 Data management

3.10.1 Data cleaning and verification

Data cleaning and verification were conducted to ensure that the existing cohort data is of good quality. The inconsistencies of data, for instance duplicates, outliers, illogical values and missing data were identified. Subsequently, outliers and illogical values were rectified according to raw data. Duplicates found to have exactly same observation values were deleted. Detailed explanation of missing data management in section 3.10.3.

3.10.2 Quality control

For quality control of the existing cohort data, 5% of the data was generated at random. Five percent data were generated as there was a small number of missing data for exposure and outcome variables. The 5% random data was compared to its original source paper-based questionnaires. Minimal discrepancies between questionnaires and electronic datasets were identified. Discrepancies were rectified according to questionnaires.

3.10.3 Missing data management

Prior to analysis, all variables were checked for completeness of data. The percentage and patterns of missing data have been identified for variables with missing data. The mechanism of missing data more than 5% was checked to assess if the missingness was missing completely at random (MCAR), missing at random (MAR) or missing not at random (MNAR).

Multiple imputation by chained equations according to sets of imputation models were conducted on variables with missing values exceeding 5%. We generated 20 databases based on the suggested thumb rule that the number of imputations should be at least equivalent to the percentage of incomplete cases (White, Royston, & Wood, 2011). Both complete case and imputed data were analysed and compared. Models with better precision according to sensitivity analysis were presented in the result section. Figure 3.4 presents the flow chat of missing data management.

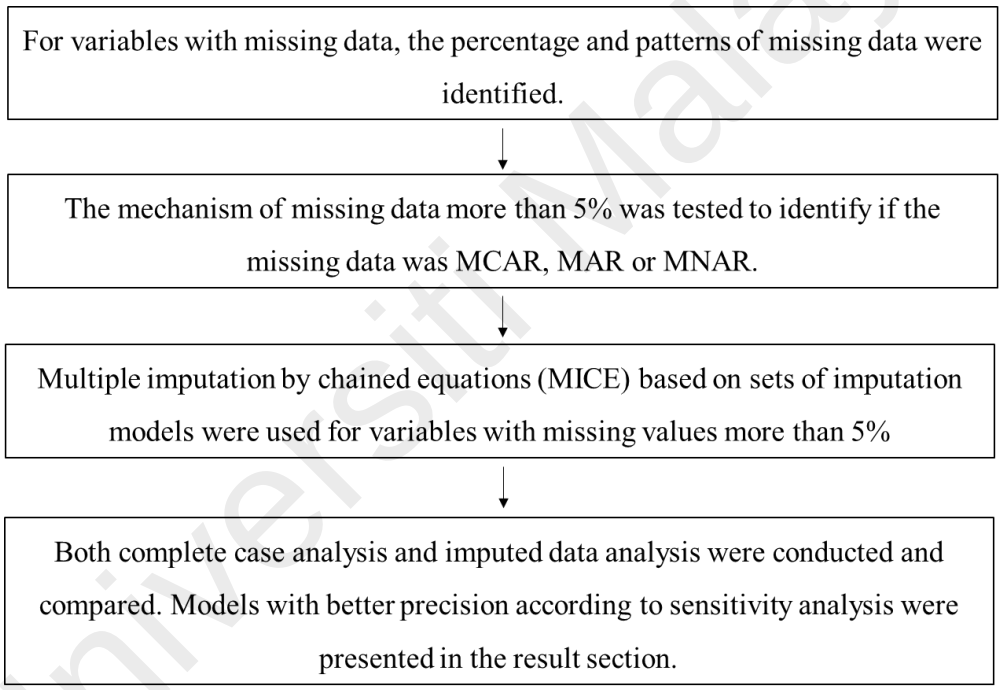

Figure 3.4 Flow chart of missing data management

3.10.4 Sampling weights calculation

The data from the existing cohort study adopted a complex sampling design involving stratification of geographical region (Ahmad et al., 2018). The complex sampling design was discussed in the previous section. The purpose of complex sampling was to enable a representativeness of the population. Sampling was conducted using a stratified 2-stage sampling method before the data was collected. Weightage was calculated prior to analysis.

Weightage was applied to the selected Living Quarters (LQs) in each Enumeration Blocks (EBs). The example of calculation of the sampling weights:

In EB 2, there are 92 LQ. A total of 16 LQ are randomly selected. The final weightage is 92/16 = 5.75.

For each respondent, an extra variable named ‘weightage’ was created based on the calculation shown above. Weightage was adjusted for chronic pain prevalence, chronic pain interference and multivariable analysis. The detailed weight calculation for each EBs were illustrated in Appendix E.

3.11 Statistical analysis

3.11.1 Descriptive analysis

For categorical data, the study respondents' socio-demographic data were described as frequencies and percentages, while mean and standard deviation were used to describe continuous data. Descriptive analysis was used to estimate chronic pain prevalence and chronic pain interference to describe the distribution of chronic pain. Chi-square test was used to measure the crude association for categorical data. Comparison between two groups of continuous variables was done using independent t-test. All analyses were conducted using STATA version 14 at 5% significant level.

3.11.2 Specific analysis according to outcome variables

3.11.2.1 Outcome 1 – Physical disability and functional limitations

Two physical disability outcome variables (Katz ADL and Lawton IADL) and two functional limitations outcome variables (walking speed & handgrip strength) were analysed in this study.

(a) ***Cross-sectional analysis***

Logistic regression analysis was used to measure the association between baseline chronic pain and outcomes of interest, along with covariates. Hosmer-Lemeshow Model building strategy were adopted. Firstly, univariable associations between chronic pain and all covariates with outcome variables of interest were tested. Subsequently, we included covariates with p-value less than 0.25 in the multivariable regression models. Since the sex and age group variables were clinically significant, both variables remained

in the multivariable models. Multivariable analysis was conducted using stepwise logistic regression. Variables that are not significant based on Wald test were removed and until we obtained a preliminary main effects model. Subsequently, interaction terms between chronic pain and sex and chronic pain and age group were tested. The final regression model included interaction terms with p-value of less than 0.05. Multicollinearity of independent variables in the final model was examined using Variance Inflation Factor (VIF) test. The cut-off of VIF used in this study was 5 (Hair, Black, Babin, & Anderson, 2013). We examined the goodness of fit of the final model using Hosmer-Lemeshow goodness of fit test, classification table and Receiver Operating Characteristic (ROC) curve.

(b) ***Longitudinal analysis***

Longitudinal associations between baseline chronic pain and the correlated responses of physical disability and functional limitation variables were analysed using Generalised Estimating Equations (GEE). GEE analysis method was selected over mixed models as the GEE approach does not require distributional assumptions because estimation of the population- average model depends only on correctly defining some of the observed data generating distribution. In contrast, mixed models require correct specification of the regression models for the so-called fixed effects coefficients as well as distributional assumptions and regression models for the random effects (Hubbard et al., 2010).

The aim of GEE was to account for within subject correlations. The "all available pairs" method was used in GEE to deal with missing data. Estimation of the working correlation parameters was used in all non-missing pairs of data. GEE provides many benefits such as follows (Ghisletta & Spini, 2004; Hanley, Negassa, Edwardes, & Forrester, 2003; Hubbard et al., 2010)

- Accounts for within-subject or within-cluster correlations.
- Production of relatively accurate standard errors, hence confidence intervals with the correct coverage rates.
- Consistent and unbiased estimate of standard errors of parameters even if the structure of correlation is not specified.
- Not needing the accurate correlation matrix specification to arrive at unbiased statistical conclusions about the effects of covariates, given that the robust, model-free estimation of standard errors is applied.

We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. The modified Poisson regression approach was used to estimate the relative risks (Yelland, Salter, & Ryan, 2011). The distribution of outcome variable was set as Poisson. The link function was set as log. For correlation structure, the unstructured correlation structure was set to allow all possible correlations. Multicollinearity was tested before performing the GEE using VIF test. The cut-off of VIF used in this study was 5 (Hair et al., 2013). GEEs were carried out for both complete case and imputed data.

First, univariable associations were examined between chronic pain and covariates with outcomes of interest. Following that, chronic pain and covariates with p-value of less than 0.25 were added in the multivariable GEE models. Since the sex and age group

variables were clinically significant, both variables were retained in the multivariable models. In multivariable analysis, insignificant variables were removed and this was done until the final model was obtained.

3.11.2.1 Outcome 2 – Mortality

We conducted survival analysis to measure the difference in mortality between groups of respondents with and without chronic pain at baseline. The Kaplan-Meier survival curve was constructed to allow 'time-to-event' analysis and comparison of survival probability between respondents with chronic pain and no chronic pain at baseline.

The associations between chronic pain and five-year mortality taking into consideration other covariates were analysed using Cox Proportional Hazard models. In univariate analysis, univariate Cox Proportional Hazard regression (semi-parametric model) was conducted to analyse the associations between chronic pain and covariates with five-year mortality. Chronic pain and covariates with p-value of less than 0.25 were added to the Cox Proportional models. In model building, non-significant variables were removed until all variables were significant in the preliminary final model. Subsequently, the interaction terms between chronic pain and sex; chronic pain and age group were checked. Interaction terms with p-value of less than 0.05 were added in the multivariable Cox Proportional model. After obtaining the final model, proportionality assumptions were tested using *stphplot* plot, *stcoxkm* plot and Schoenfeld residuals (*estat phtest*) tests. We examined the goodness of fit of the final model using Cox-Snell residuals.

3.12 Ethics

This study received ethical approval from the University of Malaya Research Ethics Committee (UNREC) (Ref: UM.TNC2/UMREC-2520) (Appendix F) and was registered with the National Medical Research and Ethic Committee (NMRR), Ministry of Health Malaysia (NMRR18-855-39981) (Appendix G). Ethics approval for the existing cohort study where the data was collected has been obtained from the UMREC (Ref: UM.TNC2/RC/H&E/UMREC-131. In the existing cohort study, written consent was sought from respondents before data collection. Permission for further analysis has been sought through discussions with the principal investigator and other members of the research team.

CHAPTER 4: RESULTS

This chapter consists of two main parts. Part 1 describes the characteristics of study population, chronic pain prevalence and chronic pain interference. Part 2 is further divided into two components. The first component describes the results on associations between chronic pain and physical disability, as well as associations between chronic pain and functional limitations. The second component describes the results on association between chronic pain and five-year mortality. The details of this chapter are as follow:

Part 1

a) Characteristics of study population
    i. The response rate, comparison of responder and non-responder at twelve months follow up
    ii. Study population's socio-demographic characteristics
    iii. Mechanism of missing data
b) Chronic pain prevalence and chronic pain interference

Part 2

a) Cross-sectional and longitudinal associations between chronic pain and physical function. Physical function includes physical disability and functional limitations. Physical disability was assessed by ADL and IADL disabilities, while functional limitations were assessed by walking speed and handgrip strength. The results were described as follow:

i. Descriptive analysis

ii. Cross sectional associations: Logistic regression

iii. Longitudinal associations: Generalized Estimating Equation

b) Chronic pain and five-year mortality. The results were described as follow:

i. Descriptive analysis

ii. Survival analysis: Cox proportional Hazard models

4.1 Study population's characteristics

4.1.1 Study's response rate

A total of 2404 respondents completed baseline interview. The baseline response rate was 96.2%. Because of severe cognitive impairment, we excluded 78 respondents from the analysis and 2326 respondents remained. The response rate at twelve months follow-up was 81.2% (n=1889). Figure 4.1 illustrates the flow chart of study responses.

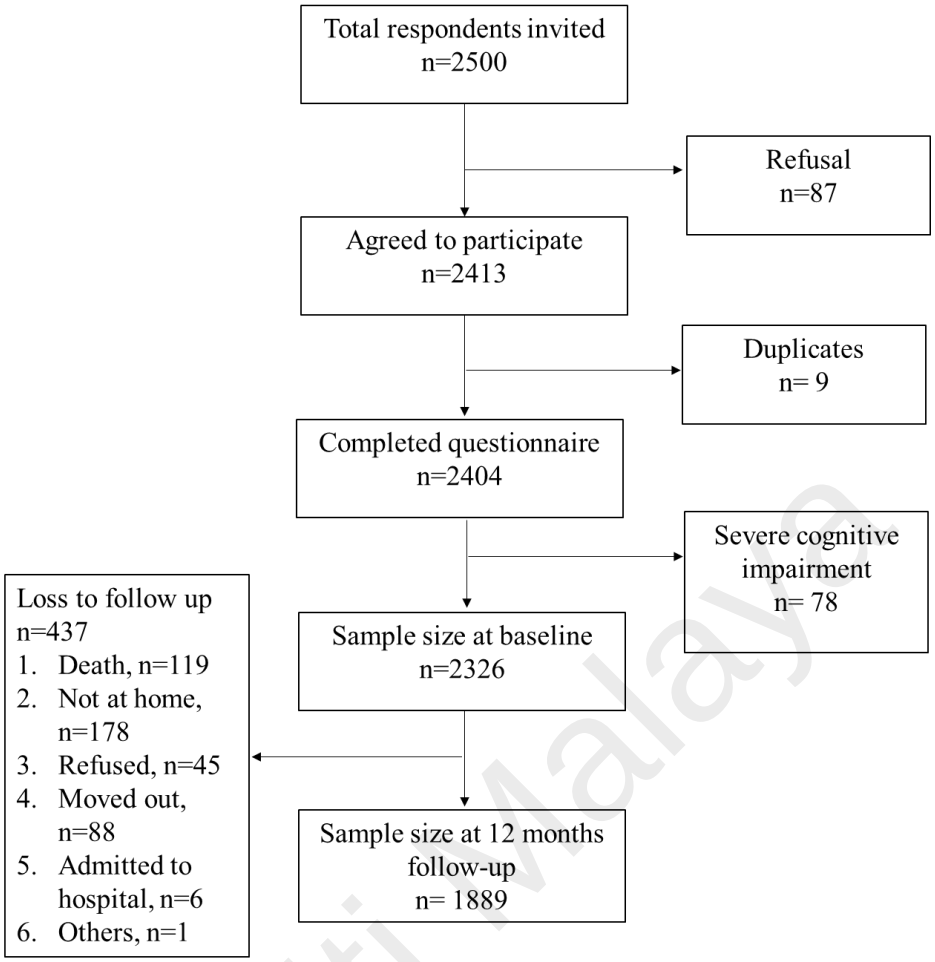

Figure 4.1: Flow chart of study responses

Table 4.1 describes the socio-demographic characteristics comparing responders and non-responders at twelve months follow-up. No significant differences detected ($p>0.05$) between those who responded and the non-respondents with regard to sex, education status and monthly household income. However, age group and ethnicity had significant associations between responders and non-responders. The significant difference in age groups were anticipated as higher mortality rates are expected as age increases. On the other hand, the significant association observed in ethnicity may be attributed to the reason that Malay ethnicity recruited outnumbered other ethnic groups in a very large proportion.

Table 4.1: Socio-demographic characteristics between responders and non-responders at twelve months follow up

Variables	Respondents n (%)	Non-respondents n (%)	Chi-square value (χ^2)	p-value
Age group				
60-69	931 (49.29)	183 (41.88)	7.81	0.005*
≥70	958 (50.71)	254 (58.12)		
Sex				
Male	726 (38.43)	161 (36.84)	0.38	0.537
Female	1163 (61.57)	276 (63.16)		
Education				
No formal education	280 (14.86)	69 (15.86)	1.01	0.605
Primary education	1152 (61.15)	271 (62.30)		
Secondary or tertiary education	452 (23.99)	95 (21.84)		
Ethnicity				
Malay	1834 (97.09)	399 (91.30)	38.36	<0.001*
Chinese	21 (1.11)	19 (4.35)		
Indian	25 (1.32)	18 (4.12)		
Others	9 (0.48)	1 (0.23)		
Monthly household income				
Low	641 (34.43)	166 (38.25)	3.03	0.220
Medium	579 (31.10)	119 (27.42)		
High	642 (34.48)	149 (34.33)		

** $p<0.05$*

4.1.2 Baseline socio-demographic characteristics of the study population

The baseline characteristics of 2326 respondents were described. More than 60% of the respondents were female. Majority of the study respondents were Malay (96%), received at least primary education (61.36%), married (62.85%) and living with spouse and/or children (81.52%). Table 4.2 describes baseline socio-demographic characteristics of the study population.

