DEVELOPMENT OF A WEB-BASED INTERVENTION TO IMPROVE HEALTH SCREENING UPTAKE IN MEN: THE SCREENMEN STUDY

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DEVELOPMENT OF A WEB-BASED INTERVENTION TO IMPROVE HEALTH SCREENING UPTAKE IN MEN: THE SCREENMEN STUDY

ABSTRACT

Health screening has been shown to improve health outcomes and reduce mortality. However, its uptake remains unsatisfactory particularly in men and among those aged below 40 years old, which is a critical window period to detect and prevent diseases from progressing. High internet access and mobile phone ownership make ICT a potential solution to improve screening uptake among young men. This study therefore aims to describe the development of ScreenMen, a mobile web app to improve screening uptake in men based on theories, evidence and users' needs. ScreenMen was developed in two phases. In the exploratory phase, a comprehensive framework was formed based on behavioural and masculinity theories, and literature review of barriers and facilitators to health screening in men. A list of evidence-based screening tests was identified using international and local clinical guidelines. A needs assessment was also conducted with men from a banking institution in Kuala Lumpur to explore their needs when undergoing health screening. In the development phase, findings from the exploratory phase were synthesized to form the content of ScreenMen. ScreenMen was developed using an iterative approach involving testing with experts and users for its utility and usability. The prototype was first tested with experts using prospective think aloud method. The revised prototype was then tested with men from the banking institution using retrospective think aloud method, and evaluated using System Usability Scale (SUS) and change in intention to screen. From the needs assessment with 31 men, misconceptions about screening, such as 'screen only when sick', were the key barriers to screening. Furthermore, men were unaware of their health risks and the screening tests they should go for. They also lacked knowledge about the cost, when and where to screen. ScreenMen addressed these barriers through three modules: health screening educational video, health assessment function

and frequently asked questions. The final ScreenMen web is male-sensitive (e.g. using car maintenance analogy), interactive (providing personalised health advice), evidence-based and mobile-responsive. It also mimics a real-life clinical consultation by interacting with a virtual doctor. During the testing with the experts, the contents were found to be valid and up-to-date. The users found ScreenMen useful as they could learn more about their health and screening without consulting a doctor. However, some users wanted ScreenMen to be shorter; therefore a 'Quick Assessment Mode' was added and the information was reordered to address this need. In addition, the importance of avoiding unnecessary screening tests was further emphasised in the revised ScreenMen to advocate evidence-based screening. The preliminary evaluation found ScreenMen to be user-friendly with a mean SUS score of 76.4 (good usability range: 71.4-85.5). Eight out of 23 men wanted to attend screening earlier than intended after using the ScreenMen. Of 12 men who were in pre-contemplation stage, four changed to either contemplation or preparation stage. The ScreenMen has been developed systematically using a user-centred approach to empower men to undergo screening. The preliminary data suggest that ScreenMen is acceptable to men and might improve their intention to screen.

Keywords: health screening, men's health, masculinity, eHealth, mobile web app

PEMBANGUNAN INTERVENSI BERASASKAN WEB UNTUK MENINGKATKAN KADAR SARINGAN KESIHATAN DALAM KALANGAN LELAKI: KAJIAN SCREENMEN

ABSTRAK

Saringan kesihatan terbukti dalam meningkatkan tahap kesihatan dan mengurangkan kematian. Namun, kadar saringan kesihatan adalah rendah terutamanya dalam kalangan lelaki dan mereka yang berumur di bawah 40 tahun, satu tempoh kritikal untuk mengesan dan mengubati penyakit sebelum penyakit menjadi lebih serius. Akses kepada internet dan pemilikan telefon mudah alih yang tinggi menjadikan teknologi maklumat dan komunikasi satu penyelesaian yang berpotensi dalam meningkatkan kadar saringan kesihatan dalam kalangan lelaki muda. Oleh itu, kajian ini bertujuan menerangkan pembangunan satu web mudah alih, ScreenMen, untuk meningkatkan kadar saringan kesihatan dalam lelaki berdasarkan teori, bukti saintifik dan keperluan pengguna. ScreenMen telah dibangunkan dalam dua fasa. Dalam fasa penerokaan, satu rangka kerja komprehensif telah dibentuk berdasarkan teori tingkah laku dan maskuliniti, dan tinjauan literatur tentang halangan dan fasilitator terhadap saringan kesihatan dalam kalangan lelaki. Satu senarai ujian saringan berdasarkan bukti telah dikenalpasti menggunakan garis panduan klinikal antarabangsa dan tempatan. Penilaian keperluan juga dilakukan dengan lelaki dari satu institusi perbankan di Kuala Lumpur untuk meneroka keperluan mereka dalam menjalani saringan kesihatan. Dalam fasa pembangunan, penemuan dari fasa penerokaan telah disintesis untuk membentuk kandungan ScreenMen. ScreenMen telah dibangunkan menggunakan pendekatan berulang yang melibatkan pengujian dengan pakar dan pengguna tentang kegunaan dan kebolehgunaannya. Prototaip ScreenMen pertamanya diuji oleh pakar menggunakan kaedah ‘prospective think aloud’. Prototaip yang telah ditambahbaik kemudiannya diuji oleh lelaki dari institusi perbankan tersebut menggunakan kaedah ‘retrospective think aloud’, dan dinilai menggunakan

System Usability Scale (SUS) dan perubahan dalam niat untuk menjalani saringan kesihatan. Daripada penilaian keperluan dengan 31 lelaki, salah tanggapan mengenai saringan kesihatan, contohnya 'saring hanya apabila sakit', merupakan penghalang utama dalam menjalani saringan kesihatan. Selain itu, lelaki tidak tahu akan risiko kesihatan mereka dan ujian saringan yang perlu mereka jalani. Mereka juga kekurangan pengetahuan tentang kos, bila dan di mana untuk menjalani saringan kesihatan. ScreenMen menangani halangan-halangan ini melalui tiga modul: video pendidikan saringan kesihatan, fungsi penilaian kesihatan dan soalan lazim. Web ScreenMen terakhir adalah sensitif-lelaki (misalnya menggunakan analogi penyelenggaraan kereta), interaktif (menyediakan nasihat kesihatan peribadi), berasaskan bukti dan responsif terhadap telefon mudah alih. Ia juga menyerupai perundingan klinikal sebenar di mana pengguna boleh berinteraksi dengan doktor alam maya. Semasa pengujian dengan pakar, kandungannya didapati sah dan terkini. Pengguna mendapati ScreenMen adalah berguna kerana mereka boleh mengetahui lebih lanjut mengenai kesihatan dan saringan kesihatan tanpa memerlukan perundingan klinikal dengan doktor. Walau bagaimanapun, sesetengah pengguna inginkan ScreenMen lebih ringkas, maka 'Mod Penilaian Pantas' ditambah dan maklumat disusunsemula untuk memenuhi keperluan ini. Selain itu, penekanan tentang kepentingan untuk mengelakkan ujian saringan yang tidak perlu telah ditingkatkan bagi menggalakkan saringan kesihatan berasaskan bukti. Penilaian awal mendapati ScreenMen adalah mesra pengguna dengan skor purata SUS 76.4 (julat kebolehgunaan baik: 71.4-85.5). Lapan daripada 23 lelaki merancang untuk menghadiri saringan kesihatan lebih awal daripada niat asal selepas menggunakan ScreenMen. Daripada 12 lelaki yang berada di tahap pra-kontemplasi, empat ubah sama ada kepada tahap kontemplasi atau bersedia. ScreenMen telah dibangunkan secara sistematik menggunakan pendekatan yang berpusatkan pengguna untuk memperkasa lelaki agar

menjalani saringan kesihatan. Data awal mencadangkan bahawa ScreenMen diterimabaik oleh lelaki dan mungkin meningkatkan niat untuk menghadiri saringan kesihatan.

Kata kunci: saringan kesihatan, kesihatan lelaki, maskuliniti, eKesihatan, aplikasi web mudah alih

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LIST OF SYMBOLS AND ABBREVIATIONS

CeHRes	:	Centre for eHealth Research
ECG	:	Electrocardiogram
GP	:	General Practitioner
HIV	:	Human Immunodeficiency Virus
HLO	:	Health Literacy Online
HTML5	:	Hypertext Markup Language 5
ICT	:	Information and Communication Technology
IM	:	Integrative Model
KL	:	Kuala Lumpur
MCG	:	Malaysian Consensus Guide
mHealth	:	Mobile Health
MSM	:	Men who have sex with men
PAPM	:	Precaution Adoption Process Model
PHP	:	PHP: Hypertext Preprocessor
PSA	:	Prostate Specific Antigen
RCT	:	Randomised controlled trial
TM	:	Transtheoretical Model
TPB	:	Theory of Planned Behaviour
UKMRC	:	United Kingdom Medical Research Council
USA	:	United States of America
USPSTF	:	United States Preventive Services Task Force
WHO	:	World Health Organisation

LIST OF APPENDICES

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter describes the current status of men's health, the possible causes of major health problems in men as well as their impact on the community and nation. It justifies the need to focus on younger men particularly looking at health prevention such as screening at a younger age. Several interventions to improve health screening uptake focusing on male-sensitive interventions as well as the role of Information and Communication Technology (ICT) in promoting screening are highlighted. Subsequently, the research questions as well as the objectives of this study are presented. This chapter ends with the description of the thesis structure, which follows the Published Papers format.

1.2 Suboptimal Men's Health Status: Causes and Impact

It has been well established that men have higher rates of premature death and are more likely to develop chronic ill-health than women (Hawkes & Buse, 2013, 2017; White et al., 2014). Globally, life expectancy at birth for men is five years shorter than women (WHO, 2015a). Recent men's health reports from Asia, Australia, Canada and Europe have confirmed that most causes of death including those from communicable diseases, non-communicable diseases and injuries are significantly higher in men than women (Australia Institute of Health & Welfare, 2013; Barford et al., 2006; Bilsker, Goldenberg & Davison, 2010; European Commission, 2011; Ng et al., 2014; Tan et al., 2013; White, Seims & Newton, 2015). In terms of morbidity, though years lived with disability (YLD) is higher in women than men globally, healthy life expectancy, which represents years lived healthily without disability, is lower in men (61.6 years) as compared to women (64.6 years) (Global Burden of Disease Collaborative Network, 2017; WHO, 2016). Apart from that, men also have higher prevalence of non-

communicable diseases risk factors such as smoking, alcohol consumption, raised fasting blood glucose and raised blood pressure (WHO, 2015b, 2015c, 2017b, 2017c).

These discrepancies in health status between men and women might be influenced by the biological, behavioural and system factors. Biologically, instead of having oestrogen which is protective of cardiovascular system, men have testosterone which is found to be enhancing cell death (Ling et al., 2002; Mendelsohn, 2002; Mendelsohn & Karas, 1999). Other than that, men only have one copy of the X chromosome, which is shown to have higher immunological advantage, unlike women who have two copies (Libert, Dejager & Pinheiro, 2010). Men are also more likely to have fat accumulated in the abdominal area, which increased the risk of cardiovascular diseases, while women tend to have fat at the hip area (Power & Schulkin, 2008). In terms of behaviour, poorer health in men has been associated with male socialisation and how men feel they should respond to health issues, with prevailing expectations of hegemonic masculinity running counter to a 'healthy' lifestyle (Connell & Connell, 2005). As a consequence of this, men tend to involve in more high risk activities (such as higher levels of smoking and alcohol intake as well as dangerous driving); have lower health awareness; are more reluctant to engage in health promotion activities; and delay or avoid seeking help when sick (Addis & Mahalik, 2003; Byrnes, Miller & Schafer, 1999; Richardson & Smith, 2011). Healthcare system and policy may also play a part in influencing the health status of men. Globally, there are very few health policies addressing the healthcare needs of men (Baker et al., 2014). The lack of male-friendly healthcare setting also discourages men to seek health care, which may lead to higher levels of potentially preventable health conditions and premature mortality in men (Banks, 2004; Druyts et al., 2013; European Commission, 2011; Johnson et al., 2015; Muula et al., 2007).

Men who have poor health will not only lead a higher risk of morbidity and mortality, they also experience poorer quality of life. As reported by Hagedoorn et al, men with a

medical condition have worse physical functioning than healthy men. Not only affecting men themselves, the authors reported that men's ill health caused psychological distress to their wives as well (Hagedoorn et al., 2001). Apart from physical and psychological impacts to men and their wives, poor men's health may also affect the growth of their children (Amato, 2005; Garbarino & Haslam, 2005). Studies have found that the presence of father and paternal guidance led to positive effect of children's health and behaviour (Lopez & Corona, 2012; Rovito & Rovito, 2015). Besides these, poor men's health also brings about financial consequence to men, women, families, employers as well as the government. Ill health may cause loss of income in men, which will also impact women and families who are depending on men (Baker & Shand, 2017). Health economists in the United States (US) have reported that premature and morbidity in men costs the government more than $142 billion annually; US employers and society $156 billion annually in terms of direct medical payment and loss of productivity; and an additional estimation of $181 billion annually due to decreased quality of life (Brott et al., 2011). These evidences have demonstrated that poor men's health caused a significant impact not only on men themselves, but on men's partner, family, employer and country, which signify the need on improving men's health.

1.3 Focusing on the Health of Younger Men

Among all age groups, the mortality gap between men and women was the widest in the middle-age group. The male to female premature death ratio is the highest in the age group between 15 and 49 years with the ratio of 1.81 (Global Burden of Disease Collaborative Network, 2017; White & Holmes, 2006). Apart from that, the age group of 25-44 is also a critical period when men begin to develop diseases and risk factors. Statistics have shown that there is a sharp rise in male morbidity after 45 years old (Diabetes UK, 2010). Men of this age spent most hours in work-related activities and have the least time for personal care (Bureau of Labor Statistics, 2016). This is the period

when men focus on career building as well as raising a family. It is common that men at this age neglect their health often citing 'no time' as the main reason. This group of men have high prevalence of smoking, alcohol use, fast food consumption and short sleep duration, which are risk factors for diseases (Anderson et al., 2011; Centres for Disease Control and Prevention, 2015, 2017; WHO, 2014). They also have the lowest general practitioner visit rate among all age groups (NHS, 2009).

Current health system has put more emphasis on the health care of children, adolescent, women and older population; men, particularly those at the age of 25-44 years old are often neglected (Baker et al., 2014; White, 2013; White & Holmes, 2006; White et al., 2014; WHO, 2001). Moreover, men at this age are often inadequately educated on health matters and not motivated to practise healthy lifestyle or to take up disease prevention measures such as screening. As a result, many develop diseases, particularly non-communicable diseases, when they reach 40 years old which may lead to morbidity and premature death. This is shown by the findings from Malaysian National Health and Morbidity Survey 2015, where the age 40 years old is the point when the prevalence of diabetes and hypertension exceeded the overall prevalence of diabetes and hypertension (Figure 1.1) (Institute for Public Health, 2015). Apart from that, the survey also found high prevalence of undiagnosed hypertension, which was significantly higher in men than women. The prevalence of undiagnosed hypertension was higher than known hypertension among people below 55 years old (Figure 1.2), which also signifies the need of focusing on younger men. Therefore, it is important to focus on younger men as it is a critical period when risk factors and early diseases can be identified and intervened using strategies such as health screening to prevent or delay the onset of health problems in men.

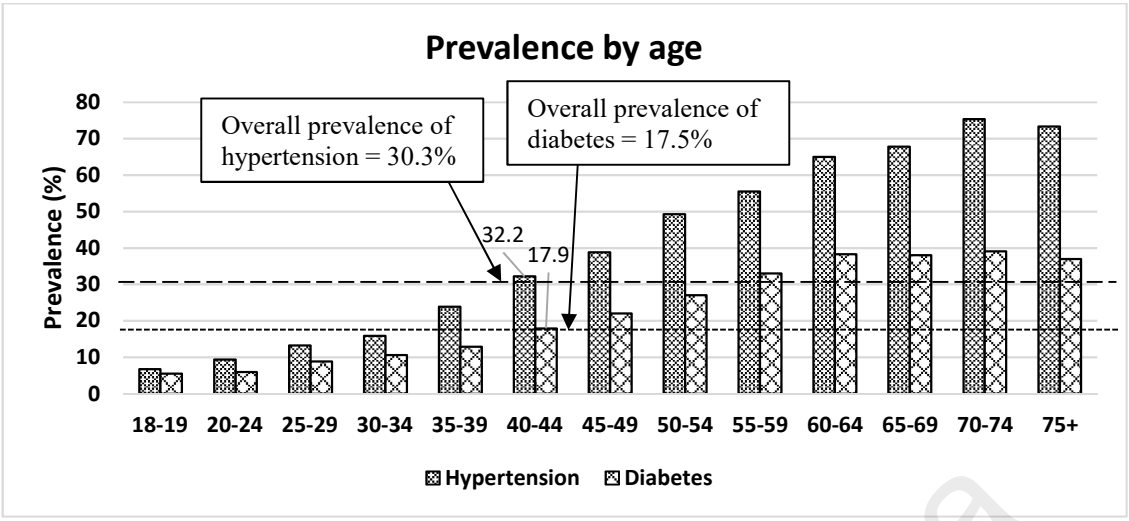

Figure 1.1: Prevalence of diabetes and hypertension in Malaysia by age group

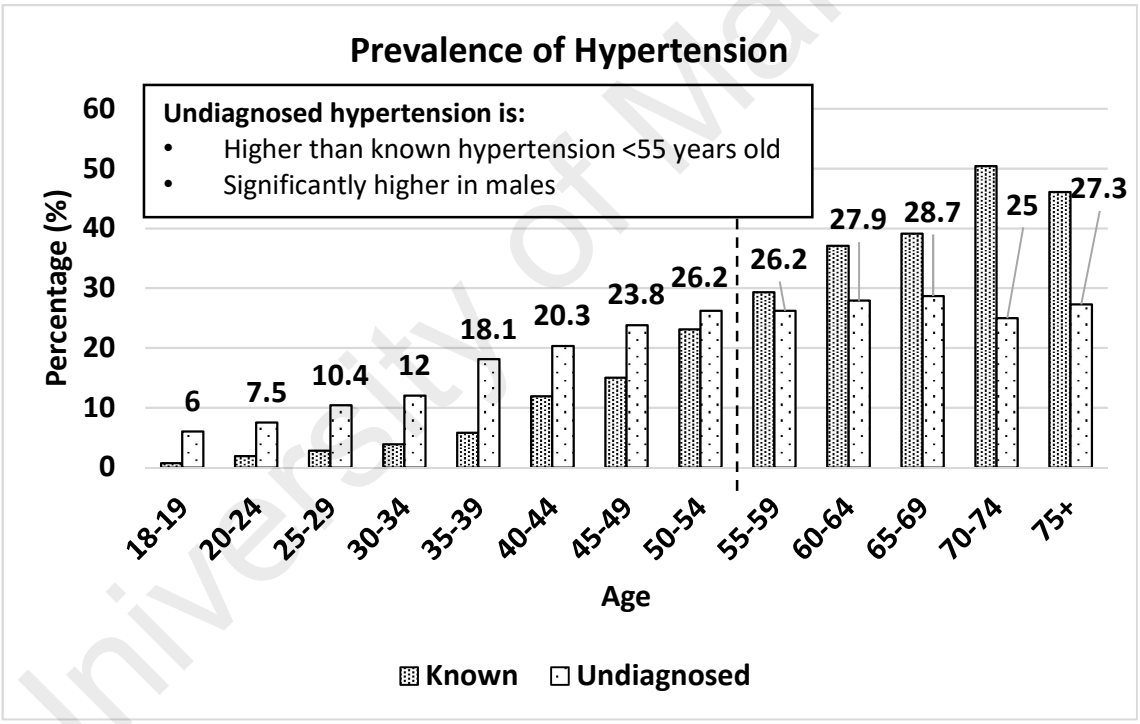

Figure 1.2: Prevalence of known and undiagnosed hypertension in Malaysian by age group

1.4 Health Screening as A Strategy to Improve Men's Health

There are many ways to improve men's health. Practising healthy lifestyle such as keep a healthy diet, maintain physically active and avoid smoking is one of the key components in disease prevention as it helps to reduce the risk of diseases (WHO, 2018). However, healthy lifestyle alone does not totally prevent the chance of getting a disease. Non-modifiable factors such as age and family history are considered as important factors which increase the risk of men getting a disease. Therefore, health screening plays an important role to detect and treat diseases at an early stage (Institute for Quality and Efficiency in Health Care, 2016). Men's involvement in disease prevention particularly early detection of disease can save huge amount of treatment cost and reduce healthcare burden (Castro-Rios et al., 2010; Chatterjee et al., 2010). Apart from cost, health screening in men may increase men's quality of life, family's wellbeing as well as national productivity (Baker & Shand, 2017; Brott et al., 2011).

The United States Preventive Services Task Force (USPSTF) recommends a list of evidence-based health screening. The USPSTF conducts rigorous review and appraisal of existing scientific evidence regularly to ensure the evidence underlying the health screening recommendations are up-to-date (United States Preventive Services Task Force, 2016a). For adult men, screening for health conditions such as high blood pressure, dyslipidaemia, diabetes, colorectal cancer and depression are highly recommended (United States Preventive Services Task Force, 2016b), and these tests are easily available and accessible to most men in Malaysia. This is particularly relevant in the Malaysia context, where the prevalence of diabetes and hypertension; cardiovascular events; colorectal cancer incidence; and suicide are on the rise (Ali et al., 2014; Aziz et al., 2015; Jan Mohamed et al., 2015; Naing et al., 2016; Veettil et al., 2017). Health screening should be individualised and include assessment of personal lifestyle and risk-taking behaviours as well as family history of diseases. This helps to stratify the risk of men and

accurately predict their likelihood of getting a disease (National Institutes of Health, 2015).

In Malaysia, health screening can be done in many places including public hospital, public health clinic, private hospital, private clinic as well as blood test lab. There is a public healthcare facility within every 5km radius including in the rural areas. The fee for utilising a public outpatient clinic including for health screening is as low as RM1. Despite the availability of screening services and programmes, statistics have shown that health screening uptake remains low, particularly in men. For example, a Bowel Cancer Screening Programme in England conducted in 2006 found that out of 2.1 million participants, only 49.6% of men returned the faecal occult blood test kits compared to 54.4% of women (Logan et al., 2012). The Malaysian National Health and Morbidity Survey 2011 found that only 34.9% of men attended medical check-up in the past 12 months during the survey period and it is significantly lower than that of women, which was 40.7% (95% CI, 39.5-41.8) (Institute for Public Health, 2011). The uptake rate was also significantly lower in the younger group (Institute for Public Health, 2011). It has been well established that age, ethnicity, socio-economic status and gender are known factors that influence screening uptake and men are consistently found to have a lower uptake of screening services (Weller & Campbell, 2009).

1.5 Gender-sensitive Interventions

Numerous interventions have been used to increase screening uptake and they include invitation appointments, letters, phone calls, educational home visits and opportunistic screening. A systematic review on the interventions to improve health screening uptake has found that these interventions have varying levels of effectiveness (Jepson et al., 2000). An important strategy of health promotion to ensure greater program success is to target specific group such people from lower socio-economic status; people living in rural areas; people with strong family history of disease; young people; gay community; or

male population rather than general population (Donovan, Egger & Francas, 1999). Having segmentation of target population done, the intervention can be developed catering for that group in a culturally sensitive manner.

Apart from culturally sensitive, experts have recommended the need of using a gender sensitive approach in health programme, recognising that men and women have different gender roles and needs (WHO, 2010). Over the past four decades, women's health has progressed tremendously as efforts have been made to empower women to improve their health status. Policies have successfully helped to change the male-dominant health service to address specific needs of women. The elevation of women's health status to what is it today reflects the importance of gender-sensitive approach to the delivery of health care, including screening.

In terms of improving health screening uptake in men, a study by Holland et al. which used male-sensitive interventions such as personalised letters or pamphlets and loved-one postcards as intervention tools to increase screening uptake in men, reported a higher prostate and cholesterol screening as well as preventive healthcare office visits compared to the non-male sensitive control group (Holland, Bradley & Khoury, 2005). There are several other studies evaluating interventions to increase health screening uptake but few focus on gender-sensitive approach in promoting health screening.

Men and women exhibit different behaviour and they should be treated differently (Baker et al., 2014). A systematic review of screening uptake interventions conducted by Weller et al. concluded that male's perspectives and attitudes towards preventive health services should be taken into account when planning strategies to increase screening uptake in men (Weller & Campbell, 2009). It is, therefore, hypothesized that a gender-sensitive approach could yield a better outcome as compared to generic intervention methods in promoting health screening in men.

1.6 Use of Information and Communication Technology in Health

Information and communication technology (ICT) is increasingly being used to improve the health of the public in the past two decades (Elbert et al., 2014; Hutchesson et al., 2015; Meier, Fitzgerald & Smith, 2013; Naslund et al., 2015). This has spawned a field called 'eHealth'. Though there are varying definitions of eHealth which never stop evolving, the simplest definition for eHealth is the use of ICT for health (WHO, 2017a).

ICT itself is defined as a diverse set of technological tools and resources used to communicate, and to create, disseminate, store and manage information (Blurton, 1999). It is being used in the clinical setting such as the electronic medical records, clinical decision support tools, eAppointments and ePrescribing. Beyond clinical setting, ICT is being used for telemonitoring as well as for health promotion. Many types of eHealth interventions have been deployed to improve health behaviour of the public for example text messaging, interactive voice response technology, computer programmes, websites as well as mobile apps and many have been found effective in improving health behaviour. A systematic review by Wantland et al. reported that web-based interventions increased health-related knowledge (nutritional status and asthma treatment knowledge) and behaviour (increased exercise time) as compared to non-web-based interventions (Wantland et al., 2004). Another systematic review by Bailey et al. reported that interactive computer-based interventions are effective in sexual health promotion and they showed positive effects on self-efficacy, intention and sexual behaviour as compared to 'minimal intervention' such as usual practice (Bailey et al., 2010). These showed that eHealth interventions can be effective in inducing behavioural change to increase health promotion activities (primary prevention). However, to date, there are few studies that use ICT to promote health screening in men particularly in promoting comprehensive health screening.

eHealth interventions particularly web-based interventions are not as labour-intensive and costly as the conventional interventions. Other than its capability of being interactive and fun, it has a wide dissemination reach to the public especially via mobile phone. Mobile health (mHealth), which is defined as medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices, has become an important means to improve healthcare in the past decade (WHO, 2011). mHealth removes geographical and temporal barriers; it helps to deliver just-in-time healthcare to people at their preferred location (Tachakra et al., 2003; WHO, 2011). Men, especially the younger group, tend to spend considerable amount of time on their mobile phone. In 2015, on average, both Americans and Malaysians spent about three hours on their mobile devices every day (eMarketer, 2015a, 2015b). Many studies have shown that mHealth interventions are effective in improving the health of the public such as in terms of treatment adherence, physical activity, healthy dietary intake, systolic blood pressure and pulmonary function (Hamine et al., 2015; Stephani, Opoku & Quentin, 2016). Therefore, mobile phone is potentially an effective medium to reach out to men to improve their health by imparting health knowledge, increasing health awareness, changing men's health attitudes and behaviours (Tyler & Williams, 2014).

1.7 Research Questions

The suboptimal health status in men needs to be addressed, specifically focusing on health prevention in younger men. There is a need for interventions to encourage young men to undergo health screening in order to detect and prevent diseases from progressing to a later stage. Using the platform of ICT as well as male-sensitive approach to improve screening uptake in men, which is currently lacking, could be an effective way to achieve this.

To ensure the intervention is effective and implemented beyond research setting, the United Kingdom Medical Research Council (UKMRC) has recommended that an intervention should be developed based on evidence, theory and needs (Craig et al., 2008). In order to develop an effective eHealth intervention to improve health screening uptake in men, the following research questions must be answered:

- What are the barriers and facilitators to health screening in men?
- What are the effectiveness of existing interventions (including eHealth interventions) in improving health screening uptake in men?
- What are the factors that influence young men's decision to undergo health screening in Malaysia?
- What do men need from a health screening mobile application?
- How to develop an eHealth intervention to improve evidence-based health screening uptake in men?
- What is the utility and usability of the eHealth intervention in improving evidence-based health screening uptake in men?

1.8 Study Aims and Objectives

In this study, the intervention will be developed based on the United Kingdom Medical Research Council (UKMRC) Complex Intervention Framework (Craig et al., 2008). The aim of the study is to develop and pilot test an innovative eHealth intervention to improve uptake of evidence-based health screening in men. The objectives of this study are to:

1. identify the barriers and facilitators to health screening in men
2. conduct a systematic review on the effectiveness of interventions to increase men's health screening uptake
3. explore the factors that influence young men's decision to undergo health screening in Malaysia

4. explore what men want in a health screening mobile application
5. develop an eHealth intervention to increase evidence-based health screening uptake in men
6. evaluate the utility and usability of the eHealth intervention to increase health screening uptake in men

1.9 Thesis Structure

This thesis follows the Published Papers format and is organised into six chapters as shown below:

Chapter 1 describes the introduction of the thesis, which includes the current state of men's health, the need to focus on improving health screening uptake in younger men and the potential of using ICT as well as gender sensitive approach in achieving that. These are followed by the list of research questions, study objectives and description of thesis structure.

Chapter 2 is the literature review chapter, which reviews men and masculinity issues, existing male-sensitive interventions, evidence-based health screening, existing eHealth and mHealth interventions to improve health, behavioural change theories and ICT development theories. Two systematic reviews on the barriers and facilitators to screening in men and the effectiveness of interventions to promote screening in men were published and presented in Chapter 4 due to the extensive methods involved.

Chapter 3 explains the overarching framework used for this study, the United Kingdom Medical Research Council Complex Intervention Framework, which emphasised the use of theories, evidence and needs when developing interventions. This chapter also provides an overview of the methods used in the two phases of this study (exploratory and development phase). The detailed methods are presented in the published papers.