Table 4.2: Baseline socio-demographic characteristics of study respondents

Variables	n (%)	Mean (SD)
Age group		
60-69	1114 (47.89)	-
≥70	1212 (52.11)	
Sex		
Male	887 (38.13)	-
Female	1439 (61.87)	
Education		
No formal education	349 (15.05)	-
Primary education	1423 (61.36)	
Secondary or tertiary education	547 (23.59)	
Ethnicity		
Malay	2233 (96.00)	-
Chinese	40 (1.72)	
Indian	43 (1.85)	
Others	10 (0.43)	
Marital status		
Married	1453 (62.85)	-
Divorced	48 (2.08)	
Widowed	764 (33.04)	
Single	47 (2.03)	
Living arrangement		
Living with spouse and/or children	1888 (81.52)	-
Living alone	297 (12.82)	
Living with others	131 (5.66)	

'Table 4.2, continued'

Variables	n (%)	Mean (SD)
Monthly household income		
Low	698 (30.40)	-
Medium	807 (35.15)	
High	791 (34.45)	
Presence of chronic disease		
Diabetes	627 (27.26)	-
Hypertension	1230 (53.02)	
Hyperlipidaemia	783 (33.81)	
Myocardial infarction	117 (5.08)	
Chronic lung disease	34 (1.47)	
Stroke	65 (2.81)	
Arthritis	476 (20.58)	
Depressive symptoms		
Yes	757 (33.39)	-
No	1510 (66.61)	
Cognitive status		
Normal	1276 (55.92)	-
Impaired	1006 (44.08)	
Self-rated health		
Good	1481 (64.00)	-
Poor	833 (36.00)	
Social support		
High	1708 (79.18)	-
Low	449 (20.82)	
Physical activity	-	97.03 (57.62)
Obesity		
Yes	785 (36.34)	-
No	1375 (63.66)	

4.1.3 Baseline characteristics of study population based on chronic pain status

Table 4.3 illustrates the baseline characteristics of study respondents based on chronic pain status. Chi-square testes found significant associations between chronic pain and age group, ethnicity, marital status, monthly household income, presence of chronic diseases, depressive symptoms, cognitive status, self-rated health and obesity. There was significant association in physical activity for respondents with chronic pain and no chronic pain.

Table 4.3: Baseline characteristics of study respondents based on chronic pain status

Variables	Chronic pain, n (%)	No chronic pain, n (%)	Chi-square value (χ^2)	P-value
Age group				
60-69	197 (17.70)	916 (82.30)	19.68	<0.001*
≥70	306 (25.29)	904 (74.71)		
Sex				
Male	177 (19.98)	709 (80.02)	2.37	0.124
Female	326 (22.69)	1111 (77.31)		
Education				
No formal education	82 (23.50)	267 (76.50)	4.15	0.126
Primary education	319 (22.46)	1101 (77.64)		
Secondary or tertiary education	102 (18.65)	445 (81.35)		
Ethnicity				
Malay	471 (21.12)	1759 (78.88)	25.47	<0.001*
Chinese	10 (25.00)	30 (75.00)		
Indian	22 (51.16)	21 (48.84)		
Others	0 (0)	10 (100.00)		
Marital status				
Married	288 (19.85)	1163 (80.15)	12.16	0.007*
Divorced	7 (14.58)	41 (85.42)		
Widowed	197 (25.82)	566 (74.18)		
Single	9 (19.15)	38 (80.85)		

'Table 4.3, continued'

Variables	Chronic pain, n (%)	No chronic pain, n (%)	Chi-square value (χ^2)	P-value
Living arrangements				
Living with spouse and/or children	398 (21.11)	1487 (78.89)	3.92	0.141
Living alone	68 (22.90)	229 (77.10)		
Living with others	37 (28.24)	94 (71.76)		
Monthly household income				
Low	211 (26.18)	595 (73.82)	27.02	<0.001*
Medium	164 (23.56)	532 (76.44)		
High	125 (15.80)	666 (84.20)		
Presence of chronic disease				
Diabetes	148 (23.60)	479 (76.40)	1.73	0.189
Hypertension	325 (26.44)	904 (73.56)	34.66	<0.001*
Hyperlipidaemia	225 (28.74)	558 (71.26)	35.02	<0.001*
Myocardial infarction	40 (34.19)	77 (65.81)	11.36	0.001*
Chronic lung disease	18 (52.94)	16 (47.06)	19.84	<0.001*
Stroke	18 (27.69)	47 (72.31)	1.43	0.231
Arthritis	229 (48.11)	247 (51.89)	246.64	<0.001*
Depressive symptoms				
Yes	197 (26.06)	559 (73.94)	13.67	<0.001*
No	291 (19.28)	1218 (80.72)		
Cognitive status				
Normal	233 (18.27)	1042 (81.73)	20.95	<0.001*
Impaired	264 (26.24)	742 (73.76)		
Self-rated health				
Good	197 (13.31)	1283 (86.69)	169.29	<0.001*
Poor	304 (36.54)	528 (63.46)		
Social support				
High	395 (23.14)	1312 (76.86)	1.38	0.241
Low	92 (20.54)	356 (79.46)		

'Table 4.3, continued'

Variables	Chronic pain, n (%)	No chronic pain, n (%)	Chi-square value (χ^2)	P-value
	Mean (SD)	Mean (SD)	-	
Physical activity	78.08 (59.29)	99.48 (57.51)		<0.001*
Obesity				
Yes	200 (25.48)	585 (74.52)	14.97	<0.001*
No	253 (18.43)	1120 (81.57)		

**p<0.05*

4.1.4 Missing data

4.1.4.1 Missing data analysis

(a) ***Predictor and covariates***

Analysis of missing data were conducted on a total of twelve predictor and covariates. From the analysis, ten out of twelve variables had missing data. Seven variables had less than 5% missing data. These were education (0.3%), monthly household income (1.29%), comorbidities (2.75%), chronic pain (0.13%), depressive symptoms (2.54%), cognitive status (1.89%) and self-rated health (0.52%). Three covariates had more than 5% missing data. These were social support (7.27%), physical activity (7.57%) and obesity (7.14%).

(b) ***Outcomes***

Analysis of missing data were conducted on outcome variables at baseline and twelve months follow-up. Outcome variables analysed were ADL disability, IADL disability, walking speed and handgrip strength. Analysis of missing data at baseline reveals the missing percentage as follows; ADL disability (0.34%), IADL disability (7.57%), slow walking speed (8.04%) and low handgrip strength (7.18%). At twelve months follow-up,

missing percentage of outcome variables were ADL disability (0.26%), IADL disability (1.16%), slow walking speed (8.58%) and low handgrip strength (10.91%).

4.1.4.2 Missing data mechanism

(a) ***Predictor and covariates***

Little's MCAR tests were conducted on predictor and covariates with missing data using the *mcartest* STATA test. Missing values of less than 5% are insignificant (Schafer, 1999). Little's MCAR tests were conducted on variables with less than 5% missing and variables with more than 5% missing separately.

The p-value for all seven predictor and covariates with missing data less than 5% was more than 0.05. This shows the mechanism of missing mechanism was MCAR. On the other hand, p-value of three covariates with more than 5% missing data was less than 0.05. Hence the missing mechanism was not MCAR.

Essentially, it is extremely difficult to differentiate MAR and MNAR using observed data. MAR assumes that the data missingness may be influenced by the observed data but is not affected by the unobserved data. In general, testing MAR is not possible because unobtainable information about the missing data is required (Li, 2013). As a consequence, MAR often remain as an assumption. In order to reinforce the assumption, logistic regressions were conducted on variables that were not MCAR. Logistic regression is one of the methods to assist in differentiating between MAR and MNAR (Fielding, Fayers, & Ramsay, 2009). A missingness variable was constructed in which "response" was coded as 1 and "non-response" was coded as 0. Cross-tabulations were performed between missingness and variables of interest. Logistic regression was then run to see which variable predicted missingness.

Logistic regression was conducted on the three covariates with more than 5% missing data which that not MCAR. First, the missingness of variable social support was significantly associated with chronic pain and primary education. Second, the missingness of variable physical activity had significant association with medium monthly household income, depression symptoms and self-rated health. Besides, the missingness of variable obesity was significantly associated with physical activity. Therefore, we proceeded with the assumption that the missingness of these three covariates to be MAR.

(b) ***Outcomes***

The missing data mechanism of outcome variables were addressed in the subsequent subsection of results.

4.1.4.3 Missing data management

Multiple methods are available in the management of missing data. Some of these methods are (i) deletion methods, for example listwise deletion and pairwise deletion, (ii) single imputation methods, for example mean or mode substitution and single regression, and (iii) model-based methods, for example maximum likelihood and multiple imputation.

In general, case deletion produces valid inferences only if the missing data are MCAR. In this study, variables with more than 5% missing data were not MCAR, so the case deletion method was chosen not to deal with missing data. In addition, the single imputation method was also not chosen as the multiple imputation method could offer more benefits. Multiple imputation preserves the benefits of single imputation from but

has extra advantage of solving the understating uncertainty problem (Schafer & Graham, 2002). Missing values of less than 5% are insignificant (Schafer, 1999). As a result, multiple imputation was selected to handle variables with more than 5% missing data in this study.

Multiple imputation is aim at managing missing data in order to obtain valid statistical inference (Schafer, 1997). Multiple imputation by chained equations equations has been conducted on variables with missing values of more than 5% according to sets of imputation models. We generated 20 databases based on the suggested rule of thumb that the number of imputations should be at least the percentage of incomplete cases (White et al., 2011).

The benefits of multiple imputation are (Kang, 2013) as following:

i. Ability to generate valid statistical inference showing the uncertainty related to the missing data estimation.
ii. Robust to the violation of the normality assumptions.
iii. Ability to produce decent results with small sample size or large number of missing data.

4.2 Chronic pain prevalence and chronic pain interference

4.2.1 Chronic pain prevalence

The overall chronic pain prevalence was 21.1% (95% CI 19.4, 22.8). For female respondents, chronic pain prevalence (65.1%) was higher than male respondents (34.9%). The prevalence of older age group (61.3%) was almost two times higher than younger age group (38.7%). Table 4.4 illustrates the chronic pain prevalence of study respondents at baseline.

Table 4.4: Chronic pain prevalence of study respondents at baseline

Variable	Chronic Pain		
	Unweighted count	Unweighted prevalence	Weighted prevalence (95%CI)
Overall	503	21.6	21.1 (19.4, 22.8)
Sex			
Male	177	35.2	34.9 (30.7, 39.4)
Female	326	64.8	65.1 (60.6, 69.3)
Age group			
60-69	197	39.2	38.7 (34.3, 43.1)
≥70	306	60.8	61.3 (56.9, 65.7)
Education			
No formal education	82	16.3	17.4 (14.2, 21.2)
Primary education	319	63.4	62.4 (57.9, 66.7)
Secondary or tertiary education	102	20.3	20.2 (16.8, 24.1)
Ethnicity			
Malay	471	93.6	92.8 (90.0, 94.9)
Chinese	10	2.0	2.2 (1.1, 4.0)
Indian	22	4.4	5.0 (3.3, 7.5)
Others	0	0	0
Marital status			
Married	288	57.5	57.3 (52.8, 61.8)
Divorced	7	1.4	1.0 (0.5, 2.2)
Widowed	197	39.3	39.8 (35.5, 44.4)
Single	9	1.8	1.8 (0.9, 3.5)
Living arrangements			
Living with spouse and/or children	398	79.1	78.9 (74.9, 82.4)
Living alone	68	13.5	13.1 (10.3, 16.4)
Living with others	37	7.4	8.0 (5.8, 11.0)
Monthly household income			
Low	211	42.2	43.5 (39.1, 48.1)
Medium	164	25.0	32.1 (28.0, 36.5)
High	125	32.8	24.4 (20.7, 28.5)

Weightage was included in the analysis to account for the complex sample design.

4.2.2 Chronic pain interference

Pain interference of respondents with chronic pain were measured. Overall, 87.4% (95%CI 87.4, 90.2) of the study respondents with chronic pain experienced pain interference. Female had higher chronic pain interference (64.4%) compared to male respondents (35.6%). Older age group respondents experienced greater chronic pain interference (63.3%) than their younger counterparts (36.7%). Table 4.5 presents baseline chronic pain interference of study respondents.

Table 4.5: Baseline chronic pain interference of study respondents

Variable	No pain interference		With pain interference	
	Unweighted count	Weighted prevalence (95%CI)	Unweighted count	Weighted prevalence (95%CI)
Overall	60	12.6 (9.8, 16.1)	441	87.4 (83.9, 90.2)
Sex				
Male	18	31.1 (20.3, 44.5)	159	35.6 (31.1, 40.4)
Female	42	68.9 (55.5, 79.7)	282	64.4 (59.6, 68.9)
Age group				
60-69	32	52.2 (39.2, 64.9)	164	36.7 (32.2, 41.5)
≥70	28	47.8 (35.1, 60.8)	277	63.3 (58.5, 67.8)
Education				
No formal education	9	16.8 (8.9, 29.4)	73	17.6 (14.1, 21.6)
Primary education	33	53.7 (40.6, 66.4)	284	63.5 (58.7, 68.1)
Secondary or tertiary education	18	29.5 (19.0, 42.7)	84	18.9 (15.4, 23.0)
Ethnicity				
Malay	59	98.2 (88.4, 99.8)	410	92.0 (88.8, 94.4)
Chinese	0	0	10	2.5 (1.3, 4.6)
Indian	1	1.8 (0.2, 11.6)	21	5.5 (3.6, 8.3)
Others	0	0	0	0
Marital status				
Married	37	61.0 (47.7, 72.9)	249	56.6 (51.8, 61.4)
Divorced	1	1.1 (0.2, 7.5)	6	1.0 (0.5, 2.3)
Widowed	21	35.4 (24.0, 48.7)	176	40.6 (36.0, 45.5)
Single	1	2.5 (0.4, 15.8)	8	1.7 (0.8, 3.4)

'Table 4.5, continued'

Variable	No pain interference		With pain interference	
	Unweighted count	Weighted prevalence (95%CI)	Unweighted count	Weighted prevalence (95%CI)
Living arrangements				
Living with spouse and/or children	49	82.7 (70.6, 90.5)	348	78.4 (74.1, 82.1)
Living alone	9	14.2 (7.2, 26.0)	58	12.8 (9.9, 16.4)
Living with others	2	3.1 (0.7, 11.7)	35	8.8 (6.3, 12.1)
Monthly household income				
Low	21	37.4 (25.6, 51.0)	189	44.4 (39.6, 49.3)
Medium	19	30.1 (19.7, 43.1)	144	32.3 (27.9, 37.0)
High	19	32.5 (21.3, 46.2)	106	23.3 (19.5, 27.6)

Weightage was included in the analysis to account for the complex sample design.

4.3 Chronic pain and ADL disability

4.3.1 Descriptive analysis

The ADL disability prevalence was 5.16% (95%CI 4.30, 6.18). Of those with chronic pain, 11.08% reported having ADL disability. On the other hand, only 3.54% of respondents without chronic pain had ADL disability. Figure 4.2 shows the prevalence of ADL disability among respondents with chronic pain and no chronic pain.

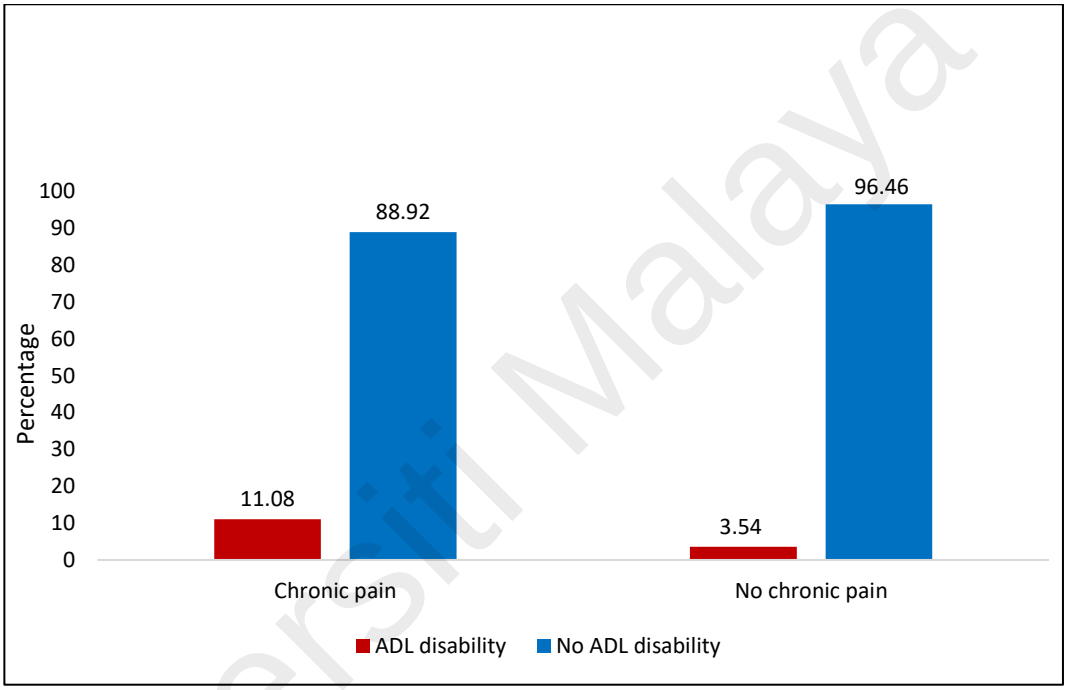

Figure 4.2: Prevalence of ADL disability between respondents with chronic pain and no chronic pain

4.3.2 Cross-sectional association between chronic pain and ADL disability

In the adjusted analysis, chronic pain, older age group, no formal education, primary education, low monthly household income, comorbidities, depressive symptoms, impaired cognitive status, poor self-rated health, low social support and physical activity were associated with ADL disability.

In the first multivariable model, only chronic pain and physical activity had significant association with ADL disability (Appendix H). Sex and age group variables remained in adjusted model due to their clinical significance. In the adjusted multivariable model, chronic pain, older age group and physical activity showed significant associations with ADL disability. Interaction terms between chronic pain and sex (OR 0.89; 95%CI 0.36, 2.21; p=0.804); chronic pain and age group (OR 0.63; 95%CI 0.21, 1.88; p=0.407) were tested. Both interaction terms were not significant. Table 4.6 presents the adjusted and unadjusted cross-sectional associations between chronic pain and ADL disability.

In the adjusted model, multicollinearity of independent variables was tested using VIF test. Multicollinearity has not been detected (VIF ranges from 1.01-1.08). Subsequently, we tested the goodness of fit of the adjusted model. The p-value of Hosmer-Lemeshow test showed evidence of poor fit ($p<0.001$). In contrast, 94.89% of the observed values for dependent outcome and the predicted values was correctly classified, hence the assumption of classification table was met. The Area Under Curve of ROC curve was 0.8537 and therefore the model can precisely differentiate 85% of the cases. In summary, two out of three assumption tests demonstrated the adjusted model was fit. Therefore, we assumed the final model was fit.

Table 4.6: Unadjusted and adjusted cross-sectional associations between chronic pain and ADL disability

Variable	Unadjusted model		Adjusted model	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Chronic pain				
No	1		1	
Yes	3.39 (2.29, 5.02)	<0.001	1.95 (1.25, 3.06)	0.003
Age group				
60-67	1		1	
≥70	4.11 (2.53, 6.66)	<0.001	1.90 (1.13, 3.21)	0.016
Sex				
Male	1		1	
Female	0.89 (0.60, 1.32)	0.561	0.86 (0.55, 1.35)	0.506
Education				
Secondary or tertiary education	1			
No formal education	3.67 (1.83, 7.34)	<0.001		
Primary education	2.32 (1.25, 4.33)	0.008		
Monthly household income				
High	1			
Low	1.94 (1.23, 3.05)	0.004		
Medium	0.94 (0.55, 1.63)	0.839		
Comorbidities	1.18 (1.01, 1.37)	0.123		

'Table 4.6, continued'

Variable	Unadjusted model		Adjusted model	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Depressive symptoms				
No	1			
Yes	1.65 (1.12, 2.44)	0.012		
Cognitive status				
Normal	1			
Impaired	4.02 (2.55, 6.34)	<0.001		
Self-rated health				
Good	1			
Poor	3.75 (2.52, 5.57)	<0.001		
Social support				
High	1			
Low	2.30 (1.52, 3.48)	<0.001		
Physical activity	0.97 (0.96, 0.98)	<0.001	0.97 (0.96, 0.98)	<0.001
Obese				
No	1			
Yes	0.72 (0.41, 1.27)	0.257		

Weightage was included in the analysis to account for the complex sample design.
Akaike Information Criterion (AIC) = 5813.47

4.3.3 Longitudinal association between chronic pain and ADL disability

Generalized Estimating Equation (GEE) analysis was conducted to determine the longitudinal association between chronic pain and ADL disability. We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. We did not detect multicollinearity between any of the independent variables in the collinearity tests.

The modified Poisson regression approach was used to estimate the relative risks (Yelland et al., 2011). The distribution of outcome variable was set as Poisson. The link function was set as log. For correlation structure, the unstructured correlation structure was set to allow all possible correlations. We conducted GEE analysis on both completed case and imputed data. The results of both analyses were fairly consistent. However, multiple imputation had generally increased the precision of estimates which could be seen through smaller standard errors across variables. Therefore, we presented the findings of imputed data in the result section. The findings of complete case analysis were shown in the appendix section (Appendix J and K).

4.3.3.1 Management of missing data

Three covariates; social support, physical activity and obesity had missing data more than 5%. Missing data mechanism analysis conducted in the previous section had assumed the missingness of these three covariates were MAR (section 4.1.4.2). On the other hand, missing data of ADL disability variable at baseline and twelve months follow-up were less than 1%. As a result, only the three covariates were managed with multiple imputation. Multiple imputation by chained equation was used to address the missing data

more than 5% to attenuate biased estimates. Twenty data sets were generated and variables involved were physical activity, social support and obesity.

4.3.3.2 GEE analysis

In the unadjusted GEE analysis, chronic pain, older age group, low monthly household income, impaired cognitive status and poor self-rated health were associated with higher risk of ADL disability. In contrast, physical activity was found to have protective effect.

In the first multivariable model, chronic pain and physical activity had significant associations with an increased risk ADL disability (Appendix I). In the adjusted multivariable model, chronic pain had significant association with increased risk of ADL disability and physical activity was found to be a protective factor.

Interaction terms between chronic pain and sex (RR 0.84; 95%CI 0.34, 2.12; p=0.723); chronic pain and age (RR 1.79; 95%CI 0.61, 5.21; p=0.288) were tested. Both interaction terms were not significant. Table 4.7 presents the adjusted and unadjusted longitudinal associations between chronic pain and ADL disability using imputed data.

Table 4.7: Unadjusted and adjusted longitudinal associations between chronic pain and ADL disability using imputed data

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	RR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	3.10 (1.95, 4.95)	<0.001	2.14 (1.38, 3.46)	0.001
Age group				
60-67	1		1	
≥70	3.06 (1.80, 5.21)	<0.001	1.65 (0.94, 2.86)	0.080
Sex				
Male	1		1	
Female	1.25 (0.76, 2.03)	0.373	1.17 (0.73, 1.88)	0.507
Education				
Secondary or tertiary education	1			
No formal education	2.23 (0.97, 5.05)	0.060		
Primary education	1.57 (0.78, 3.19)	0.206		
Monthly household income				
High	1			
Low	2.61 (1.40, 4.85)	0.002		
Medium	1.62 (0.83, 3.16)	0.164		
Comorbidities	1.20 (1.01, 1.43)	0.042		

'Table 4.7, continued'

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	RR (95%CI)	P-value
Depressive symptoms				
No	1			
Yes	1.39 (0.85, 2.25)	0.184		
Cognitive status				
Normal	1			
Impaired	2.05 (1.28, 3.29)	0.003		
Self-rated health				
Good	1			
Poor	2.16 (1.36, 3.46)	0.001		
Social support				
High	1			
Low	1.39 (0.78, 2.48)	0.264		
Physical activity	0.98 (0.97, 0.98)	<0.001	0.98 (0.97, 0.99)	<0.001
Obese				
No	1			
Yes	1.06 (0.64, 1.75)	0.814		

Weightage was included in the analysis to account for the complex sample design.
QIC = 611.98

4.4 Chronic pain and IADL disability

4.4.1 Descriptive analysis

The IADL disability prevalence was 30.27% (95%CI 28.31, 32.32). A total of 50.84% respondents with chronic pain had IADL disability. In contrast, only 24.85% of respondents without chronic pain had IADL disability. Figure 4.3 illustrates the prevalence of IADL disability among respondents with chronic pain and no chronic pain.

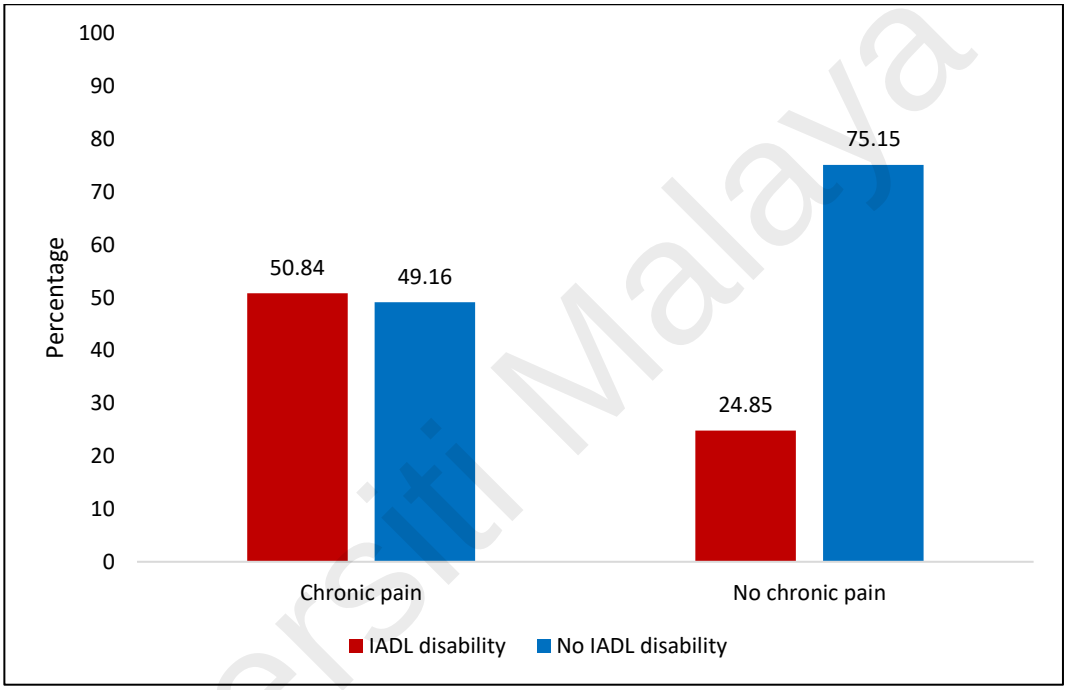

Figure 4.3: Prevalence of IADL disability among respondents with chronic pain and no chronic pain

4.4.2 Cross-sectional association between chronic pain and IADL disability

In the adjusted analysis, chronic pain, older age group, sex, no formal education, primary education, low monthly household income, medium monthly household income, comorbidities, depressive symptoms, impaired cognitive status, poor self-rated heath, low social support and physical activity had significant associations with IADL disability.

In the first multivariable model, chronic pain, older age group, sex, comorbidities, impaired cognitive status, poor self-rated health, low social support and physical activity had significant associations with IADL disability (Appendix L). In the adjusted model, eight variables demonstrated significant associations with IADL disability. These were chronic pain, older age group, sex, comorbidities, impaired cognitive status, poor self-rated health, low social support and physical activity. Interaction terms between chronic pain and sex (OR 1.32; 95%CI 0.74, 2.36; p=0.340); chronic pain and age group (OR 1.42; 95%CI 0.80, 2.53; p=0.234) were tested. Both interaction terms showed no significant associations. Table 4.8 shows the unadjusted and adjusted cross-sectional associations between chronic pain and IADL disability.

In the adjusted model, VIF test revealed no multicollinearity of independent variables (VIF ranges from 1.08-1.18). We tested the goodness of fit of the final model. First, the Hosmer-Lemeshow test revealed no evidence of poor fir (p=0.2861). Second, 77.41% of the observed values for the dependent outcome and the predicted values was correctly classified, hence the assumption of classification was met. Third, the AUC of ROC curve was 0.8035 and hence the final model can accurately discriminate 80% of the cases. In short, the adjusted model was fit.

Table 4.8: Unadjusted and adjusted cross-sectional associations between chronic pain and IADL disability

Variable	Unadjusted model		Adjusted model	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	3.13 (2.51, 3.90)	<0.001	1.86 (1.39, 2.49)	<0.001
Age group				
60-67	1		1	
≥70	3.24 (2.64, 3.97)	<0.001	2.03 (1.57, 2.62)	<0.001
Sex				
Male	1		1	
Female	1.99 (1.62, 2.45)	<0.001	1.88 (1.44, 2.45)	<0.001
Education				
Secondary or tertiary education	1			
No formal education	4.25 (3.04, 5.95)	<0.001		
Primary education	2.13 (1.63, 2.78)	<0.001		
Monthly household income				
High	1			
Low	2.79 (2.20, 3.55)	<0.001		
Medium	1.67 (1.30, 2.16)	<0.001		
Comorbidities	1.31 (1.22, 1.41)	<0.001	1.12 (1.01, 1.23)	0.025

'Table 4.8, continued'

Variable	Unadjusted model		Adjusted model	
	OR (95% CI)	P-value	OR (95%CI)	P-value
Cognitive status				
Normal	1		1	
Impaired	3.99 (3.25, 4.89)	<0.001	2.24 (1.74, 2.89)	<0.001
Self-rated health				
Good	1		1	
Poor	3.93 (3.22, 4.80)	<0.001	2.79 (2.16, 3.60)	<0.001
Social support				
High	1		1	
Low	1.52 (1.20, 1.92)	<0.001	1.42 (1.05, 1.02)	0.022
Physical activity	0.99 (0.98, 0.99)	<0.001	0.999 (0.99, 0.99)	<0.001
Obese				
No	1			
Yes	0.92 (0.75, 1.14)	0.453		

Weightage was included in the analysis to account for the complex sample design.
Akaike Information Criterion (AIC) = 15421.57

4.4.3 Longitudinal association between chronic pain and IADL disability

Generalized Estimating Equation (GEE) analysis was conducted to determine the longitudinal association between chronic pain and IADL disability. We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. We did not detect multicollinearity between any of the independent variables in the collinearity tests.

The modified Poisson regression approach was used to estimate the relative risks (Yelland et al., 2011). The distribution of outcome variable was set as Poisson. The link function was set as log. For correlation structure, the unstructured correlation structure was set to allow all possible correlations. We conducted GEE analysis on both completed data and imputed data. The results of both analyses were fairly consistent. The results of imputed data analysis had smaller standard errors across variables which indicated better precision of estimates. Therefore, we presented the findings of imputed data in the result section. Findings of complete case analysis were shown in the appendix section (Appendix N and O).

4.4.3.1 Management of missing data

IADL disability has baseline missing data of 7.57% and 1.16% at twelve month follow up. As a result, the missing mechanism of IADL disability at baseline and the three covariates with more than 5% missing data were tested using Little's MCAR test. The Little's MCAR result was significant. Hence, the missing data in all four variables was not MCAR. Three covariates with more than 5% missing data were assumed MAR in the previous section (section 4.1.4.2).

For baseline IADL disability variable, logistic regression, one of the methods to assist in differentiating between MAR and MNAR (Fielding et al., 2009) was adopted to examine the mechanism of missingness. Logistic regression was conducted to determine which variable predicted missingness. Table 4.9 shows logistic regression between baseline IADL disability and missingness.

The logistic regression model was statistically significant ($p<0.01$). The missingness can be predicted by observed data in chronic pain, low monthly household income and comorbidities. Other variables were not related to missingness. Therefore, the missing data mechanism of baseline IADL disability was assumed to be MAR.

Multiple imputation by chained equation were used to address the missing data more than 5% to attenuate biased estimates. Twenty data sets were generated and variables involved were physical activity, social support, obesity and baseline IADL variable.

Table 4.9: Logistic regression between baseline IADL disability and missingness

Variable	OR (95%CI)	P-value
Chronic pain		
No	1	
Yes	1.97 (1.23, 3.14)	0.005
Age group		
60-67	1	
≥70	1.53 (0.96, 2.45)	0.074
Sex		
Male	1	
Female	1.55 (0.96, 2.49)	0.073
Education		
Secondary or tertiary education	1	
No formal education	1.38 (0.64, 2.99)	0.412
Primary education	0.78 (0.46, 1.35)	0.383
Monthly household income		
High	1	
Low	1.87 (1.05, 3.31)	0.033
Medium	1.67 (0.99, 2.83)	0.056
Comorbidities	0.40 (0.30, 0.54)	<0.001
Depressive symptoms		
No	1	
Yes	0.73 (0.45, 1.19)	0.205
Cognitive status		
Normal	1	
Impaired	1.11 (0.73, 1.69)	0.630
Self-rated health		
Good	1	
Poor	0.64 (0.40, 1.02)	0.063
Social support		
High	1	
Low	0.87 (0.53, 1.42)	0.567
Physical activity	1.00 (0.99, 1.00)	0.174
Obese		
No	1	
Yes	1.25 (0.79, 1.99)	0.341

4.4.3.2 GEE analysis

In the unadjusted analysis, chronic pain, older age group, sex, no formal education, primary education, low monthly household income, comorbidities, impaired cognitive status and low social support had significant associations with higher risk of IADL disability. Physical activity was found to have protective effect.

The first multivariable analysis model revealed that chronic pain, older age group, sex, no formal education, primary education, comorbidities and physical activity had significant associations with IADL disability (Appendix M). In the adjusted model, six variables were associated with an increased risk of IADL disability. These were chronic pain, older age group, sex, no formal education, comorbidities. Physical activity was found to be a protective factor.

Interaction terms between chronic pain and sex (RR 0.90; 95%CI 0.48, 1.70; p=0.750); chronic pain and age group (RR 1.40; 95%CI 0.88, 2.24; p=0.159) were tested. Both interaction terms were not significant. Table 4.10 illustrates the unadjusted and adjusted longitudinal associations between chronic pain and IADL disability using imputed data.