Chapter 4 presents the six papers in journal publication format which lead to the finalised ScreenMen mobile web app: four from the exploratory phase and two from the development phase. (Figure 1.1)

Chapter 5 discusses the cumulative effects of the papers presented in Chapter 4, importance of refocusing on knowledge, addressing masculinity barriers and using male-sensitive approach to improve health screening uptake in men, advocacy of evidence-based screening, using ICT in promoting health screening in men as well as the strengths and limitations of this study.

Chapter 6 provides the conclusion of the study, recommendations for future research and implication for use and practice.

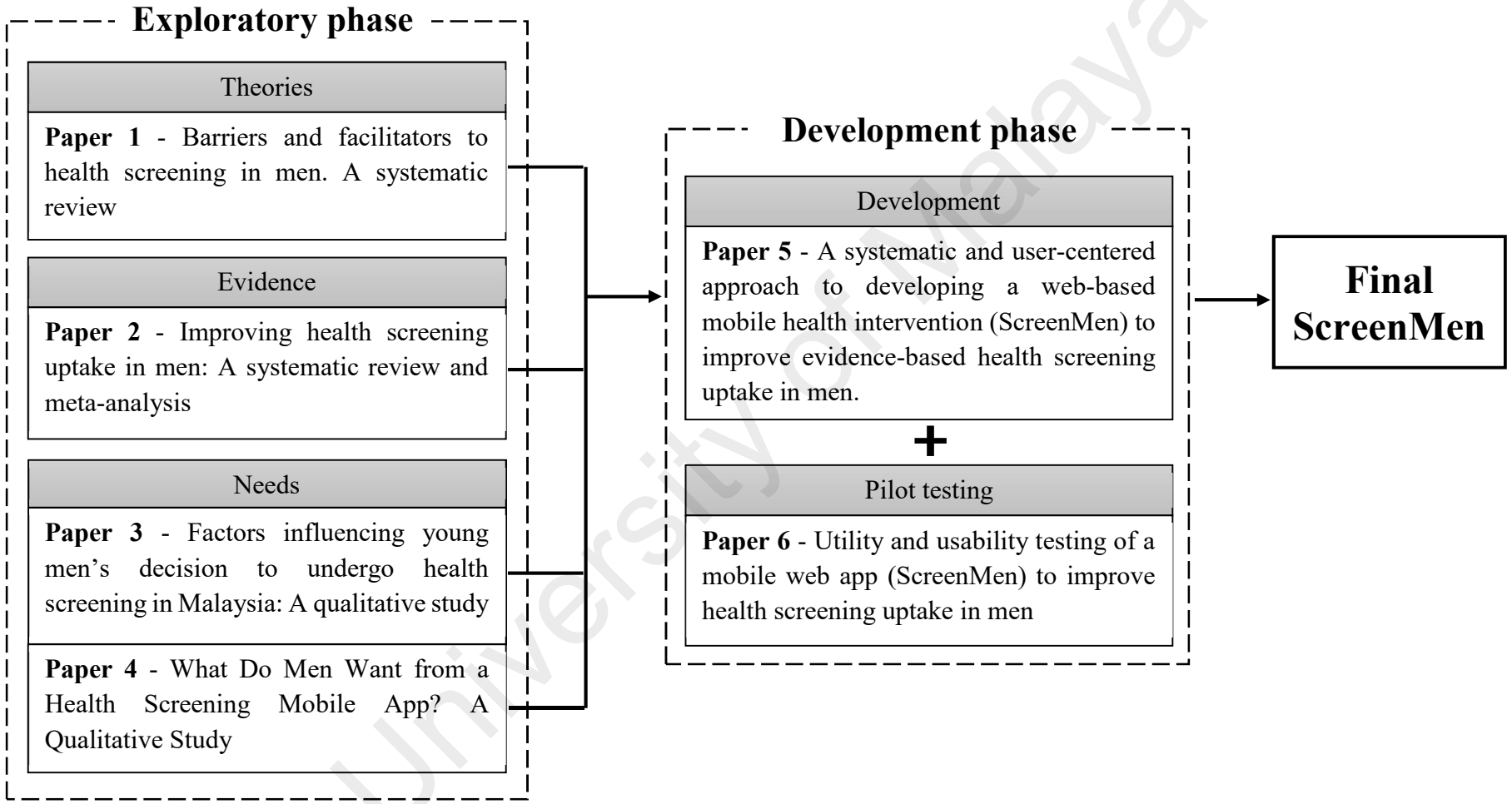

Figure 1.3: Linkage of the six publications in the thesis

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter starts with the exploration and understanding of issues surrounding men and their behaviour which include the masculinity issue. Subsequently, a review on the existing interventions that work for men are conducted. Since this study aims to promote evidence-based health screening in men, evidence on health screening was sought from international as well as local guidelines to come to a final list of screening that is tailored to the local context which will be recommended to men. As this study will be using the eHealth approach to improve health screening uptake in men, the existing evidences on eHealth interventions on various health conditions were described. This chapter then narrows down to mHealth, where comparison between mobile app and mobile web app are also made. Then, as recommended by the UKMRC Complex Intervention Framework, behavioural change theories as well as ICT development guidelines identified, which are crucial to be incorporated into the intervention in order to achieve high usefulness and effectiveness, are explained in this chapter.

2.2 Men and Masculinity Issues

Before developing an intervention to improve men's health behaviour, it is crucial to recognise that men have specific issues and needs which are different from women. As described in the Introduction chapter, men have lower life expectancy and higher mortality rate than women across most diseases (European Commission, 2011; Tan et al., 2013; WHO, 2015a). Men's health related behaviours could be the main explanation for this discrepancy of health status. Statistics have shown that men are more engaged in high risk activities such as smoking, alcohol abuse and drug use, which lead to increased risk for heart, liver and kidney diseases (Van Etten, Neumark & Anthony, 1999; WHO, 2015b, 2015c). Many studies have also found that men are less likely to engage in health

promoting behaviour such as performing testicular self-examination which contributed to testicular cancer mortality (Evans et al., 2005; Yeazel et al., 2004). Apart from that, men have poorer dietary habit than women, which leads to an increased risk for diseases including cardiovascular disease (Melanson, 2008; Wardle et al., 2004).

Besides the poor health promotional behaviour, men are also found to have less health knowledge and are less likely to utilise healthcare services than women (Allen et al., 2009; NHS, 2009; Santos-Hovener et al., 2015; Wong et al., 2013). Despite the suboptimal health statistics, men are less likely to perceive they are at risk than women and rated their health better than women (Courtenay, 2011). Men also have smaller social support circle and use avoidant coping strategies such as alcohol consumption, smoking, denial and distraction to cope with stress instead of expressing their problems (Umberson, 1992). Men's suboptimal health status is also contributed by death due to injuries such as road traffic accident and violence, where more men are found to drive recklessly and avoid wearing safety belt as compared to women (Mayrose & Jehle, 2002; Schlundt, Warren & Miller, 2004). In terms of violence, men are also found more likely to be both the perpetrators and victims, increasing mortality due to homicide (Loeber et al., 2005).

These poor health attitudes and behaviours of men were often linked to the concept of masculinity (Sloan, Conner & Gough, 2015). Masculinity is a set of attributes that are associated with 'being a man'. Connell defines masculinities as the configurations of practice within gender relations, a structure that includes large-scale institutions and economic relations as well as face-to-face relationships and sexuality (Connell & Connell, 2000). Traditionally, a man must be seen to be independent, aggressive, stoic, courage, tough, risk-taking, competitive and heterosexual and masculinity is often defined as avoidance of femininity generally (Courtenay, 2000). It is the construction of gender roles within the society that created the concept of masculinity and femininity. The cultural

stereotypes about gender informed how men and women are expected to act or behave in a community. Instead of acting based on own role identities and psychological traits, men often choose to do something that conform to the masculine norm.

Masculinity attributes greatly impact men's health seeking behaviour. Hooper et al has constructed and defined health seeking in men as a dynamic, multidimensional, interactive process driven by a man defining a concern as a problem; influenced by individual biological, psychological, and social components that allow him to maintain fidelity with his masculine self-schema while seeking care; and influenced by the healthcare system (Hooper & Quallich, 2016). Studies have found that men tend to exhibit the sense of invulnerability, denial of illness and inexpressiveness when it comes to health matter (Brown, 2001; Fish et al., 2015; Moller-Leimkuhler, 2002; O'Brien, Hunt & Hart, 2005; Wenger, 2011; White & Johnson, 2000). Men believe that they are strong and they are invulnerable to diseases; if acquired a disease, men would deny and endure it instead of discussing it with others or seeking medical help. This stereotype may still hold true globally, though some qualitative studies in the recent years found no difference in help seeking between men and women (Emslie et al., 2007; Farrimond, 2012; MacLean et al., 2017). The lack of difference in help seeking between men and women in these studies may be due to the health conditions studied such as lung cancer which are often perceived more seriously by both men and women as well as the selected study samples who are from higher socio-economic status (Emslie et al., 2007; Farrimond, 2012; MacLean et al., 2017). More quantitative studies and meta-analyses need to conduct to ascertain this finding.

This poor health seeking behaviour in men also applies in the context of attending health screening. Christy et al. has proposed a framework to explain men's colorectal cancer screening behaviour (Christy, Mosher & Rawl, 2014). She listed four masculinity

variables that would influence men's uptake of colorectal cancer screening: avoidance of femininity; risk-taking; self-reliance; and heterosexual self-presentation. Avoidance of femininity is the central value of the traditional masculinity norms which suggests that men tend to avoid action that could be perceived as feminine such as help-seeking or going for health screening (Brannon, 1976; Mahalik et al., 2003). The traditional masculinity norms also illustrate men's belief that they should be daring and often do not perceived themselves vulnerable to disease (Brannon, 1976). Men also believe that they should not rely on others and must be independent in their actions and thoughts, hence, do not seek for medical help (Brannon, 1976). To be seen as a man, men also avoid activities that are indicative of being gay such as going through colonoscopy (Brannon, 1976; Parent & Moradi, 2009; Thompson, Reeder & Abel, 2012).

Masculinity is not static but a dynamic concept. Masculinity attributes vary individually instead of being practiced homogenously in a society. There are many factors that are associated with the likelihood of endorsing masculinity norms. Studies have shown that men from lower socioeconomic status and educational level as well as men who have separated parents are more likely to have gender role conflict and endorsing masculinity norms, which are also associated with adopting fewer health promoting behaviours and higher level of stress and anxiety (Houle et al., 2015; Mansor et al., 2014) Apart from that, men redefine and reconfigure masculinity throughout their life course and life events (Courtenay, 2000; Lohan, 2007; Oliffe, 2009). While men at different age exhibit different practices of masculinity, Rochelle et all found that younger age was associated with greater preventive care behaviour engagement, practice healthier dietary habit and having higher levels of social support (Rochelle, 2015). However, younger age was also associated with higher level of desire to win, having many sexual partners, more likely to resort in violent action as well as involvement in more high risk activities while

older men were more likely to rely on themselves rather than others, keep feeling to themselves and make work a priority (Rochelle, 2015).

Other than that, experts have also argued that masculinity manifestation differs according to locality. Hasan et al found scarce literature on masculinity in Asian men. They discussed that in South Asia which includes India, men play a dominant role in a family and make decisions for the family including health care. Not only masculinity prevents men from maintaining good health, the male dominant attribute has also impacted and become a barrier for women in the family to seek help. There is a lack of positive roles of masculinity in promoting health care in South Asian men, which are present in the West (Hasan, Aggleton & Persson, 2015). This male dominant role in household decision making was also found prominently in a survey conducted among Malay university students in Malaysia. In the study, it was found that the highest proportion of male respondents 'like to be seen to be followed by their wife and children'. This highlights the strong presence of the dominance masculinity attribute in Asian men (Alam, 2016). Apart from that, the familial preference for sons among the Chinese also signifies this male dominance attribute. Sons are preferred as men maintain the family lineage ties and considered the lead of a family. Once married, women are required to move to join men's family. Having sons and wives in the family, parents are able to maintain a good old-age support. Men are also deemed more appropriate in worshiping the ancestors instead of women (Rochelle, 2015; Wang, 2005). These demonstrate the strong presence of the male dominance attribute in Asian countries.

Instead of focusing on the negative impact caused by masculinity, there is an increasing effort to view masculinity in a positive lens. MacDonald has recommended the salutogenesis approach to address men's health at the population level, which is by focusing on 'building health' instead of 'tackling pathologies' (MacDonald, 2016). For

example, instead of negative impact of masculinity, a qualitative study conducted with young Malaysian men found positive masculinity attributes where a family man is considered masculine if they could assume responsibilities and take care of the family (Fazli Khalaf et al., 2013). Having gentle personality, being able to maintain a caring and communicative relationship with women as well as being a good father is also considered masculine (Fazli Khalaf et al., 2013). In Hong Kong, it is a norm for the sons to take care of his parents, where parents commonly reside under one roof with them. Rochelle argued that men looking after themselves by engaging preventive health activities can be perceived as a sign of masculinity so that they are able to take care of their parents (Rochelle, 2015). These suggest that looking at masculinity in a positive way and recognising the strengths of men could be a better approach to tackle men's health issues.

In a summary, men have different sets of health behaviour as compared to women which are influenced by societal expectation of masculinity in men. This masculinity attribute greatly impacts men's health seeking behaviour including in attending health screening. Nevertheless, masculinity attributes vary from person to person and change according to age and locality. It should be addressed uniquely according to men's needs and using a positive approach by recognising the strengths of men.

2.3 Male-sensitive Interventions

Generic health interventions that target both genders may fail to achieve their objectives as men and women have different gender roles and needs. In view of that, there is an increasing call to develop male-sensitive interventions when targeting men in health promotion programme. To date, many interventions have been deployed to improve the health of men. A systematic review conducted by Robertson et al in 2008 identified 27 interventions that aimed to improve the health of men specifically targeting health conditions such as prostate cancer screening, testicular self-examination, alcohol

consumption, diet, physical activity, smoking cessation and cardiovascular disease (Robertson et al., 2008). Many of the interventions found were sex specific (targeting diseases that are unique in men) rather than male-sensitive (designing the interventions specifically with men in mind). Some of the interventions targeted locations where men often come together such as sport clubs or workplace while some delivered the interventions via wives. Only three interventions were categorised as male-sensitive. One using a video introduced by a national football personality focusing on being a good father and the health risks of secondhand-smoking for newborns (Stanton et al., 2004). Another study used personalised letters that focused on the recommended preventive health screenings based on men's age (Holland, Bradley & Khoury, 2005). The third study employed a brochure about skin cancer with an invitation letter signed by a popular sportsman (Youl et al., 2005). Based on only these three studies, the authors cannot conclude whether interventions designed specifically for men work better than delivering a general service to all people (Robertson et al., 2008). Though these studies were suggestive of effectiveness, the authors called for more robust research on male-sensitive interventions to be conducted in order to make a more solid conclusion on the effect of male-sensitive approach.

Since then, more male-sensitive interventions have been developed and evaluated. The Football Fans in Training programme, which is a gender-sensitised weight-loss and healthy living programme targeting football fans in Scotland, was found to be effective in reducing weight, waist circumference and body fat as well as improving dietary intake, alcohol consumption and psychological wellbeing of men over the control group (Hunt et al., 2014). The authors described that this programme was male-sensitised in terms of context (football clubs), content (science about weight loss, alcohol's role in weight management and branding with club insignia) and style of delivery (participative and using male banter to help discussing sensitive subjects). Other than that, the systematic

reviews of and integrated report on the management of obesity in men found that men prefer more factual information on how to lose weight and emphasis on physical activity programmes as compared to women (Robertson et al., 2014). The study also concluded that the opportunity to attend men-only groups; individually tailored feedback; and conduct of intervention in male dominant setting such as sports club and workplaces may improve the effectiveness of interventions.

In terms of mental health, a scoping review conducted by Seaton et al found 25 studies on mental health promotion interventions for men, of which, nine involved men's workplaces while only five interventions used male-sensitive approach (Seaton et al., 2017). The male-sensitive interventions identified in this review involved cognitive behavioural therapy or psycho-education programme supplemented with discussions of men's adherence to masculine norms; building social network via football, gardening and drumming activities; delivering message by watching classic rugby league games; team-based football integration; and widening social support using the men's shed model. In addition, the report on the interventions promoting mental health and wellbeing with men and boys published by Robertson et al also emphasised the importance of using 'male-friendly' and culturally sensitive settings according to the groups of males such as workplace for working men while sports venue for young men and boys. The authors also recommended that staff or facilitator should take the non-judgemental and male positive approach when dealing with boys and men. The use of male-oriented terms such as using 'activity' rather than 'health'; 'regaining control' rather than 'help-seeking'; and 'coaching' rather than 'therapy' is encouraged when delivering interventions (Robertson et al., 2015).

Apart from targeting male-friendly settings; emphasising father's role; expanding social support using male-interested activities; and delivering message using sports, there

were also programmes that were delivered using the concept of car maintenance especially in terms of maintaining health. One of the examples is the Pit Stop Health Check programme, where a series of mechanical-tune-up-resembling health screening stations such as oil pressure station (for blood pressure) and chassis check station (for waist circumference) were organised (Alston & Hall, 2001; MENGAGE, 2010). Men who participate in the health screening programme were given a 'work order' to complete at every station, which was followed by an evaluation by the 'Marshall' at the end of the pit stop. The evaluation of this programme conducted at Farm World 2010 not only was beneficial clinically but also found that 98% of men enjoyed participating in it and 92% will participate again in the future (MENGAGE, 2010).

Moving towards a more macro perspective, a study interviewing various practitioners who have organised 35 successful men's health promotion initiatives for various health topics concluded that the key factors to the success were (Robertson et al., 2013):

1. using the right setting which is often outside statutory services;
2. employed the right approach by focusing on male-specific interests;
3. listen to the voice of the local targeted men;
4. ensuring appropriate training of the personnel delivering the programme; and
5. collaboration with local community groups

On top of that, Barker et al. have conducted a broad review and evaluated 58 programmes with men and boys in five health topics including sexual and reproductive health; father involvement; gender-based violence; maternal, new-born and child health; as well as gender socialisation (Barker et al., 2010). The authors concluded that gender-transformative programmes, which are programmes that seek to transform gender norms and promote gender-equitable relationships between men and women, seemed to show more success in improving men and boys' behaviour (Barker et al., 2010).

The research on male-sensitive interventions is ever growing. Increasingly, there are more evidence which showed effectiveness of male-sensitive interventions. However, the evidence are heterogenous and is still insufficient to form a solid conclusion using a rigorous meta-analysis method. More robust research need to be conducted to come to a more definitive answer on the effectiveness of male-sensitive interventions. In the meantime, the characteristics of male-sensitive interventions collated may work as a start for future research. The effort in designing and developing more creative solutions in addressing men's health issue should never stop.

2.4 Evidence-based Health Screening

Health screening should be recommended based on Wilson and Jungner classic screening criteria (Andermann et al., 2008). Briefly, a condition should be an important health problem; have a latent stage; be understood pathophysiologically; have acceptable and accurate diagnostic tool; have acceptable treatment; be cost-effective; have an agreed policy on whom to treat as patients; and be followed up continuously if positive in order to be recommended for screening. However, health screening is often linked to medical overuse or over-diagnosis issue (Busfield, 2015; Morgan et al., 2015). Non-evidence-based screening tests are commonly offered and done in the community. Undergoing non-evidence-based screening will not only waste resources but also pose unnecessary harms such as anxiety and pain to the public.

It is important to identify health screenings that are likely to produce more benefits than harms. One of the most established body which produce evidence-based guideline for health screening is the United States Preventive Service Task Force (USPSTF). The USPSTF actively conducts rigorous review on existing peer-reviewed clinical preventive services evidence including screening (United States Preventive Services Task Force, 2016a). The Task Force provides graded recommendation for each health screening test

based on the strength of evidence and the balance of benefits and harms of the preventive service. Among the highly-recommended conditions for screening in men are abdominal aortic aneurysm, alcohol misuse, blood pressure, colorectal cancer, depression, diabetes, dyslipidaemia, healthy diet and physical activity, hepatitis B and C, Human Immunodeficiency Virus (HIV), lung cancer, obesity, sexually transmitted infections, skin cancer, tobacco use, tuberculosis and syphilis (United States Preventive Services Task Force, 2016b). These, however, should be done based on an individual's health profile like age, family history, obesity, high risk behaviour such as smoking and unsafe sex.

Although recommendations made by the USPSTF are credible, the evidences used are not based on the Malaysian population. It is important to consider the differences in morbidity and mortality patterns in the local context so that screenings are recommended appropriately. The Family Medicine Specialists Association of Malaysia has recently published the Malaysian Consensus Guide to Adult Health Screening for General Population Attending Primary Care Clinics (Tong et al., 2015). The authors reviewed primary literature from MEDLINE and Cochrane database as well as screening guidelines from the USPSTF, the Canadian Task Force for Preventive Care and Guidelines for preventive activities in general practice 8th edition.

The health screening recommendations made by the USPSTF are modified to fit the Malaysian context. Abdominal aortic aneurysm and skin cancer screening are not recommended in Malaysia due to its low prevalence in the Asian population. For diabetes, the USPSTF recommends screening for men 40 to 70 years old who are overweight or obese. The local guideline recommends diabetes screening earlier in adults starting at 30 years old without any risk factors due to high prevalence of diabetes among Malaysian. The USPSTF also recommends HIV screening in adolescents and adults ages 15 to 65

years in the USA. In contrast, HIV is only recommended for high risk individual in Malaysia as HIV is concentrated among intravenous drug users, commercial sex workers, men who have sex with men (MSM), and transgender persons. There is no difference in the recommendation for health screening such as for alcohol misuse, high blood pressure, colorectal cancer, depression, dyslipidaemia, unhealthy diet, physical activity, hepatitis B and C, obesity and tobacco use between international and local guidelines. There was no information on lung cancer and syphilis in the Malaysian Consensus Guide due to limited resources. Thus, these will be recommended based on the USPSTF's recommendation. The final list of health screening to be recommended for Malaysian men is shown in Table 2.1.

Table 2.1: The list of evidence-based health screening for Malaysian men

No	Category	Health Condition and Recommendation	Source
1	**Lifestyle**	**Obesity** All	USPSTF & MCG
2		**Unhealthy diet** All	USPSTF & MCG
3		**Physical activity** All	USPSTF & MCG
4		**Tobacco use** All	USPSTF & MCG
5		**Alcohol misuse** All	USPSTF & MCG
6	**Cardiovascular risk**	**High blood pressure** All (18 years old and above)	USPSTF & MCG
7		**Diabetes** ≥30 years old OR younger if have risk factors: - overweight - have family history - have hypertension	MCG
8		**Dyslipidaemia** - ≥40 years old OR younger if have risk factors: - overweight - have family history - have hypertension - have diabetes	USPSTF & MCG

9	**Cancer**	**Colorectal cancer** - 50 to 75 years old OR younger if have risk factors: - have family history (screen 10 years earlier than the diagnosed aged of relative)	USPSTF & MCG
10		**Lung cancer** - 55 to 80 years old - 30 pack-year smoking history - Currently smoke or quit within the past 15 years	USPSTF
11	**Communicable diseases**	**HIV** - partner was diagnosed with sexually transmitted disease - have more than one sexual partner - men who have sex with men - inject drugs - received blood transfusion - have family history of HIV	MCG
12		**Syphilis** - partner was diagnosed with sexually transmitted disease - have more than one sexual partner - men who have sex with men	USPSTF
13		**Hepatitis B** - partner was diagnosed with sexually transmitted disease - have more than one sexual partner - men who have sex with men - inject drugs - received blood transfusion - have family history of hepatitis B	USPSTF & MCG
14		**Hepatitis C** - partner was diagnosed with sexually transmitted disease - have more than one sexual partner - men who have sex with men - inject drugs - received blood transfusion - have family history of hepatitis C	USPSTF & MCG
15	**Mental health**	**Depression** All	USPSTF & MCG

Note: USPSTF: United States Preventive Services Task Force; MCG: Malaysian Consensus Guide

2.5 eHealth Interventions

2.5.1 Existing eHealth Interventions to Improve Health Behaviour

There is an increasing use of ICT in health care to date. In the 58th World Health Assembly in 2005, the WHO acknowledged the potential of eHealth in improving health systems and increasing quality, safety and access to care. The WHO also urged stakeholders to incorporate eHealth into health services and systems globally (WHO, 2005). There are many types of eHealth interventions such as those using text messaging, phone call, computer programme, voice-response technology, web-based technology and mobile app that are used to improve health of the public to date. eHealth interventions especially web-based interventions have many advantages over conventional interventions, such as: lower development and implementation costs; less labour-intensive as it can be automated; more convenient to use whenever needs arise; have tailoring potential and interactive; can be used in anonymous manner in the context of sensitive issues; able to incorporate multiple forms of media and allow simulation; can be fun and appealing; as well as have wide dissemination and high networkability (Noar & Harrington, 2012).

On top of these advantages, studies have also shown that eHealth interventions are effective in improving health behaviour and outcomes. A systematic review conducted by Wantland et al. reported that web-based interventions showed improved behavioural change outcomes such as increased exercise time, increased nutritional status knowledge, and asthma treatment knowledge compared to non-web-based interventions (Wantland et al., 2004). Another systematic review of interactive computer-based interventions on sexual health promotion also demonstrated positive outcomes on self-efficacy, intention and sexual behaviour (Bailey et al., 2010). The same is true for interventions that are delivered via mobile devices. There were also many studies that reported the effectiveness of mobile apps and mobile web apps in modifying health behaviour and improving health

status. Mobile apps and mobile web apps have been found effective in promoting healthy diet and physical activity; improving coping with depression; reducing self-injurious thoughts and behaviours; and decreasing medication error (Birney et al., 2016; Franklin et al., 2016; Irvine et al., 2015; Mira et al., 2014; Wang et al., 2016).

These growing evidences showed the potential of eHealth interventions including those delivered via the mobile platform in promoting behavioural change in therapeutic (tertiary prevention) as well as health promotional activities (primary prevention). Though there are shortcoming such as breach of data confidentiality which could be prevented, the potential benefits of eHealth interventions exceed the potential harms. Despite these growing evidences of eHealth interventions on primary and tertiary prevention, there is a lack of eHealth interventions in improving health screening uptake in men (secondary prevention), which is a gap this study will be addressing. It is hypothesised that the effectiveness and usefulness of eHealth interventions may be replicable to the field of health screening as well.

2.5.2 Comparison Between Mobile App and Mobile Web App

There are several types of mHealth intervention which include those using text messaging, interactive voice response technology, phone call, app as well as website. Websites that are aimed to be delivered via mobile phone are increasingly being developed in the form of mobile web app. Mobile web apps are actually websites that are built using the web-based technology such as Hypertext Markup Language 5 (HTML5) and PHP: Hypertext Preprocessor (PHP), but are designed with the look and feel mimicking mobile app. Just like a normal website, it can be accessed via any internet browser in smartphones and even in computers. The user interface and the resolution of mobile web apps (which are commonly screen-responsive) are designed to fit nicely into the resolution of a mobile phone in order to improve user experience.

Table 2.2: Pros and cons of mobile web app and mobile app

Criteria	Mobile Web App	Mobile App
Processing speed	Lack of smoothness for heavy graphical animation	**Allow heavy graphical animation**
Device features	May not utilise device's features	**Can utilise device's features such as GPS, camera and sensors**
Offline functioning	Need internet to work	**Can work offline**
Multi-resolutions	**Usable in phone and computer**	Not usable in computer
Accessibility	**Can be accessed quickly via a web browser**	Need to download from AppStore and install
Discoverability	**Easily discovered on web**	Need to search in AppStore
Maintenance	**Easy to update contents**	More hassles
Development cost	**Cheaper**	More expensive
Phone storage	**Does not take up storage space**	Take up storage space
Other costs	Server and domain fee	AppStore subscription fee
Incompatibility	**No operating system incompatibility issue**	Outdated operating system incompatibility issue
Cross-platform	**The same web app can be used in both Apple and Android**	Need to develop separate app for Apple and Android

Note: Items in bold indicates pros.

Another type of mobile health intervention that are getting most attention nowadays is the mobile app. Mobile apps are programmes or applications that are developed to be used in mobile devices such as smart phones and tablets. It must be downloaded and installed from the application store (such as Google Play or the Apple's App Store) for one to use it. The terms 'mobile app' and 'mobile application' may be confused as they are being used interchangeably. However, experts have formed consensus and recommended to use 'mobile app' instead of 'application' to represent this (Lewis et al., 2014).

Though studies have shown that both mobile apps and mobile web apps are effective in improving health, it is crucial to understand their differences both in terms of strengths and limitations (Budiu, 2013). Mobile app is better when heavy programming and graphical illustration are essential for a high speed and smooth usage. It can also provide more functions by making use of the device's features such as GPS, camera, sensors, gestures and notifications. Once installed, it can be used without internet access (Budiu, 2013). Mobile web app is more favourable in terms of its discoverability. It is more easily found by users as people usually search for information in the internet browser when they have questions, where a mobile web app may emerge as the results. There is also no need for installation and mobile web app can be accessed directly with internet connection. This removes the hassle of downloading and also prevents the limited phone storage issue. In terms of maintenance, mobile web app is easier to be maintained by changing the back-end of the web unlike for mobile app where changes need to be packaged and uploaded in the app store and subsequently downloaded again by users to update it (Budiu, 2013).

Apart from that, the development and maintenance cost of a mobile web app is much lower than a mobile app as it requires more advanced development skills (Charland & Leroux, 2011). Though building a web requires server and domain fee, there is no subscription fee such as in the Apple's App Store. Furthermore, mobile web app can be accessed via any internet browser and there is no need to develop multiple versions of the mobile web app unlike mobile app where multiple versions need to be developed to cater for different groups of smartphone users such as those using Android and iOS. However, careful testing needs to be done to ensure that the layout fit nicely in different web browsers. Mobile web app also does not suffer from incompatibility issue like mobile app especially after the updates of smartphone operating system (Budiu, 2013).

To sum up, both mobile app and mobile web app both have their strengths. The decision to choose mobile app or mobile web app should be done considering the context, needs or users as well as resources available.