Table 4.10: Unadjusted and adjusted longitudinal associations between chronic pain and IADL disability using imputed data

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	RR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	1.40 (1.10, 1.78)	0.006	1.30 (1.04, 1.62)	0.019
Age group				
60-67	1		1	
≥70	1.90 (1.56, 2.32)	<0.001	1.44 (1.18, 1.75)	<0.001
Sex				
Male	1		1	
Female	3.31 (2.51, 4.37)	<0.001	2.79 (2.11, 3.68)	<0.001
Education				
Secondary or tertiary education	1		1	
No formal education	5.55 (3.93, 7.85)	<0.001	2.94 (2.03, 4.25)	<0.001
Primary education	2.40 (1.72, 3.36)	<0.001	1.90 (1.36, 2.66)	<0.001
Monthly household income				
High	1			
Low	1.83 (1.45, 2.32)	<0.001		
Medium	1.14 (0.88, 1.49)	0.320		
Comorbidities	1.12 (1.03, 1.21)	0.005	1.08 (1.003, 1.17)	0.043

'Table 4.10, continued'

Variable	Unadjusted model		Adjusted model	
	Unadjusted RR (95%CI)	P-value	Adjusted RR (95%CI)	P-value
Depressive symptoms				
No	1			
Yes	1.10 (0.89, 1.36)	0.378		
Cognitive status				
Normal	1			
Impaired	1.98 (1.63, 2.40)	<0.001		
Self-rated health				
Good	1			
Poor	1.08 (0.87, 1.35)	0.490		
Social support				
High	1			
Low	1.37 (1.08, 1.73)	0.009		
Physical activity	0.99 (0.99, 0.99)	<0.001	0.99 (0.99, 0.99)	<0.001
Obese				
No	1			
Yes	1.05 (0.85, 1.28)	0.668		

Weightage was included in the analysis to account for the complex sample design
Results from imputation 1
QIC = 11658.87

4.5 Chronic pain and slow walking speed

4.5.1 Descriptive analysis

The prevalence of slow walking speed was 69.43% (95%CI 67.36, 71.43). Among respondents with chronic pain, 81.13% had slow walking speed. On the other hand, 66.56% of respondents without chronic pain were reported to have slow walking speed. Figure 4.4 presents the prevalence of slow walking speed among respondents with chronic pain and no chronic pain.

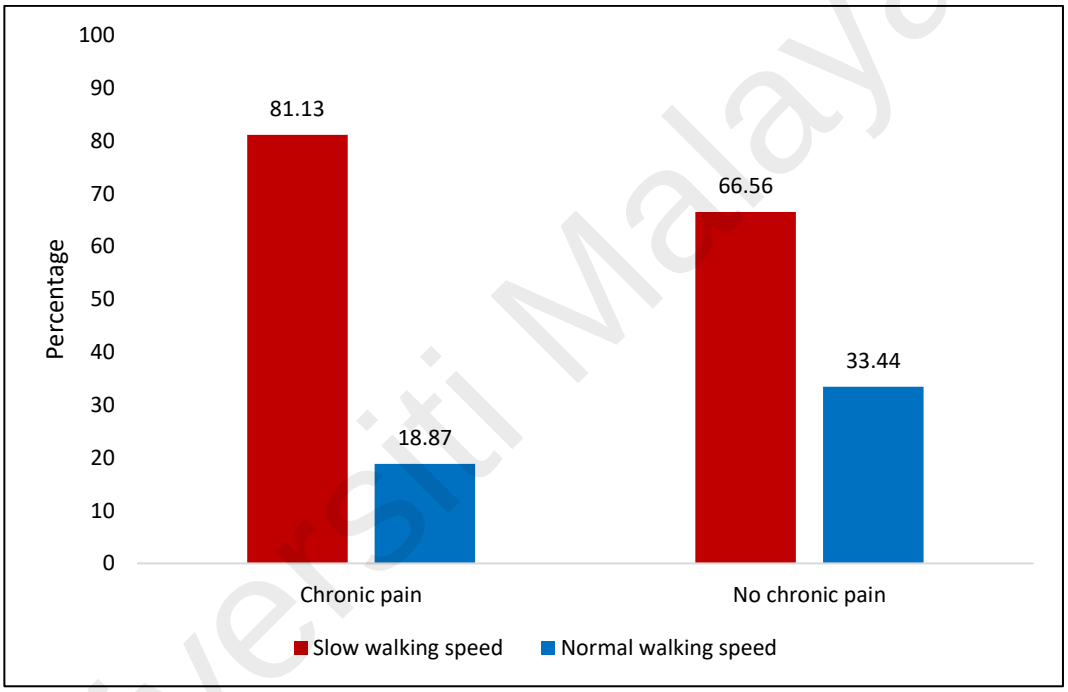

Figure 4.4: Prevalence of walking slow walking speed between respondents with chronic pain and no chronic pain

4.5.2 Cross-sectional association between chronic pain and slow walking speed

In the unadjusted analysis, chronic pain, older age group, sex, no formal education, primary education, low monthly household income, medium monthly household income, comorbidities, impaired cognitive status, poor self-rated health and physical activity were significantly associated with slow walking speed.

The first multivariable model showed that chronic pain was no longer had significant association with slow walking speed. Variables with significant associations with slow walking speed were older age group, sex, low monthly household income, comorbidities, impaired cognitive status, poor self-rated health and physical activity (Appendix P).

In the adjusted multivariable model, seven variables had significant association with slow walking speed. These were older age group, sex, low monthly household income, comorbidities, impaired cognitive status, poor self-rated health and physical activity. Nevertheless, chronic pain did not have significant association with slow walking speed (OR 1.35; 0.99, 1.84). Interaction terms between chronic pain and sex (OR 1.08; 95%CI 0.59, 1.97; p=0.809); chronic pain and age group (OR 1.75; 95%CI 0.91, 3.36; p=0.094) were tested. Both interaction terms were not significant. Table 4.11 shows the unadjusted and adjusted associations of chronic pain and slow walking speed.

In the adjusted model, VIF test found no multicollinearity of independent variables (VIF ranges from 1.10-1.18). We tested the goodness of fit of the final model. The Hosmer-Lemeshow test show no evidence of poor fit (p=0.937). Besides, 74.05% of the observed values for the dependent outcome and predicted values was correctly classified, therefore the assumption of classification table was met. The AUC of ROC curve was 0.7633 and the final model can accurately differentiate 76% of the cases. In short, the adjusted model was fit.

Table 4.11: Unadjusted and adjusted cross sectional associations between chronic pain and slow walking speed

Variable	Unadjusted model		Adjusted model	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	2.16 (1.64, 2.84)	<0.001	1.35 (0.99, 1.84)	0.055
Age group				
60-67	1		1	
≥70	3.28 (2.67, 4.03)	<0.001	2.38 (1.87, 3.03)	<0.001
Sex				
Male	1		1	
Female	2.38 (1.96, 2.90)	<0.001	2.24 (1.77, 2.83)	<0.001
Education				
Secondary or tertiary education	1			
No formal education	5.60 (3.83, 8.18)	<0.001		
Primary education	2.41 (1.93, 3.00)	<0.001		
Monthly household income				
High	1		1	
Low	3.18 (2.47, 4.09)	<0.001	1.51 (1.16, 1.98)	0.002
Medium	1.53 (1.22, 1.93)	<0.001		
Comorbidities	1.31 (1.21, 1.43)	<0.001	1.19 (1.08, 1.31)	<0.001

'Table 4.11, continued'

Variable	Unadjusted model		Adjusted model	
	OR (95% CI)	P-value	OR (95% CI)	P-value
Depressive symptoms				
No	1			
Yes	1.11 (0.90, 1.36)	0.336		
Cognitive status				
Normal	1		1	
Impaired	2.98 (2.40, 3.70)	<0.001	1.63 (1.26, 2.10)	<0.001
Self-rated health				
Good	1		1	
Poor	1.97 (1.58, 2.45)	<0.001	1.53 (1.17, 2.00)	0.002
Social support				
High	1	0.343		
Low	1.13 (0.88, 1.46)			
Physical activity	0.99 (0.99, 0.99)	<0.001	0.99 (0.99, 0.99)	<0.001
Obese				
No	1			
Yes	1.16 (0.95, 1.42)	0.151		

Weightage was included in the analysis to account for the complex sample design.
Akaike Information Criterion (AIC) = 17923.25

4.5.3 Longitudinal association between chronic pain and slow walking speed

Generalized estimating equation (GEE) analysis was conducted to determine the longitudinal association between chronic pain and slow walking speed. We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. We did not detect multicollinearity between any of the independent variables in the collinearity tests.

The modified Poisson regression approach was used to estimate the relative risks (Yelland et al., 2011). The distribution of outcome variable was set as Poisson. The link function was set as log. For correlation structure, the unstructured correlation structure was set to allow all possible correlations. We conducted analysis on both complete case and imputed data. The results of both analyses were fairly consistent. The results of imputed data analysis had smaller standard errors across variables which indicated better precision of estimates. Therefore, we presented the findings of imputed data in the result section. Findings f complete case analysis was presented in the appendix section (Appendix R, S and T).

4.5.3.1 Management of missing data

At baseline, walking speed variable had 8.04% missing data and 8.58% missing data at twelve months follow-up. Little's MCAR test was conducted on the walking speed at baseline and twelve months follow-up and the three covariates with missing data more than 5% to determine the missing mechanism. The result of Little's MCAR test was significant. The missing data of the five variables were not MCAR. Three covariates with more than 5% missing data were assumed MAR in the previous section (section 4.1.4.2).

Logistic regression, one of the methods to assist in differentiating between MAR and MNAR (Fielding et al., 2009) was adopted to determine the missing data mechanism of walking speed at baseline and twelve months follow-up. Logistic regression was then run to see which variable predicted missingness.

The logistic regression model between baseline waking speed and missingness was statistically significant, ($p<0.01$). Missingness of walking speed at baseline can be predicted by observed data in older age group, physical activity and obesity. Other variables were not related to missingness. Therefore, the mechanism of missing data of walking speed at baseline was assumed to be MAR. Table 4.12 shows logistic regression between baseline walking speed and missingness.

The logistic regression model between walking speed at twelve months follow-up and missingness was statistically significant, ($p<0.01$). Missingness of walking speed at twelve months follow-up can be predicted by observed data low social support and physical activity. Other variables were not related to missingness. Therefore, the missing data of walking speed at twelve months follow-up was assumed to be MAR. Table 4.13 shows logistic regression between walking speed at twelve months follow-up and missingness.

Multiple imputation by chained equation was used to address the missing data more than 5% to attenuate biased estimates. Twenty data sets were generated and variables involved were physical activity, social support, obesity, baseline walking speed and walking speed at twelve months follow-up.

Table 4.12: Logistic regression between baseline walking speed and missingness

Variable	OR (95%CI)	P -value
Chronic pain		
No	1	
Yes	1.03 (0.51, 2.05)	0.944
Age group		
60-67	1	
≥70	2.13 (1.07, 4.25)	0.032
Sex		
Male	1	
Female	0.95 (0.48, 1.89)	0.889
Education		
Secondary or tertiary education	1	
No formal education	0.66 (0.26, 1.57)	0.331
Primary education	0.64 (0.79, 1.27)	0.990
Monthly household income		
High	1	
Low	1.51 (0.60, 3.79)	0.377
Medium	1.17 (0.47, 2.93)	0.735
Comorbidities	1.00 (0.79, 1.27)	0.990
Depressive symptoms		
No	1	
Yes	1.05 (0.56, 1.99)	0.876
Cognitive status		
Normal	1	
Impaired	1.20 (0.66, 2.21)	0.550
Self-rated health		
Good	1	
Poor	1.35 (0.71, 2.58)	0.358
Social support		
High	1	
Low	0.80 (0.34, 1.88)	0.608
Physical activity	0.99 (0.99, 0.99)	0.022
Obese		
No	1	
Yes	2.06 (1.07, 3.95)	0.030

Table 4.13: Logistic regression between walking speed at twelve months follow-up and missingness

Variable	OR (95%CI)	P-value
Chronic pain		
No	1	
Yes	1.31 (0.98, 1.74)	0.065
Age group		
60-67	1	
≥70	1.29 (0.98, 1.70)	0.069
Sex		
Male	1	
Female	1.18 (0.90, 1.53)	0.227
Education		
Secondary or tertiary education	1	
No formal education	0.61 (0.37, 1.01)	0.055
Primary education	0.81 (0.59, 1.12)	0.207
Monthly household income		
High	1	
Low	1.10 (0.80, 1.51)	0.566
Medium	0.92 (0.68, 1.25)	0.604
Comorbidities	1.02 (0.92, 1.13)	0.728
Depressive symptoms		
No	1	
Yes	0.92 (0.72, 1.18)	0.519
Cognitive status		
Normal	1	
Impaired	1.30 (0.98, 1.72)	0.065
Self-rated health		
Good	1	
Poor	1.11 (0.86, 1.44)	0.416
Social support		
High	1	
Low	1.54 (1.16, 2.06)	0.003
Physical activity	0.99 (0.99, 0.99)	<0.001
Obese		
No	1	
Yes	0.94 (0.72, 1.23)	0.641

4.5.3.2 GEE analysis

Eight variables had significant associations with an increased risk of slow walking speed in the unadjusted model. These variables were older age group, sex, no formal education, primary education, low monthly household income, comorbidities, impaired cognitive status and physical activity. However, chronic pain was not associated with an increased risk of slow walking speed (RR 1.01; 95%cI 0.78, 1.31).

The first multivariable model found older age group and no formal education were significantly associated with higher risk of slow walking speed. Chronic pain remained no significant association with an increased risk of slow walking speed (Appendix Q). In the adjusted multivariable model, older age group and no formal education were associated an increased risk of slow walking speed. Chronic pain was not associated with higher risk of slow walking speed (RR=0.94, 95%CI 0.73, 1.21).

Interaction terms between chronic pain and sex (RR 1.17; 95%CI 0.70, 1.96; p=0.548); chronic pain and age group (RR 1.21; 95%CI 0.74, 2.00; p=0.445) were tested. Both interaction terms were not significant. Table 4.14 illustrates the unadjusted and adjusted longitudinal associations between chronic pain and slow walking speed using imputed data.

Table 4.14: Unadjusted and adjusted longitudinal associations between chronic pain and slow walking speed using imputed data

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	(95%CI)	P-value
Chronic pain				
No	1		1	
Yes	1.01 (0.78, 1.31)	0.934	1.01 (0.79, 1.29)	0.935
Age group				
60-67	1		1	
≥70	1.69 (1.43, 2.00)	<0.001	1.61 (1.35, 1.92)	<0.001
Sex				
Male	1		1	
Female	1.24 (1.04, 1.47)	0.018	1.19 (0.99, 1.43)	0.055
Education				
Secondary or tertiary education	1		1	
No formal education	2.27 (1.78, 2.89)	<0.001	1.36 (1.10, 1.69)	0.005
Primary education	1.38 (1.11, 1.71)	0.003	-	
Monthly household income				
High	1			
Low	1.36 (1.10, 1.69)	0.005		
Medium	1.19 (0.97, 1.45)	0.101		
Comorbidities	1.07 (0.99, 1.15)	0.056		

'Table 4.14, continued'

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	(95%CI)	P-value
Depressive symptoms				
No	1			
Yes	1.18 (0.96, 1.44)	0.114		
Cognitive status				
Normal	1			
Impaired	1.31 (1.10, 1.57)	0.003		
Self-rated health				
Good	1			
Poor	1.08 (0.88, 1.31)	0.477		
Social support				
High	1			
Low	1.09 (0.87, 1.35)	0.458		
Physical activity	0.99 (0.99, 0.99)	0.002		
Obese				
No	1			
Yes	1.08 (0.90, 1.31)	0.398		

Weightage was included in the analysis to account for the complex sample design.
Results from imputation 1.
QIC = 1299.67

4.6 Chronic pain and low handgrip strength

4.6.1 Descriptive analysis

The prevalence of low handgrip strength was 68.49% (95%CI 66.41, 70.50). Among respondents with chronic pain, 77.89% had low handgrip strength. In contrast, only 66.14% of those without chronic pain had low handgrip strength. Figure 4.5 showed the prevalence of low handgrip strength among respondents with chronic pain and no chronic pain.

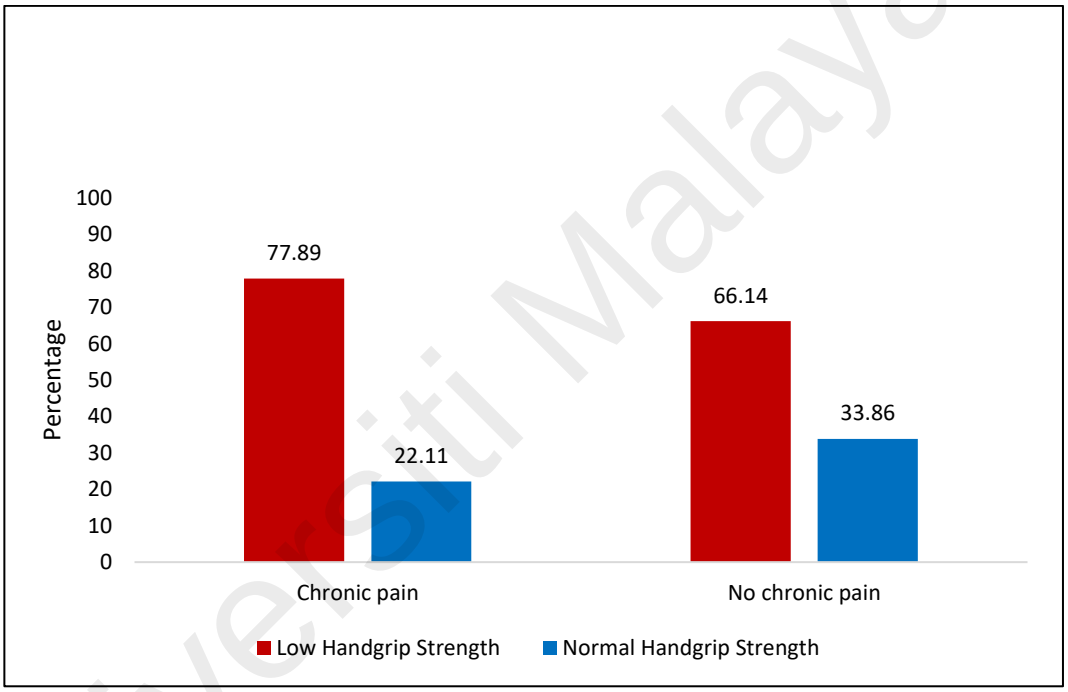

Figure 4.5: Prevalence of handgrip strength between respondents with chronic pain and no chronic pain

4.6.2 Cross-sectional association between chronic pain and low handgrip strength

In the adjusted analysis, chronic pain, older age group, sex, no formal education, primary education, low monthly household income, medium monthly household income, comorbidities, impaired cognitive status poor self-rated health and physical activity had significant associations with low handgrip strength.