2.6 Behavioural Change Theories

Theories allow researchers to understand the mechanism of actions of how an intervention works (Craig et al., 2008). Interventions that have theoretical basis are more likely to be effective in achieving their objectives (Craig et al., 2008). There are several theories that need to be considered since this study involves developing a complex intervention. To encourage men to go for health screening, it is important to first understand the factors that may influence their decision to undergo health screening, specifically the barriers and facilitators to health screening. It is also important to understand men's stages of readiness to undergo screening as the intervention may work differently for men who are in different stages of readiness.

There are many theories that can be used to explain the change of behaviour in undergoing health screening. One of the commonly used theories in the context of health screening is the Theory of Planned Behaviour (TPB) (Ajzen, 1991). The TPB postulates that the uptake of health screening is likely to occur if there is an intention to change, which in turn is influenced by men's attitude, social norm and perceived control. The Health Belief Model (HBM) proposed that one's perceived susceptibility and severity of a condition, perceived benefits and barriers to a health action as well as self-efficacy may explain the likelihood of engaging in health promoting behaviour (Champion & Skinner, 2008). The HBM also included 'cues to action' which can act as a stimulus to trigger health promoting action. The Integrative Model (IM) is a newer model which combined the TPB, HBM and several other theories (Fishbein, 2000). It is more comprehensive and well-developed which can also be adapted to a researcher's specific behaviour of interest.

When designing behaviour change interventions, it is also important to take into account the stages of behaviour change. The Transtheoretical Model (TM) explains the stages of behaviour change and it starts from the stage of precontemplation (no intention to change within the next 6 months), contemplation (intend to change within the next 6 months), preparation (intend to take action within the next 30 days), action (behaviour changed for less than 6 months), maintenance (maintained changed behaviour for more than 6 months) to termination (no temptation to relapse) (Prochaska, DiClemente & Norcross, 1992). The Precaution Adoption Process Model (PAPM) also describes the stages of behaviour change (Weinstein & Sandman, 2002). This model further expands the precontemplation stage in the TM to 'unware of issue' and 'unengaged by issue'. Men who are unaware about the importance of health screening will react differently to the intervention as compared to those who are aware but not yet engaged. Men in the community have varying levels of understanding and need of health screening. It is important to consider these stages when developing an intervention and it has to be carefully planned with strategies to accommodate and benefit both groups of men.

The TPB, HBM and IM will be the used as the main guide in developing the intervention. These provide explanation on the mechanism of action of how the intervention cause behaviour change. The TM and PAPM which explain the stage of behaviour change will be considered when measuring the outcome of behaviour change.

2.7 Guidelines on Software Development

Apart from behavioural change theories, it is also important to consider ICT-development guidelines when developing and designing an eHealth intervention as this may promote the usage, improve the usability and increase the effectiveness of the intervention (Hou, 2012; Monkman & Kushniruk, 2013). One of the most commonly used guideline when designing a system is Nielsen's 'Ten Usability Heuristics for User

Interface Design' (Nielsen, 1993; Nielsen, 1994). The ten usability heuristics with explanations are shown in Table 2.1. Nielsen also states that a product with good usability must be easy to learn, efficient to use, easy to remember, have few errors and subjectively pleasing.

Table 2.3: Nielsen's Ten Usability Heuristics for User Interface Design

No	Heuristics	Explanation
1	Visibility of system status	Always keep the users informed of the progress
2	Match between system and the real world	Use easy to understand language and familiar concepts
3	User control and freedom	Give user navigation freedom such as allowing emergency exit, undo or redo
4	Consistency and standards	Use consistent words and instructions
5	Error prevention	Check for errors and prevent errors from occurring
6	Recognition rather than recall	Make options visible and easy to remember to minimise users' memory load
7	Flexibility and efficiency of use	Allow the system to be used by novice as well as expert users
8	Aesthetic and minimalist design	Reduce irrelevant information as it diminishes the important information
9	Help users recognise, diagnose and recover from errors	Help users to recover from errors by indicating the problem using an error message
10	Help and documentation	Provide help document for users

Monkman and Kushniruk have also developed the Health Literacy Online (HLO) Heuristics which contains components of health literacy and design heuristics as a guide to evaluate consumer health information system (Monkman & Kushniruk, 2013). The HLO Heuristics contains a new set of heuristics generated based on the HLO guide which is also modified to evaluate mobile health app. The heuristics in this model are clustered

into five categories: screens, content, display, navigation and interactivity. In brief, this model highlights that the screen of a home page must be simple and engaging as well as to make registration as simple as possible. This model also emphasises the need for presenting the content in a way that is accurate and easy to learn. In terms of display, it is important to ensure that the words are easy to read and to use images to facilitate learning. The users should also be able to navigate easily with large button size. Finally, an app or web should be interactive and engaging by providing feedback to the users.

Apart from that, Mayer, Sweller and Moreno have also described a list of multimedia instructional design principles to promote effective e-learning (Clark & Mayer, 2016; Low & Sweller, 2005; Mayer, 1997; Mayer, 2003; Mayer & Moreno, 2003; Moreno & Mayer, 2007). There are nine key principles that were recommend to be considered when developing an e-learning module. First of all, the Multimedia Principle emphasises that learning will be more effective when graphics, audio and text are combined as learners will be able to visualise the concepts guided by audio or text. The Coherent Principle recommends that unnecessary content should be avoided so that learners will not be distracted by unrelated contents which may increase cognitive load. The third principle is the Contiguity Principle, where related information should be kept closely together in terms of spatial (image and text which are related) and temporal (feedback right after users provide an input) in order for user to internalise the information. The Segmenting Principle explains that learning will be more effective if a module is segmented into several smaller chunks to reduce cognitive load. The Signalling Principle recommends the use of arrows, cues or highlights to indicate to learners the more critical elements of the lesson. The sixth principle is the Learner Control Principle, where user should be allowed to control the learning rate as everyone has different level of learning. The Personalisation Principle indicates that a conversational script in a first person or second person voice may help to promote deeper learning as this is easier to understand as

compared to rigid statements. The Pre-training Principle explains that presenting key concepts from the start may aid learners to grasp concepts more easily as they progress. The last Redundancy Principle recommends to avoid using both audio narration and on-screen text in a video as this will disallow learners to fully-utilise the graphics. All of these principles will be used as guidance when developing the intervention in the development phase of this study.

Apart from the heuristics and learning principle, the concept of user-centred design is also important in this study. It is a method where stakeholders including users are involved in the designing and development process of an intervention. This concept, which is also interchangeably used with co-design and participatory design, is being increasingly used to date as user involvement has been recognised as a key factor to successful adoption of intervention to date (Kanstrup et al., 2017; Kushniruk & Nøhr, 2016; Moody, 2014; O'Brien et al., 2016). O'Brien et al described that the stages where stakeholders can contribute in the development including the brainstorming phase to come up with the contents of the intervention and the prototype testing phase (O'Brien et al., 2016). Although the co-design method is more resource-intensive in terms of time and cost as it involves more stakeholders and more rounds of revision of the intervention, numerous studies have reported that involvement of user and stakeholder in the design process is rewarding as it provides creative ideas, especially looking from user's perspective, which results in higher acceptability and potentially increased effectiveness of the intervention (Moody, 2014; Voorberg, Bekkers & Tummers, 2015). This user-centred design is line with the UKMRC Complex Intervention Framework which is used in this study.

2.8 Summary of Literature Review

Men's health and behavioural issues are often linked to masculinity attributes such as risk taking, denial and self-reliance which are formed due to societal expectation on men. Masculinity is dynamic and is endorsed differently by different group of people, depending on factors such as age, education, socio-economic status and location. To more effectively improve men's behaviour, experts have urged academicians to view masculinity positively, by recognising their strength rather than problematise masculinity.

In order to increase effectiveness of intervention, experts have recommended that interventions targeting men should be developed in a male-sensitive manner. To date, there is limited evidence on male-sensitive interventions that are effective in improving health. Among the characteristics of male-sensitive intervention identified are targeting male-dominant setting, using male-specific interests and involving community support groups.

In terms of the evidence-based health screening, the list of health screening to be recommended to men was obtained from the USPSTF. The local guideline was also referred to in order to ensure the recommendations are tailored to local context. The final list of health conditions which are recommended for screening include obesity, diet, physical activity, smoking, alcohol use, high blood pressure, diabetes, high cholesterol, lung cancer, colorectal cancer, sexually transmitted disease, HIV, syphilis, hepatitis B, hepatitis C and depression.

On eHealth interventions, several systematic reviews and studies reported that interventions using computers, websites, mobile app and mobile web app were effective in promoting behavioural change in therapeutic as well as health promotional activities. This justifies the use of ICT to develop an intervention to improve screening behaviour

in men. The comparison of mobile app and mobile web app reveals that both have pros and cons and should be considered based on context, needs and resources available.

A review on theories was conducted and several behavioural change theories were identified (Theory of Planned Behaviour, Health Belief Model and Integrative Model). In addition, theories on stages of behaviour change such as the Transtheoretical Model and the Precaution Adoption Process Model were also included in the review. ICT development guidelines such as the Nielsen's Heuristics, the Health Literacy Online Heuristics and e-learning instructional design principles were identified to guide the development of the ICT aspects of the intervention.

The potential of ICT in improving health behaviour and the lack of ICT-based screening intervention in promoting comprehensive health screening justify the need for its development. With the understanding of men's behaviour in attending health screening, male-sensitive approach identified, evidence on health screening gathered, behaviour change theories and ICT development guidelines found, an innovative eHealth intervention that is potentially effective and impactful can be developed.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter describes the overarching framework used in this study, which is the United Kingdom Medical Research Council (UKMRC) Complex Intervention Framework. It explains the concept of complex intervention as well as the four recommended stages in the UKMRC framework. Then, the phases of this study are illustrated and the methods used in each phase are described briefly. The detailed methods can be found in the Published Paper chapter. Finally, a summary of methods in all phases are presented.

3.2 United Kingdom Medical Research Council Complex Intervention Framework

This study used the UKMRC Complex Intervention Framework to develop an intervention to improve health screening uptake in men. A complex intervention is described as an intervention that contains multiple interacting components in its built. An intervention is also considered complex when it involves multiple processes in delivering the intervention, different organisational levels, a wide range of possible outcomes and different degree of tailoring of the intervention (Craig et al., 2008). The ICT-based intervention which will be developed in this study is considered a complex intervention as it aimed to induce behaviour change in men by increasing men's health awareness, changing their perception of their own health and health screening, providing guides to undergo screening as well as motivating them to take up screening. Other than that, using ICT to deliver these, which may give rise a high degree of intervention tailoring to users as well as incorporating male-sensitive components in the intervention add another layer of complexity to the intervention. Thus, the UKMRC Complex Intervention Framework was used as an overarching framework for the development of intervention in this study.

Not only in terms of development, the UKMRC stresses the importance of considering four stages when developing an intervention: development, pilot testing, evaluation and implementation (Figure 3.1) (Craig et al., 2008). It highlights the importance of developing an intervention in a systematic manner, based on best available evidence, appropriate theory as well as the needs of the target population. Due to the complexity of intervention, it is very crucial to use a good theoretical basis to understand how the intervention works. Furthermore, the intervention should be pilot tested and followed by evaluation of its effectiveness (including cost-effectiveness) and implementation (with monitoring and long term follow up). As described in the study objectives, this study only focuses on the development and pilot testing stage. Further evaluation and implementation will be conducted in the future. Nevertheless, the evaluation and implementation factors were being actively considered throughout the intervention development and piloting phase to ensure the its implementability beyond this study.

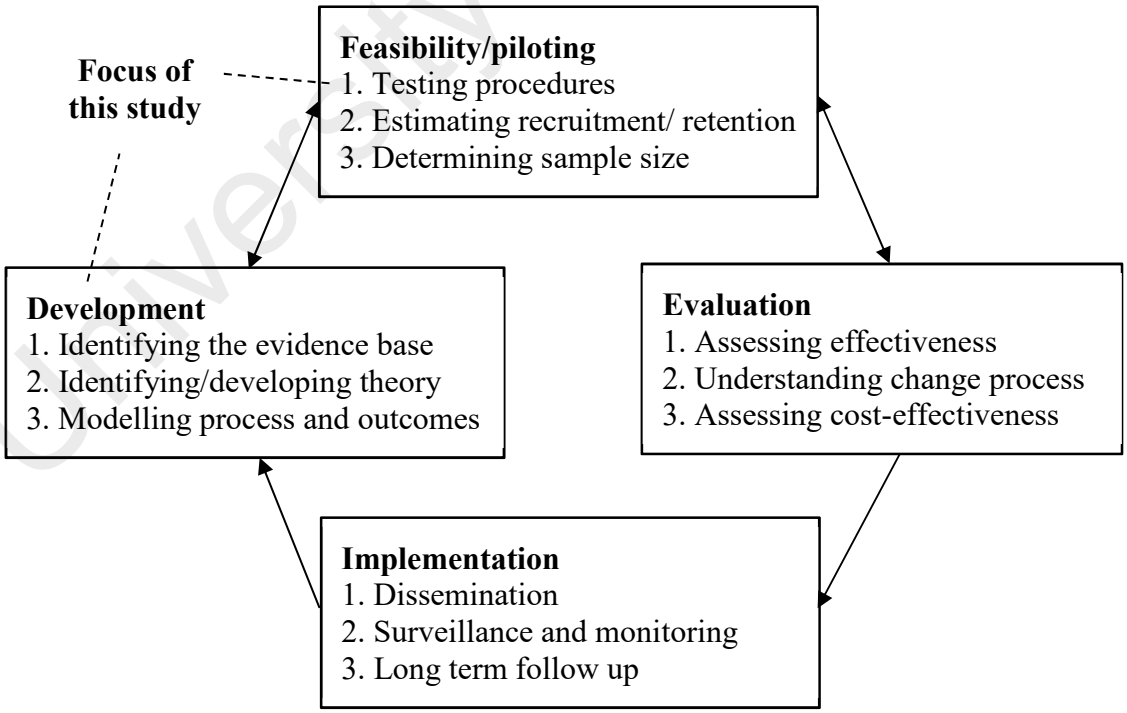

Figure 3.1: Key elements of the UKMRC Complex Intervention Framework. Adopted from (Craig et al., 2008)

3.3 Study Phases

There are two phases of this study which are the exploratory and development phase as shown in Figure 3.1. This chapter provide an overview of the methods used and the samples involved in this study. The detailed methods of each study phases including the systematic reviews, needs assessments, development and pilot testing of ScreenMen were described in the Published Papers chapter.

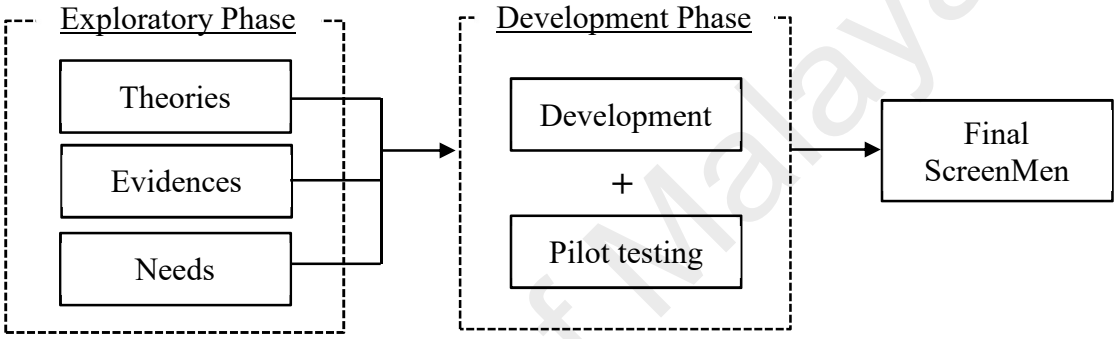

Figure 3.2: The two main phases of this study

3.3.1 Exploratory Phase

Following the UKMRC Complex Intervention Framework, an exploratory phase, which consists of the following activities, was carried out:

1. Search for theories that explain men's health screening behaviour as well as ICT development guidelines
2. Gathering evidence on the effectiveness of interventions that aim to improve health screening uptake in men as well as the list of evidence-based health screening
3. Conduct needs assessment in men about the factors that influencing their decision to undergo health screening and what do they want from a health screening mobile application

In the exploratory phase, the search for theories involved searching the internet, journals, books as well as seeking experts' recommendation. Apart from that, the evidence-based health screenings were compiled and finalised based on international and local guidelines as well as experts' inputs. The outcomes from these were presented in the Literature Review chapter. To supplement the theories that explain men's health screening behaviour, a systematic review was conducted to form a comprehensive framework on the barriers and facilitators to health screening in men using the best-fit qualitative meta-synthesis approach. Another systematic review using the quantitative meta-analysis approach was also conducted to identify the existing interventions and their effectiveness in improving screening uptake in men. The protocol of this quantitative systematic review was registered in PROSPERO, an international systematic review registry database in 2016, with the ID of CRD42016033298. However, the first qualitative systematic review, which was conducted in 2014, wasn't registered in PROSPERO as PROSPERO was only established in 2011 and the registration had yet to be widely recommended in 2014. Both of these qualitative and quantitative systematic reviews were presented in Chapter 4: Published Papers chapter due to its extensiveness and the rigorous methods employed.

For the needs assessment, the qualitative method was used to identify the factors influencing young men's decision to undergo health screening and what do they want from a health screening mobile application. The participants of this study were healthy men who are working in a banking institution in Kuala Lumpur. They were chosen due to the stressful (busy and have no time for screening) and sedentary nature (increased risk for diseases) of their job. Various worrying issues for workers in financial services were reported by the International Labor Organisation including excessive work demands and increased work-related stress (Giga & Hoel, 2003; Silva & Navarro, 2012). A review has found 20 articles which have congruently showed that the stress level in banking

workplace is critical, which affected their psychological as well as physical health including smoking and alcohol overuse, depression, body posture issue and visual problem (Giorgi et al., 2017; Makhbul et al., 2011; Michailidis & Georgiou, 2005; Mocci, Serra & Corrias, 2001). Instead of sampling men randomly from the community, including men within an institution reduce heterogeneity of sample particularly in terms the impact of institutional policy on workers' behaviour. However, to increase generalisability of findings, the participants were purposively sampled according to age, ethnicity, job positions and screening status to ensure maximal variation of data. For ethnicity, the purposive sampling was also done to resemble the ethnic groups distribution in Malaysia (Malay 54.7%; Chinese 23.2%; Indian 7.0%; and Others 14.1%) instead of equal group purposive sampling. The recruitment of participants was stopped at 31 men once data saturation was reached. This qualitative study was approved by the University of Malaya Medical Centre Medical Research Ethics Committee (MECID.NO:201410701).

3.3.2 Development Phase

The findings gathered from the exploratory phase (theories, evidences and needs) were used to inform the development of the intervention in the development phase. In addition, to improve 'implementability' of the intervention beyond the life span of the study, a group of international and local experts was convened to provide feedback on the intervention in the development phase. The expert panel consisted of health screening experts, clinicians with special interest in men's health, psychologists, decision making experts, health innovators and ICT experts. A total of 12 experts provided feedback on the prototype in two iterations. The prospective think aloud method, which is mainly using the qualitative approach, was used to gather feedback from the experts.

The intervention prototype was then further tested with end users in the pilot testing phase to assess and further improve its utility, usability and acceptability before it was finalised. The same banking institution where the needs assessment was conducted in the earlier phase was selected as the recruitment site for this pilot testing. Healthy men who have a smartphone from the banking institution were recruited to participate in this study. They were also purposively sampled accordingly to their job position, age, education level and screening status in order to achieve maximal variation of the feedback on ScreenMen. The same participants from the needs assessment were recruited to participate in this study for the purpose of confirming the needs emerged in the earlier phase. New participants were also recruited to participate in this pilot testing to explore new ideas and obtain feedback on the intervention from different perspectives. In this user testing, qualitative (retrospective think aloud) as well as quantitative (pre- and post-intervention questionnaires) methods were used to evaluate and gather feedback on the intervention. There was a total of 24 men who had participated in this pilot testing, where 13 of them were the repeat participants from the needs assessment while 11 were new participants. This pilot testing was approved by the University of Malaya Medical Centre Medical Research Ethics Committee (MRECID.NO: 201610144372).

3.4 Summary of Study Methods

The UKMRC Complex Intervention Framework which recommends the importance of considering theories, evidence and needs when developing an intervention was used to guide this study. There were two phases of this study which were the exploratory and development phase. The summary of aim, method used, sample involved and output chapter of each phase are presented in Table 3.1. The detailed methods can be found in the Published Paper chapter.

Table 3.1: Summary of methods used in each phase of the study

Aim	Method	Sample	Output
Phase 1: Exploratory			
Theories			
To identify behavioural change theories	Searching the internet, journals, books and seeking experts' recommendation	-	Chapter 2: Literature review
To identify the barriers and facilitators to health screening in men	**Mixed-methods Systematic review (Meta-synthesis)**	103 studies 53 qualitative 44 quantitative 6 mixed-methods	Chapter 4: Paper 1
To identify ICT development guideline	Searching the internet, journals, books and seeking experts' recommendation	-	Chapter 2: Literature review
Evidence			
To find out the evidence-based health screening	Searching international and local guidelines as well as obtaining experts' inputs	-	Chapter 2: Literature review
To determine the effectiveness of interventions to increase men's health screening uptake	**Quantitative Systematic review (Meta-analysis)**	58 quantitative studies	Chapter 4: Paper 2
Needs			
To explore the factors influencing young men's decision to undergo health screening	**Qualitative study** - Individual interview - Focus group discussion	31 men who are working in a banking institution	Chapter 4: Paper 3
To explore what do men want from a health screening mobile application	**Qualitative study** - Individual interview - Focus group discussion	31 men who are working in a banking institution	Chapter 4: Paper 4
Phase 2: Development			
Development			
To develop an eHealth intervention to increase evidence-based health screening uptake in men	**Development Qualitative study** - Prospective think aloud	12 experts (clinicians, mHealth, screening and behavioural)	Chapter 4: Paper 5 (including pilot testing in brief)
Pilot testing			
To evaluate the utility and usability of the eHealth intervention to increase health screening uptake in men	**Mixed-methods study** Qualitative (main) - Retrospective think aloud Quantitative - System usability scale - Intention to screen	24 men who are working in a banking institution	Chapter 4: Paper 6

CHAPTER 4: PUBLISHED PAPERS

4.1 Introduction

This chapter contains six papers in publication format (Figure 4.1). There are four papers published from the exploratory phase: one under theories, one under evidence while two under needs. There are two more papers from the development phase of this study which are currently under review.

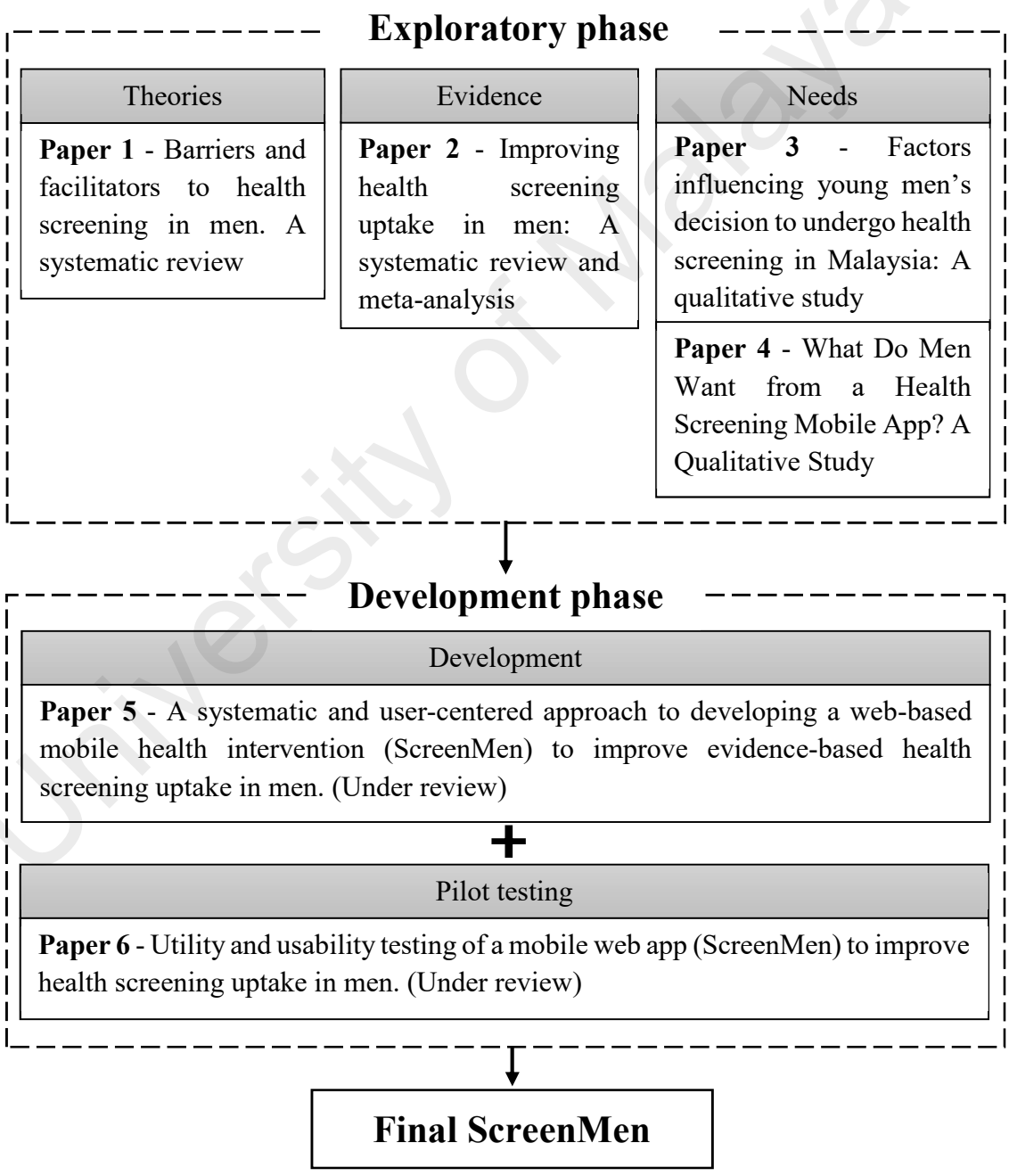

Figure 4.1: The six papers presented in Chapter 4

4.2 Exploratory Phase

4.2.1 Paper 1: Teo, C. H., Ng, C. J., Booth, A. & White, A. (2016). Barriers and facilitators to health screening in men: A systematic review. Soc Sci Med, 165, 168-176.

Statement of Authors' Contribution: Teo, C. H., Ng, C. J., Booth, A. and White, A. have contributed extensively in this systematic review. Teo, C. H., Ng, C. J. and White A. conceptualised this study and developed the search strategy of this systematic review. Screening of titles, abstracts and full texts as well as data extraction were done by Teo, C. H. and Ng, C. J.. Booth, A. provided extensive guidance on methodology especially in the data synthesis. All authors were involved in the interpretation of the data which led to the finalisation of study results. Teo, C. H. drafted the first version and led the revision of the paper. Ng, C. J., Booth, A. and White, A. provided critical intellectual input to revise the manuscript. All authors have read and approved the final manuscript to be published.

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Review article

Barriers and facilitators to health screening in men: A systematic review

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ABSTRACT

Rationale: Men have poorer health status and are less likely to attend health screening compared to women.
Objective: This systematic review presents current evidence on the barriers and facilitators to engaging men in health screening.
Methods: We included qualitative, quantitative and mixed-method studies identified through five electronic databases, contact with experts and reference mining. Two researchers selected and appraised the studies independently. Data extraction and synthesis were conducted using the 'best fit' framework synthesis method.
Results: 53 qualitative, 44 quantitative and 6 mixed-method studies were included. Factors influencing health screening uptake in men can be categorized into five domains: individual, social, health system, healthcare professional and screening procedure. The most commonly reported barriers are fear of getting the disease and low risk perception; for facilitators, they are perceived risk and benefits of screening. Male-dominant barriers include heterosexual -self-presentation, avoidance of femininity and lack of time. The partner's role is the most common male-dominant facilitator to screening.
Conclusions: This systematic review provides a comprehensive overview of barriers and facilitators to health screening in men including the male-dominant factors. The findings are particularly useful for clinicians, researchers and policy makers who are developing interventions and policies to increase screening uptake in men.

1. Introduction

Globally, men do not live as long as women (Barford et al., 2006; WHO, 2011) and have higher mortality and morbidity rates across most of the diseases (AIHW, 2013; Bilsker et al., 2010; EC, 2011; Ng et al., 2014; White et al., 2011a). Possible explanations include men's poor health seeking behavior, lack of health knowledge, risk taking behavior as well as their reluctance to engage in health promotion activities (Addis and Mahalik, 2003; Byrnes et al., 1999; Courtenay, 2003).

Various strategies can be used to improve the status of men's health, particularly health screening. Through health screening, one can identify a disease at the early stage allowing intervention before the disease worsens. For instance, a study on the impact of cardiovascular disease (CVD) screening reported that screening attenders have lower CVD mortality rate, all-cause mortality rate, healthcare utilization and cost compared to non-attenders (Lee et al., 2015). A one percent reduction of cardiovascular events through a preventive program across England and Wales has the potential to save at least £30 million of health services cost per year (Barton et al., 2011). Similarly, screening for colorectal cancer using faecal occult blood test (FOBT) was reported to decrease the relative risk of colorectal cancer death by 15–20%, save 3.8–8.29 quality adjusted life days per person and £1890-£2576 of healthcare cost per life year (Hewitson et al., 2007; Tappenden et al., 2004).