In the first multivariable mode, older age group, sex, low monthly household income, medium monthly household income, impaired cognitive status, poor self-rated health and physical activity were significantly associated with low handgrip strength (Appendix U). However, chronic pain no longer had significant association with low handgrip strength.

Interaction term between chronic pain and age (OR 0.65; 95%CI 0.35, 1.19; p=0.165) was not significant. In contrast, interaction term between chronic pain and sex (OR 0.53; 95%CI 0.29, 0.96; p=0.036) was found to be significant. Therefore, we added the interaction term of chronic pain and sex in the adjusted model.

In the adjusted multivariable model, chronic pain had a significant association with low handgrip strength (OR 1.65; 95%CI 1.06, 2.57). Older age group, sex, low monthly household income, medium month household income, impaired cognitive status, poor self-rated health and physical activity had significant associations with low handgrip strength. Table 4.15 presents the adjusted and adjusted cross-sectional associations between chronic pain and low handgrip strength.

VIF test revealed no multicollinearity of independent variables in the adjusted multivariable model (VIF ranges from 1.10-1.53). We tested the goodness of fit of the adjusted model. Hosmer-Lemeshow test did not show evidence of poor fit (p=0.1026). Besides, 74.24% of the observed values for the dependent outcome and the predicted values was correctly classified, therefore, the assumption of classification table was met.

The AUC of ROC curve was 0.7715 and hence the model can precisely differentiate 77% of the cases. In summary, the adjusted model was fit.

Table 4.15: Unadjusted and adjusted cross sectional associations between chronic pain and low handgrip strength

Variable	Unadjusted model		Adjusted model	
	Or (95%CI)	P-value	OR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	1.80 (1.40, 2.32)	<0.001	1.65 (1.06, 2.57)	0.026
Age group				
60-67	1		1	
≥70	2.55 (2.09, 3.10)	<0.001	1.71 (1.35, 2.17)	<0.001
Sex				
Male	1		1	
Female	2.75 (2.26, 3.34)	<0.001	2.95 (2.30, 3.79)	<0.001
Education				
Secondary or tertiary education	1			
No formal education	5.14 (3.54, 7.56)	<0.001		
Primary education	2.31 (1.86, 2.87)	<0.001		
Monthly household income				
High	1		1	
Low	3.74 (2.92, 4.80)	<0.001	2.05 (1.54, 2.73)	<0.001
Medium	1.87 (1.49, 2.36)	<0.001	1.46 (1.12, 1.90)	0.005
Comorbidities	1.23 (1.14, 1.33)	<0.001		

'Table 4.15, continued'

Variable	Unadjusted model		Adjusted model	
	OR (95%CI)	P-value	OR (95%CI)	P-value
Depressive symptoms				
No	1			
Yes	0.99 (0.81, 1.22)	0.935		
Cognitive status				
Normal	1		1	
Impaired	3.66 (2.94, 4.55)	<0.001	1.92 (1.49, 2.49)	<0.001
Self-rated health				
Good	1		1	
Poor	2.68 (2.14, 3.37)	<0.001	2.50 (1.92, 3.25)	<0.001
Social support				
High	1			
Low	1.05 (0.81, 1.34)	0.728		
Physical activity	0.99 (0.99, 0.99)	<0.001	0.99 (0.99, 0.99)	<0.001
Obese				
No	1			
Yes	0.86 (0.71, 1.06)	0.153		
Chronic pain*sex			0.53 (0.29, 0.96)	

Weightage was included in the analysis to account for the complex sample design.
Akaike Information Criterion (AIC) = 18533.36

4.6.3 Longitudinal association between chronic pain and low handgrip strength

Generalized estimating equation (GEE) analysis was conducted to determine the longitudinal association between chronic pain and low handgrip strength. We excluded respondents with baseline outcome of interest to make sure that the respondents did not have outcome of interest in the longitudinal analysis. We did not detect multicollinearity between any of the independent variables in the collinearity tests.

The modified Poisson regression approach was used to estimate the relative risks (Yelland et al., 2011). The distribution of outcome variable was set as Poisson. The link function was set as log. For correlation structure, the unstructured correlation structure was set to allow all possible correlations. We conducted analysis on both complete case and imputed data. The results of both analyses were fairly consistent. The results of imputed data analysis had smaller standard errors across variables which indicated better precision of estimates. Therefore, we presented the findings of imputed data in the result section. Findings of complete case analysis was illustrated in the appendix section (Appendix W and X).

4.6.3.1 Management of missing data

Handgrip strength variable has 7.18% of missing data at baseline and 10.91% missing data at twelve months follow-up. Little's MCAR test was conducted on baseline handgrip strength, handgrip strength at twelve months follow-up and three covariates with missing data more than 5% to examine the missing mechanism. The result of Little's MCAR test was significant. Hence, the missing data of all five variables were not MCAR.

Three covariates with more than 5% missing data were assumed MAR in the previous section (section 4.1.4.2). Logistic regression, one of the methods to assist in differentiating between MAR and MNAR (Fielding et al., 2009) was adopted to determine the missing data mechanism for baseline handgrip strength and twelve months follow-up variables. Logistic regression was then run to see which variable predicted missingness.

The logistic regression model between baseline handgrip strength and missingness was statistically significant, ($p<0.01$). Missingness of variable handgrip strength at baseline can be predicted by observed data in poor self-rated health, social support and physical activity. Other variables were not related to missingness. Therefore, the missing data mechanism of handgrip strength at baseline is assumed to be MAR. Table 4.16 shows logistic regression between baseline handgrip strength and missingness.

The logistic regression model of handgrip strength at twelve months follow-up was statistically significant, ($p<0.01$). Missingness of handgrip strength at twelve months follow-up can be predicted by observed data in mild cognitive impairment, poor social support and physical activity. Other variables were not related to missingness. Therefore, the missing data mechanism of handgrip strength at twelve months follow-up is assumed to be MAR. Table 4.17 presents logistic regression between handgrip strength at twelve months follow-up and missingness.

Table 4.16: Logistic regression between baseline handgrip strength and missingness

Variable	OR (95%CI)	P-value
Chronic pain		
No	1	
Yes	0.73 (0.40, 1.32)	0.294
Age group		
60-67	1	
≥70	0.87 (0.52, 1.48)	0.614
Sex		
Male	1	
Female	1.12 (0.67, 1.88)	0.667
Education		
Secondary or tertiary education	1	
No formal education	1.38 (0.56, 3.41)	0.490
Primary education	1.24 (0.63, 2.41)	0.532
Monthly household income		
High	1	
Low	0.92 (0.49, 1.72)	0.786
Medium	1.01 (0.53, 1.91)	0.980
Comorbidities	1.15 (0.95, 1.40)	0.198
Depressive symptoms		
No	1	
Yes	0.90 (0.54, 1.48)	0.669
Cognitive status		
Normal	1	
Impaired	0.72 (0.45, 1.16)	0.176
Self-rated health		
Good	1	
Poor	2.87 (1.70, 4.83)	<0.001
Social support		
High	1	
Low	2.04 (1.22, 3.40)	0.006
Physical activity	0.99 (0.98, 0.99)	0.001
Obese		
No	1	
Yes	0.75 (0.45, 1.26)	0.278

Table 4.17: Logistic regression between handgrip strength at twelve months follow-up and missingness

Variable	OR (95%CI)	P-value
Chronic pain		
No	1	
Yes	1.29 (0.97, 1.70)	0.078
Age group		
60-67	1	
≥70	1.16 (0.90, 1.50)	0.258
Sex		
Male	1	
Female	1.02 (0.79, 1.31)	0.881
Education		
Secondary or tertiary education	1	
No formal education	0.72 (0.45, 1.17)	0.185
Primary education	0.96 (0.71, 1.31)	0.818
Monthly household income		
High	1	
Low	1.17 (0.87, 1.58)	0.302
Medium	0.88 (0.65, 1.18)	0.386
Comorbidities	1.02 (0.93, 1.12)	0.681
Depressive symptoms		
No	1	
Yes	0.87 (0.68, 1.12)	0.283
Cognitive status		
Normal	1	
Impaired	1.34 (1.03, 1.75)	0.031
Self-rated health		
Good	1	
Poor	0.97 (0.75, 1.25)	0.829
Social support		
High	1	
Low	1.37 (1.04, 1.82)	0.027
Physical activity	0.99 (0.99, 0.99)	<0.001
Obese		
No	1	
Yes	0.99 (0.77, 1.28)	0.950

4.6.3.2 GEE analysis

In the unadjusted model, chronic pain, older age group, sex, no formal education, low monthly household income, depressive symptoms and impaired cognitive status had significant associations with an increased risk of low handgrip strength. Physical activity was found have protective effect.

Variables older age group, sex, no formal education and depressive symptoms had significant associations with an increased risk of low handgrip strength in the first multivariable model. Nonetheless, chronic pain was no longer associated with higher risk of low handgrip strength (Appendix V).

In the adjusted multivariable model, chronic pain was not associated with an increased risk of low handgrip strength (RR=1.15; 95%CI 0.94, 1.40). In contrast, older age group, sex, no formal education and depressive symptoms had significant associations with higher risk of low handgrip strength. Interaction terms between chronic pain and sex (RR 0.75; 95%CI 0.49, 1.13; p=0.168); chronic pain and age (RR 1.21; 95%CI 0.80, 1.83; p=0.358) were tested. Both interaction terms were not significant. Table 4.18 presents the unadjusted and adjusted longitudinal associations between chronic pain low handgrip strength using imputed data.

Table 4.18: Unadjusted and adjusted longitudinal associations between chronic pain and low handgrip strength using imputed data

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	RR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	1.33 (1.08, 1.62)	0.006	1.15 (0.94, 1.40)	0.182
Age group				
60-67	1		1	
≥70	1.29 (1.08, 1.54)	0.004	1.31 (1.10, 1.56)	0.002
Sex				
Male	1		1	
Female	1.77 (1.48, 2.13)	<0.001	1.68 (1.39, 2.04)	<0.001
Education				
Secondary or tertiary education	1		1	
No formal education	2.00 (1.59, 2.53)	<0.001	1.51 (1.24, 1.84)	<0.001
Primary education	1.06 (0.86, 1.29)	0.601	-	-
Monthly household income				
High	1			
Low	1.45 (1.18, 1.79)	0.001		
Medium	1.08 (0.87, 1.34)	0.494		
Comorbidities	1.09 (1.01, 1.16))	0.019		

'Table 4.18, continued'

Variable	Unadjusted model		Adjusted model	
	RR (95%CI)	P-value	RR (95%CI)	P-value
Depressive symptoms				
No	1		1	
Yes	1.26 (1.05, 1.50)	0.011	1.26 (1.06, 1.50)	0.008
Cognitive status				
Normal	1			
Impaired	1.59 (1.33, 1.89)	<0.001		
Self-rated health				
Good	1			
Poor	1.15 (0.93, 1.42)	0.194		
Social support				
High	1			
Low	1.11 (0.89, 1.39)	0.353		
Physical activity	0.99 (0.99, 0.99)	0.017		
Obese				
No	1			
Yes	1.10 (0.92, 1.32)	0.280		

Weightage was included in the analysis to account for the complex sample design.
Results from imputation 1
QICC = 1346.83

4.7 Chronic pain and five-year mortality

4.7.1 Descriptive analysis

Mortality data was collected until December 2018, five years after completion of baseline assessment. According to the mortality data provided by the National Registry Department of Malaysia, 20.25% (n=471) of respondents were confirmed passed away. The mortality rate was higher among respondents having chronic pain (26.24%) compared to those not having chronic pain (18.51%). Male respondents had higher proportion of mortality rate (25.25%) compared to female counterparts (17.16%). Older respondents had more than twice the mortality rate than younger respondents. Table 4.19 presents the mortality status of study respondents based on socio-demographic characteristics from 2013 to 2018.

Table 4.19: Mortality Status of Study Respondents based on Socio-demographic Characteristics from 2013 to 2018

Variables	Overall, n	Dead, n (%)	Alive, n (%)
Chronic pain			
No	1820	337 (18.52)	1483 (81.48)
Yes	503	132 (26.24)	371 (73.76)
Sex			
Male	887	224 (25.25)	663 (74.75)
Female	1439	247 (17.16)	1192 (82.84)
Age group			
60-69	1114	131 (11.76)	983 (88.24)
≥70	1212	340 (28.05)	872 (71.95)
Education			
Primary education	349	92 (26.36)	257 (73.64)
Secondary or tertiary education	1423	303 (21.29)	1120 (78.71)
No formal education	547	75 (13.71)	472 (86.29)
Monthly household income			
Low	807	218 (27.01)	589 (72.99)
Medium	698	116 (16.62)	582 (83.38)
High	791	131 (16.56)	660 (83.44)

4.7.2 Survival analysis

Kaplan Meier Curve in Figure 4.6 shows the cumulative survival proportion against time of two groups: respondents with chronic pain and no chronic pain. Throughout these five years, respondents with no chronic pain had higher survival functions compared to respondents with chronic pain.

The mean survival time for respondent with chronic pain was 1618 days, and the mean for those with no pain was 1712 days. Log-rank test revealed a significant difference between the survival functions of bother groups with Chi-square value of 17.16 and p-value less than 0.001.

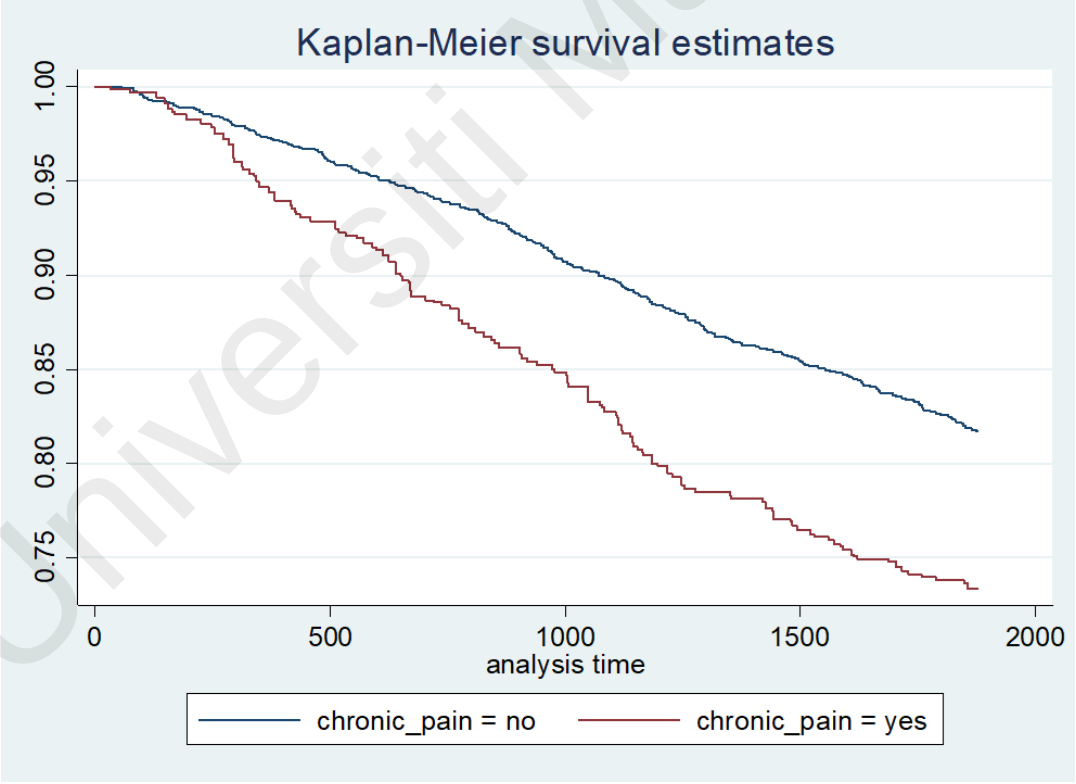

Figure 4.6: Kaplan Meier Curve showing survival analysis of study respondents

**blue line: no pain, * red line: with chronic pain*
N=2326, alive respondents converted into 1876 days (31 Dec 18)

4.7.3 Cox Proportional Hazard regression

In the unadjusted model, ten variables had significant associations with an increased risk of five-year mortality. These were chronic pain, older age group, no formal education, primary education, low monthly household income, comorbidities, impaired cognitive status, poor self-rated health, low social support and physical activity. In contrast, female sex and obesity were found to have protective effect.