In spite of all the benefits of screening, screening uptake is low, particularly in men. The uptake rates of guaiac-based faecal occult blood (gFOB) test in the UK Bowel Cancer Screening Programme were lower in men across all three rounds of the biennial invitation (first round: men 53.3% vs women 61.3%; second round: men 58.0%

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vs women 63.7%; third round: men 64.1% vs women 68.2%) (Lo et al., 2015). Another study on screening uptake in Ontario showed a similar pattern where the uptake of screening was lower in men for colorectal cancer (men 55.1% vs women 61.6%), diabetes (men 61.4% vs women 72.9%) and cholesterol (men 70.3% vs women 82.4%) (Borkhoff et al., 2013). A narrative scoping review on socio-determinants of screening uptake cites nine studies that indicated men were less likely to engage health screening compared to women, particularly men who are less educated, unemployed and from low socio-economic status (Dryden et al., 2012). However, this review did not provide reasons for the low screening uptake in men.

For a screening intervention to be effective, it is important that it is tailored to the characteristics of the population, such as using a gendered approach. Masculinity attributes like avoidance of femininity, toughness and risk taking have been used to explain the difference in health screening behavior between men and women (Connell, 1987, 1995). The Madrid Statement, released by the World Health Organization (WHO) in 2001, clearly states that health policies must recognize that men and women have different needs, obstacles and opportunities in order to attain the highest standard of health (WHO, 2001). Experts have argued the importance of considering gender when developing interventions, programs and policies in recognition that men and women behave differently (Baker et al., 2014; Banks, 2004; Weller and Campbell, 2009; White et al., 2011b).

This systematic review thus aims to review the existing evidence on the barriers and facilitators to engaging men in health screening. We sought to identify the most commonly reported barriers and facilitators to health screening along with those barriers and facilitators that are particularly prominent in a male population (male-dominant). We hope that identification of these factors will help in the development of effective interventions to overcome these barriers and improve screening uptake in men. However, this review did not include studies focusing on certain male populations, such as gay and aboriginal men, as there are unique factors that influence their health screening behavior which deserve separate reviews.

2. Methods

2.1. Eligibility criteria

We included qualitative, quantitative and mixed-method studies that identified men's barriers or facilitators in engaging with health screening. For inclusion, a study must clearly differentiate the barriers or facilitators between men and women. Informants could include men or women patients or healthcare professionals as long as the barriers or facilitators discussed are those for male patients. Studies included in the review investigate men who have attended for screening, as well as non-attenders. Participants could be derived from any age group and they must be asymptomatic of the disease for the screening planned in each study. We excluded studies that focused on men who were gene carriers, prisoners, disabled, drug users, in military service, homeless, immigrants, refugees as well as aboriginal and gay men. These groups of men face additional barriers when seeking healthcare and they deserve separate reviews.

We included all types of screening recommended by the United States Preventive Services Task Force (USPSTF) as well as male-specific diseases like prostate and testicular cancer screening (United States Preventive Services Task Force, 2016). We included studies on prostate cancer screening conducted before 2012 as USPSTF recommended against prostate cancer screening after that. Studies of barriers or facilitators of screening carried out as a part of a screening program were also included in this review. We excluded genetic tests for prostate cancer and studies that focus on screening at the emergency department. Studies that used an intervention to increase screening uptake, looked solely at socio-demographic determinants or focused on physicians' screening practices were also excluded from this review.

2.2. Information sources and search

We searched five key databases (PubMed, Embase, CINAHL via EBSCOHost, PsycINFO via OvidSP and Web of Science) up to 23 October 2014 to identify relevant articles. We combined three main concepts (men, screening, barrier/facilitator) and a methodological filter (qualitative/survey) using keywords and subject headings from respective databases in the search. The search strategy can be found in Appendix A. We only included articles published in English. Apart from database searching, we also sourced relevant articles from men's health experts and followed up references in eligible articles.

2.3. Study selection and appraisal

Two researchers performed all phases of study sifting and selection independently, including screening of titles, abstracts and full-texts. In cases of doubt, the researchers were encouraged to be inclusive. Any discrepancies were resolved through discussion and consensus. All the included studies were appraised using the Mixed-Method Appraisal Tool (MMAT) which allows appraisal of the validity, reliability and generalizability of the quantitative, qualitative and mixed-method studies (Appendix B) (Pluye et al., 2011). It can also be used quickly and reliably (Pace et al., 2012). For mixed-method studies, both qualitative and quantitative components of the studies were appraised. The appraisal was conducted to report the quality of the studies and not used as a threshold for selecting studies for inclusion.

2.4. Data extraction and synthesis

Data extraction and synthesis were conducted based on the 'best fit' framework synthesis method which provides 'a means to test, reinforce and build on an existing published model, conceived for a potentially different but relevant population' (Carroll et al., 2013). Researchers can combine several frameworks if necessary and refine the framework by adding new themes that emerged from the data, which are not found in the initial framework.

We first identified a framework on the barriers and facilitators to screening from the studies included in this review (Garcia-Dominic et al., 2012), supplemented by two other frameworks by Christy et al. and Denberg et al., which focused on masculinity (avoidance of femininity, self-reliance, risk taking and heterosexual self-presentation) and screening procedure respectively, to form a more comprehensive meta-framework (Christy et al., 2014; Denberg et al., 2005). This meta-framework was then pilot tested by two researchers against ten studies before the final framework was decided.

Two researchers extracted the data from each included paper and coded them deductively using the meta-framework. Data that could not fit the meta-framework were coded separately under a new theme in a subsequent inductive phase. Data that were unclear or without sufficient explanation were excluded from the analysis.

Once data from all studies were extracted, the researchers compared the coding, discussed and resolved any discrepancy through consensus. The themes from the meta-framework and the newly generated themes were combined using the thematic approach to produce the final framework of barriers and facilitators

to health screening in men. The analysis including the quotations can be obtained from the researchers upon request.

2.5. Additional analysis

Besides aiming to develop the comprehensive framework of barriers and facilitators to health screening in men, we also sought to find out which are the most common barriers or facilitators by counting the number of studies that reported a barrier or facilitator and ranking them accordingly.

In addition, we sought to identify the barriers and facilitators that are found predominantly in men, using to two methods. For qualitative studies (53 qualitative paper plus qualitative components of 4 mixed-method papers), criteria for deciding male-dominant barriers and facilitators in men appear in Appendix C. For quantitative studies, barriers and facilitators were considered male-dominant when there were significantly higher percentage of barriers or facilitators reported by men compared to women, with $p < 0.05$.

3. Results

3.1. Included studies' characteristics

We identified 14,322 articles from five databases, contact with experts and follow up of references (excluding duplicates and non-journal articles) (Fig. 1). We eventually included 103 studies in the review which consisted of 53 qualitative, 44 quantitative and 6 mixed-method studies. In four out of six mixed-method studies, only the qualitative component of the study was included as the quantitative component did not meet our inclusion criteria. In the other two mixed-method studies both qualitative and quantitative components of the study were included in the analysis.

The characteristics of all studies and their references are presented in Appendix D. The studies were conducted from 1985 to 2012 and in North America ($k = 62$), Europe ($k = 14$), Africa ($k = 9$), Oceania ($k = 8$), Asia ($k = 6$) and South America ($k = 4$). Most of the studies were conducted in the community ($k = 70$); few in the healthcare setting ($k = 19$); and a small number in both settings ($k = 3$). All included quantitative studies were cross-sectional studies. Most qualitative studies ($k = 53$) did not report their study design and the most commonly reported study designs were grounded theory ($k = 3$), phenomenology ($k = 2$) and ethnography ($k = 1$). More than half of the included studies ($k = 65$) did not report using a theory in their study. Of those reported, the Health Belief Model ($k = 16$) was the most commonly used theory (Champion VL, 2008).

Among the included studies, the most commonly studied screening topics were prostate cancer ($k = 40$), colorectal cancer ($k = 33$) and HIV ($k = 15$) and the remainder included sexually transmitted disease ($k = 4$), cancer ($k = 4$), testicular cancer ($k = 3$), cardiovascular disease ($k = 2$), skin cancer ($k = 1$) and multiphasic examination ($k = 1$). Twenty studies were conducted as a part of a screening program. Most included both attendees and non-attendees of screening ($k = 73$), 11 studies included ever-screened participants; 9 studies included never-screened participants; while 10 studies did not report.

Out of 103 studies, 37 reported barriers, 13 facilitators and 55 both barriers and facilitators. Only 30 studies focused exclusively on barriers or facilitators to screening while 73 studies focused on participants' attitudes, beliefs and knowledge of a disease of which barrier to screening was only a constituent of the studies. Among the 103 studies, 47 compared men's barriers and facilitators to those of women while 56 only focused on men's barriers. Of 24 quantitative studies comparing barriers/facilitators between men and women, only 13 reported p-values in their studies.

3.2. Barriers and facilitators to health screening in men

Factors influencing uptake of health screening in men fall within five domains: individual, social, health system, healthcare professional and screening procedure (Table 1). The six individual factors that influence health screening uptake in men are knowledge, attitudes and values, fear, masculinity attributes, communication and resources. Factors within the social domain include influence of family and/or peers as well as stigma. For the health system domain, factors include accessibility to screening services, cost and insurance, health information, screening program or policy, men's health advocacy and quality of service. Healthcare professional factors include attitudes, communication, physician's gender and ethnicity as well as physician's recommendation. The nature of the screening procedure also affects men's decisions as to whether or not to attend health screening.

There are several barriers and facilitators under each factor. The most commonly reported barrier to health screening across all domains is fear of being diagnosed with the disease and its consequences ($k = 52$) (Table 2), followed by a perception of low risk ($k = 39$) and fear of a painful screening procedure ($k = 37$). The most commonly reported facilitators are perceived risk ($k = 31$), perceived benefits of screening ($k = 29$) and physicians' recommendations to attend screening ($k = 24$).

Table 3 shows barriers and facilitators to screening found to be dominant in heterosexual men based on the 57 qualitative studies. Heterosexual self-presentation ($k = 18$), avoidance of femininity ($k = 18$), self-reliance ($k = 10$), seeking help only when disease is severe ($k = 9$) and avoidance of illness ($k = 7$) are the most commonly reported male dominant barriers to screening. Partner's role ($k = 18$), perceived risk ($k = 2$), wanting to stay healthy to take care of family ($k = 2$), non-invasive screening procedure ($k = 2$) and physicians' gender ($k = 2$) are the most commonly reported male dominant facilitators to screening.

Table 4 shows barriers and facilitators to screening found to be dominant in men based on the 13 quantitative studies. Lack of time ($k = 6$), fear of getting disease and its consequences ($k = 2$), painful screening procedure ($k = 2$) and lack of knowledge about disease and screening ($k = 2$) are the barriers found to be significantly more common in men compared to women. For facilitators, having knowledge about disease and screening ($k = 1$) and physician's recommendation to screening ($k = 1$) were found to be more important in men. However, unlike qualitative studies, masculinity factors were rarely reported in the quantitative studies.

Among the five domains, the individual domain is the most commonly cited domain in the ten most commonly reported barriers (70.0%) as well as in qualitative (60.9%) and quantitative studies (62.5%) reporting male-dominant barriers (Table 5). The pattern is less obvious for the facilitators to health screening in men.

3.3. Quality assessment

Overall, included studies carried a moderate risk of bias. Most qualitative studies satisfied all assessment criteria except for criteria 4, where most studies did not report whether the researchers' role might influence the outcome of the study (Appendix B). The quality of quantitative studies was substantially lower as only about half of the studies satisfied criteria 1 (sampling strategy) and criteria 4 (response rate). These patterns were almost similar to the included mixed-method studies. The quality of mixed-method integration was moderate.

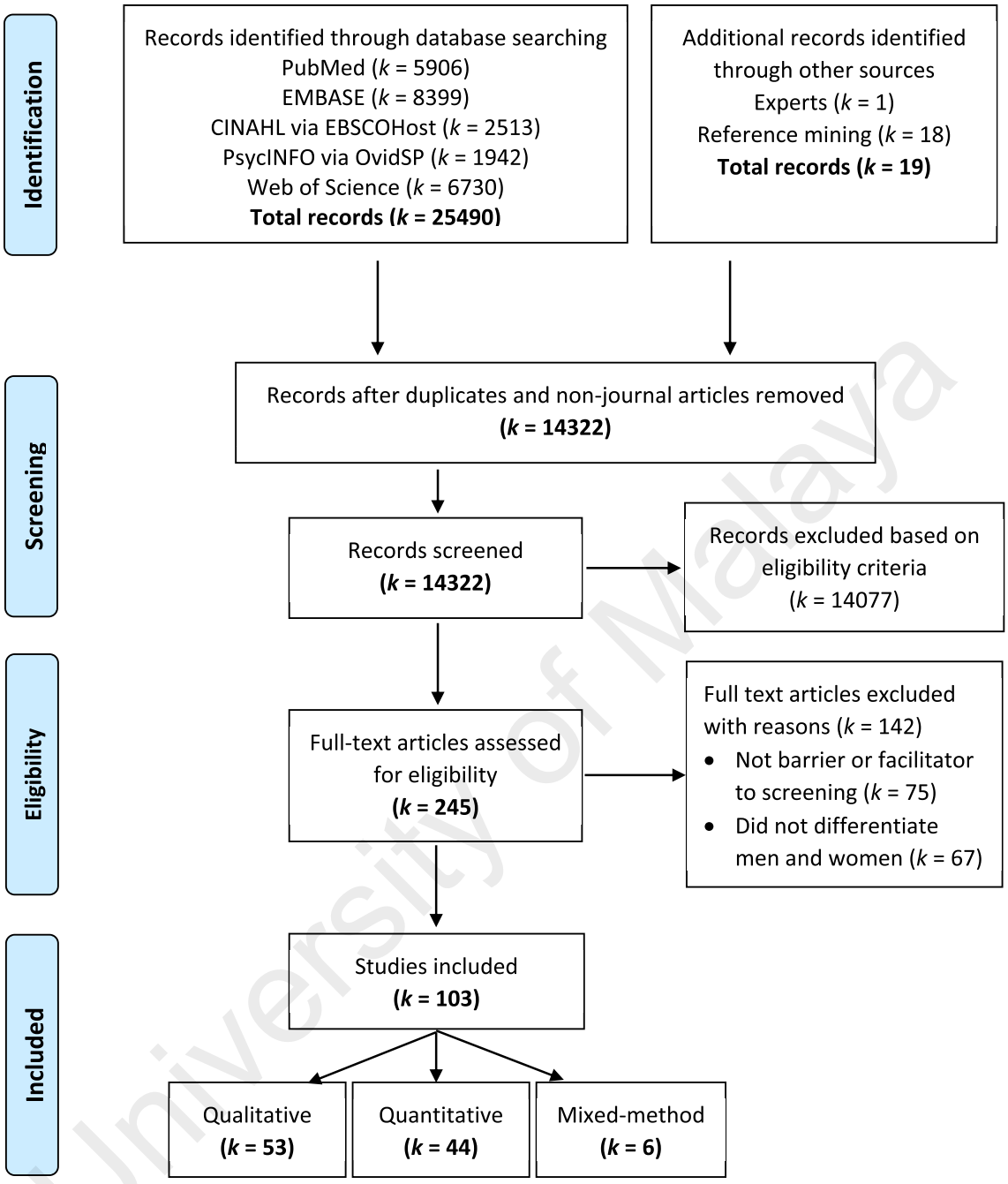

Fig. 1. PRISMA flow diagram.

4. Discussion

This systematic review is the first to provide a comprehensive coverage of barriers and facilitators to health screening in men. The barriers and facilitators extracted in this study are those specifically expressed by men and are different from other disease-specific systematic reviews, which are often not gender-specific. Masculinity and characteristics of the screening procedure are highlighted as two important factors among the list of barriers and facilitators that influence men's decisions in taking up screening. We also identified the most common factors as well as those that are predominant in men.

This review identified 'masculinity' as an important factor which impedes screening in men; this factor is seldom highlighted in the literature as a barrier to screening in men. We used a previously published concept of masculinity as part of our analysis framework during data extraction (Christy et al., 2014) and masculinity attributes such as self-reliance, avoidance of femininity and heterosexual self-presentation emerged as barriers to screening. Only 'invincibility belief' emerged as a new barrier under masculinity attributes from the studies. Interestingly, an important masculinity attribute on 'risk taking' did not feature specifically as a barrier in the studies included in this review, which could be because 'risk taking' is an attribute that is difficult to probe in an interview when men do not perceive themselves to be at risk. We also realized that most papers included in this review only

Table 1
Barriers and facilitators to health screening in men synthesized from all studies.

Factors	Barriers	Facilitators
Individual domain		
Knowledge	• Low risk perception (lack of symptom, no family history)	• Perceived at risk (having symptoms, having family history, being old and following a risky event)
	• Lack of knowledge about disease and screening	• Having knowledge about disease and screening
	• Feeling inferior/fear of attending screening due to limited education and literacy	
Attitudes and values	• Avoiding and denying illness	
	• Fatalism belief	• Religious belief that a man should take care of his body
	• Negative attitude (lazy, procrastination or forgot)	• Positive attitude (health conscious, screening as a routine and care for others)
	• Sceptical of the benefits of screening	• Perceived benefits of screening (early intervention and peace of mind)
	• Seek help only when disease is severe	
	• Health is not a priority	• Stay healthy to take care of family
	• Not trusting the doctor or health system	• Trusting the doctor or health system
	• Having other health concerns	
	• Already tested or diagnosed	• Already tested or diagnosed
	• Belief that illness can be healed naturally or with CAM	
Emotion – Fear	• Fear of getting disease and consequence and don't want to know	• Fear of disease and consequence and want to find out earlier
Masculinity	• Avoidance of femininity – seeking help or talking about health is considered feminine or weak	
	• Heterosexual self-presentation – Undergoing DRE or colonoscopy may be perceived as gay	• Heterosexual self-presentation – Use other screening method rather than DRE
	• Self-reliance – do not want to depend on doctors	• To feel in control
	• Invincibility belief	• Non-existence of machismo attributes
Communication	• Discomfort discussing issues regarding private part and disease	
	• Language barrier	
Resource	• Lack of time	
	• Lack of income and personal insurance	• Having personal insurance
	• Lack of personal transport	• Having personal transportation
Social domain		
Family and peer influence	• Lack of encouragement	• Encouragement and support from siblings, children, relative, friends and other social contact
	• Past negative health care experience	• Partner's role
	• No social contact with the disease	• Knowing someone with disease or died due to the disease
Stigma	• Concern about being stigmatized	
Health system domain		
Accessibility to screening services	• Inconvenient opening hour, day and location	• Convenient screening location, hour and day
	• Difficulty in making appointment	• Screening without appointment required
	• ong waiting time	• Short waiting time
	• Busy HCP	
Cost and insurance	• Costly services	• Free/reduced cost exams
	• Lack of insurance	• Having insurance coverage
Health information	• Lack of public education	• More public education programs through media, community, school and health centre
	• Inaccurate and negative information	• Church as a platform to promote health screening
		• Celebrity-led campaign and advertisement
Screening programme or policy		• Availability of screening program or policy (workplace, marriage)
Men's health advocacy	• Lack of men's health advocacy	
Quality of service	• Male-unfriendly healthcare setting	• Reminder by health provider
	• Lack of confidentiality	• Confidentiality
	• Negative experience in health centre	• Opportunistic screening
	• Limited access to treatment	• Availability of treatment
		• Trained HCP
Healthcare professional domain		
Attitude	• Negative attitude (rude, discrimination and uncaring)	
Communication	• Lack of rapport with doctor	• Having good rapport with doctor
	• Lack of bilingual physicians	• Availability of bilingual healthcare professional
		• Shared decision making
Physician's gender and ethnicity	• Availability of physician of the same ethnicity	• Preference of female physicians to perform DRE
Physician's recommendation	• Lack of physician recommendation for screening tests	• Recommended to screening
Screening procedure domain		
The nature of screening procedure	• Painful and uncomfortable	• Less painful and discomfort procedure
	• Embarrassing procedure	
	• Complication following procedure	
	• Lack of privacy	
	• Difficult procedure preparation	• Convenience test procedure
	• Difficult sample collection	
	• Impersonal procedure	
	• Screening package lack comprehensiveness	

CAM=Complementary alternative medicine. DRE = Digital Rectal Examination. HCP=Healthcare Professional.

Table 2
Ten most commonly reported barriers and facilitators to health screening in men from all studies.

Barriers	No. of citing studies ($k = 92$)	Facilitators	No. of citing studies ($k = 68$)
Fear of getting disease and consequence (I)	52	Perceived at risk – having symptoms, having family history, being old and following a risky event (I)	31
Low risk perception – lack of symptom, no family history (I)	39	Perceived benefits of screening – early intervention and peace of mind (I)	29
Painful and uncomfortable screening procedure (SP)	37	Physician's recommendation to screening (HCP)	24
Lack of time (I)	33	Partner's role (S)	22
Lack of knowledge about disease and screening (I)	30	More public education program through media, community, school and health centre (HS)	18
Embarrassing screening procedure (SP)	29	Positive attitude – health conscious, screening as a routine and care for others (I)	16
Costly screening services (HS)	23	Knowing someone with disease or died due to the disease (S)	15
Seeking help or talking about health is considered feminine or weak (I)	21	Encouragement and support from siblings, children, relative, friends and other social contact (S)	12
Undergoing DRE or colonoscopy may be perceived as gay (I)	20	Availability of screening program or policy – workplace, marriage (HS)	11
Avoiding and denying illness (I)	20	Having knowledge about disease and screening (I)	11

DRE = Digital Rectal Examination. HCP=Healthcare Professional. HS=Health System. I=Individual. S=Social. SP=Screening Procedure.

Table 3
Barriers and facilitators to screening found to be dominant in men based on 57 qualitative studies.

Factors	Number of studies
Barriers	
Heterosexual self-presentation – Undergoing DRE[6] or colonoscopy may be perceived as gay (I)	18
Avoidance of femininity – seeking help or talking about health is considered feminine or weak (I)	18
Self-reliance – do not want to depend on doctors (I)	10
Seek help only when disease is severe (I)	9
Avoiding and denying illness (I)	7
Invincibility belief (I)	6
Embarrassing screening procedure (SP)	5
Health is not a priority (I)	4
Fear of getting disease and consequence (I)	4
Lack of encouragement (S)	3
Male-unfriendly healthcare setting (HS)	3
Lack of privacy (SP)	3
Lack of knowledge about disease and screening (I)	3
Fatalism belief (I)	3
Lack of Men's Health Advocacy (HS)	2
Negative attitude – lazy, procrastination or forgot (I)	2
Lack of public education (HS)	2
Not trusting the doctor or health system (I)	2
Low risk perception – lack of symptom, no family history (I)	2
Difficult sample collection (SP)	1
Complication following procedure (SP)	1
Lack of time (I)	1
Concern about being stigmatized (S)	1
Facilitators	
Partner's role (S)	18
Heterosexual self-presentation – Use other screening method rather than DRE[6] (SP)	2
Preference of female physicians to perform DRE[6] (HCP)	2
Stay healthy to take care of family (I)	2
Perceived at risk – Having symptoms, having family history, being old and following a risky event (I)	2
Inexistence of machismo attributes (I)	1
To feel in control (I)	1
Opportunistic screening (HS)	1
Convenience test procedure (SP)	1
More public education programs through media, community, school and health center (HS)	1
Recommended to attend screening (HCP)	1

DRE = Digital Rectal Examination. HCP=Healthcare Professional. HS=Health System. I=Individual. S=Social. SP=Screening Procedure.

discussed masculinity in the context at individual level. Nonetheless, masculinity can be structured in institutional practices and policies, which are not explored in this review (Connell, 1987, 1995; Dovel et al., 2015). Some of the individual factors, such as 'avoiding and denying illness', 'seek help only when disease is severe', and 'fear of getting disease', could be related to masculinity, but the authors did not explicitly report the link. Future studies should explore this issue.

'Screening procedure' was another unique factor that emerged from our review. Though many studies identify screening procedures as a barrier, such as the collection of faeces for bowel cancer screening, different procedures impose different levels of

Table 4
Barriers and facilitators to screening which are either more dominant in men (Sig-male), no significant difference (*ns*), or more dominant in women (Sig-female) based on *p*-value reported in 13 quantitative papers.

Factors	Sig-male	*ns*	Sig-female
Barriers			
Lack of time (I)	6	1	0
Fear of getting disease and consequence (I)	2	5	2
Painful and uncomfortable (SP)	2	2	1
Lack of knowledge about disease and screening (I)	2	1	0
Low risk perception – lack of symptom, no family history (I)	1	4	1
Embarrassing procedure (SP)	1	1	3
Complication following procedure (SP)	1	1	1
Skeptical of the benefits of screening (I)	1	1	0
Costly services (HS)	0	5	0
Difficult procedure preparation (SP)	0	2	1
Negative attitude – lazy, procrastination or forgot (I)	0	2	0
Lack of personal transport (I)	0	2	0
Concern about being stigmatized (S)	0	2	0
Inconvenient opening hour, day and location (HS)	0	2	0
Having other health concerns (I)	0	1	1
Already tested or diagnosed (I)	0	1	1
Lack of physician's recommendation (HCP)	0	1	1
Avoiding and denying illness (I)	0	1	0
Health is not a priority (I)	0	1	0
Lack of income and personal insurance (I)	0	1	0
Past negative health care experience (HS)	0	1	0
Difficulty in making appointment (HS)	0	1	0
Lack of confidentiality (HS)	0	1	0
HCP's negative attitude (HCP)	0	1	0
Difficult sample collection (SP)	0	1	0
Lack of encouragement (S)	0	0	1
Facilitators			
Having knowledge about disease and screening (I)	1	0	0
Recommended to screening (HCP)	1	0	0
Perceived at risk – Having symptoms, having family history, being old and following a risky event (I)	0	2	1
Availability of screening program or policy – workplace, marriage (HS)	0	2	0
Perceived benefits of screening – early intervention and peace of mind (I)	0	1	0
Partner's role (S)	0	1	0
Positive attitude – Health conscious, screening as a routine and care for others (I)	0	0	1
Physician of the same gender (HCP)	0	0	1

HCP=Healthcare Professional. HS=Health System. I=Individual. S=Social. SP=Screening Procedure.

Table 5
Summary of the ten most commonly reported and male-dominant (qualitative and quantitative study) barriers and facilitators to screening in men according to domain.

Domain	Barriers *k* (%)	Facilitators *k* (%)
Ten most commonly reported factors	**10 (100%)**	**10 (100%)**
Individual (I)	7 (70.0%)	4 (40.0%)
Social (S)	0 (0%)	3 (30.0%)
Health system (HS)	1 (10.0%)	2 (20.0%)
Healthcare professional (HCP)	0 (0%)	1 (10.0%)
Screening procedure (SP)	2 (20.0%)	0 (0%)
Male-dominant – qualitative study	**23 (100%)**	**11 (100%)**
Individual (I)	14 (60.9%)	4 (36.4%)
Social (S)	2 (8.7%)	1 (9.1%)
Health system (HS)	3 (13.0%)	2 (18.2%)
Healthcare professional (HCP)	0 (0%)	2 (18.2%)
Screening procedure (SP)	4 (17.4%)	2 (18.2%)
Male-dominant – quantitative study	**8 (100%)**	**2 (100%)**
Individual (I)	5 (62.5%)	1 (50.0%)
Social (S)	0 (0%)	0 (0%)
Health system (HS)	0 (0%)	0 (0%)
Healthcare professional (HCP)	0 (0%)	1 (50.0%)
Screening procedure (SP)	3 (37.5%)	0 (0%)

reluctance for men to present for screening (Lo et al., 2013; Vart, 2010). Procedures that are most commonly cited as a barrier are digital rectal examination, colonoscopy and sigmoidoscopy. Such procedures, involving anal penetration, have a sexual connotation and heterosexual men are concerned that they might be perceived as being gay. Clinicians should emphasize that these procedures are recommended for all men and the invasive nature of the procedure is necessary to detect tumors in the colon; therefore, men should not perceive the procedures as being gay. Unlike other factors, such as individual, social, healthcare system and healthcare professional factors, which are non-disease specific, screening procedure is therefore disease-specific. More work needs to be done to overcome this barrier.

In the included studies, the most commonly reported factor influencing men's attendance at health screening relates to their knowledge regarding health and screening, which in turn, affects men's perception of their own health risk and the benefits of screening. Some men are fearful of being diagnosed with the disease if they go for screening and, therefore, choose not to know about their health status. It is important for healthcare providers to assess and provide information on individual health risks as well as to explain the benefit and risks of health screening.

We also identified several male-dominant barriers and facilitators to health screening in men. Masculinity attributes such as heterosexual self-presentation, avoidance of femininity and self-reliance are the most commonly cited male-dominant barriers to screening. It is important to note that masculinity attributes vary in different contexts. For example, a study comparing barriers to colorectal screening between two Hispanics subpopulations, Spanish Americans and first-generation Mexicans, in New Mexico,

USA found that machismo is more prominent in the latter (Getrich et al., 2012). Other barriers, such as lack of time, lack of knowledge, fear and screening procedure are also found more predominantly in men. For facilitators to screening, knowledge, partner's role and physicians' recommendation are the most important factors that motivate men to attend health screening.

We also found that while individual factors contribute to most barriers to health screening in men, it is not as commonly cited as a facilitator. Thus, for a screening intervention targeting men to be effective, it may not be enough to just address individual barriers; strategies involving external factors, such as family and friends, health system, healthcare professional and screening procedure, may need to be incorporated to enhance screening uptake. A study by Holland et al. has found that combining personalized letter to men and a reminder system by the healthcare professional resulted in a higher uptake of health screening as compared to sending a personalized letter alone (Holland et al., 2005). The uptake is even higher when the intervention was supplemented by asking the partners to encourage men to go for health screening.

Another important point to note is that this systematic review only included studies that reported barriers and facilitators to screening from men themselves independent from associations with social determinants to screening uptake. Dryden et al. reported that those not attending health checks were typically from low socio-economic status, less well educated, single (not married), smokers, having low self-efficacy and less likely to believe in the efficacy of health checks. In contrast attenders were usually White and older in age (Dryden et al., 2012). We did not include these social determinants because this systematic review aimed to find out the actual barriers and facilitators to screening in men irrespective of the profile of men who would or would not seek help.