In the first multivariable model, older age group, sex, comorbidities, poor self-rated health, physical activity and obesity were statistically significant with and increased risk of five-year mortality. Nonetheless, chronic pain no longer significant in the first multivariable model (Appendix Y).

In the adjusted multivariable mode, chronic pain remained not associated with an increased risk of five-year mortality (HR 1.19; 95%CI 0.93, 1.54). Four variables had higher risk of mortality. These were age group, comorbidities, poor self-rated health and physical activity. In contrast, female sex and obesity had protective effect.

Interaction terms between chronic pain and sex (HR 1.03; 95%CI 0.62, 1.72; p=0.898); chronic pain and age (HR 1.07; 95%CI 0.61, 1.87; p=0.825) were tested. Both interaction terms were not significant. Table 4.20 presents the unadjusted and adjusted Cox Proportional Hazard model.

Table 4.20: Unadjusted and adjusted Cox Proportional Hazard model

Variable	Unadjusted model		Adjusted model	
	HR (95%CI)	P-value	HR (95%CI)	P-value
Chronic pain				
No	1		1	
Yes	1.56 (1.26, 1.93)	<0.001	1.09 (0.84, 1.41)	0.532
Age group				
60-67	1		1	
≥70	2.63 (2.14, 3.25)	<0.001	1.76 (1.36, 2.26)	<0.001
Sex				
Male	1		1	
Female	0.65 (0.54, 0.78)	<0.001	0.62 (0.50, 0.78)	<0.001
Education				
Secondary or tertiary education	1			
No formal education	2.10 (1.53, 2.89)	<0.001		
Primary education	1.67 (1.28, 2.17)	<0.001		
Monthly household income				
High	1			
Low	1.82 (1.45, 2.27)	<0.001		
Medium	1.10 (0.85, 1.42)	0.487		
Comorbidities	1.16 (1.08, 1.24)	<0.001	1.15 (1.05, 1.26)	0.003

'Table 4.20, continued'

Variable	Unadjusted model		Adjusted model	
	HR (95%CI)	P-value	HR (95%CI)	P-value
Depressive symptoms				
No	1			
Yes	1.13 (0.92, 1.38)	0.238		
Cognitive status				
Normal	1			
Impaired	1.86 (1.53, 2.26)	<0.001		
Self-rated health				
Good	1		1	
Poor	2.02 (1.67, 2.44)	<0.001	1.38 (1.10, 1.74)	0.005
Social support				
High	1			
Low	1.28 (1.01, 1.61)	0.037		
Physical activity	0.99 (0.99, 0.99)	<0.001	0.99 (0.99, 0.99)	<0.001
Obese				
No	1		1	
Yes	0.61 (0.48, 0.77)	<0.001	0.63 (0.49, 0.82)	0.001

Weightage was included in the analysis to account for the complex sample design.

4.7.3.1 Proportionality assumption

One of the main assumptions of Cox Proportional Hazard model is proportionality. The hazard ratio is assumed to be constant overtime in Cox Proportional Hazard model. There are a few methods available to assess the proportionality assumption. This study used *stphplot* plot, *stcoxkm* plot and Schoenfeld residuals (*estat phtest*) methods to test the proportionality assumptions.

Figure 4.7 shows *stphplot* with lines that are parallel, indication that the proportional hazard assumption for chronic pain was not violated. Besides, Figure 4.8 illustrates the observed values and predicted values are close to each other, it is less likely that the proportionality assumptions has been violated. Table 4.21 showed the *estat phtest* with p-values of all variables more than 0.05 and hence show no evidence that the proportional hazard assumption was violated. In summary, the proportional assumption in the adjusted model has not been violated.

(a) ***stphplot*** **plot**

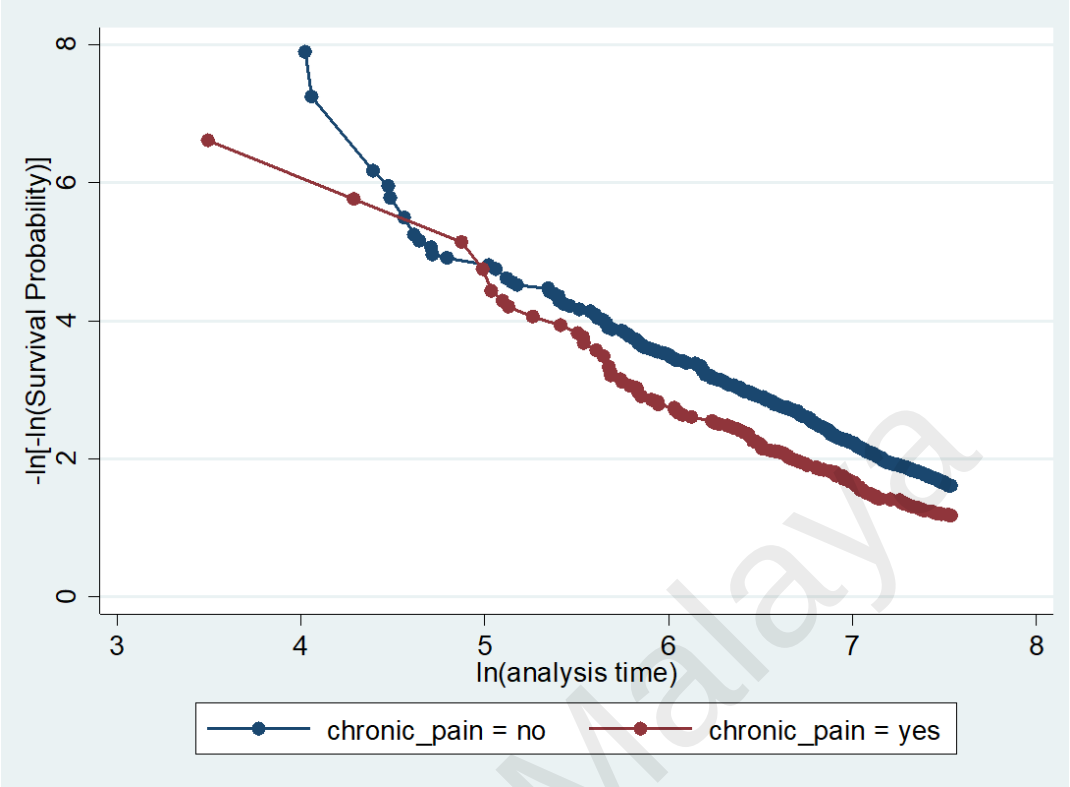

Figure 4.7: *stphplot* plot. It has parallel lines, indicating that the proportional hazard assumption for chronic pain was not violated

(b) ***stcoxkm*** **plot**

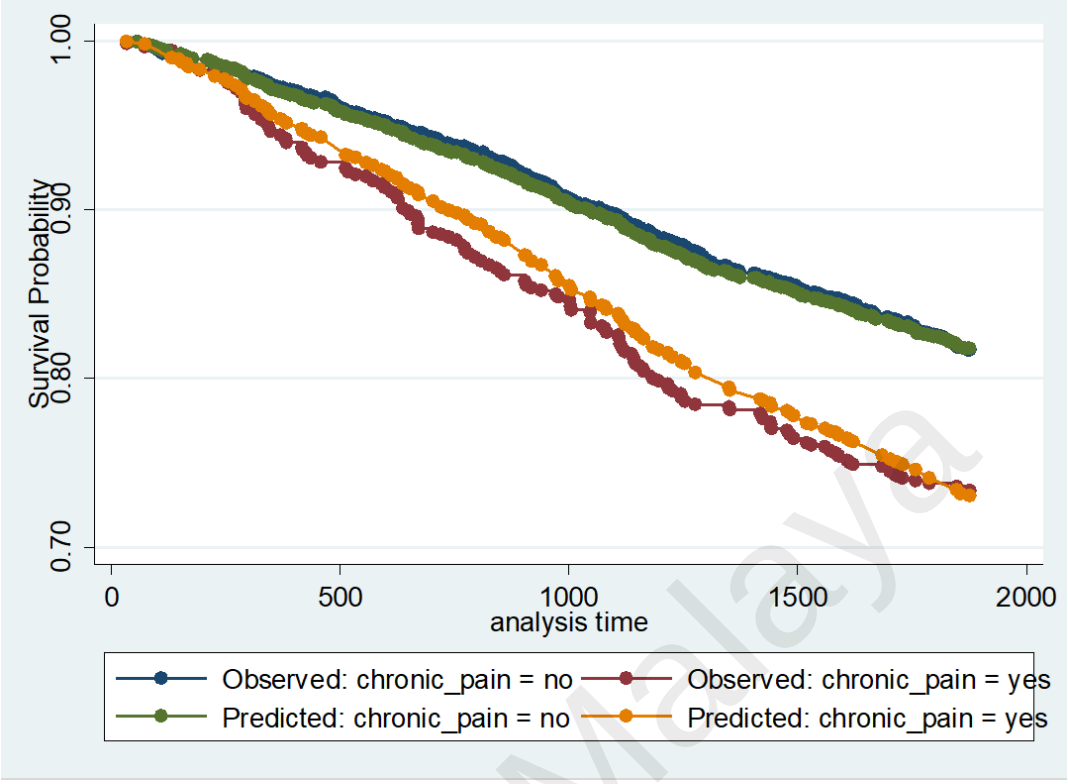

Figure 4.8: ***stcoxkm*** **plot. The observed values and predicted values are close together, it is less likely that the proportionality assumptions has been violated**

(c) ***Schoenfeld residuals (estat phtest)***

Table 4.21: Schoenfeld residuals (*estat phtes*t). P-values of all variables more than 0.05 and therefore did not show evidence that the proportional hazard assumption was violated

	Rho	Chi2	df	Prob>chi2
Chronic pain	-0.02800	0.29	1	0.5918*
Age group	-0.02737	0.31	1	0.5751*
Sex	-0.03250	0.42	1	0.5149*
Comorbidities	-0.04673	1.08	1	0.2993*
Self-rated health	0.01093	0.04	1	0.8381*
Physical activity	0.04072	0.96	1	0.3270*
Obesity	0.01484	0.09	1	0.7692*
Global test		4.65	7	0.7023*

4.7.3.2 Goodness of fit

We evaluated the goodness of fit of the adjusted multivariable Cox Proportional model using Cox-Snell residuals. Apart from very large values of time, the hazard function matches the 45-degree line. It has roughly an exponential distribution with a hazard rate of one. Therefore, the model fits the data well. Figure 4.9 illustrates the Cox-Snell residuals.

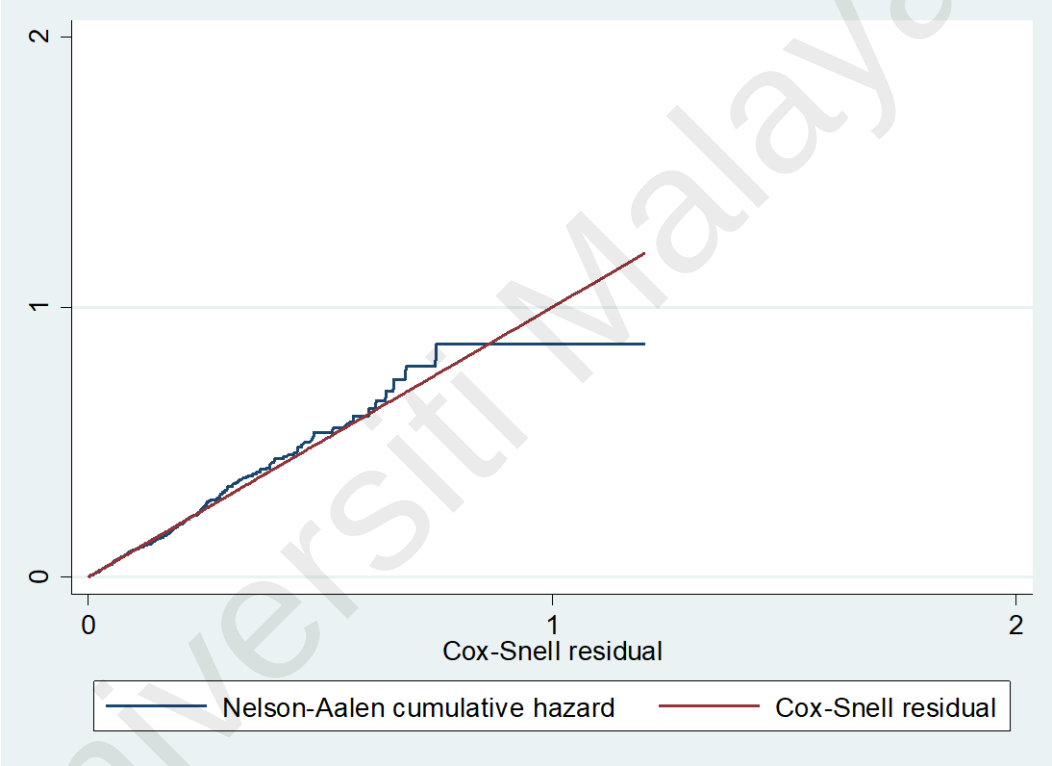

Figure 4.9: Cox-Snell residual. Apart from very large values of time, the hazard function closely matches the 45-degree line. It has roughly an exponential distribution with a hazard of one. Therefore, the model fits the data well.

CHAPTER 5: DISCUSSIONS

The first part of this chapter describes the summary of this study's research objectives. Following that, chronic pain prevalence was discussed. Subsequent part discusses the main findings and compared them with previous studies. This is followed by explanation on the strength and limitations of this study. The final part of this chapter discusses implications of study findings.

5.1 Summary of research objectives

Globally, nearly one third of adults are affected by chronic pain and higher chronic pain prevalence among older adults was reported. In addition, the number of older adults worldwide is also growing rapidly. Consequently, chronic pain distribution among older adults may increase with the rising number of older adults. Previous studies found that rural older adults tend to be more vulnerable, have poorer health and lower quality of life.

Chronic pain has various adverse health effects on older adults. For instance, consequences on physical health, mental health and risk of premature mortality. In developing countries, there are limited studies examining the association between chronic pain and physical function among older adults, as well as risk of premature mortality of older chronic pain sufferers.

Therefore, this thesis is aimed at addressing the following research questions:

1. What are the associations between chronic pain and physical function among older adults from the existing literature?
2. Does chronic pain increase the risk of physical disability among older adults with chronic pain in rural Malaysia?
3. Does chronic pain increase the risk of functional limitations among older adults with chronic pain in rural Malaysia?
4. Does chronic pain increase the risk of five-year mortality among older adults in rural Malaysia?

5.2 Consequences of chronic pain on physical function among older adults from the existing literature

A systematic search was carried out to obtain a comprehensive literature review of the association of chronic pain with physical function among older adults. The search was carried out using the PRISMA guidelines (Moher et al., 2015). Two levels of screening were done, followed by data extraction and quality appraisal. Studies were qualified if they were published in English between 1990 and 2019. Inclusion criteria were: a) studies with primary data collection; b) written in English; c) respondents 60 years and above; d) published between 1990 and 2019 and; e) definition of chronic pain as having pain for a minimum period of three months. Exclusion criteria were: a) abstracts and incomplete reports; b) duplicate studies and; c) qualitative studies.

Electronic search was done using the six databases. These databases are Pubmed, ScienceDirect, EMBASE, CINAHL, SCOPUS and EBScohost–SocINDEX. After two levels of screening, four studies were selected for data extraction and quality appraisal.

Among the four studies, three were conducted in developed countries (75%); one in the United States and two in Australia. Only one study (25%) was conducted in developing countries; China. There is an under-representation from low- and middle-income regions. All four studies were cross-sectional study design, and hence we could not establish the causal relationship between chronic pain and physical function.

Findings from the selected studies have shown that chronic pain was associated with poorer physical function among older adults. Chronic pain was found to be significantly associated with ADL disability (Hairi et al., 2013; Si et al., 2019) and IADL disability (Si et al., 2019). According to Hairi (2013), ADL disability was more common among respondents who reported chronic pain, pain that interferes with activities, moderate and strong to severe pain (Hairi et al., 2013). Si H (2019) also identified older adults experienced chronic pain were at an increased risk of ADL and IAD disabilities (Si et al., 2019).

Besides, chronic pain has been shown to have significant associations with physical function measured by objective tests. Morone (2014) found that the gait speed and stair climbing of the respondents deteriorates as the pain scores increases (Morone et al., 2014). Pereira (2014) reported chronic pain was associated with a lower LLSPP score (Pereira et al., 2014). In addition, respondents with chronic pain were found to have association with poor lower extremity physical performance (Si et al., 2019). Nonetheless, chronic pain has not been reported to have association with poor grip strength because common chronic pain locations among older Chinese adults were lower extremity and lower back (Si et al., 2019).

In summary, chronic pain was associated with poorer physical function among older adults in all selected studies. Nevertheless, all the selected studies were cross-sectional in study design and the majority were carried out in developed countries. Hence, a gap of evidence in the causal relationship between chronic pain and physical function in low- and middle-income countries has been identified.

5.3 Chronic pain prevalence and chronic pain interference

5.3.1 Chronic pain prevalence

In this study, chronic pain prevalence among older adults living in rural areas was 21.1%. The percentage found in this study is greater than of another study in Malaysia (Zaki & Hairi, 2014). This may be due attributed to the discrepancies in recruited respondents. The previous research recruited respondents from all over Malaysia. In contrast, this study recruited respondents from rural areas. Past studies have shown that chronic pain appears to occur more in rural population (Dahlhamer et al., 2018; Hoffman, Meier, & Council, 2002; Tripp, VanDenKerkhof, & McAlister, 2006). Hoffman (2002) claimed that higher prevalence of chronic pain in rural sample than urban sample may because of groups' differing physical and social environments. Rural individuals may be more socially isolated and live or work in an unstimulating environment, allowing them more time for inner reflection and the monitoring of their physical symptoms (Hoffman et al., 2002). In addition, rural population has lesser availability to healthcare services and was associated with lesser healthcare utilization, which may lead to the higher prevalence of chronic pain in rural areas (Hoffman et al., 2002; Tripp et al., 2006).

In this study, chronic pain prevalence is lower than other low- and middle-income countries. Chronic pain prevalence among older adults in China was 41.1% (Si et al., 2019). A population-based study in Iran reported 31.7% of older adult experienced chronic pain (Salman Roghani et al., 2019). Taiwanese older adults and South Indian older adults were found to have chronic pain prevalence of 42% and 47.6% respectively (Kirubakaran & Dongre, 2019; Yu et al., 2006).

Chronic pain prevalence found in this study was lower than developed countries. The chronic pain prevalence in a systematic review of seven studies in the United Kingdom ranged from 35% to 51.3% (Fayaz et al., 2016). In addition, chronic pain was observed in 38.5% older Swedish adults (Larsson et al., 2017). Chronic pain prevalence among older adults in Santa Catarina, Brazil and Poland was 29.3% and 42% respectively (Kozak-Szkopek et al., 2017; Santos et al., 2015). In the United States, half (52.9%) of the respondents reported pain in the last month, according to a survey conducted using nationally representative older adults population (Patel, Guralnik, Dansie, & Turk, 2013).

This study found that chronic pain prevalence among female respondents (65.1%) was higher than male respondents (34.9%). This result is in line with prior studies (Bernfort et al., 2015; Kozak-Szkopek et al., 2017; Patel et al., 2013; Salman Roghani et al., 2019; Santos et al., 2015; Satghare et al., 2016; Yu et al., 2006). Female was nearly twice more likely to experience pain than male among older Singaporean adults (Satghare et al., 2016). In Taiwan, older female had significant higher incidence of pain than older males ($p<0.001$) (Yu et al., 2006). In Iran, significant statistical differences of both neuropathic ($p<0.001$) and nociceptive ($p<0.001$) pain experiences between male and female older adults were reported; with female older adults are more affected (Salman Roghani et al., 2019). Older Swedish female reported significantly higher chronic pain prevalence compared with older males ($p=0.016$). The findings from a study conducted in the United

States reported that female older adults had a higher pain burden than male counterparts ($p<0.001$) (Patel et al., 2013). One of the possible explanations is that respondents who considered themselves more masculine and less feminine exhibit higher pain thresholds and tolerances. A meta-analysis analysed six studies found a significant positive correlation between masculine and feminine personality traits and pain threshold and tolerance ($r=0.17$, z-test=2.56, $p=0.01$). Four studies used Gender Role Expectations of Pain Questionnaire, one study used the 14-item Appropriate Pain Behaviour Questionnaire and one study used Gender Norm for Pain Tolerance Questionnaire to measure pain. Masculinity was positively associated with pain threshold pain tolerances. (Alabas, Tashani, Tabasam, & Johnson, 2012).

Although the prevalence of chronic pain among female respondents was higher in this study, but male respondents had higher proportion of mortality rate (25.25%) compared to female counterparts (17.16%). One possible explanation for this situation is the mortality-morbidity paradox. This paradox describes that although female experience more medical conditions and illnesses that male counterparts over their lifespan, they have lower mortality rates (Austad & Fischer, 2016).

5.3.2 Chronic pain interference

The overall chronic pain interference found in this study was 87.4% (95%CI 87.4, 90.2). The chronic pain interference in this study was similar to another study in Malaysia (88.3%) (Rafidah & Zaki, 2016). However, other studies have found lower chronic pain interference. Two studies conducted in the United States found that pain interference among older adults was 51.8% and 22.3% respectively (Przekop, Haviland, Oda, & Morton, 2015; Shi, Hooten, Roberts, & Warner, 2010).

5.4 Prevalence of outcome variables: ADL disability, IADL disability, slow walking speed and low handgrip strength

In this study, physical disability prevalence: ADL and IADL disability were 5.15% and 30.27% respectively. This study found higher prevalence of functional limitations measured by walking speed and handgrip strength. The prevalence of slow walking speed was 69.43% and the prevalence of low handgrip strength was 68.49%.

In longitudinal analysis, respondents with outcome of interest at baseline were omitted from analysis to make sure respondents are free from outcome of interest. Therefore, outcome variables with high baseline prevalence had relatively lower estimated power at twelve months follow-up (section 3.5). Low power has less chance of identifying true effects (Button et al., 2013). Therefore, the detection of true effects of outcome variables with lower estimated power may be affected.

5.5 Chronic pain and ADL disability

Chronic pain had significant association with ADL disability after covariates were adjusted in cross-sectional analysis (OR 1.95; 95%CI 1.25, 3.06). In longitudinal analysis, chronic pain was also associated with an increased risk of ADL disability after covariates were adjusted (RR 2.14; 95%CI 1.38, 3.46).

This finding was consistent with an 18 month follow-up longitudinal cohort study. The cohort study observed more than threefold higher risk of ADL disability for those with multisite pain than those without pain, after confounders were adjusted (Eggermont et al., 2014). Nonetheless, a 10-year prospective cohort study showed after confounders were adjusted, respondents with pain did not have higher risk of ADL disability (Andrews,

Cenzer, Yelin, & Covinsky, 2013). The discrepancies in the results indicate that pain may have short term effect on ADL disability, or that certain physical limitations may be reversible. Hence, duration of study may possibly have influence on the outcome of interest.

This study also found significant association in cross-sectional analysis between physical activity and ADL disability (OR 0.97; 95%CI 0.96, 0.98). In addition, physical activity was found to be protective of ADL disability in longitudinal analysis (RR 0.98; 95%CI 0.97, 0.99). The finding was similar to a cohort study reported that those with ADL disability were more likely to have less physical activity (Balzi et al., 2009). However, this finding has to be interpreted with caution because although the association between physical activity and ADL disability was significant in this study, the odds ratio was 0.97, which is close to 1.

In Disablement Process model, chronic pain and low physical activity are risk factors of the model. These two factors had significant associations with ADL disability in this study. Early diagnosis of chronic pain and appropriate pain management are required to reduce the ADL disability risk among older adults. Prevention strategies and effective interventions are also essential to reduce the ADL disability risk among older adults. We could promote an adequate level of physical activity among older adults for preventive purposes.

5.6 Chronic pain and IADL disability

In cross-sectional analysis, chronic pain was associated with IADL disability after covariates were adjusting in this study (OR 1.86; 95%CI 1.39, 2.49). In longitudinal analysis, chronic pain continues to have significant association with higher risk of IADL disability after covariates were adjusted (RR 1.30; 95%CI 1.18, 1.75). This finding is in line with 18 month follow-up longitudinal study. The 18 months longitudinal study found that the risk of IADL disability was more than two times higher for respondents with multisite pain and respondents with widespread pain, than to respondents without pain, after adjustment of confounders (Eggermont et al., 2014).

In addition, older age group has significant association with IADL disability in cross-sectional (OR 2.03; 95%CI 1.57, 2.62) and longitudinal analysis (RR 1.44; 95%CI 1.18, 1.75). This finding is consistent with prior studies reported that older age group had significant association with IADL disability (Carmona-Torres et al., 2019; Connolly, Garvey, & McKee, 2017; Wiśniowska-Szurlej & Wilmowska-Pietruszyńska, 2018). A study conducted among older Spain adults found that older age group had a significant association with IADL disability (Carmona-Torres et al., 2019). In addition, another study conducted among older Irish adults reported similar findings (Connolly et al., 2017).

In addition, female was also associated with IADL disability in cross-sectional (OR 1.88; 95%CI 1.44, 2.45) and longitudinal (RR 2.79; 95%CI 2.11, 3.68) analysis. This result is consistent with another study demonstrated that female was independently associated with IADL disability (Carmona-Torres et al., 2019). Comorbidities had significant association with IADL disability in cross-sectional (OR 1.12; 95%CL 1.01, 1.23) and longitudinal analysis (RR 1.08; 95%CI 1.003, 1.17). Prior studies found that having chronic condition is independently associated with IADL disability (Connolly et al., 2017; Wiśniowska-Szurlej & Wilmowska-Pietruszyńska, 2018). An Irish longitudinal

study on ageing reported that having a chronic condition was associated with IADL disability (Connolly et al., 2017). The number of chronic diseases was significantly associated with IADL disability among older South-eastern Poland adults (Wiśniowska-Szurlej & Wilmowska-Pietruszyńska, 2018).

Physical activity had significant association with IADL disability in cross-sectional (OR 0.991; 95%CI 0.988, 0.993) and longitudinal analysis (RR 0.99; 95%CI 0.99, 0.99). This result is in line with prior studies (Connolly et al., 2017; Wiśniowska-Szurlej & Wilmowska-Pietruszyńska, 2018). Low physical activity was associated with IADL disability in a study conducted among older Irish adults (Connolly et al., 2017). Older adults living in south-eastern Poland performing low level of physical activity were associated with IADL disability (Wiśniowska-Szurlej & Wilmowska-Pietruszyńska, 2018). However, this finding has to be interpreted with caution because although the association between physical activity and IADL disability was significant in this study, the odds ratio was 0.99, which is close to 1.

Chronic pain, older age group, female gender, comorbidities and low physical activity are risk factors of the Disablement Process model. These factors had significant associations with IADL disability in this study. Age group and gender are non-modifiable factors. Early diagnosis of chronic pain and adequate pain management are required for reduction of IADL disability risk found among older adults. Prevention strategies and effective interventions, for instance adequate level of physical activity could be promoted as preventive measure to reduce IADL disability risk among older adults. Effective management of chronic diseases could also be another prevention strategy.

5.7 Chronic pain and slow walking speed

Chronic pain did not have significant association with slow walking speed after covariates were adjusted in cross-sectional analysis (OR 1.35, 95%CI 0.99, 1.84). Similarly, chronic pain did not increase the risk of slow walking speed after covariates were adjusted in longitudinal analysis (RR 1.01; 95%CI 0.79, 1.29).

This finding is in line with a research conducted among older adults in China where chronic pain did not have significant association with slow walking speed (Si et al., 2019). In contrast, other studies found significant association between chronic pain and slow walking speed. A cross-sectional study showed that in the last month, respondents with pain were more likely to have slow gait speed after relevant variables were controlled (Taylor, Parker, Szanton, & Thorpe Jr, 2018). Another cross-sectional study reported moderate and severe pain intensity had significant association with slow gait speed among older adults after demographic data and clinical characteristics were adjusted (Sawa et al., 2017).

One possible explanation of chronic pain was not associated with slow walking speed in this study may be because the pain site in this study was not available. Without knowing the pain site, we were unable determine the effect of chronic pain on walking speed precisely. For example, if the respondents had chronic pain of upper limbs, chronic pain may not have a significant effect on walking speed of the respondents.

In addition, the low estimated power observed in twelve months follow-up of the variable walking speed may be the explanation for an insignificant longitudinal association between chronic pain and slow walking speed. In this study, 69.43% of respondents with slow walking speed at baseline were excluded. As a result, the number of respondents included in longitudinal analysis has been substantially reduced, which in

turn decreased the power. Low power decreases the chance of detecting the true effects (Button et al., 2013).

Older age group had a significant association with slow walking speed in cross-sectional analysis (OR 2.38; 95%CI 1.87, 3.03) and longitudinal analysis (RR 1.61; 95%CI 1.35, 1.92). Similar finding was reported in previous studies (de Almeida Busch et al., 2015; Pérez-Zepeda, González-Chavero, Salinas-Martinez, & Gutiérrez-Robledo, 2015). In a population-based study, age was associated with slow walking speed (de Almeida Busch et al., 2015). In Mexico, a study reported that age was associated with the development of slow walking speed among older adults (Pérez-Zepeda et al., 2015). This is anticipated as the ageing process leads to distinct muscle mass and loss of strength (Keller & Engelhardt, 2013), which eventually affects walking speed.

In Disablement Process model, older age group and low physical activity are categorized into risk factors. These two factors had significant associations with slow walking speed in this study. Age group is a non-modifiable factor. Therefore, adequate level of physical activity may be recommended as a prevention strategy to reduce the risk of slow walking speed among older adults.

5.8 Chronic pain and handgrip strength

Cross-sectional analysis showed chronic pain had a significant association with low handgrip strength after covariates were adjusted (OR 1.65; 95%CI 1.06, 2.57). However, longitudinal analysis revealed that chronic pain did not increase the risk of low handgrip strength after covariates were adjusted (RR 1.15; 95%CI 0.94, 1.40).

The significant cross-sectional association between chronic pain and low handgrip strength was consistent with another study. A Korean study found that low back pain was associated with low handgrip strength and the association remained significant after confounders were adjusted (Park et al., 2018).

The insignificant longitudinal association between chronic pain and low handgrip strength in this study may be due to the low estimated power found in twelve months follow-up of walking speed variable. In this study, 68.49% of respondents with low handgrip strength at baseline were excluded in longitudinal analysis. This has substantially reduced the numbers of respondents included in longitudinal analysis, which in turn lowers the power. Low power decreases the probability of detecting the true effects (Button et al., 2013).

Besides, older age group had a significant association with low handgrip strength in cross-sectional analysis (OR 1.70; 95%CI 1.34, 2.15) and longitudinal analysis (RR 1.31; 95%CI 1.10, 1.56). Previous studies have reported similar findings (Confortin et al., 2018; Damayanthi, Moy, Abdullah, & Dharmaratne, 2018). In population-based study in Brazil, older age group was associated with low handgrip strength among older female adults (Confortin et al., 2018). Similar findings have been reported among older adults in Sri Lanka (Damayanthi et al., 2018). This finding is anticipated as the ageing process leads to distinct muscle mass and loss of strength (Keller & Engelhardt, 2013).

Female sex had a significant association with low handgrip strength in cross-sectional analysis (OR 2.64; 95%CI 2.10, 3.32 and longitudinal analysis (RR 1.68; 95%CI 1.39, 2.04). This result is in line with prior studies (Damayanthi et al., 2018; Demura, Aoki, & Sugiura, 2011). Damayanthi HD (2018) reported that older male respondents had higher handgrip strength than female respondents (Damayanthi et al., 2018). Similar findings were found in another study (Demura et al., 2011).

In Disablement Process model, both older age group and female sex are categorized as risk factors. These two factors had significant associations with low handgrip strength in this study. Therefore, older age group and female sex should be taken into consideration as significant risk factors in developing screening tool and interventions for low handgrip strength among older adults.

5.9 Chronic pain and mortality

In the unadjusted analysis, chronic pain was associated with an increased risk of five-year mortality (HR 1.56; 95%CI 1.26, 1.93). Nonetheless, chronic pain no longer associated with higher risk of five-year mortality after covariates were adjusted (HR 1.09; 95%CI 0.84, 1.41). On the other hand, respondents with chronic pain have a 9% higher percentage of five-year mortality than those without chronic pain.

This finding is inconsistent to previous studies. A study conducted using two large population cohorts reported that participants who were often troubled with pain and those reported pain interferences had higher risk of all-cause mortality (Smith et al., 2018). In addition, another study reported that severe chronic pain had significant association with ten-year higher risk of mortality, and the association remained after socio-demographic factors were adjusted (Torrance, Elliott, Lee, & Smith, 2010). One possible explanation

of the discrepancies may be the difference in length of follow-up between previous studies and this study. This study only follows up respondents for five years, while previous research explored the association of ten years mortality. In the future research, it might take a longer follow-up duration to detect the long-term effect of chronic pain on mortality.

5.9.1 Mechanism of how chronic pain affect mortality

Severe acute and chronic pain causes of glucocorticoids and catecholamines to be released by the hypothalamic-pituitary-adrenal axis in response to stress (Nees, Löffler, Usai, & Flor, 2019). Catecholamines stimulate cardiovascular system and cause severe tachycardia and high blood pressure (Herman & Sandoval, 1983). In addition to the release of adrenal catecholamine, pain flares cause over activity of the autonomic, sympathetic nervous system, which adds more stimulus to tachycardia and high blood pressure triggered by catecholamine. The physiological effects of excessive secretion and autonomic and sympathetic discharge may cause stress to the heart. As a result, the combined physiological effects can potentially lead to coronary spasm, cardiac arrhythmia, and sudden death (Nakagawa & Hosokawa, 1994). However, there were controversial evidence chronic pain increases the risk of mortality (Sarcon, Ghadri, & Templin, 2019).