4.1. Limitations

This review has several limitations. This review did not include studies focusing on men who were gene carriers, prisoners, disabled, drug users, in military service, homeless, immigrants, refugees as well as aboriginal and gay men. These groups of men face additional barriers when seeking healthcare and deserve separate reviews, some of which have been published. For example, systematic reviews have been conducted on barriers to HIV testing in men who have sex with men (MSM) (Lorenc et al., 2011) and hepatitis C testing in people who inject drugs (Jones et al., 2014).

We also did not analyze the barriers and facilitators according to age, which may influence how men decide to go for screening. Most of these studies included in this systematic review were conducted in Western countries, which may reduce their validity in the global South. We also identified four potentially relevant non-English articles (2 Japanese; 1 Korean; 1 Swedish) which we did not include in this review.

The quality of the quantitative studies included in this review was generally poor, particularly in terms of questionnaire design. The questionnaires were not validated rigorously and factor analysis was typically not performed. Some included options represent compound questions (e.g., 'costly/lack of insurance'); some responses were not meaningful (e.g., 'I do not know' and 'I just do not want to'). Unlike the findings from qualitative studies, the barriers and facilitators reported in quantitative studies lack depth and hence were less useful for the understanding of the factors that influence men's decision to attend screening. We only reported 'commonly reported barriers' rather than 'the most common barriers' due to the heterogeneity of study methods. Some studies permitted participants to choose multiple barriers while others only allowed them to choose the single most important barrier. Masculinity-related factors are less commonly reported because it is both difficult to ask men about this and, in turn, for them to admit such issues. Many studies did not incorporate masculinity attributes in the design of the questionnaire. Additionally, only 13 out of 24 studies that compared men and women reported a *p*-value. Further evidence is required to support the male-dominant barriers or facilitators based on *p*-values, such as reported in this review. We also did not exclude lower quality studies based on the MMAT in order to elicit the widest possible range of barriers and facilitators.

5. Conclusion

This systematic review identified individual, social, health system, healthcare professional and screening procedure factors as important barriers and facilitators to health screening in men. In addition, it expands existing framework on factors influencing health screening uptake in men, incorporating male-dominant barriers and facilitators such as avoidance of femininity, heterosexual self-presentation and partner's role into the framework. The findings from this review also provide a better understanding of men's screening behaviour; they highlight the importance of considering the role of gender when advising men on health screening and when developing health policy on health prevention. The development of interventions to promote health screening should take into consideration the gender-specific barriers and facilitators identified in this review.

Conflict of interest

The authors declare that there is no conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.socscimed.2016.07.023.

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Appendix A. Search strategy

PubMed (*k*=5906)

NO.	SEARCH STRATEGY
#5	**(#1 AND #2 AND #3 AND #4)**
#4	(Qualitative Research[mh] OR Interviews as topic[Mh] OR Questionnaires[Mh] OR Nursing methodology research[mh] OR Qualitative[tiab] OR "Focus group*"[tiab] OR Interview*[tiab] OR Survey*[tiab])
#3	(facilitat*[tiab] OR encourag*[tiab] OR promot*[tiab] OR motivat*[tiab] OR enabl*[tiab] OR Predict*[tiab] OR Support*[tiab] OR barrier*[tiab] OR obstacle*[tiab] OR difficult*[tiab] OR imped*[tiab] OR reluctan*[tiab] OR refus*[tiab] OR Counteract*[tiab] OR Challeng*[tiab] OR Utiliz*[tiab] OR Utilis*[tiab] OR Uptake*[tiab] OR Decision making[mh] OR patient acceptance of health care[mh] OR attitude to health[mh])
#2	(Early diagnosis[mh] OR mass screening[mh] OR preventive health services[mh:noexp] OR Screen*[tiab] OR "Health check*"[tiab] OR checkup*[tiab] OR check-up*[tiab] OR ((routine[tiab] OR regular[tiab] OR yearly[tiab] OR annual[tiab] OR periodic[tiab]) AND ("health examination" [tiab] OR "medical examination" [tiab] OR "health assessment" [tiab])))
#1	(Male[tiab] OR Man[tiab] OR Males[tiab] OR Men[tiab] OR Boy[tiab] OR Boys[tiab] OR Gender*[tiab] OR Prostat*[tiab])

EMBASE (*k* =8399)

NO.	SEARCH STRATEGY
#5	**#1 AND #2 AND #3 AND #4**
#4	'qualitative research'/exp OR qualitative:ab,ti OR 'interview'/exp OR 'questionnaire'/exp OR 'nursing methodology research'/exp OR 'focus group':ab,ti OR 'focus groups':ab,ti OR interview*:ab,ti OR survey*:ab,ti
#3	facilitat*:ab,ti OR encourag*:ab,ti OR promot*:ab,ti OR motivat*:ab,ti OR enabl*:ab,ti OR predict*:ab,ti OR support*:ab,ti OR barrier*:ab,ti OR obstacle*:ab,ti OR difficult*:ab,ti OR imped*:ab,ti OR reluctan*:ab,ti OR refus*:ab,ti OR counteract*:ab,ti OR challeng*:ab,ti OR utiliz*:ab,ti OR utilis*:ab,ti OR uptake*:ab,ti OR 'decision making'/exp OR 'patient attitude'/exp OR 'attitude to health'/exp
#2	male:ab,ti OR man:ab,ti OR males:ab,ti OR men:ab,ti OR boy:ab,ti OR boys:ab,ti OR gender*:ab,ti OR prostat*:ab,ti
#1	'early diagnosis'/exp OR 'mass screening'/de OR 'anonymous testing'/de OR 'auditory screening'/de OR 'cancer screening'/de OR 'genetic screening'/de OR 'preventive health services'/de OR screen*:ab,ti OR 'health check':ab,ti OR 'health checks':ab,ti OR checkup*:ab,ti OR 'check up':ab,ti OR 'check ups':ab,ti OR (routine:ab,ti OR regular:ab,ti OR yearly:ab,ti OR annual:ab,ti OR periodic:ab,ti AND ('health examination':ab,ti OR 'medical examination':ab,ti OR 'health assessment':ab,ti))

CINAHL via EBSCOHOST (*k* =2513)

NO.	SEARCH STRATEGY
#5	**(#1 AND #2 AND #3 AND #4)**
#4	(MH “Qualitative Research”+) OR (MH "Interviews+") OR (MH "Focus Groups") OR (MH "Questionnaires+") OR TI (Qualitative OR “Focus group*” OR Interview* OR Survey*) OR AB (Qualitative OR “Focus group*” OR Interview* OR Survey*)
#3	TI (facilitat* OR encourag* OR promot* OR motivat* OR enabl* OR Predict* OR Support* OR barrier* OR obstacle* OR difficult* OR imped* OR reluctan* OR refus* OR Counteract* OR Utiliz* OR Utilis* OR Uptake*) OR AB (facilitat* OR encourag* OR promot* OR motivat* OR enabl* OR Predict* OR Support* OR barrier* OR obstacle* OR difficult* OR imped* OR reluctan* OR refus* OR Counteract* OR challeng* OR Utiliz* OR Utilis* OR Uptake*) OR (MH "Decision Making, Patient") OR (MH "Decision Making") OR (MH "Decision Support Techniques") OR (MH "Attitude to Health") OR (MH "Health Beliefs") OR (MH "Attitude to Risk") OR (MH "Attitude to Life") OR (MH "Patient Attitudes")
#2	TI (Male OR Man OR Males OR Men OR Boy OR Boys OR Gender* OR Prostat*) OR AB (Male OR Man OR Males OR Men OR Boy OR Boys OR Gender* OR Prostat*) OR (MH "Gender Bias")
#1	(MH "Health Screening+") OR (MH "Early Diagnosis+") OR (MH "Preventive Health Care") OR TI (Screen* OR “Health check*” OR Checkup* OR check-up* OR ((routine OR regular OR yearly OR annual OR periodic) AND (‘health examination’ OR ‘medical examination’ OR ‘health assessment’))) OR AB (Screen* OR “Health check*” OR Checkup* OR check-up* OR ((routine OR regular OR yearly OR annual OR periodic) AND (‘health examination’ OR ‘medical examination’ OR ‘health assessment’)))

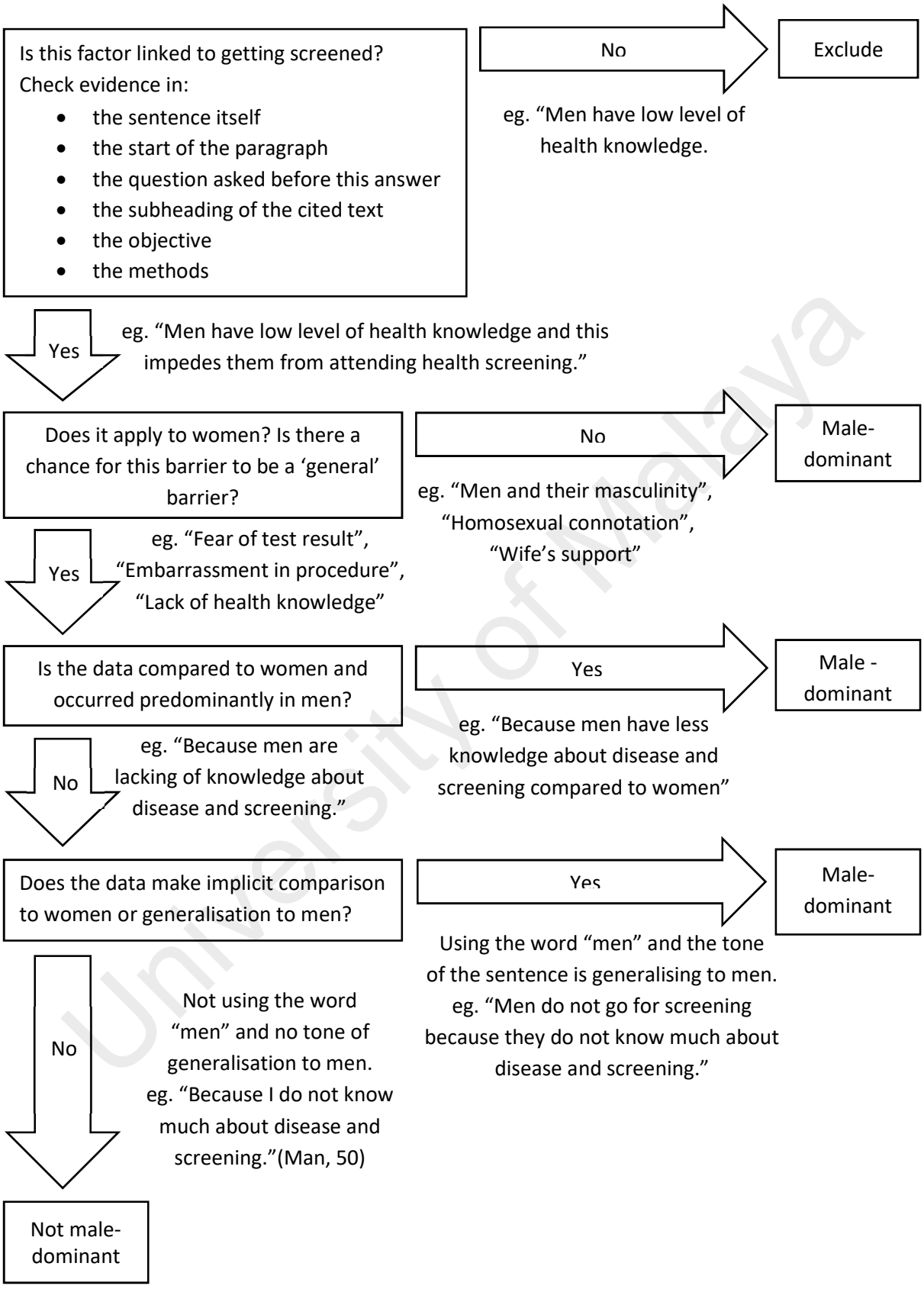
PscyInfo via OvidSP (*k* =1942)

NO.	SEARCH STRATEGY
#5	**(#1 and #2 and #3 and #4)**
#4	exp Qualitative Research/ or exp Questionnaires/ or Interviews/ or Qualitative.ti,ab. or 'Focus group*'.ti,ab. or Interview*.ti,ab. or Survey*.ti,ab.
#3	(facilitat* or encourag* or promot* or motivat* or enabl* or Predict* or Support* or barrier* or obstacle* or difficult* or imped* or reluctan* or refus* or Counteract* or challeng* or Utiliz* or Utilis* or Uptake*).ti,ab. or exp Decision making/ or exp health attitude/ or health behaviour/
#2	(Male or Man or Males or Men or Boy or Boys or Gender* or Prostat*).ti,ab. or Human sex differences/
#1	exp health screening/ or preventive medicine/ or Screen*.ti,ab. or 'Health check'.ti,ab. or 'Health checks'.ti,ab. or Checkup*.ti,ab. or check-up*.ti,ab. or ((routine or regular or yearly or annual or periodic) and ('health examination' or 'health examinations' or 'medical examination' or 'medical examinations' or 'health assessment' or 'health assessments')).ti,ab.

Web of Science (*k* =6730)

NO	SEARCH STRATEGY
# 5	**#4 AND #3 AND #2 AND #1**
# 4	TOPIC: (Qualitative OR “focus group*” OR “interview*” OR Questionnaire* OR Survey*)
# 3	TOPIC: (facilitat* OR encourag* OR promot* OR motivat* OR enabl* OR Predict* OR Support* OR barrier* OR obstacle* OR difficult* OR imped* OR reluctan* OR refus* OR Counteract* OR Challeng* OR Utiliz* OR Utilis* OR Uptake* OR “Decision making” OR Attitude* OR Accept*)
# 2	TOPIC: (Male OR Man OR Males OR Men OR Boy OR Boys OR Gender* OR Prostat*)
# 1	TOPIC: (“Early diagnosis” OR “Early detection” OR Screen* OR “Health check*” OR checkup* OR check-up* OR “preventive health” OR ((routine OR regular OR yearly OR annual OR periodic) AND ("health examination” OR “medical examination” OR “health assessment”)))

Appendix B. Criteria for male-dominant barriers and facilitators in qualitative studies



Appendix C. Results of quality assessment using MMAT.

Criteria		QL *k*=53	QN *k*=44	MM *k*=6
QL.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question (objective)?	Yes	89%		67%
	No	2%		0%
	Can't tell	9%		33%
QL.2. Is the process for analyzing qualitative data relevant to address the research question (objective)?	Yes	92%		50%
	No	2%		33%
	Can't tell	6%		17%
QL.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected?	Yes	100%		100%
	No	0%		0%
	Can't tell	0%		0%
QL.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?	Yes	8%		0%
	No	83%		100%
	Can't tell	9%		0%
QN.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)?	Yes		61%	83%
	No		9%	17%
	Can't tell		30%	0%
QN.2. Is the sample representative of the population understudy?	Yes		91%	83%
	No		0%	0%
	Can't tell		9%	17%
QN.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)?	Yes		98%	100%
	No		0%	0%
	Can't tell		2%	0%
QN.4. Is there an acceptable response rate (60% or above)?	Yes		41%	50%
	No		23%	33%
	Can't tell		36%	17%
M.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed methods question/objective?	Yes			83%
	No			17%
	Can't tell			0%
M.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (objective)?	Yes			50%
	No			17%
	Can't tell			33%
M.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design?	Yes			33%
	No			17%
	Can't tell			50%

*Type of study: QL=Qualitative; QN=Quantitative; MM=Mixed-method

Appendix D. Summary of the characteristics of studies included in this review.

CHARATERISTICS	No. of studies (k=103)
Type of study	
• Qualitative	53
• Quantitative	44
• Mixed-method	6
Gender focus	
• Focusing on men's barriers only	56
• Comparing men's and women's barriers	47
Barrier/facilitator or broad focus	
• Main focus on barrier	30
• Broad focus (knowledge, attitude, belief)	73
Outcome reported (barrier or facilitator)	
• Barrier only	37
• Facilitator only	13
• Both	55
Study design	
• Cross-sectional	44
• Grounded theory	3
• Phenomenology	2
• Ethnography	1
• Not reported (qualitative)	53
Range of study dates	1985-2012
Country	
• North America (USA & Canada)	62
• Europe (UK, Germany, Spain, Sweden, Denmark, France & Israel)	14
• Africa (Uganda, Nigeria, South Africa, Burkina Faso and Ethiopia)	9
• Oceania (Australia & New Zealand)	8
• Asia (Japan, China, Hong Kong, Singapore & Taiwan)	6
• South & Central America (Brazil, Jamaica, Trinidad and Tobago)	4
Setting	
• Healthcare setting	19
• Community	70
• Both	3
• Not reported	11
Disease	

- Prostate cancer 40
- Colorectal cancer 33
- HIV 15
- Sexually transmitted diseases 4
- Cancer (in general) 4
- Testicular Cancer 3
- Cardiovascular disease 2
- Skin cancer 1
- Multiphasic examination 1

Screening programme involved
- Yes 20
- No 83

Age range 14-98 years

Screening status
- Ever 11
- Never 9
- Both 73
- Not reported 10

Sampling strategy
- Convenience 36
- Purposive 31
- Random 17
- Universal 6
- Not reported 6
- Systematic 5
- Consecutive 2

Data collection method
- Self-completion questionnaire 15
- Interviewer-assisted 18
- Telephone interview 6
- Postal questionnaire 7
- Focus group discussion 31
- In-depth interview 24
- Focus group discussion and In-depth interview 4

Theories used
- Not Reported 65
- Health belief model 16
- No theory used (grounded theory) 5

• Theory of planned behaviour	1
• Theory of reasoned action	1
• Transtheoretical model	1
• Social marketing	1
• Andersen's Behavior Model of Health Services Use	1
• Preventive Health Model	1
• Social-cognitive models, health action process approach	1
• Health Belief Model and Social Determinants of Health	1
• Culture Care Diversity and Universality theory	1
• Precaution Adoption Process Model	1
• Masculinity and health theory (Courtenay)	1
• Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation (PRECEDE) model	1
• Cues to action	1

Characteristics of included qualitative studies (*k*=53)

First author and year	Disease for screening	Country and setting	Year of study	Gender focus	Sampling and sample size	Ethnicity, age and screening status	Theory used	Data collection method	Data analysis
Austin 2009	Colorectal Cancer	UK NR	Feb 2007 – July 2008	Comparison	Convenience 20 men 33 women	Minorities 50 - 78 NR	Health belief model	FGD	Framework and thematic
Bass 2011	Colorectal Cancer	USA Healthcare setting	Sep 2007 – Feb 2008	Comparison	Purposive 8 men 25 women	African American 50 - 64 Both	NR	FGD	Thematic
Blocker 2006	Prostate Cancer	USA Community	Fall 2002 – winter 2003	Male-specific	Convenience 14 men 15 women	African American 34 - 68 Both	Health Belief Model	FGD	Thematic
Carter 2008	Prostate Cancer	USA Community	NR	Male-specific	NR 35 men 39 women	African American >40 Both	NR	FGD	Thematic
Chaudhary 2010	Chlamydia	UK Community	NR	Male-specific	Purposive 15 men	Various 19-24 Both	NR	FGD	Thematic
Christianson 2008	HIV	Sweden Healthcare setting	NR	Comparison	Convenience 9 men 14 women	Various 18-24 Ever-screened	NR	FGD	Thematic

Conde 2011	Prostate Cancer	USA Community	NR	Male-specific	Purposive 20 men	Filipino above 40 Both	NR	FGD	Thematic
Dale 1999	Prostate Cancer	USA Community	NR	Male-specific	Convenience 96 men	African American and White 39 to 95 Both	Health belief model	FGD	Framework and textual
Elwood 1975	Multiphasic examinatio n	USA NR	NR	Male-specific	Systematic 25 men	White 53-62 Never-screened	NR	IDI	NR
Evans 2007	Prostate Cancer	UK Community	NR	Male-specific	Purposive 28 men	White 40 to 75 Both	NR	IDI	Constant comparison and thematic
Fernandez 2008	Colorectal Cancer	USA Community	NR	Comparison	Purposive 33 men 55 women 5 female lay health worker	Latino 50 to 91 Both	NR	FGD	Thematic
Ferrante 2011	Prostate Cancer	USA Community	Mar 2009 – May 2010	Male-specific	Purposive 64 men	Various 50 and above Both	Andersen's Behavior Model of Health Services Use	IDI	Grounded

Ford 2006	Prostate Cancer	USA Community	NR	Male-specific	Random 21 men	African American 55 and above Both	Preventive Health Model	FGD	Content and thematic
Forrester-Anderson 2005	Prostate Cancer	USA Community	NR	Male-specific	Convenience 104 men	African American 40 to 80 Both	Grounded theory	FGD	Thematic
Friedemann-Sanchez 2007	Colorectal Cancer	USA Healthcare setting	Sep 2004 – Dec 2004	Comparison	Purposive 43 men 27 women	Various 50 to 75 Both	Grounded and interpretive	FGD	Grounded and interpretive
Garcia-dominic 2012	Colorectal Cancer	USA NR	Apr 2009 – May 2009	Comparison	Convenience 40 men 42 women	Latino 26-77 Both	Health belief model	FGD	Thematic
Gesink 2014	Colorectal Cancer	Canada NR	Jun 2011 – May 2012	Comparison	Convenience 33 men 88 women 19 HCP	Various 20 and above for HCP, 30 and above for laymen Both	Grounded theory	IDI and FGD	Grounded
Getrich 2012	Colorectal Cancer	USA Healthcare setting	Aug 2008 – Jul 2009	Comparison	Purposive 26 men 26 women 14 HCP	Hispanic 50 and above Both	NR	IDI	Thematic and Iterative analytic process

Hannover 2010	Prostate Cancer	Germany Healthcare setting	NR	Male-specific	Convenience 83 men	Various 45 above Both	Social-cognitive models, health action process approach	IDI	Content
Harris 1998	Colorectal Cancer	Australia NR	NR	Comparison	Random 12 men 12 women	Various 40 to 70 Ever-screened	NR	FGD	Thematic
Harvey 2011	Prostate Cancer	USA Community	NR	Male-specific	Convenience 15 men	African American 40 and above Both	Preventive health model	FGD	Thematic
Hunter 2007	Cardiovascular	USA NR	May 2002 – Apr 2003	Male-specific	Convenience 29 men 83 women 25 HCP	Mexican American 40 and above NR	NR	IDI	Content and thematic
Ilic 2005	Prostate Cancer	Australia NR	NR	Male-specific	Purposive 67 men	Various 45 above Both	Grounded theory	FGD	Thematic
James 2013	Colorectal Cancer	USA Community	2006 – 2008	Male-specific	Convenience 29 men	American Indian 50 or older Both	NR	FGD	Thematic

Jernigan 2001	Cancer	USA NR	Mar 1998 – May 1998	Comparison	Convenience 26 men 19 women	African American 50 or older Both	NR	FGD	NR
Jones RA 2009	Prostate Cancer	USA Community	NR	Male-specific	Convenience 17 men	African American 40 to 71 Both	NR	IDI	Thematic
Jones RA 2010	Prostate Cancer	USA Community	NR	Male-specific	Convenience 17 men	African American 40 to 71 Both	NR	IDI	Thematic
Larsson 2010	HIV	Uganda Community	Apr 2008 – Apr 2009	Male-specific	Convenience 103 men	Various NR Both	NR	IDI and FGD	Thematic
Lasser 2008	Colorectal Cancer	USA Community	Jan 2005 – Dec 2006	Comparison	Convenience 9 men 14 women 10 HCP	Various 52-74 Both	NR	IDI	Coding and constant comparison
Lupton 1995	HIV	Australia Community	Mar 1993 – Aug 1993	Comparison	Purposive 50 men and women	Various below and above 30 Ever-screened	NR	IDI	Thematic
MacCaffery 2001	Colorectal Cancer	UK Community	NR	Comparison	Purposive 30 men 30 women	Various 55-64 Never-screened	Not using	IDI	Thematic

Madjar 2007	Prostate Cancer	Australia Community	Oct 2004 – Mar 2005	Male-specific	Purposive 38 healthy men 7 healthy women 18 Pca men 9 spouse	Various 18 to 80 Both	NR	IDI and FGD	Thematic
Molina-Barcelo 2011	Colorectal Cancer	Spain Community	Mar – Apr 2009	Comparison	Purposive 24 men 32 women	Various 50 to 69 Both	Health Belief Model and Social Determinants of Health.	FGD	Thematic
Ocho 2013	Prostate Cancer	Trinidad and Tobago Community	Aug 2011 – Jan 2012	Male-specific	Purposive 75 men	Various 19 to 60 Both	NR	FGD	Thematic
Odedina 2004	Prostate Cancer	USA Community	Oct 2001 – Mar 2002	Male-specific	Purposive 49 men	African American 40 and above Both	Not using - Mentioned many but did not apply in method	FGD	Ethnographical
Oliver 2007	Prostate Cancer	USA Community	NR	Male-specific	Convenience 9 men	African American 43 to 72 Both	NR	IDI	Content and thematic

Palmer 2008	Colorectal Cancer	USA Community	Aug 2005 – Mar 2006	Comparison	Convenience 18 men 18 women	African American 50 - 76 Both	Predisposing, Reinforcing, and Enabling Constructs in Educational/ Environmental Diagnosis and Evaluation (PRECEDE) model	IDI	Thematic
Patinkin 2007	HIV	Israel Community	Aug 2003 – Oct 2003	Male-specific	Purposive 10 men	Various 24 to 60 Ever-screened	NR	IDI	Content and thematic
Pinnock 1998	Prostate Cancer	Australia Community	NR	Male-specific	Purposive 134 men 14 women	Various NR NR	Health Belief Model	FGD	analysed according to HBM
Plowden 2006	Prostate Cancer	USA Community	NR	Male-specific	Purposive 12 men 24 sig other/wives/ HCP/child of men at risk	African American Men 40 to 79 others 30 to 72 Both	Culture Care Diversity and Universality theory	IDI	Constant comparative and thematic

Puaina 2008	Cancer	USA Community	NR	Male-specific	Purposive 60 men	Samoan 50 and above NR	NR	FGD	Content and thematic
Rai 2007	Prostate Cancer	UK Community	2005	Male-specific	Purposive 20 men	White 45 to 75 Ever-screened	NR	IDI	Thematic
Reeder 2011	Colorectal Cancer	New Zealand Community	NR	Comparison	Convenience 20 men 30 women	White 50 to 71 NR	NR	IDI	Content
Ritvo 2013	Colorectal Cancer	Canada Community	NR	Comparison	Random 32 men 49 women	Various 50 to 84 Never-screened	Precaution Adoption Process Model	IDI	Constant comparison, grounded and thematic
Robinson 1996	Prostate Cancer	USA NR	Dec 1993 – Feb 1994	Male-specific	Purposive 56 men	African American 40 and above Both	NR	FGD	NR
Salas-Lopez 2007	Cancer	USA Community	NR	Comparison	Convenience 9 medical residents	Various mean = 29.6 NR	NR	FGD	Constant comparison
Sanchez 2007	Prostate Cancer	USA Community	Dec 2004 – Apr 2005	Male-specific	Convenience 31 men	African American 40 to 70 Both	NR	FGD	Thematic

Singleton 2008	Testicular Cancer	Australia Community	NR	Male-specific	Purposive 12 men	Various 18 to 23 Both	Social constructionist of masculinity	FGD	Thematic
Thompson 2012	Colorectal Cancer	New Zealand Community	NR	Comparison	Convenience 27 men 53 women	Various 40 to 70 Both	Men and masculinity	IDI	Thematic
Wackerbarth 2005	Colorectal Cancer	USA Community	NR	Comparison	Purposive 13 men 17 women	Various 48 to 55 Both	Health belief model	IDI	Thematic
Wackerbarth 2008	Colorectal Cancer	USA Community	NR	Comparison	Purposive 13 men 17 women	Various 48-60 Both	Kurt Lewin's theory of decision making	IDI	Constant comparative
Webb 2006	Prostate Cancer	USA Healthcare setting and community	NR	Male-specific	Convenience 18 men 14 women	African American 40-70 Both	NR	FGD	Thematic
Winterich 2009	Prostate and colorectal cancer	USA Community	NR	Male-specific	Purposive 64 men	African American and White 40 to 64 Both	Masculinity and health theory	IDI	Framework and thematic

Note: NR = Not reported; Screening status = Ever-screened or never-screened or both

Characteristics of included quantitative studies (*k*=44)

First author and year	Disease for screening	Country and setting	Study year	Gender focus	Sampling and sample size	Ethnicity, age and screening status	Theory used	Data collection method	Response rate	P-value reported
Ashford 2001	Prostate Cancer	USA Healthcare setting and community	Feb 1995 – Jun 1996	Male-specific	Universal 723 men	African American 50 - 74 Both	Health Belief Model	Interview assisted survey	95% clinic, 65% community	No
Baseman 2001	Syphillis	USA Community	NR	Comparison	Purposive 446 men 245 women	Various >18 Both	NR	Interview assisted survey	NR	No
Bergenmar 1997	Melanoma	Sweden Community	1994	Comparison	Universal 61 men 66 women	Various 40 - 60 Both	Health Belief Model	Telephone interview	63%	No
Biadglegne 2011	HIV	Ethiopia Healthcare setting	Aug 2008 – Oct 2008	Comparison	Systematic 91 men 131 women	Various 18 - 70 Both	NR	Interview assisted survey	NR	Yes
Blanchard 2005	Prostate Cancer	USA NR	NR	Male-specific	Convenience 324 women	Various >18 NR	NR	Self-completion questionnaire	>90%	No
Blesch 1986	Testicular Cancer	USA Community	NR	Male-specific	Random 128 men	Various 20 - 60 Both	Health Belief Model	Self-completion questionnaire	55%	No
Bloom 2006	Prostate Cancer	USA Community	NR	Male-specific	Convenience 208 men	African American 40 - 74 Both	Health Belief Model	Interview assisted survey	50%	No
Bourne 2010	Prostate Cancer	Jamaica Healthcare setting	Feb 2008 – Mar 2008	Male-specific	Random 170 men	Various >29 Both	NR	Interview assisted survey	76.8%	No

Calazel-Benque 2011	Colorectal Cancer	France Community	Jan 2005 – Feb 2005, Dec 2007 – Jan 2008	Comparison	NR 270 men 305 women	Various 40 - 75 Both	NR	Telephone interview	NA	Yes
Cormier 2003	Prostate Cancer	USA Community	1995-2000	Male-specific	Convenience 138 men	Various 42 - 93 Both	NR	Postal questionnaire	89%	No
Cunningham 2009	Sexual transmitted disease	USA Community	Apr 2004 – Apr 2007	Comparison	Random 230 men 364 women	Various 15 - 24 Both	NR	Interview assisted survey	51%	No
Day 2003	HIV	South Africa Healthcare setting	Jul 2001	Male-specific	Systematic 105 men	Various 24 - 61 Both	NR	Interview assisted survey	95%	No
Demark-Wahnefried 1995	Prostate Cancer	USA Healthcare setting	1992	Male-specific	NR 1504 men	African American and White Median: 64 Ever-screened	NR	Self-completion questionnaire	NR	No
Elnicki 1995	Cardiovascular	USA Healthcare setting	1991	Comparison	Consecutive 75 men 113 women	Various 18 - 88 Both	NR	Interview assisted survey	100%	Yes
Farraye 2004	Colorectal Cancer	USA Healthcare setting	NR	Comparison	Purposive 241 men 300 women	Various 50 - 89 Both	NR	Postal questionnaire	56%	Yes
Foldspang 1990	HIV	Denmark Community	Oct 1998 – Dec 1988	Male-specific	Random 230 men	Danish 20 - 49 Both	NR	Postal questionnaire	77%	No

Green 2004	Colorectal Cancer	USA Community	NR	Comparison	Convenience 42 men 58 women	African American 50 - 90 Both	Health Belief Model	Self-completion questionnaire	NR	No
Iyaniwura 2006	HIV	Nigeria Community	Apr 2004 – May 2004	Comparison	Purposive 196 men 197 women	Various 15 - 29 Both	NR	Interview assisted survey	NR	No
Katz 1995	Testicular Cancer	USA Community	1993 – 1994	Male-specific	Convenience 78 men	Various mean =23 Both	NR	Self-completion questionnaire	NR	No
Larson 2005	Cancer	USA Community	Dec 2001 –Jul 2002	Comparison	Random 140 men 360 women	Various Men ≥50 Women ≥40 NR	NR	Telephone interview	72%	No
Li 1998	Colorectal Cancer	Japan Community	1991 – 1996	Comparison	Universal 182 men 174 women	Various 40 - 79 Never-screened	NR	Postal questionnaire	81%	Yes
Lin 2011	Prostate Cancer	Taiwan Community	Jun 2009 – Jan 2010	Male-specific	NR 330 men	Various 38 - 82 Both	NR	Self-completion questionnaire	NR	No
McCoy 1995	Prostate Cancer	USA Community	2 weeks over summer 1990	Male-specific	Random 897 men	African American, White and Hispanic >65 Both	NR	Telephone interview	NR	No
McDougall 2004	Prostate Cancer	USA Healthcare setting	NR	Male-specific	Convenience 19 men	African American 45 - 76	NR	Self-completion questionnaire	NR	No

						Ever-screened				
Mugisha 2010	HIV	Uganda Community	2007	Comparison	Random 66 men 61 women	Various 16 - 44 Both	NR	Interview assisted survey	NR	No
Naik 2012	HIV	South Africa Community	Sep 2009 – Jan 2011	Comparison	Systematic 560 men 111 women	Various 14 - 98 Never-screened	NR	Interview assisted survey	99%	Yes
Neale 1989	Colorectal Cancer	USA Community	1985	Male-specific	Universal 128 men	White mean =41 Never-screened	NR	Telephone interview	68%	No
Obermeyer 2009	HIV	Burkina Faso Healthcare setting	Jan 2006 – Feb 2006	Comparison	Convenience 63 men 236 women	Various mean =34 Both	NR	Interview assisted survey	100%	No
Oliver 2011	Prostate Cancer	USA Community	May 2007 – Aug 2007	Male-specific	Convenience 94 men	African American and White >40 Both	Health Belief Model	Self-completion questionnaire	100%	No
Paiva 2011	Prostate Cancer	Brazil Community	NR	Male-specific	Random 160 men	African American, White and Mestizo 50 - 80 Both	NR	Self-completion questionnaire	NR	No
Parchment 2004	Prostate Cancer	USA Community	NR	Male-specific	Convenience 100 men	African American and	The Theory of	Self-completion questionnaire	Low	No

						Caribbean men 37 - 89 Both	Reasoned Action			
Rafael 2012	Prostate Cancer	Brazil Healthcare setting	Jun 2011	Male-specific	Random 101 men	Various 40 - 59 Both	NR	Interview assisted survey	NR	No
Raich 1997	Prostate Cancer	USA Community	1994	Male-specific	Universal 436 men	Various Not clear Ever-screened	NR	Postal questionnaire	64%	No
Ramos 2011	Colorectal Cancer	Spain Healthcare setting	Jan 2009 – Jun 2009	Comparison	Systematic 261 men 361 women	Various 50 - 69 Both	NR	Self-completion questionnaire	95%	No
Sanders 2007	Sexual transmitted disease	USA Community	2004 – 2005	Comparison	NR 50 men 106 women	Various 14 - 20 Never-screened	Health Belief Model	Self-completion questionnaire	40.6%	No
Shelton 1999	Prostate Cancer	USA Community	NR	Male-specific	Purposive 1395 men	African American 40 - 70 Both	Theory of Planned Behavior	Self-completion questionnaire	NR	No
Tobin-west 2014	HIV	Nigeria Community	May 2011 – Jun 2011	Comparison	Random 267 men 368 women	Various >15 Both	NR	Interview assisted survey	NR	Yes
Vernon 1990	Colorectal Cancer	USA Community	Spring 1988	Male-specific	Purposive 113 men	Various NR Both	NR	Telephone interview	80.7%	No
Vincent 2011	Colorectal Cancer	USA Community	Jan 2009 – Feb 2009	Comparison	Random 542 men 689 women	Various 50 - 80 Both	Transtheoretical Model	Postal questionnaire	30.85%	Yes

Watanabe 2004	HIV	Japan Healthcare setting	Apr 2001 – Mar 2002	Comparison	Universal 2515 men 1587 women	Various 19 - 70 Ever-screened	NR	Self-completion questionnaire	56.6%	No
Wong MC 2013	Colorectal Cancer	Hong Kong Healthcare setting	May 2008 – Sep 2012	Comparison	Consecutive 4384 men 5689 women	Various 50 - 70 Never-screened	Health Belief Model	Self-completion questionnaire	NR	Yes
Wong RK 2013	Colorectal Cancer	Singapore Community	2007 – 2008	Comparison	Random 693 men 1050 women	Various >50 Both	Health Belief Model	Interview assisted survey	88.2%	Yes
Zhou 2009	HIV	China Healthcare setting	Jul 2006 – Jun 2007	Comparison	NR 1957 men 719 women	Various 20 - 65 Ever-screened	NR	Interview assisted survey	35.6%	Yes
Zimmerman 1997	Prostate Cancer	USA Healthcare setting	1995	Male-specific	Convenience 51 men	Hispanic 35 - 78 Ever-screened	Social Marketing	Interview assisted survey	100%	No

Note: NR = Not reported; Screening status = Ever-screened or never-screened or both

Characteristics of included mixed-method studies (*k*=6)

First author and year	Disease for screening	Country	Setting	Study year	Gender focus	Sampling and sample	Ethnicity, age and screening status	Theory used	Data collection method	Data Analysis
Bastani 2001 (QL)	Colorectal Cancer	USA	NR	Sep 1998 – Dec 1998	Comparison	Purposive 23 men 28 women	Various >50 NR	NR	FGD	Thematic
Bwambale 2008 (QL)	HIV	Uganda	Healthcare setting	Jan 2005 – Apr 2005	Male-specific	Purposive 40 men 10 women	Various >18 Both	NR	FGD and IDI	Thematic
Bwambale 2008 (QN)			Community			Random 780 men	Various 18 - 90 Both		Interview assisted survey	Response rate: NR P-value: No
Denberg 2005 (QL)	Colorectal Cancer	USA	Community	Mar 2004 – Apr 2004	Comparison	Convenience 25 men 27 women	Various >50 Never-screened	Grounded theory	IDI	Thematic
Jones RM 2010 (QL)	Colorectal Cancer	USA	Community	Dec 2005 – Jun 2006	Comparison	Convenience 15 men 25 women	Various 45 - 75 Both	NR	FGD	Thematic
Jones RM 2010 (QN)				Jun 2005 –Jul 2005		Random 103 men 201 women	Various 50 - 75 Both		Postal questionnaire	Response rate: 48% P-value: Yes
Katz 2004 (QL)	Colorectal Cancer	USA	Community	1998	Comparison	Convenience 3 grps men 3 grps women	African American >50 NR	NR	FGD	NR
Matterne 2008 (QL)	Colorectal Cancer	Germany	Community	NR	Male-specific	Convenience 71 men	Various 45 - 70 Both	Cues to Action	IDI	Thematic

Note: NR = Not reported; Screening status = Ever-screened or never-screened or both

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4.2.2 Paper 2: Teo, C. H., Ling, C. J. & Ng, C. J. (2018). Improving health screening uptake in men. A systematic review and meta-analysis. Am J Prev Med, 54(1), 133-143.

Statement of Authors' Contribution: Teo, C. H., Ling C. J. and Ng, C. J. have made substantial contributions in this systematic review. Teo, C. H. and Ng, C. J. first conceptualised this study and developed the protocol of this systematic review. Ling C. J. contributed in improving the search strategy for this systematic review. Teo, C. H. and Ling, C. J. screened the titles, abstracts and full texts gathered. Ng, C. J. acted as the third person to confirm the final included articles. Data extraction and meta-analysis were performed by Teo, C. H. and Ling, C. J.. All authors were involved in the data analysis as a whole, which led to the finalised results to be presented. Teo, C. H. drafted the first version of the paper and led its revision subsequently. Ng, C. J. and Ling, C. J. expanded and revised the article intellectually based on the findings analysed. All authors have read and approved the final manuscript to be published.

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REVIEW ARTICLE

Improving Health Screening Uptake in Men: A Systematic Review and Meta-analysis

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Context: Globally, uptake of health screening in men remains low and the effectiveness of interventions to promote screening uptake in men is not well established. This review aimed to determine the effectiveness of interventions in improving men's uptake of and intention to undergo screening, including interventions using information and communication technology and a male-sensitive approach.

Evidence acquisition: Studies were sourced from five electronic databases (October 2015), experts, and references of included studies. This study included RCTs or cluster RCTs that recruited men and reported uptake of or intention to undergo screening. Two researchers independently performed study selection, appraisal, and data extraction. The interventions were grouped into those that increase uptake and those that promote informed decision making. They were further sub-analyzed according to types of intervention, male-sensitive, and web- and video-based interventions. The analysis was completed in December 2016.

Evidence synthesis: This review included 58 studies. Most studies were on prostate cancer (k=31) and HIV (k=11) screening. Most of the studies had low methodologic quality (79.3%) and after excluding them from the analysis, one study found that educational intervention (which was also male-sensitive) was effective in improving men's intention to screen (risk ratio=1.36, 95% CI=1.23, 1.50, k=1) and partner educational intervention increased men's screening uptake (risk ratio=1.77, 95% CI=1.48, 2.12, k=1). Video-based educational interventions reduced prostate cancer screening uptake (risk ratio=0.89, 95% CI=0.80, 0.99, k=1) but web-based interventions did not change men's screening intention or uptake.

Conclusions: This review highlights the need to conduct more robust studies to provide conclusive evidence on the effectiveness of different interventions to improve men's screening behavior.
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CONTEXT

Globally, the average lifespan of men is 5 years shorter than that of women; this trend has not changed for decades.[1] One important explanation for this discrepancy is men's health-seeking behavior. Men tend to delay seeking help when they are ill; they are also less likely to take up health promotion and preventive activities, such as screening.[2–6] Studies have found that lack of awareness, masculine behavior, and lack of time are important barriers to screening in men whereas men's partners can help to motivate men to take up screening.[7] Therefore, interventions have been developed to improve health screening uptake though healthcare professionals, outreach programs, invitation letters, phone calls, and opportunistic screening.[8] However, the effectiveness of these interventions varies[8]; in particular, there is a lack of evidence on whether interventions tailored to men and those using information and communication technology (ICT) are effective in changing men's screening behavior.

Men's health experts recommend that interventions targeting men should be male-sensitive; they should be tailored for men rather than be gender neutral.[9–11] Although this approach seems appropriate, evidence to support this is lacking. A systematic review on

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health-promoting interventions targeting men published a decade ago identified only two male-sensitive interventions to improve health screening uptake, and they were found to have poor methodologic quality.[12] Therefore a need exists to validate the assumption that gender-sensitive interventions are more effective in improving men's health-seeking behavior than those using a gender-neutral approach.

With the advent of technology, there was an upsurge of ICT usage to seek health information.[13,14] A survey in the U.S. reported that 72% of Internet users have searched for health information via the Internet in the past year.[14] In addition, ICT-based interventions, such as videos, websites, and mobile apps have been found to be effective in promoting weight loss, increasing physical exercise, and improving medication adherence and self-care.[15–19] However, the scope and effectiveness of these ICT-based interventions in terms of changing men's uptake of health screening remain unknown.

Therefore, this systematic review aims to evaluate the effectiveness of interventions in changing men's intention to undergo and uptake of screening, specifically those using a male-sensitive approach and ICT.

EVIDENCE ACQUISITION

Information Sources and Eligibility Criteria

This review was guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[20] Five key databases (PubMed, Embase, CINAHL via EBSCOHost, PsycINFO via OvidSP, and Web of Science) were searched up to October 19, 2015 using four main concepts: men, intervention, screening, and trial (detailed search strategy can be found in Appendix Table 1, available online). The search was limited to articles published in English. Supplementary methods such as reference follow-up and article sourcing from experts were also used. This review was registered with the International Prospective Register of Systematic Reviews (PROSPERO; Registration number: CRD42016033298).

This review included studies that used interventions to improve men's behavior in health screening. The study inclusion criteria were: RCT or cluster RCT (cRCT); recruited only male participants; screenings recommended by the U.S. Preventive Services Task Force (grade A and B); screenings for male-specific diseases (prostate and testicular cancers)[21]; any type of intervention such as reminder, letter, workshop, media, or website; studies reporting actual uptake of screening or intention to undergo screening as outcome measures. Male subpopulations, such as men who have sex with men, were also included.

Study Selection, Appraisal, and Extraction

Two trained researchers (CHT and CJL) sifted through the titles and abstracts independently before meeting to discuss any discrepancy and agree on the full-text articles to be retrieved for assessment. Subsequently, using a standardized form, the two researchers independently appraised the included studies using the Cochrane Collaboration's tool for assessing risk of bias, followed by data extraction.[22,23] A third researcher (CJN) was present at all the meetings as an independent assessor to resolve any discordance in study selection, appraisal, and data extraction.

The information extracted from each study included, but was not limited to: country; setting (defined as location where intervention was delivered to subjects, not the recruitment location); study design (RCT versus cRCT); details of the intervention and comparator; and study outcomes (screening intention and uptake). Four study authors were contacted for missing data. Because of the wide range of interventions used in the studies, the researchers classified the interventions based on the content of the intervention, such as educational information, decision aid, invitation, counseling, and simplified screening procedure. The comparison groups were categorized into two groups: comparator versus usual care. A comparator is a control group with an active component that might result in altered screening behavior or intention, but contains features different from the intervention arm (e.g., intervention: patient decision aid; comparator: educational pamphlet). In usual care, no information or information on unrelated topics (e.g., highway safety video, diabetes mellitus education) was delivered.

Data Analysis

The researchers used Review Manager, version 5.3 to perform meta-analysis.[24] Screening uptake was defined as completion of screening test, either by self-report or review of medical chart or insurance claims. Outcomes were presented as dichotomized data: completed versus no screening uptake and intended versus not intended to screen. For studies that measured intention to screen using a Likert scale, the researchers agreed on a cut-off point based on the description of the scale categories (e.g., definitely interested, probably interested, and do not mind are categorized as intention to screen). The data analysis was completed in December 2016.

Risk ratio (RR) was calculated for each study for screening uptake and intention. The RRs were pooled according to type of interventions and as the study heterogeneity (I^2) was $>40\%$, a random-effect model was used. To pool the data of RCT and cRCT, adjustment of the sample size of cRCT is necessary because the sample size was inflated initially to adjust for clustering effect. The adjusted sample size is calculated by dividing the cRCT sample size by the design effect reported in the study or from similar studies.[25–27]

Although most of the studies aimed to increase screening uptake/intention (e.g., HIV testing and colorectal cancer screening), there were some that aimed to promote shared decision making with participants, in which the desired endpoint was not necessarily to increase screening uptake/intention (e.g., decision aid for prostate-specific antigen testing). Thus, interventions that aimed to increase screening uptake were analyzed separately from those involving shared decision making. Control groups using an active comparator were also analyzed separately from those involving usual care. For studies with multiple intervention arms, the intervention arms were combined according to type of intervention to create a pair-wise comparison.[27] For 2×2 factorial trials, they were combined and analyzed as a two-arm parallel group trial.[27] Subgroup analyses were also conducted to evaluate the effectiveness of male-sensitive, web-, and video-based interventions. These analyses only included studies with a comparator

group that is non-male sensitive, non-web-, or non-video-based, respectively. Sensitivity analyses were performed by excluding studies with lower methodologic quality (i.e., if one of the parameters in the risk of bias table was assessed as high risk, or if at least three of the parameters were assessed as unclear).[22,23,28] The research team developed a framework to define male-sensitive interventions as follows:

- related to something men like or are interested in (e.g., sports, cars);
- conducted at a place where only or mostly men would go (e.g., pubs, workplace);
- delivered in a manner that specifically addresses men's concerns (e.g., men have a higher risk of getting cardiovascular disease); and
- addressing behaviors that are unique to men (e.g., poor health-seeking behavior, masculinity).

Interventions that satisfy any of the above criteria were labeled as male-sensitive interventions.

EVIDENCE SYNTHESIS

Of 12,867 articles screened, 54 studies met the inclusion criteria (Figure 1). An additional four studies were identified from reference follow-up, making a total of 58 studies (51 RCTs and seven cRCTs) included in this review.[29–86]

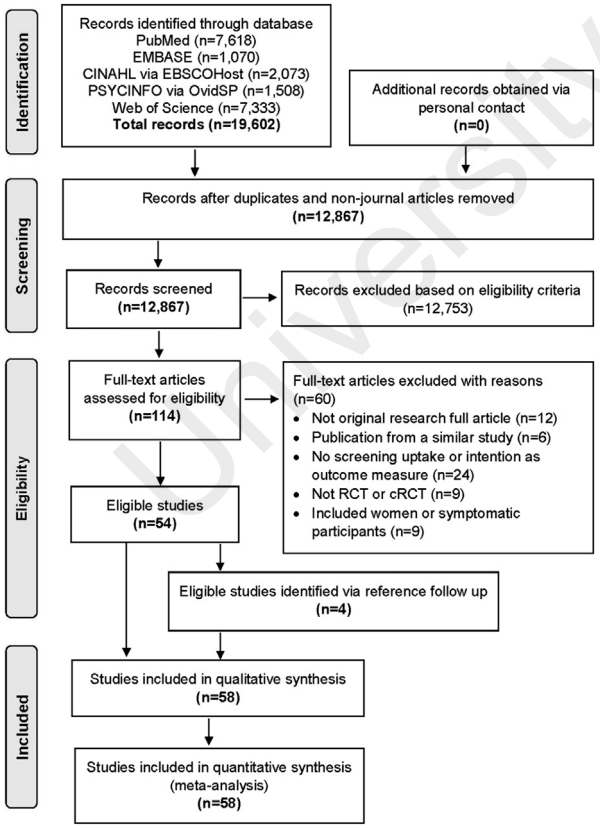

Figure 1. PRISMA flow diagram.
cRCT, cluster RCT.

Study Characteristics

The studies evaluated effectiveness of interventions on screening for the following conditions: prostate cancer (k=31), HIV (k=11), sexually transmitted infection (STI) (k=4), HIV and STI (k=1), testicular cancer (k=3), melanoma (k=3), and combinations of more than one disease (k=5) which include colorectal cancer, gastric cancer, prostate cancer, cholesterol, and general health conditions (Appendix Tables 2 and 3, available online). Most studies were conducted in the U.S. (k=31), Australia (k=9), and the United Kingdom (k=5). The interventions were delivered in the community (k=27), clinics (k=16), online (k=8), and in combinations of different settings (online and clinic, k=7).

The range of interventions included educational information (k=23), decisions aids (k=13), invitations (k=3), simplified screening procedure (k=4), decision counseling (k=3), implementation intention (k=2), and others such as clinical practice improvement, community jury, and value-clarification method. In five studies, interventions were delivered through men's female partners or female family members.

In this review, 28 studies aimed to increase health screening uptake (Table 1), of which 25 reported only screening uptake whereas three reported both uptake and intention to undergo screening.[36,85,86] The other 30 studies aimed to promote informed decision making and all were on prostate cancer screening. Of these 30 studies, 12 reported only screening uptake, 12 reported only intention to undergo screening, and six reported both uptake and intention.

Thirteen studies used interventions that were male-sensitive, of which five targeted men who have sex with men.[35,36,64,85,86] These male-sensitive interventions included a football club captain promoting health screening,[44] a sports personality promoting screening,[51,52,73] an invitation letter signed by a sportsman,[84] a personalized letter signed by a male medical director,[29] invitation to attend screening in a bar,[39] and a decision aid addressing men's masculine behavior.[34] For interventions using ICT, 12 studies used websites[30,35,36,40,42,47,49,50,53,56,71,73,81,85,86] and 16 used videos.[31,36,43,46,47,49–52,56,65,71,73,78,79] No study used mobile apps to improve screening behavior.

Risk of Bias

Overall, most of the studies had low methodologic quality; 79% of the studies were classified as low methodologic quality in the context of this review (Figure 2). Blinding of participants was the most common reason for studies being rated as unclear (65.52%) whereas blinding of personnel was the reason for most studies being rated as high risk of bias (31.03%). Details

Table 1. Comparison Between Interventions and Comparators/No Intervention According to Type of Intervention

	Versus comparators		Versus no intervention	
Type of intervention	**k**	**RR (95% CI)**	**k**	**RR (95% CI)**
Intervention to increase uptake of screening				
Education				
Education (Uptake)	**5**	**1.11 (1.01, 1.21)**	7	1.37 (1.00, 1.88)
Education (Uptake)[a]	3	1.12 (0.99, 1.27)		–
Education (Intention)		–	**1**	**2.19 (1.20, 4.01)**
Education (Intention)[a]	**1**	**1.36 (1.23, 1.50)**		–
Counselling (Uptake)		–	3	1.21 (0.73, 1.99)
Invitation to testing (Uptake)	**4**	**1.78 (1.17, 2.68)**		–
Screening procedure (Uptake)	**2**	**1.89 (1.20, 2.97)**	2	2.99 (0.15, 59.60)
Implementation intention (Uptake)	1	0.97 (0.78, 1.20)	1	1.63 (1.00, 2.65)
Peer leader				
Peer leader (Uptake)	2	1.39 (0.37, 5.18)		–
Peer leader (Intention)	**1**	**2.09 (1.46, 2.98)**		–
Clinical practice improvement (Uptake)		–	**1**	**5.25 (1.31, 21.06)**
Motivational interviewing (Uptake)	**1**	**2.50 (1.58, 3.97)**		–
Partner education (Uptake)[a]		–	**1**	**1.77 (1.48, 2.12)**
HCP recommendation (Uptake)	1	1.10 (0.81, 1.49)		–
HCP training (Uptake)		–	**1**	**1.27 (1.09, 1.50)**
Intervention promoting informed decision making				
Decision aid				
Decision aid (Uptake)	2	0.97 (0.88, 1.07)	5	1.0 (0.89, 1.12)
Decision aid (Uptake)[a]		–	2	0.99 (0.90, 1.09)
Decision aid (Intention)	2	0.96 (0.92, 1.01)	8	**0.86 (0.77, 0.95)**
Decision aid (Intention)[a]	1	0.97 (0.89, 1.06)	2	0.86 (0.67, 1.10)
Education				
Education (Uptake)	2	**2.04 (1.85, 2.26)**	4	0.91 (0.76, 1.07)
Education (Uptake)[a]		–	1	0.94 (0.83, 1.07)
Education (Intention)	1	1.02 (0.88, 1.18)	1	0.78 (0.56, 1.08)
Education (Intention)[a]	1	1.02 (0.88, 1.18)	1	1.00 (0.91, 1.09)
Decision counseling				
Decision counseling (Uptake)	2	1.23 (0.55, 2.74)	1	1.09 (0.94, 1.26)
Decision counseling (Intention)		–	1	1.06 (0.85, 1.32)
Value clarification (Intention)	1	0.97 (0.90, 1.05)		–
Chronic disease trajectory model (Intention)	1	0.97 (0.91, 1.03)		–
Community jury (Intention)	1	0.53 (0.26, 1.09)		–

Note: Boldface indicates statistical significance ($p < 0.05$). Detailed version in Appendix Table 5, available online.
[a]Studies with high methodological quality.
HCP, healthcare professional; RR, risk ratio.

of the risk of bias assessment can be found in Appendix Table 4 (available online).

Interventions to Increase Screening Uptake

Educational interventions were found to be effective in increasing men's screening intention (versus comparator: RR=1.36, 95% CI=1.23, 1.50, k=1; versus usual care: RR=2.19, 95% CI=1.20, 4.01, k=1) and uptake (versus comparator: RR=1.11, 95% CI=1.01, 1.21, k=5; versus usual care: RR=1.37, 95% CI=1.00, 1.88, k=7) (Table 1).

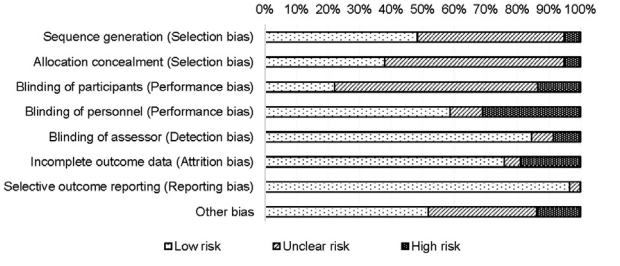

Figure 2. Risk of bias summary as percentages across all included studies.

However, when studies with low methodologic quality were excluded, there was no significant difference in men's screening uptake between educational interventions and comparators (RR=1.12, 95% CI=0.99, 1.27, k=3); nevertheless, their intention to undergo screening remained higher for one study that involved peer education (RR=1.36, 95% CI=1.23, 1.50).

A study involving partner education was shown to be effective in increasing men's screening uptake compared with usual care (RR=1.77, 95% CI=1.48, 2.12, k=1). Interventions that used invitation (RR=1.78, 95% CI=1.17, 2.68, k=4), simplified screening procedure (RR=1.89, 95% CI=1.20, 2.97, k=2), and motivational interviewing (RR=2.50, 95% CI=1.58, 3.97) were shown to be more effective than comparators. In addition, clinical practice improvement interventions (RR=5.25, 95% CI=1.31, 21.06) and healthcare professional training (RR=1.27, 95% CI=1.09, 1.50) were shown to be more effective in increasing men's screening uptake compared with usual care. Peer leader–based intervention improved men's intention to undergo screening (RR=2.09, 95% CI=1.46, 2.98) but not uptake (RR=1.39, 95% CI=0.37, 5.18, k=2) when compared with comparators. However, most of these interventions had low methodologic quality, except one that involved partner education. Interventions using counseling, implementation intention method, and healthcare professional recommendation were ineffective in improving screening intention and uptake.

Interventions to Promote Informed Decision Making in Screening

Patient decision aids were the only intervention that reduced men's intention to undergo prostate cancer screening compared with usual care (RR=0.86, 95% CI=0.77, 0.95, k=7); however, they did not increase or reduce screening uptake when compared with either comparators (RR=0.97, 95% CI=0.88, 1.07, k=2) or usual care (RR=1.00, 95% CI=0.89, 1.12, k=5) (Table 1). Most of these studies are of poor methodologic quality (11/14). The other interventions, such as decisional counseling, value clarification, chronic disease trajectory model, and community jury, did not change men's screening intention or behavior.

Male-Sensitive Interventions

For male-sensitive interventions that aimed to increase screening uptake, screening uptake was higher for interventions involving invitations (RR=1.30, 95% CI=1.10, 1.52, k=1, low methodologic quality) than for comparators (Table 2). Similarly, the intention to screen was higher for educational (RR=1.36, 95% CI=1.23, 1.50, k=1, high methodologic quality) and peer leader–led (RR=2.09, 95% CI=1.46, 2.98, k=1, low methodologic quality) interventions than for comparators. For interventions promoting informed decision making, being male-sensitive did not change men's screening intention (RR=0.98, 95% CI=0.89, 1.08, k=1) when compared with usual care.

Web-Based Interventions

For studies aiming to increase screening uptake, no significant difference was found in screening uptake between web-based educational interventions and usual care (RR=1.75, 95% CI=0.45, 6.83, k=2) (Table 2). However, there was a higher intention to undergo screening as compared with usual care (RR=2.19, 95% CI=1.20, 4.01, k=1, low methodologic quality).

For studies promoting informed decision making, there was no significant difference in screening uptake (RR=1.05, 95% CI=0.94, 1.17, k=2) and intention (RR=0.81, 95% CI=0.55, 1.18, k=2) between web-based decision aid and usual care. However, for web-based educational intervention, men's screening uptake was significantly higher (RR=1.12, 95% CI=1.01, 1.25, k=1, high methodologic quality) than comparators but not their intention to screen (RR=1.12, 95% CI=0.89, 1.42, k=1, high methodologic quality).