5.9.2 Risk factors of five-year mortality

Older age group was found to have a significant association with an increased risk of five-year mortality (HR 1.76; 95%CI 1.36, 2.26). This finding is consistent with prior studies (Borim, Francisco, & Neri, 2017; Fried et al., 1998; Jotheeswaran, Williams, & Prince, 2010; Maia, Duarte, Lebrão, & Santos, 2006). In Brazil, individuals aged more than 75 were found to be associated with mortality (Borim et al., 2017). A five-year prospective population cohort in the United States reported that increasing age was associated with an increased risk of mortality among older adults (Fried et al., 1998). Another three-year population cohort study reported that mortality was associated with older age (Jotheeswaran et al., 2010). Maia et al (2006) reported that advanced age was associated with mortality (Maia et al., 2006).

In addition, comorbidities had a significant association with higher risk of five-year mortality (HR 1.15; 95%CI 1.05, 1.26). This is consistent with existing study reported that comorbidities found to have negative effects, for instance shorter life and greater dependence (Rizzuto, Melis, Angleman, Qiu, & Marengoni, 2017). Furthermore, metabolic syndrome has been associated with increased cardiovascular mortality among older Italians (Zambon et al., 2009).

5.9.3 Protective factor of mortality

5.9.3.1 Physical activity

Physical activity was found to be a protective factor of five-year mortality (HR 0.99; 95%CI 0.99, 0.99). Prior studies reported similar findings (Fried et al., 1998; Gulsvik et al., 2011; Jotheeswaran et al., 2010; Llamas-Velasco et al., 2016). Among older adults, lack of moderate or vigorous exercise was independently associated with mortality (Fried et al., 1998). A three-year study revealed that mortality was significantly associated with physical inactivity among older adults in Chennai (Jotheeswaran et al., 2010). Llamas-Velasco et al (2016) reported that physical activity prevents long-term mortality among older Spanish adults (Llamas-Velasco et al., 2016). Therefore, adequate level of physical activity among older adults may be recommended to reduce mortality risk among older adults with chronic pain. However, this finding has to be interpreted with caution because although the association between physical activity and five-year mortality was significant in this study, the odds ratio was 0.99, which is close to 1.

5.9.3.2 Obesity

In the adjusted analysis, obesity was shown to have protective effect on five-year mortality (HR 0.63; 95%CI 0.49, 0.82). Previous studies have reported contradictory findings (Aune et al., 2016; Cetin & Nasr, 2014; Weiss et al., 2008). Studies suggest that moderately elevated BMI provides protective effect on mortality risk among older adults (Cetin & Nasr, 2014; Weiss et al., 2008). In contrast, studies reported that BMI more than 30 is associated with many health risks (Cetin & Nasr, 2014) and severely obese people are at risk of increased mortality (Aune et al., 2016).

The contradictory findings could be explained by a U shape association between BMI and all-cause mortality among older adults (F. W. Cheng et al., 2016). Overweight and class one obese older adults had lesser mortality risk than normal weight older adults. This is referred as "obesity paradox" (Kalantar-Zadeh et al., 2007) or "reverse epidemiology" (Kalantar-Zadeh, Kilpatrick, Kuwae, & Wu, 2005).

This study categorised obesity into two groups: obese (BMI ≥ 27.5) and not obese (BMI < 27.5). As a result, we were not able to distinguish the risk of mortality for various obesity groups, for instance mild, moderate or severely elevated BMI. Although this study found that obesity had a protective effect on five-year mortality, this finding should be interpreted with caution as this study did not classify obesity into various obesity groups.

5.9.3.3 Female gender

Female sex was found to have protective effect on five-year mortality (HR 0.62, 95%CI 0.50, 0.78). This finding is consistent with prior studies. Prior studies suggest that female older adults demonstrated better survival compared to male counterparts (Kaneda, Zimmer, Fang, & Tang, 2009; Liang, Bennett, Sugisawa, Kobayashi, & Fukaya, 2003). A representative survey of older adults in three districts in the municipality of Beijing found that older females had a survival advantage over male (Kaneda et al., 2009). One possible explanation for this situation is the mortality-morbidity paradox. This paradox describes that although female experience more medical conditions and illnesses that male counterparts over their lifespan, they have lower mortality rates (Austad & Fischer, 2016). Feminization of ageing could also describe this situation. It is a phenomenon in which women outliving men, but at the same time women experience social isolation and economic diversity (Davidson, DiGiacomo, & McGrath, 2011).

5.9.4 Medications for chronic pain and mortality

To date, there are a number of treatment approaches available to manage chronic pain. Generally, these approaches are classified into biomedical and biopsychosocial approaches (Hylands-White, Duarte, & Raphael, 2017). Pharmaceutical, surgical and electrical approaches are included in the biomedical treatment approaches. The biopsychosocial approaches included physiology, occupational therapy, specialist nursing, clinical psychology, cognitive behavioral and acceptance and commitment therapy (Hylands-White et al., 2017).

Opioids is one of the most prescribed medications to treat chronic pain, (Hoots et al., 2018), due to effectiveness of opioids for pain relief. However, opioids efficacy in treatment of chronic pain is initially successful but is not always sustainable in long-term opioid treatment (Ballantyne & Shin, 2008). In addition, opioids administration could also bring undesirable side effects, for instance sedation, nausea, constipation, dependence and tolerance (Ricardo Buenaventura, Rajive Adlaka, & Nalini Sehgal, 2008). Opioid use was reported to reduce pain among chronic non-cancer pain respondents compared to placebo in a meta-analysis of RCTs of patients (Busse et al., 2018).

An estimated 27 million people worldwide have been affected by opioid use disorder in 2016 (WHO, 2018). Opioid use disorder has demonstrated high morbidity and mortality in a general healthcare setting, which pressure healthcare providers to find new ways of identifying and treating patients with opioid use disorder (Hser et al., 2017).

Opioid use in chronic pain can also have a very detrimental outcome, which is opioid overdose mortality. This undesirable outcome is growing in number and statistics show that opioids overdose mortality in United States has risen over the years (Hedegaard, Miniño, & Warner, 2020). In 2015, around 160 thousands people passed away directly related to drug used disorder and around 118 thousands with opioid use disorder ("Information sheet on opioid overdose," August 2018). The prescription of long-acting opioid for non-cancer pain has significantly associated with an increased risk of all-cause mortality compared to prescription of anticonvulsants or cyclic antidepressant (Ray, Chung, Murray, Hall, & Stein, 2016).

Pharmaceutical treatment is one of the effective approaches for treating chronic pain, but at the same time it has many negative effects, including a higher risk of mortality. In the original cohort data, medications used for chronic pain treatment was not available. As a result, we were unable to measure the potential effects of medications in the association between chronic pain and five-year mortality. Therefore, future research should collect this crucial piece of information in order to assess the role of medications used in the association between chronic pain and mortality.

5.10 Strength of the study

This study has several strengths. First, this was the first study to determine the longitudinal relationship between chronic pain and physical disability; longitudinal relationship between chronic pain and functional limitations in Malaysia. In addition, this was also the first study to examine the five-year mortality among older adults suffering from chronic pain.

The second strength of this study is the prospective cohort study design. The study design allows determination of causal inferences between predictor and outcome of interests. We removed respondents with outcome of interests at baseline to make sure all respondents did not have outcome of interest in the longitudinal analysis. In addition, the number of respondents recruited in the study was relatively high and reflective of Malaysian population in the rural areas.

Proper sampling was conducted in the dataset from existing cohort study. In the existing cohort study, study population was chosen at random from older adults living in Kuala Pilah district. Stratified two-stage sampling has been carried out. First, the Kuala Pilah district was split into Enumeration Blocks (EBs) which served as primary stratum. Each stratum has 80-120 living quarters (LQs). Consequently, 16 LQs were selected at random from each EB.

5.11 Limitation of the study

There are a few limitations to this study. First, our main concern was the self-reported data collection method because it could introduce recall bias. The predictor variable chronic pain was collected via self-reported data collection method. In order to minimize recall bias, we omitted respondents who had severe cognitive impairment in the data analysis. Second, this study only analysed data up to twelve months follow-up period. Therefore, we could not determine the long-term effects of chronic pain on physical disability, functional limitations and mortality among older adults. The short follow-up duration could introduce immortal time bias. The outcomes of interest in this study could not have occurred due to short follow-up duration (Suissa, 2008).

In addition, a few useful data were not available in the existing cohort dataset. One of it was the pain site of chronic pain. Without knowing the pain site of chronic pain, we could not to examine the effect of chronic pain on specific outcomes of interest. For instance, respondents with chronic pain of knees may have greater limitation in walking speed in comparison to respondents with chronic pain of upper limbs. Two clinically significant variables, ethnicity and living arrangement were not included in the inferential analysis of this study. This is due to imbalanced data of these two variables. One classification of these two variables has more than 80% data than other classification. The imbalanced data may lead to inaccuracy of findings (Akila & Reddy, 2016).

In addition, there are issues of time to event analysis with hazard ratio estimated using Cox Proportional Hazard model (Hernán, 2010). One of the issues is that hazard ratio may change over time. This study reported an average single hazard ratio over the follow-up of the study. This study reported a single hazard ratio averaged over the duration of the study's follow-up. Therefore, the conclusion may depend critically on the length of follow-up.

5.12 Implications of study findings

5.12.1 Public health implications

One in five older adults (21.1%) was found to have chronic pain in this study. This indicates that the chronic pain distribution among older adults in rural Malaysia was high. Therefore, we must ensure that early chronic pain diagnosis and appropriate pain management are in place to tackle the high distribution of chronic pain among older adults in Malaysia.

This study reveals that older adults suffering from chronic pain have more than double ADL disability and IADL disability than older adults without chronic pain. Moreover, chronic pain was associated with higher risk of ADL disability and IADL disability. Physical activity was found to be protective factor of ADL disability and IADL disability. Since chronic pain had significant associations with ADL and IADL disabilities, effective chronic pain management and preventive strategies are crucial in reducing ADL and IADL disabilities risk. Adequate level of physical activity may be recommended as one of the preventive strategies given that physical activity had protective effects on ADL and IADL disabilities.

Slow walking speed and low handgrip strength prevalence among respondents with chronic pain were higher than respondents without chronic pain in this study. Nonetheless, chronic pain was not found to have significant association with an increased risk of slow walking speed and low handgrip strength. Effective chronic pain interventions and preventive measures would still be beneficial in addressing the high slow walking speed and low handgrip strength prevalence.

Respondents with chronic pain were found to have a higher five-year mortality prevalence than those without chronic pain in this study. Nonetheless, chronic pain was not significantly associated with five-year mortality after covariates were adjusted. In contrast, comorbidities and poor self-rated health were associated with an increased risk of five-year mortality. On the other hand, female sex, physical activity and obesity have been shown to be protective factors. Effective chronic pain interventions and preventive measures should therefore be implemented in view of higher mortality rates among respondents with chronic pain. In addition, effective interventions for chronic diseases should also be implemented since comorbidities are one of the risk factors of five-year mortality among older adults. Adequate level of physical activity could be recommended as one of the preventive strategies.

5.12.2 Public health potential for prevention

This study found that older adults with chronic pain have higher prevalence of physical disability, functional limitations and five-year mortality. Early diagnosis of chronic pain and effective management of pain might therefore be one of the initial steps to prevent these undesirable outcomes. For example, chronic pain screening and identification may be carried out in primary care. We may implement screening methods used in other countries, for instance STaRT Back to recognise patients that are at risk of progression from acute to chronic pain (Mills, Torrance, & Smith, 2016).

In addition, physical activity has protective effect on ADL disability, IADL disability and five-year mortality among older adults. As a consequence, a recommendation of adequate level of physical activity may be one of the preventive strategies. WHO recommended that all healthy adults 65 years and over to do a minimum of 150 minutes moderate-intensity aerobic physical activity in a week or do a minimum of 75 minutes vigorous-intensity aerobic physical activity in a week or an equal combination of moderate and vigorous intensity activity (WHO, 2011). Recommendation on an adequate level of physical activity may be implemented as part of comprehensive chronic disease management for older adults seeking primary care services.

CHAPTER 6: CONCLUSION

This chapter summarises the study's main findings and relate to the research objectives. The subsequent part discusses the recommendations based on the thesis findings.

6.1 Conclusion

This thesis aimed to determine the association of chronic pain with physical disability, functional limitations and five-year mortality among older adults in rural Malaysia.

Chronic pain prevalence among older adults was 21.1%. Among older adults with chronic pain, higher prevalence of ADL and IADL disabilities has been identified compared to those with no chronic pain. Chronic pain also had significant association with an increased risk of ADL and IADL disabilities. In addition, older adults suffering from chronic pain had higher slow walking speed and low handgrip strength prevalence. Nonetheless, chronic pain did not associate significantly with slow walking speed and low handgrip strength. Moreover, this study reported a higher five-year mortality rate among respondents suffering from chronic pain than respondents with no chronic pain. Nevertheless, chronic pain was not significantly associated higher risk of five-year mortality among older adults.

6.2 Recommendations based on findings of the thesis

6.2.1 Recommendations on chronic pain policies and guidelines for older adults in Malaysia

The National Policy for Older Persons was established in anticipation of increasing number of older adults in Malaysia (Ibrahim, Mat Saad, Ramli, & Zailly, 2014). Following that, the policy action plan was developed to facilitate the implementation of the policy. In addition, Malaysia's National Health Policy of Older Persons was developed in 2008, in order to improve the health status of older adults. These policies have been developed to ensure that comprehensive and adequate services are in place for senior citizens to safeguard their wellbeing and to make Malaysia ready to become a healthy aged nation.

In Malaysia, the number of older adults is rising rapidly. We need to be proactive and take early action to prepare our country to become a healthy aged nation. One strategy would be to build on the existing policies and strengthen our efforts to prepare Malaysia for a healthy aged nation. The study's findings could be used as part of our efforts to improve health status of older adults. For instance, early diagnosis of chronic pain and appropriate pain management could be implemented to address the challenges of high chronic pain distribution. Appropriate management of chronic pain could, in turn, reduce the risk of ADL and IADL disabilities among older adults. Preventive strategies such as adequate level of physical activity may be recommended for the prevention ADL disability, IADL disability and five-year mortality. Chronic pain prevalence was found to be higher among older adults in rural areas than a nationwide study in Malaysia. Therefore, more resources should be allocated to rural areas in the management and prevention of chronic pain in older adults.

A number of guidelines on the pain management are available in Malaysia. These include (i) The Pain Management Handbook, (ii) The 3rd edition of Pain as the 5th Vital Sign Guideline and (iii) The first edition of Guidelines for Pain Management in The Elderly. These guidelines and handbooks provide healthcare providers in our country with essential information on pain management strategies. However, these guidelines focus mainly on the management of acute pain. Therefore, we identified a gap in chronic pain management in the existing guidelines. According to the findings of this study, we have learned that there is a high distribution of chronic pain among older adults in this country. Furthermore, chronic pain was associated with an increased risk of ADL and IADL disabilities. Understanding the consequences of chronic pain will help to guide the planning and development of future strategies and prevention in our local contexts. Therefore, we recommend adding a chronic pain management component to Malaysia's existing guidelines and providing guidance on chronic pain management to all relevant stakeholders. Our results have also shown that physical activity is a protective factor for ADL disability, IADL disability and five-year mortality among older adults in rural Malaysia. These findings have significant implications for the prescription of an adequate level of physical activity to older adults in rural Malaysia.

6.2.2 Recommendations for future research

The first recommendation for future research is a longer duration cohort study exploring the consequences of chronic pain on physical function and mortality among older adults. With longer follow-up cohort study, we will be able to determine the long-term effects of chronic pain on physical disability, functional limitations and mortality. In addition, the potential reversibility of chronic pain and the effects of chronic pain reversibility on physical disability, functional limitations and mortality may also be observed.

There is a need to identify chronic pain site and cause of pain in future research. With the additional information, we will be able to determine the effect of different locations of pain site and cause of pain on outcomes of interest. In addition, we could also collect data on methods used by respondents to manage chronic pain. The effects of various methods used to manage chronic pain on the outcome of interest may be observed.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

Type	Title	Journal/Venue	Status
Conference Presentation	Chronic Pain among Older Adults: What are the Consequences?	APRU Global Health Conference "PLANETARY HEALTH, THE NEXT FRONTIER", University of Malaya, Malaysia on 28-30 October 2018	Poster presentation
Publication	Longitudinal association between chronic pain and physical disability among rural community dwelling older adults in Malaysia	Chan, Y.M., Hairi, N.N., Choo, W.Y., Hairi, F., Ismail, N., Peramalah, D., Kandiben, S., Mohd Ali, Z., Ahmad, S., Abdul Razak, I. & Bulgiba, A. (2020). Longitudinal association between chronic pain and physical disability among rural community dwelling older adults in Malaysia. ASM Science Journal, 13 (Special Issue 5), 75-82.	Publication
Conference Presentation	Chronic pain and five-year mortality among rural community dwelling older adults in Malaysia	"Virtual Conference for 4th National Pain Free Conference & 7th MASP Biennial Scientific Meeting", Malaysia on 23rd - 24th September 2020	Poster presentation (Awarded for first place poster presentation)