Video-Based Interventions

For studies aiming to increase screening uptake, no significant difference was found in screening uptake between video-based interventions and comparators (RR=1.12, 95% CI=0.99, 1.27, k=3) and usual care (RR=2.43, 95% CI=0.36, 16.23, k=2) (Table 2). However, for video-based educational intervention, the uptake (RR=0.89, 95% CI=0.80, 0.99, k=1, high methodologic quality) and intention to undergo screening (RR=0.77, 95% CI=0.63, 0.95, k=1, low methodologic quality) were significantly lower.

DISCUSSION

This systematic review addressed several important questions in preventive medicine. First, it provides evidence on effectiveness of screening interventions based on gender; educational interventions were found to be effective in improving men's health screening intention and to a lesser degree, behavior. Second, this review highlights the need for clarity in the definition of male-sensitive interventions, despite extensive use by researchers and policy makers. Third, despite increasing use of ICT in health care, this review found that its use in interventions on screening uptake remain low and mostly focused on websites; very few used social media

Table 2. Comparison Between Interventions and Comparators/No Intervention in Male-sensitive, Internet-based, and Video-based Studies

	Versus comparator		Versus no intervention	
Types of intervention	**k**	**RR (95% CI)**	**k**	**RR (95% CI)**
Male-sensitive intervention[a]				
Intervention to increase uptake of screening				
Education				
Education (Uptake)	3	1.16 (0.91, 1.46)	1	0.94 (0.65, 1.36)
Education (Uptake)[b]	2	1.19 (0.79, 1.79)		–
Education (Intention)[b]	**1**	**1.36 (1.23, 1.50)**		–
Peer leader				
Peer leader (Uptake)	2	1.41 (0.38, 5.21)		–
Peer leader (Intention)	**1**	**2.09 (1.46, 2.98)**		–
Invitation to testing (Uptake)	**1**	**1.30 (1.10, 1.52)**		–
Intervention promoting informed decision making				
Decision aid (Intention)		–	1	0.98 (0.89, 1.08)
Web-based intervention[c]				
Intervention to increase uptake of screening				
Education				
Education (Uptake)		–	2	1.75 (0.45, 6.83)
Education (Intention)		–	**1**	**2.19 (1.20, 4.01)**
Intervention promoting informed decision making				
Decision aid				
Decision aid (Uptake)		–	2	1.05 (0.94, 1.17)
Decision aid (Intention)		–	2	0.81 (0.55, 1.18)
Education				
Education (Uptake)[b]	**1**	**1.12 (1.01, 1.25)**		–
Education (Intention)[b]	1	1.12 (0.89, 1.42)		–
Video-based intervention[d]				
Intervention to increase uptake of screening				
Education				
Education (Uptake)	3	1.12 (0.99, 1.27)	2	2.43 (0.36, 16.23)
Education (Uptake)[b]	3	1.12 (0.99, 1.27)		–
Education (Intention)	**1**	**1.36 (1.23, 1.50)**		–
Intervention promoting informed decision making				
Decision aid				
Decision aid (Uptake)		–	1	1.01 (0.91, 1.13)
Decision aid (Intention)	1	0.98 (0.86, 1.11)	3	0.84 (0.63, 1.11)
Education				
Education (Uptake)		–	2	0.84 (0.49, 1.44)
Education (Uptake)[b]	1	**0.89 (0.80, 0.99)**		
Education (Intention)	1	0.91 (0.79, 1.06)	1	**0.77 (0.63, 0.95)**

Note: Boldface indicates statistical significance ($p < 0.05$). Detailed version in Appendix Table 6, available online.
[a]Eight of 13 studies analyzed.
[b]Studies with high methodological quality.
[c]Seven of 12 studies analyzed.
[d]Fifteen of 16 studies analyzed.
RR, risk ratio.

and mobile apps to change men's screening behavior. Finally, the review also identified gaps in the design of interventions targeting screening in men; more than two thirds of the studies were rated as low methodologic quality.

This review found that interventions involving provision of educational information improved men's intention and uptake of screening. This is consistent with the findings that men, in general, have poorer health knowledge compared with women, including knowledge on

health promotion and prevention.[87–90] These educational interventions were delivered mainly through pamphlets (paper-based), videos, and websites. This presents an opportunity to improve men's screening behavior through improving their health knowledge using different approaches. For instance, with the increasing access to mobile technology worldwide, it would be appropriate to develop mobile health apps or websites on health screening to reach out to men, especially young and middle-aged men, where use of mobile phone and Internet are frequent.[91,92] Men prefer to use websites and mobile apps to access health information, as the Internet is a means of seeking help that can provide privacy and does not compromise masculinity norms.[93–95] However, this review found very few studies on the use of social media and mobile apps to improve men's screening intention and behavior. More studies are needed in the future to evaluate the effectiveness of ICT-based interventions in changing men's health screening behavior.

Most of the studies in this review were of poor methodologic quality, as many failed to disclose/have high risk of bias in allocation concealment and participant and personnel blinding; therefore, the results from this review should be interpreted with caution. Nevertheless, other types of interventions such as reaching out to men via partner education and direct invitations (reminders) through partners and letters, may supplement health education to improve men's screening behavior.

Tailored interventions have been advocated as an effective way to improve individual's health behavior, including screening uptake; a gender-sensitive approach is one such tailored strategy.[96,97] Recently, there was a call by the Global Action for Men's Health to develop more male-sensitive interventions so that the health system can be more responsive to men's health needs.[98,99] However, this review found few male-sensitive interventions and most did not explicitly describe the inclusion criteria for male-sensitive interventions. Therefore, for the purpose of this review, the researchers developed a set of criteria to define male-sensitive interventions based on their previous research work, which include interventions that address male-specific behaviors (e.g., risk-taking behavior), interests (e.g., interest in cars, soccer), and framing of messages (e.g., comparing men and women).[100] The researchers intend to stimulate discussion on defining, developing, and evaluating gender-sensitive interventions for future gender-based studies.

This review also uncovered research gaps on screening in men. First, more than half of the studies in this review focused on prostate cancer and HIV screening. Very few investigated the uptake of evidence-based screening, such as colorectal cancer and cardiovascular risk factors (hypertension, diabetes, and dyslipidemia). Future studies should consider developing and evaluating interventions to increase screening intention and uptake of these conditions. Second, interventions that aimed to promote informed decision making (mostly patient decision aids on prostate cancer screening) were less effective in changing men's screening behavior compared with those that aimed to increase screening uptake. This might be because healthcare professionals tend to emphasize the benefits and underplay the harms of screening to push men to take up screening. For instance, despite recommendations against prostate cancer screening or sharing decisions with patients in prostate cancer screening, many physicians still remain reluctant to change their screening practices.[101] This might be one reason why interventions were less effective in the informed decision making for reducing prostate-specific antigen screening uptake. Third, evidence of screening is changing rapidly; for example in 2012, the U.S. Preventive Services Task Force changed its recommendation against using prostate-specific antigen to screen for prostate cancer.[102] This affected the analysis of this systematic review.

Limitations

This systematic review had a few limitions. First, based on meta-analyses, the strength of evidence is weak because of the small number of high-quality studies. In addition, the RRs calculated in the meta-analyses were not adjusted for covariates, as they were inconsistently reported in the studies and the number of studies is small. Hence, the outcomes of the meta-analysis should be interpreted with caution. Some interventions were multifaceted, comprising several active components. The researchers had to ascertain which was the active component and grouped them accordingly for analysis. For example, some studies included both dissemination strategy (online versus mail) and educational materials (video and brochure) in the intervention. This requires more complex analyses, such as network analysis, which were beyond the scope of this systematic review. Although one of the objectives of this review was to determine the impact of male-sensitive interventions, there was no clear definition of male-sensitive. The research team therefore developed the criteria based on researchers' previous research work and discussion with men's health experts. Another limitation is that the two outcome measures (screening uptake and intention to screen), which were intended to be extracted as dichotomous data, were presented in a Likert scale or as percentages; hence, the numerical data had to be inferred. Finally, the researchers originally aimed to analyze

knowledge, decisional conflict, and participants' satisfaction as secondary outcome measures. However, when extracting the data, it was found that there were huge variations in the reporting, which made it difficult for the researchers to draw meaningful conclusions.

CONCLUSIONS

This systematic review found that educational interventions were effective in improving men's screening intention and, to a lesser degree, uptake. The evidence for the effectiveness of websites and videos to improve men's screening intention and behavior remain weak because of lack of good-quality studies. This review highlighted the need to develop better-designed interventions and more rigorously conducted evaluation strategies, to conclusively ascertain the effectiveness of different approaches to improve screening in men.

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SUPPLEMENTAL MATERIAL

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Appendix Table 1. Search strategy
PubMed (*k*=7,618)

No.	Search strategy
#5	**(#1 AND #2 AND #3 AND #4)**
#4	(Man[tiab] OR Men[tiab] OR Male[tiab] OR Males[tiab] OR Boy[tiab] OR Boys[tiab] OR Gender*[tiab] OR Prostat*[tiab] OR men's health[mh])
#3	(appointment*[tiab] OR Call[tiab] OR calls[tiab] OR calling[tiab] OR Campaign*[tiab] OR cell phones[mh] OR "cell phone"[tiab] OR "cell phones"[tiab] OR cellular[tiab] OR communications media[mh] OR community-based[tiab] OR counseling[mh] OR counsel* [tiab] OR "decision aid"[tiab] OR "decision aids"[tiab] OR decision support techniques[mh] OR "education material"[tiab] OR "education materials"[tiab] OR "home visit"[tiab] OR "home visits"[tiab] OR electronic mail[mh] OR email*[tiab] OR e-mail*[tiab] OR football[mh] OR football[tiab] OR "fridge magnet"[tiab] OR "health day"[tiab] OR "health event"[tiab] OR "health events"[tiab] OR hotlines[mh] OR hotline*[tiab] OR house calls[mh] OR "house call"[tiab] OR "house calls"[tiab] OR incentiv*[tiab] OR information*[tiab] OR internet[mh] OR internet*[tiab] OR intervention*[tiab] OR intervention studies[mh] OR "intervention study"[tiab] OR "intervention studies"[tiab] OR invit*[tiab] OR leaflet*[tiab] OR letter*[tiab] OR mass media[mh] OR media[tiab] OR messag*[tiab] OR mobile[tiab] OR "mobile app"[tiab] OR "mobile application"[tiab] OR "mobile applications"[tiab] OR mobile applications[mh] OR "mobile apps"[tiab] OR mobile health units[mh] OR "mobile health unit"[tiab] OR "mobile health units"[tiab] OR "mobile phone"[tiab] OR "mobile phones"[tiab] OR "net surfing"[tiab] OR nurse-led[tiab] OR online[tiab] OR opportunistic[tiab] OR outreach[tiab] OR pamphlet*[tiab] OR pamphlets[mh] OR persuasive communication[mh] OR "persuasive communication"[tiab] OR phone[tiab] OR postal[tiab] OR poster*[tiab] OR program*[tiab] OR questionnaires[mh] OR questionnaire*[tiab] OR reimbursement, incentive[mh] OR reimbursement*[tiab] OR reminder*[tiab] OR reminder systems[mh] OR "resource centre"[tiab] OR "resource center"[tiab] OR "resource centers"[tiab] OR reward[mh] OR reward*[tiab] OR SMS[tiab] OR social media[mh] OR "social media"[tiab] OR telephone*[tiab] OR telephone[mh] OR text messaging[mh] OR website*[tiab] OR workplace[mh] OR workplace[tiab] OR Judicial role[mh] OR Spouses[mh] OR tape recording[mh] OR video recording[mh] OR health education[mh] OR postal service[mh] OR reagent kits, diagnostic[mh] OR brochure*[tiab] OR web-based[tiab] OR web[tiab] OR flyer[tiab] OR mail*[tiab] OR survey[tiab] OR booklet*[tiab] OR video[tiab] OR educational session*[tiab] OR smartphone*[tiab] OR partner[tiab] OR wife[tiab] OR spouse*[tiab] OR sports[mh] OR sport*[tiab])
#2	(Prostate-specific antigen[mh] OR "prostate-specific antigen"[tiab] OR PSA[tiab] OR occult blood[mh] OR "occult blood"[tiab] OR "fecal immunochemical test"[tiab] OR "faecal immunochemical test"[tiab] OR "faecal immunochemical testing"[tiab] OR "fecal immunochemical testing"[tiab] OR colonoscopy[mh] OR colonoscop*[tiab] OR sigmoidoscopy[tiab] OR ((HIV[mh] OR HIV[tiab] OR "Human Immunodeficiency Virus"[tiab] OR "Human Immunodeficiency Viruses"[tiab]) AND (screen[tiab] OR screening[tiab] OR test[tiab] OR testing[tiab] OR tests[tiab])) OR "risk factor assessment"[tiab] OR "risk factor assessments"[tiab] OR Early diagnosis[mh] OR "early diagnosis"[tiab] OR mass screening[mh] OR preventive health services[mh:noexp] OR

	Screen*[tiab] OR “Health check”[tiab] OR “Health checks”[tiab] OR checkup*[tiab] OR check-up*[tiab] OR “medical examination”[tiab] OR “health examination”[tiab] OR “medical examinations”[tiab] OR “health examinations”[tiab] OR ((routine[tiab] OR regular[tiab] OR yearly[tiab] OR annual[tiab] OR periodic[tiab]) AND ("health examination”[tiab] OR "health examinations”[tiab] OR “medical examination”[tiab] OR “medical examinations”[tiab] OR “health assessment”[tiab] OR “health assessments”[tiab]))) OR ((Sexually Transmitted Diseases[mh] OR STI[tiab] OR “Sexually Transmitted Infection”[tiab] OR “Sexually Transmitted Infections”[tiab] OR STD[tiab] OR “Sexually Transmitted Disease”[tiab] OR “Sexually Transmitted Diseases”[tiab]) AND (test*[tiab] OR screen*[tiab]))
#1	(“Clinical trial”[pt] OR "Randomized Controlled Trial"[pt] OR trial*[tiab] OR randomi*[tiab] OR controlled[tiab])

EMBASE (*k*=1,070)

No.	Search strategy
#5	**(#1 AND #2 AND #3 AND #4)**
#4	man:ab,ti OR men:ab,ti OR male:ab,ti OR males:ab,ti OR boy:ab,ti OR boys:ab,ti OR gender*:ab,ti OR prostat*:ab,ti OR 'men`s health'/exp
#3	'professional practice'/exp OR 'mobile phone'/exp OR 'mass communication'/exp OR 'counseling'/exp OR 'decision support system'/exp OR 'e-mail'/exp OR 'football'/exp OR 'telephone'/exp OR 'reimbursement'/exp OR 'Internet'/exp OR 'intervention study'/exp OR 'mobile application'/exp OR 'persuasive communication'/exp OR 'postal mail'/exp OR 'community program'/exp OR 'questionnaire'/exp OR 'reminder system'/exp OR 'reward'/exp OR 'social media'/exp OR 'text messaging'/exp OR 'workplace'/exp OR 'spouse'/exp OR 'recording'/exp OR 'videorecording'/exp OR 'health education'/exp OR 'diagnostic kit'/exp OR 'health survey'/exp OR 'videotape'/exp OR 'sport'/exp OR appointment*:ab,ti OR call*:ab,ti OR campaign*:ab,ti OR (cell NEXT/1 phone*):ab,ti OR cellular:ab,ti OR community-based:ab,ti OR counsel*:ab,ti OR (decision NEXT/1 aid*):ab,ti OR (education NEXT/1 material*):ab,ti OR (home NEXT/1 visit*):ab,ti OR email*:ab,ti OR (e NEXT/1 mail*):ab,ti OR football:ab,ti OR (fridge NEXT/1 magnet):ab,ti OR (health NEXT/1 day):ab,ti OR (health NEXT/1 event*):ab,ti OR hotline*:ab,ti OR (house NEXT/1 call*):ab,ti OR incentiv*:ab,ti OR information*:ab,ti OR internet*:ab,ti OR intervention*:ab,ti OR (intervention NEXT/1 stud*):ab,ti OR invit*:ab,ti OR leaflet*:ab,ti OR letter*:ab,ti OR media:ab,ti OR messag*:ab,ti OR mobile:ab,ti OR (mobile NEXT/1 app*):ab,ti OR (mobile NEXT/1 application*):ab,ti OR (mobile NEXT/1 health NEXT/1 unit*):ab,ti OR (mobile NEXT/1 phone*):ab,ti OR (net NEXT/1 surfing):ab,ti OR nurse-led:ab,ti OR online:ab,ti OR opportunistic:ab,ti OR outreach:ab,ti OR pamphlet*:ab,ti OR "persuasive communication":ab,ti OR phone:ab,ti OR postal:ab,ti OR poster*:ab,ti OR program*:ab,ti OR questionnaires*:ab,ti OR reimbursement*:ab,ti OR reminder*:ab,ti OR (resource NEXT/1 cent*):ab,ti OR reward*:ab,ti OR SMS:ab,ti OR (Social NEXT/1 media):ab,ti OR telephone*:ab,ti OR website*:ab,ti OR workplace:ab,ti OR brochure*:ab,ti OR web-based:ab,ti OR web:ab,ti OR flyer:ab,ti OR mail*:ab,ti OR survey:ab,ti OR booklet*:ab,ti OR video:ab,ti OR educational session*:ab,ti OR smartphone*:ab,ti OR partner:ab,ti OR wife:ab,ti OR spouse*:ab,ti OR sport*:ab,ti
#2	'prostate specific antigen'/exp OR 'occult blood'/exp OR 'colonoscopy'/exp OR 'sigmoidoscopy'/exp OR 'early diagnosis'/exp OR 'screening'/exp OR 'preventive health service'/exp OR 'periodic medical examination'/exp OR PSA:ab,ti OR (prostate NEXT/1 specific NEXT/1 antigen):ab,ti OR (occult NEXT/1 blood*):ab,ti OR (f?cal NEXT/1 immunochemical NEXT/1 test*):ab,ti OR colonoscop*:ab,ti OR sigmoidoscop*:ab,ti OR (risk NEXT/1 factor NEXT/1 assessment*):ab,ti OR (early NEXT/1 diagnosis):ab,ti OR screen*:ab,ti OR (health NEXT/1 check*):ab,ti OR checkup*:ab,ti OR (check NEXT/1 up*):ab,ti OR (health NEXT/1 examination*):ab,ti OR (medical NEXT/1 examination*):ab,ti OR (('Human immunodeficiency virus'/exp OR (Human NEXT/1 Immunodeficiency NEXT/1 Virus*):ab,ti OR HIV:ab,ti) AND (screen*:ab,ti OR test*:ab,ti)) OR ((routine:ab,ti OR regular:ab,ti OR yearly:ab,ti OR annual:ab,ti OR periodic:ab,ti) AND ((health NEXT/1 examination*):ab,ti OR (medical NEXT/1 examination*):ab,ti OR (health NEXT/1 assessment*):ab,ti)) OR (('sexually

	transmitted disease'/exp OR STI:ab,ti OR (Sexually NEXT/1 Transmitted NEXT/1 Infection*):ab,ti OR STD:ab,ti OR (Sexually NEXT/1 Transmitted NEXT/1 Disease*):ab,ti) AND (test*:ab,ti OR screen*:ab,ti))
#1	[controlled clinical trial]/lim OR [randomized controlled trial]/lim OR trial*:ab,ti OR randomi*:ab,ti OR controlled:ab,ti

CINAHL via EBSCOHost (*k*=2,073)

No.	Search strategy
#5	**(#1 AND #2 AND #3 AND #4)**
#4	TI (man OR men OR male OR males OR boy OR boys OR gender* OR prostat*) OR AB (man OR men OR male OR males OR boy OR boys OR gender* OR prostat*) OR (MH "men's health")
#3	(MH "Appointments and Schedules+") OR (MH "Cellular Phone+") OR (MH "Communications Media+") OR (MH "Counseling+") OR (MH "Decision Support Techniques+") OR (MH "Electronic Mail") OR (MH "Electronic Publications+") OR (MH "Football") OR (MH "Health Education") OR (MH "Health Fairs") OR (MH "Home Visits") OR (MH "Internet+") OR (MH "Intervention Trials") OR (MH "Magnetic Tape") OR (MH "Mail+") OR (MH "Mobile Applications") OR (MH "Mobile Health Units") OR (MH "Pamphlets") OR (MH "Patient Education+") OR (MH "Persuasive Communication") OR (MH "Posters") OR (MH "Questionnaires+") OR (MH "Reagent Kits, Diagnostic+") OR (MH "Reimbursement, Incentive") OR (MH "Reminder Systems") OR (MH "Reward") OR (MH "Smartphone") OR (MH "Social Media") OR (MH "Sports+") OR (MH "Spouses") OR (MH "Surveys+") OR (MH "Teaching Materials+") OR (MH "Telecommunications+") OR (MH "Telephone Information Services") OR (MH "Telephone+") OR (MH "Text messaging") OR (MH "Videorecording+") OR (MH "Voicemail") OR TI (appointment* OR call* OR campaign* OR "cell phone*" OR cellular OR community-based OR counsel* OR "decision aid*" OR "education material*" OR "home visit*" OR email* OR e-mail* OR football OR "fridge magnet" OR "health day" OR "health event*" OR hotline* OR "house call*" OR incentiv* OR information* OR internet* OR intervention* OR "intervention stud*" OR invit* OR leaflet* OR letter* OR media OR messag* OR mobile OR "mobile app*" OR "mobile application*" OR "mobile health unit*" OR "mobile phone*" OR "net surfing" OR nurse-led OR online OR opportunistic OR outreach OR pamphlet* OR "persuasive communication" OR phone OR postal OR poster* OR program* OR questionnaires* OR reimbursement* OR reminder* OR "resource cent*" OR reward* OR SMS OR "Social media" OR telephone* OR website* OR workplace OR brochure* OR web-based OR web OR flyer OR mail* OR survey OR booklet* OR tape OR video OR educational session* OR smartphone* OR partner OR wife OR spouse* OR sport*) OR AB (appointment* OR call* OR campaign* OR "cell phone*" OR cellular OR community-based OR counsel* OR "decision aid*" OR "education material*" OR "home visit*" OR email* OR e-mail* OR football OR "fridge magnet" OR "health day" OR "health event*" OR hotline* OR "house call*" OR incentiv* OR information* OR internet* OR intervention* OR "intervention stud*" OR invit* OR leaflet* OR letter* OR media OR messag* OR mobile OR "mobile app*" OR "mobile application*" OR "mobile health unit*" OR "mobile phone*" OR "net surfing" OR nurse-led OR online OR opportunistic OR outreach OR pamphlet* OR "persuasive communication" OR phone OR postal OR poster* OR program* OR questionnaires* OR reimbursement* OR reminder* OR "resource cent*" OR reward* OR SMS OR "Social media" OR telephone* OR website* OR workplace OR brochure* OR web-based OR web OR flyer OR mail* OR survey OR booklet* OR video OR tape OR educational session* OR smartphone* OR partner OR wife OR spouse* OR sport*)

#2	(MH "Prostate-Specific Antigen") OR (MH "occult blood") OR (MH "Colonoscopy+") OR (MH "health screening+") OR (MH "early diagnosis+") OR (MH "preventive health care+") OR TI (PSA OR "prostate-specific antigen" OR "occult blood*" OR "f#ecal immunochemical test*" OR colonoscop* OR sigmoidoscop* OR "risk factor assessment*" OR "early diagnosis" OR screen* OR "health check*" OR checkup* OR "check up*" OR "health examination*" OR "medical examination*") OR AB (PSA OR "prostate-specific antigen OR "occult blood*" OR "f#ecal immunochemical test*" OR colonoscop* OR sigmoidoscop* OR "risk factor assessment*" OR "early diagnosis" OR screen* OR "health check*" OR checkup* OR "check up*" OR "health examination*" OR "medical examination*") OR ((MH "Human Immunodeficiency Virus+") OR TI ("Human Immunodeficiency Virus*" OR HIV) OR AB ("Human Immunodeficiency Virus*" OR HIV)) AND (TI (screen* OR test*) OR AB (screen* OR test*)) OR ((TI (routine OR regular OR yearly OR annual OR periodic) OR AB (routine OR regular OR yearly OR annual OR periodic)) AND (TI ("health examination*" OR "medical examination*" OR "health assessment*") OR AB ("health examination*" OR "medical examination*" OR "health assessment*")) OR (((MH "Sexually Transmitted Diseases+") OR TI ("sexual transmitted disease*" OR "sexual transmitted infection*" OR "STI*" OR "STD*") OR AB ("sexual transmitted disease*" OR "sexual transmitted infection*" OR "STI*" OR "STD*")) AND (TI (test* OR screen*) OR AB (test* OR screen*)))
#1	PT (clinical trial OR randomized controlled trial) OR TI (trial* OR randomi* OR controlled) OR AB (trial* OR randomi* OR controlled)

PSYCINFO via OvidSP (*k*=1,508)

No.	Search strategy
#5	**(#1 AND #2 AND #3 AND #4)**
#4	(Male OR Man OR Males OR Men OR Boy OR Boys OR Gender* OR Prostat* OR 'mens health').ti,ab OR exp Human Sex Differences/
#3	exp mass media/ OR exp health education/ OR exp cellular phones/ OR exp communications media/ OR exp internet/ OR exp messages/ OR exp counseling/ OR exp decision making/ OR exp decision support systems/ OR exp home visiting programs/ OR exp computer mediated communication/ OR exp football/ OR exp hot line services/ OR exp incentives/ OR exp printed communications media/ OR exp social media/ OR exp messages/ OR exp telephone systems/ OR exp mobile devices/ OR exp outreach programs/ OR exp online social networks/ OR exp reading materials/ OR exp persuasive communication/ OR exp questionnaires/ OR exp "Learning Centers (Educational)"/ OR exp rewards/ OR exp websites/ OR exp spouses/ OR exp videotapes/ OR exp digital video/ OR exp surveys/ OR exp wives/ OR exp sports/ OR (appointment* OR call* OR campaign* OR 'cell phone*' OR cellular OR community-based OR counsel* OR 'decision aid*' OR 'education material*' OR 'home visit*' OR email* OR e-mail* OR football OR 'fridge magnet' OR 'health day' OR 'health event*' OR hotline* OR 'house call*' OR incentiv* OR information* OR internet* OR intervention* OR 'intervention stud*' OR invit* OR leaflet* OR letter* OR media OR messag* OR mobile OR 'mobile app*' OR 'mobile application*' OR 'mobile health unit*' OR 'mobile phone*' OR 'net surfing' OR nurse-led OR online OR opportunistic OR outreach OR pamphlet* OR 'persuasive communication' OR phone OR postal OR poster* OR program* OR questionnaires* OR reimbursement* OR reminder* OR 'resource cent*' OR reward* OR SMS OR 'Social media' OR telephone* OR website* OR workplace OR brochure* OR web-based OR web OR flyer OR mail* OR survey OR booklet* OR video OR educational session* OR smartphone* OR partner OR wife OR spouse* OR sport*).ti,ab
#2	exp Health screening/ OR exp Screening tests/ OR exp prevention/ OR exp HIV testing/ OR (PSA OR 'prostate-specific antigen' OR 'occult blood*' OR 'f#ecal immunochemical test*' OR colonoscop* OR sigmoidoscop* OR 'risk factor assessment*' OR 'early diagnosis' OR screen* OR 'health check*' OR checkup* OR 'check up*' OR 'preventive health' OR 'health examination*' OR 'medical examination*').ti,ab OR ((exp HIV/ OR (HIV OR 'Human Immunodeficiency Virus*').ti,ab) AND (screen* OR test*).ti,ab) OR ((routine OR regular OR yearly OR annual OR periodic).ti,ab AND ('health examination*' OR 'medical examination*' OR 'health assessment*').ti,ab) OR ((exp Sexually Transmitted Diseases/ OR (STI OR 'Sexually Transmitted Infection*' OR STD OR 'Sexually Transmitted Disease*').ti,ab) AND ((test* OR screen*).ti,ab))
#1	(trial* OR randomi* OR controlled).ti,ab

Web of Science (*k* = 7333)

No.	Search strategy
#5	**(#1 AND #2 AND #3 AND #4)**
#4	TS=(man OR men OR male OR males OR boy OR boys OR gender* OR prostat* OR men's health)
#3	TS=(appointment* OR call* OR campaign* OR "cell phone*" OR cellular OR community-based OR counsel* OR "decision aid*" OR "education material*" OR "home visit*" OR email* OR e-mail* OR football OR "fridge magnet" OR "health day" OR "health event*" OR hotline* OR "house call*" OR incentiv* OR information* OR internet* OR intervention* OR "intervention stud*" OR invit* OR leaflet* OR letter* OR media OR messag* OR mobile OR "mobile app*" OR "mobile application*" OR "mobile health unit*" OR "mobile phone*" OR "net surfing" OR nurse-led OR online OR opportunistic OR outreach OR pamphlet* OR "persuasive communication" OR phone OR postal OR poster* OR program* OR questionnaires* OR reimbursement* OR reminder* OR "resource cent*" OR reward* OR SMS OR "Social media" OR telephone* OR website* OR workplace OR brochure* OR web-based OR web OR flyer OR mail* OR survey OR booklet* OR video OR educational session* OR smartphone* OR partner OR wife OR spouse* OR sport*)
#2	TS=(PSA OR "prostate-specific antigen" OR "occult blood*" OR "f#ecal immunochemical test*" OR colonoscop* OR sigmoidoscop* OR "risk factor assessment*" OR "early diagnosis" OR screen* OR "health check*" OR checkup* OR "check up*" OR "preventive health" OR "health examination*" OR "medical examination*") OR TS=(("Human Immunodeficiency Virus*" OR HIV) AND (screen* OR test*)) OR TS=((routine OR regular OR yearly OR annual OR periodic) AND ("health examination*" OR "medical examination*" OR "health assessment*")) OR TS=((STI OR "Sexually Transmitted Infection*" OR STD OR "Sexually Transmitted Disease*") AND (test* OR screen*))
#1	TS=(trial* OR randomi* OR "controlled")

Appendix Table 2. Summary of Study Characteristics

Characteristics	Number of studies
Range of study year	1990–2015
Study design	
RCT	51
Cluster RCT	7
Country	
U.S.	31
Australia	9
U.S. and Australia	1
United Kingdom	5
Korea	2
Peru	2
Ireland	1
Greece	1
France	1
Kenya	1
South Africa	1
Congo	1
Uganda	1
Cameroon and Dominican Republic and India and Georgia	1
Condition	
Prostate cancer	31
HIV	11
Chlamydia	2
Chlamydia and gonorrhea	2
HIV and chlamydia and gonorrhea and syphilis	1
Testicular cancer	3
Melanoma	3
Colorectal cancer	1
Gastric cancer	1
Gastric cancer and colorectal cancer	1
Colorectal cancer and prostate cancer and hypercholesterolemia	1
General conditions (smoking, weight, blood pressure, etc.)	1
Setting	
Community	27
Clinic	16
Online	8
Community and online	3
Community and clinic	3
Clinic and online	1
Male sensitive	
Yes	13
No	45
ICT	
Yes	12

No	46
Video	
Yes	16
No	43
Outcome measure reported	
Screening uptake	33
Intention to screen	13
Both screening uptake and intention to screen	12

ICT, information and communication technology

Appendix Table 3. Detailed Characteristic of Included Studies

Author, year (Country)	Disease, screening procedure	Setting	Participants (age, ethnicity, inclusion, exclusion)	Study description (study design, intervention, control, sample size)	Outcome
Bauermeister, 2015 (U.S.)[a,d]	HIV, chlamydia, gonorrhea, syphilis, Test: NA	Online	**Age:** 15–24 years (M=21) **Ethnicity:** White, black, Latino, Middle Eastern, Asian/Pacific Islander **Inclusion:** Men self-identify as cis-male (assigned sex at birth as male and self-identifies as male); report having had sex with a male partner in the prior 6 months.	RCT (2 arms) Description: **I: n=86** Online educational content tailored to the participant's characteristics (MSM sensitive) **C: n=44** Provide online access to provider directory	Screening uptake: At 30 days I: 22/68 (32.4%) C: 8/36 (22.2%) (*p*=ns)
Fuller, 2015 (United Kingdom)[a]	STI (chlamydia, gonorrhea), Urine-based test kit	Community (Football club)	**Age:** ≥18 years **Ethnicity:** NA **Inclusion:** Football players	Cluster RCT (3 arms) Description: **I1: clusters n=2; participants n=56** Poster and test kit collection box at football club, with team captain delivering brief screening promotional talk and handed a test kit to each participant **I2: clusters n=2; participants n=46** Poster and test kit collection box at football club, with sexual health adviser delivering brief screening promotional talk and handed a test kit to each participant **C: clusters n=2; participants n=51**	Screening uptake: At 4 weeks I1: 28/56 (50.0%) I2: 31/46 (67.0%) C: 31/51 (61.0%)

				Poster and test kit collection box at football club	
Lewis, 2015 (U.S.)[e]	PCa, PSA	Clinic	**Age:** 50–75 years (M=59) **Ethnicity:** White, black, Asian, Hispanic, other **Inclusion:** Men who did not have a PCa diagnosis; had not had a PSA test in the past 10 months; had not seen their primary care physician in the last 3 months.	RCT (4 arms) Description: **I1: n=631** Mailed decision support intervention (DESI) in DVD **I2: n=656** Invitation to participate in a shared medical appointment (SMA) to watch and discuss the DESI with a mid-level healthcare provider and other patients **I3: n=636** both the DVD DESI and an invitation to participate in a SMA **C: n=627** Brief information on PSA testing	Screening uptake: At 12 months I1: 134/631 (21%) I2: 158/656 (24%) I3: 139/636 (22%) C: 131/627 (21%) (*p*=0.51)
Tran, 2015 (France)	PCa, PSA	Clinic	**Age:** 50–75 years (M=61) **Ethnicity:** NA **Inclusion:** Men consulting physician regardless of their history of PCa screening **Exclusion:** Men with history of PCa; any urinary tract symptoms; history of PCa in a first-degree relative; known exposition to	RCT (2 arms) Description: **I: n=588** Paper-based pDA given to participants after a clinic consultation **C: n=582** Blank pages given to participants after a clinic consultation	Intention to screen: Immediate PI I: 331/588 (56.3%) C: 432/582 (90.2%) (***p*<0.0001**)

			chlordecone (found to be a risk factor); cognitive or psychiatric conditions		
Young, 2015 (Peru)[a,d]	HIV, Rapid test	Online	**Age:** ≥18 years (M=28.9) **Ethnicity:** White, black, mixed **Inclusion:** Men who have sex with men in the past 12 months; HIV negative or serostatus unknown; had a Facebook account or willing to create one	RCT (2 arms) Description: **I: n=278** Peer-leader guided chats, messages, wall posts on Facebook on HIV prevention and testing, weekly over 12 weeks **C: n=278** Standard HIV prevention and testing services + opportunity to join an online community, without peer-leader guidance	Screening uptake: At 12 weeks I: 43/252 (17.1%) C: 16/246 (6.5%) (***p*<0.0001**) Intention to screen: At 12 weeks I: 77/252 (30.6%) C: 36/246 (14.6%) (***p*=0.0003**)
Hong, 2014 (Korea)	Gastric cancer, Upper GI series/ endoscopy. Colorectal cancer, Fecal occult blood test	Community	**Age:** 50–59 years **Ethnicity:** NA **Inclusion:** Recipient of National Health Insurance Corporation **Exclusion:** Men with liver cancer; received cancer-screening tests before August 31, 2012; Medical Aid recipients	RCT (4 arms) Description: **I1: n=230** Paper-based educational information sent by mail **I2: n=243** Educational information and promotion to undergo screening through telephone counselling **I3: n=227** Combination of I1 and I2, with I1 delivered 2 weeks after I2 **C: n=223** Usual care	Screening uptake: At 3 months Gastric cancer I1: 51/230 (22.2%) I2: 77/243 (31.7%) I3: 92/227 (40.5%) C: 40/223 (17.9%) Colorectal cancer I1: 38/230 (16.5%) I2: 56/243 (24.3%) I3: 63/227 (27.8%) C: 30/223 (13.5%)
Janda, 2014 (Australia)[a,e]	Melanoma, Clinical skin examination	Community	**Age:** ≥50 years **Ethnicity:** NA	RCT (2 arms) Description: **I: n=469**	Screening uptake: At 7 months I: 246/436 (56.4%)

			Inclusion: Men who are proficient in English; have access to a DVD player; no previous history of melanoma.	Video-based skin awareness educational materials with a message from national sports personality and melanoma survivors + written educational materials **C: n=461** Written educational materials only	C: 229/434 (52.8%) (*p*=0.28)
Orne-Gliemann, 2014 (Cameroon, Dominican Republic, India, Georgia)	HIV, Rapid test and ELISA testing	Community	(Only details of female participants were reported.)	RCT (2 arms) Description: **I: n=970** Couple-oriented post-test HIV counseling delivered to female partner, aiming to empower women to discuss HIV and sexual issues with their partner **C: n=973** Standard post-test HIV counselling delivered to female partner	Screening uptake: At 6 months I: 267/970 (27.5%) C: 151/973 (15.5%)
Osoti, 2014 (Kenya)	HIV, Test: NA	Community	(Only details of female participants were reported.)	RCT (2 arms) Description: **I: n=150** After routine antenatal care, community health worker accompanied woman for a home visit to invite male partner for HIV counseling and testing **C: n=150** Female partners were given a written note to invite their male partner for reproductive health education, HIV counseling and testing at the antenatal clinic	Screening uptake: At 6 weeks I: 128/150 (85.3%) C: 54/150 (36.0%) (***p*<0.001**)

Thomas, 2014 (Australia)	PCa, PSA	Community	**Age:** 50–70 years **Ethnicity:** NA **Inclusion:** Men with no history of PCa	RCT (2 arms) Description: **I: n=12** Received PSA fact sheet + attended 2-day community jury where three experts discussed the benefits, harm and general information about PSA testing, with discussion between participants and experts. **C: n=14** Received PSA fact sheet only	Intention to screen: Immediate PI I: 5/12 (41.7%) C: 11/14 (78.6%) Intention to screen=5, 6, 7, 8, 9, 10 on a scale of 0–10 (0=not at all, 5=maybe and 10=absolutely)
Watts, 2014 (Australia)[d]	PCa, PSA	Online	**Age:** 40–79 years (M=55.9) **Ethnicity:** NA **Inclusion:** Men with no history of PCa; had at least one first- or second-degree relative with a previous diagnosis of PCa; proficient in English	RCT (2 arms) Description: **I: n=69** Tailored online pDA **C: n=69** Non-tailored online educational information	Screening uptake: At 12 months I: 29/42 (69.0%) C: 36/48 (75.0%) (*p*=0.57)
Pignone, 2013 (Australia)	PCa, PSA	Online	**Age:** 50–70 years (M=59.8) **Ethnicity:** White, non-white **Inclusion:** NA **Exclusion:** Men with visual limitations or inability to understand English	RCT (3 arms) Description: **I1: n=355** Rating and ranking task (explicit value clarification) **I2: n=357** Discrete choice experiments (explicit value clarification) **C: n=324** Balance sheet task (implicit value clarification)	Intention to screen: Immediate PI I1: 236/307 (76.8%) I2: 222/302 (73.5%) C: 233/302 (77.1%) (*p*=0.731)

Read, 2013 (Australia)	HIV, Rapid test/ conventional HIV serology	Clinic (Sexual health)	**Age:** ≥18 years **Ethnicity:** NA **Inclusion:** Men reported having sex with men within the previous year; had a negative HIV test result within the previous 2 years. **Exclusion:** Men seeking post-exposure prophylaxis for HIV	RCT (2 arms) Description: **I: n=200** Rapid HIV testing with finger prick **C: n=200** Conventional HIV serology (venipuncture)	Screening uptake: At 18 months I: 161/200 (80.5%) C: 141/200 (70.5%)
Taylor, 2013 (U.S.)[c]	PCa, PSA/DRE	Community and online	**Age:** 45–70 years (M=56.9) **Ethnicity:** White, African American, other **Inclusion:** Men with no history of PCa; English speaking; independent living (e.g.,: nursing home residents were excluded); had an outpatient appointment in the 24 months before enrolment	RCT (3 arms) Description: **I1: n=631** Web-based pDA **I2: n=630** Mailed paper-based pDA **C: n=632** Usual care	Screening uptake: At 13 months I1: 268/452 (59.3%) I2: 282/474 (59.5%) C: 281/499 (56.3%) (*p*=ns)
Young, 2013 (U.S.)[b,c]	HIV, Home-based HIV testing kit	Online	**Age:** ≥18 years (M=31.5) **Ethnicity:** African American, Latino, white, Asian	RCT (2 arms) Description: **I: n=57** Peer-leader guided chats, messages, wall posts on Facebook on HIV	Screening uptake: At 3 months I: 9/57 (15.8%) C: 2/55 (3.6%)

			Inclusion: Men who have a Facebook account; had sex with men in the past 12 months	prevention and testing, weekly over 12 weeks **C: n=55** Peer-leader guided chats, messages, wall posts on Facebook on importance of healthy lifestyle, weekly over 12 weeks	Intention to screen: At 3 months I: 25/57 (44%) C: 11/55 (20%)
Hirshfield, 2012 (U.S.)[c,e]	HIV, Test: NA	Online	**Age:** ≥18 years (median=39) **Ethnicity:** White, black, Hispanics, Asian, mixed, others **Inclusion:** Men who had oral or anal sex with a current male partner (new or not), and oral, anal, or vaginal sex with at least one new partner (male or female) in the previous 60 days; have the ability to read and respond in English.	RCT (3 arms) Description: **I1: n=1,554** Online video containing theory-based educational information (social learning theories) **I2: n=491** CDC webpage containing educational information about HIV in MSM **C: n=502** Usual care	Screening uptake: At 2 months I1: 142/676 (21%) I2: 41/205 (20%) C: 48/240 (20%)
Lee, 2012 (Korea)	Gastric cancer, Upper GI series/ endoscopy	Community	**Age:** 40–65 years **Ethnicity:** NA **Inclusion:** Men who received an invitation letter to undergo gastric cancer screening from the National Health Insurance Corporation	RCT (4 arms) Description: **I1: n=39** Telephone counseling encouraging screening and assisting in scheduling appointments **I2: n=88**	Screening uptake: At 3 months **Never-screened** I1: 4/28 (14.3%) I2: 15/42 (35.7%) I3: 4/27 (14.8%) C: 10/97 (10.3%) I2 vs C: (p<0.05)

			at the beginning of 2010. **Exclusion:** Men previously diagnosed with cancer	Telephone counseling as above, followed by tailored postcard through mail **I3: n=53** Tailored postcard through mail, followed by telephone counseling **C: n=180** Usual care	**Ever-screened** I1: 6/11 (54.6%) I2: 28/46 (60.9%) I3: 18/26 (69.2%) C: 48/83 (57.8%)
Lepore, 2012 (U.S.)	PCa, PSA	Community	**Age:** 45–70 years (M=55.04) **Ethnicity:** Black African **Inclusion:** Accessible by telephone **Exclusion:** Men who had PCa test in the 12 months before enrolment; previous history of PCa.	RCT (2 arms) Description: **I: n=244** Mailed pamphlet with educational information + telephone decision counseling **C: n=246** Telephone education on fruit and vegetable consumption	Screening uptake: At 1 year I: 110/244 (45.1%) C: 113/246 (45.9%) At 2 years I: 153/244 (62.7%) C: 164/246 (66.7%) Intention to screen: Immediate PI I: 174/215 (80.9%) C: 175/216 (81.0%)
Reagan, 2012 (U.S.)	STI (chlamydia, gonorrhea), Urine-based test kit	Community and clinic	**Age:** 18–45 years **Ethnicity:** White, black, other **Inclusion:** English-speaking men	RCT (2 arms) Description: **I: n=100** Mailed test kit with usage instruction, with prepaid, preaddressed return mailer **C: n=100** Given conventional collection kit upon arrival at clinic	Screening uptake: Immediate PI I: 72/100 (72%) C: 48/100 (48%) (***p*<0.01**)
Sheridan, 2012 (U.S.)[e]	PCa, PSA	Clinic	**Age:** 40–80 years **Ethnicity:** White, non-white	RCT (2 arms) Description: **I: n=60**	Screening uptake: At 9 months I: 11/58 (19%)

			Inclusion: Men with no history of PCa **Exclusion:** Men presenting for an acute medical visit or if they had evidence of a serious medical illness	Video pDA + decision counseling session by a physician in the clinic **C: n=70** Highway safety video, no decision counseling	C: 29/70 (41%) Intention to screen: Immediate PI I: 26/58 (45%) C: 55/70 (79%)
Byamugisha, 2011 (Uganda)	HIV, Rapid test	Community	(Only details of female participants were reported.)	RCT (2 arms) Description: **I: n=530** Invitation letter through female partner, for male partner to accompany them to next antenatal visit **C: n=530** Informational leaflet about antenatal care delivered through female partner	Screening uptake: At 4 weeks I: 82/530 (15.47%) C: 68/530 (12.83%)
Chan, 2011 (U.S.)	PCa, PSA	Community (Subsidized senior housing site and senior center)	**Age:** ≥40 years (M=60.9) **Ethnicity:** Hispanic American **Inclusion:** Men with no history of PCa	Cluster RCT (2 arms) Description: **I: clusters n=12; participants n=161** Group-based Spanish language educational program on PCa **C: clusters n=13; participants n=160** Group-based Spanish language educational program on diabetes	Intention to screen: Immediate PI I: 123/160 (77%) C: 116/157 (74%) (p=0.56)
Ditekemena, 2011 (Democratic Republic of Congo)[a]	HIV, Rapid test	Community	**Age:** ≥18 years (M=36.2) **Ethnicity:** NA **Inclusion:** Men whose female sexual partners had received	RCT (3 arms) Description: **I1: n=891** Invitation through female partner for HIV oriented voluntary counseling and testing in bar	Screening uptake: Immediate PI I1: 236/891 (26.49%) I2: 189/906 (20.86%) C: 166/909 (18.26%)

			voluntary counseling and testing at Kingasani Maternity **Exclusion:** Father of the unborn baby did not live in the city	**I2: n=906** Invitation through female partner for HIV oriented voluntary counseling and testing in church **C: n=909** Invitation through female partner for HIV oriented voluntary counseling and testing in clinic	I1 vs C: ***p*<0.001** I2 vs C: *p*=0.163
Heverin, 2011 (Ireland)[f]	Testicular cancer, Testicular self-examination	Community (University)	**Age:** 18–32 years (M=20.77) **Ethnicity:** NA **Inclusion:** University students	RCT (3 arms) Description: **I1: n=31** TSE demonstration video and once implementation intention **I2: n=30** TSE demonstration video and twice implementation intention **C: n=32** TSE demonstration video only	Screening uptake: At 8 weeks I1: 25/29 (86.2%) I2: 18/24 (75%) C: 21/25 (84%) Intention to screen: At 8 weeks I1: M=19.34 (SD: 3.42) I2: M=18.25 (SD: 5.91) C: M=19.8 (SD: 5.07) Scale: 5 (low) to 25 (high)
Janda, 2011 (Australia)[b,e]	Melanoma, Whole-body skin self-examination	Community	**Age:** ≥50 years **Ethnicity:** NA **Inclusion:** NA **Exclusion:** Men who were too ill; could not speak English; had previously had a melanoma.	RCT (2 arms) Description: **I: n=469** Researcher guide and color brochure containing educational information + body chart diagram + video/DVD + two postcard reminders **C: n=460** Researcher guide and color brochure only	Screening uptake: At 7 months I: 120/436 (27.5%) C: 99/433 (22.9%) (*p*=0.114) At 13 months I: 153/420 (36.4%) C: 126/411 (30.7%) (*p*=0.083)

Mohlala, 2011 (South Africa)	HIV, Rapid test and ELISA testing	Community	(Only details of female participants were reported.)	RCT (2 arms) Description: **I: n=500** Invitation through female partner to HIV oriented voluntary counseling and testing **C: n=500** Invitation through female partner to pregnancy information session that focused on general information about pregnancy	Screening uptake: At 12 weeks I: 161/500 (32.2%) C: 57/500 (11.4%) (***p*<0.0001**)
Myers, 2011 (U.S.)	PCa, PSA	Clinic	**Age:** 50–69 years **Ethnicity:** White, non-white **Inclusion:** Men with no history of PCa or BPH; did not have a PSA test in the previous 11 months	RCT (2 arms) Description: **I: n=156** Mailed booklet containing education information + nurse-led decision counseling session **C: n=157** Only mailed booklet containing education info	Screening uptake: After 120 days I: 96/152 (63%) C: 109/153 (71%) (*p*=0.102)
Allen, 2010 (U.S.)[a]	PCa, PSA	Community (Work sites)	**Age:** ≥45 years **Ethnicity:** White, non-Hispanic, other **Inclusion:** Permanent employees working ≥20 hours per week	Cluster RCT (2 arms) Description: **I: clusters n=6; participants n=398** Tailored pDA on a computer available in public space in each worksite, over 3 months **C: clusters n=6; participants n=414** Usual care	Intention to screen: At 3 months I: 225/291 (77%) C: 264/334 (79%) (*p*=0.88)
Blas, 2010 (Peru)[a,d,e]	HIV, Test: NA	Online	**Age:** ≥18 years **Ethnicity:** NA **Inclusion:** Be a man and report having had	RCT (2 arms) Description: **I: gay n=142, non-gay n=97**	Screening uptake: M: 125.5 days of observation **Gay**

			sex with men; not have been tested for HIV during the last year; do not report being HIV positive	Online video containing tailored educational information on HIV testing **C: gay n=90, non-gay n=130** Online standard public health text about HIV	I: 8/142 (5.6%) C: 10/130 (7.7%) **Non-gay** I: 11/97 (11.3%) C: 0/90 (0.0%) Intention to screen: Immediate PI **Gay** I: 120/142 (84.5%) C: 90/130 (69.2%) **Non-gay** I: 97/97 (100%) C: 57/90 (63.3%) *Gay and non-gay group were combined for quantitative analysis *Intention to screen=Made an Internet appointment, planning in next 30 days or planning in next 6 months
Evans, 2010 (UK)[c]	PCa, PSA	Community and online	**Age:** 50–75 years **Ethnicity:** White, black African, Indian, mixed, others **Inclusion:** Men who had not previously had	RCT (4 arms) Description: **I1: n=129** Web-based pDA **I2: n=126** Mailed paper-based pDA	Screening uptake: At 6 months I1: 4/127 (3.1%) I2: NA (9.1%) C1: 11/123 (8.9%) C2: 2/126 (1.6%)

			a PSA test; able to use a computer. **Exclusion:** Men who could not read English; had previously had PCa or a PSA test	**C1: n=127** Questionnaire control group **C2: n=132** No-questionnaire control group	I1 vs C1: ***p*=0.014** Intention to screen: Immediate PI I1: 36/89 (40%) I2: 46/86 (53%) C1: 60/103 (58%) C2: NA I1 vs C1: ***p*=0.02** I1 vs I2: *p*=0.1
Outlaw, 2010 (U.S.)[b]	HIV, Oral swab	Community	**Age:** 16–24 years (M=19.79) **Ethnicity:** African American **Inclusion:** Men who self-identify as MSM; to not currently be aware of their HIV status (i.e., no HIV testing or results within 3 months prior to enrollment) **Exclusion:** Men with active psychiatric disorder	RCT (2 arms) Description: **I: n=96** 30-minutes motivational interviewing-based field outreach session by peer outreach worker **C: n=92** 30-minutes standard HIV education field outreach session by peer outreach worker	Screening uptake: Immediate PI I: 47/96 (49%) C: 18/92 (20%) (***p*=0.000**)
Frosch, 2008 (U.S.)[d]	PCa, PSA	Online	**Age:** ≥50 years **Ethnicity:** White, African American, Hispanic, Asian, others **Inclusion:** NA	RCT (4 arms) Description: **I1: n=155** Web-based traditional didactic pDA **I2: n=153** Online chronic disease trajectory model and time trade off exercise **I3: n=152**	Intention to screen: At 2–3 weeks I1: 134/155 (86.4%) I2: 135/153 (88.0%) I3: 139/152 (91.4%) C: 140/151 (92.7%) (***p*=0.047**)

				Combination of both I1 and I2 **C: n=151** Provided links to PCa-specific public websites from credible sources	
Husaini, 2008 (U.S.)[e]	PCa, PSA/DRE	Community (Church)	**Age:** 40–70 years (M=54.9) **Ethnicity:** African American **Inclusion:** NA	Cluster RCT (2 arms) Description: **I: clusters n=28; participants n=NA** Video on PCa followed by physician led question and answer + educational pamphlet **C: clusters n=19; participants n=NA** Usual care	Screening uptake: Baseline I: 134/235 (57%) C: 62/115 (53.9%) At 3 months I: 169/235 (71.9%) C: 77/115 (67%)
Ilic, 2008 (Australia)[c,e]	PCa, PSA	Community and online	**Age:** ≥45 years **Ethnicity:** NA **Inclusion:** Men who had not previously been tested for PCa **Exclusion:** Men who were unable to understand English; not contactable by telephone	RCT (3 arms) Description: **I1: n=55** Mailed video containing standard educational information about PCa **I2: n=56** Website containing standard educational information about PCa **C: n=50** Mailed 28-pages pamphlet containing standard educational information about PCa (content/messages of all three groups are identical)	Intention to screen: At 1 week I1: 47/53 (88.7%) I2: 52/54 (96.3%) C: 40/49 (81.6%) Intention to screen=Not mind, probably want or definitely want
Stamatiou, 2008 (Greece)	PCa, PSA/DRE	Clinic (University-based)	**Age:** 50–86 years **Ethnicity:** NA **Inclusion:** Men who had a scheduled appointment from	RCT (2 arms) Description: **I: n=NA**	Screening uptake: 24 months PSA I: 442/548 (80%) C: 227/587 (38.6%)

			April 2004 to 2006, for various medical conditions except prostate-related conditions	Regular recommendation by physician + additional educational leaflet pre-consultation **C: n=NA** Regular recommendation by physician only	(***p*<0.05**) DRE I: 22/548 (4%) C: 29/587 (5%) (***p*<0.05**)
Krist, 2007 (U.S.)[c]	PCa, PSA	Clinic	**Age:** 50–70 years **Ethnicity:** White, African American **Inclusion:** Men who scheduled a health maintenance examination.	RCT (3 arms) Description: **I1: n=196** Mailed paper-based pDA pre-clinic visit **I2: n=226** Web-based pDA pre-clinic visit **C: n=75** Usual care	Intention to screen: I1: 167/196 (85%) I2: 194/226 (86%) C: 71/75 (94%) I1 vs C: *p*=0.06 I2 vs C: ***p*=0.04**
Scholes, 2007 (U.S.)	STI (chlamydia), Urine-based test kit	Community and clinic	**Age:** 21–25 years **Ethnicity:** NA **Inclusion:** All male Group Health Cooperative enrollees	RCT (3 arms) Description: **I1: n=2,940** Mailed invitation letter to be tested and a preaddressed, stamped return card to request a urine-based test kit **I2: n=2,940** Mailed invitation letter along with a home sampling kit **C: n=2,940** Usual care	Screening uptake: At 4 months follow up I1: 130/2,940 (4.5%) I2: 249/2,940 (8.4%) C: 24/29,40 (0.8%)
Taylor, 2006 (U.S.)[b,e]	PCa, PSA/DRE	Community	**Age:** 40–70 years (M=56.0) **Ethnicity:** African American **Inclusion:** Men with no history of PCa; not having been a	RCT (2 arms) Description: **I: n=139** Mailed video containing educational material on PCa with Frank Robinson (Baseball player) as the celebrity spokesperson	Screening uptake: At 1 year PSA I: 63/87 (72.4%) C: 60/77 (77.9%) DRE

			participant in the focus groups conducted for the formative research	**C: n=124** Mailed paper-based educational material on PCa with Frank Robinson as the celebrity spokesperson	I: 57/87 (65.9%) C: 59/77 (77.0%)
Watson, 2006 (UK)	PCa, PSA	Community	**Age:** 40–75 years **Ethnicity:** White, black, Asian, mixed, other **Inclusion:** Men with no history of PCa	RCT (2 arms) Description: **I: n=475** Mailed paper-based pDA **C: n=522** Usual care	Intention to screen: I: 119/465 (25.6%) C: 149/512 (29.1%) (*p*=0.17)
Ferreira, 2005 (U.S.)	Colorectal cancer, Fecal occult blood test/ flexible sigmoidoscopy / colonoscopy	Clinic	**Age:** ≥50 years (M=67.8) **Ethnicity:** White, African American, other **Inclusion:** Male veterans who were scheduled to be seen for a new or ongoing health problem by one of the providers from the two outpatient firms at the study medical center **Exclusion:** Men who had a personal or family history of colorectal cancer or polyps; a personal history of inflammatory bowel disease; had a home	Cluster RCT (2 arms) Description: **C: clusters n=1; participants n=1,049** Physician training - physician in the cluster attended 2 hour workshop on colorectal cancer screening and improving communication with patients with low literacy skill **C: clusters n=1; participants n=997** Usual care	Screening uptake: At 6–18 months I: 419/1,015 (41.3%) C: 312/963 (32.4%) (***p*=0.003**)

			FOBT in the previous year or a flexible sigmoidoscopy or colonoscopy in the previous 5 years		
Gattellari, 2005 (Australia)[e]	PCa, PSA	Community	**Age:** 50–70 years (M=54) **Ethnicity:** NA **Inclusion:** Men with no history of PCa; fluent in English.	RCT (3 arms) Description: **I: n=141** Mailed 20-minutes video pDA **I2: n=140** Mailed pDA booklet **C: n=140** Mailed leaflet contains only educational information on PCa, not fulfilling pDA criteria and not evidence-based approach	Intention to screen: At 21 days I1: 115/138 (83.33%) I2: 107/131 (81.68%) C1: 116/136 (85.29%) Intention to screen=Not mind, probably want or definitely want.
Holland, 2005 (U.S.)[a]	PCa, PSA/DRE Cholesterol Test: NA Colorectal cancer, Fecal occult blood test/ sigmoidoscopy / colonoscopy/ double-contrast barium enema	Community and clinic	**Age:** 40–60 years **Ethnicity:** NA **Inclusion:** Men who were enrolled in a managed-care product who had seen a primary care provider but had not received any preventive health screenings in the past 2 years	RCT (6 arms) Description: **I1: n=1,000** Chart sticker tagged on participant's note for physician to invite them for screening **I2: n=1,170** Chart sticker tagged on participant's note for physician to invite them for screening + Mailed personalized letter with information for screening, bearing signature of a male medical director **I3: n=1,169** Chart sticker tagged on participant's note for physician to invite them for screening + Postcard directed to any	Screening uptake: Colorectal cancer I1: NA (7.93%) (***p*=0.046**) I2: 51/478 (10.67%) (*p*=0.37) I3: NA (7.94%) (***p*=0.04**) I4: NA (8.17%) (*p*=0.054) I5: NA (8.15%) (*p*=0.05) C: 47/413 (11.4%) Cholesterol I1: 240/1,000 (24.00%) (***p*=0.005**)

				female household member to invite participant to screening **I4: n=1,169** Mailed personalized letter with information for screening, bearing signature of a male medical director **I5: n=1,169** Postcard directed to any female household member to invite participant to screening **C: n=1,000** Usual care	I2: 303/1,170 (25.9%) (***p*=0.001**) I3: 290/1,169 (24.8%) (***p*=0.001**) I4: 276/1,169 (23.60%) (***p*=0.008**) I5: 272/1,169 (23.30%) C: NA PCa I1: 100/1,000 (10.0%) (*p*=0.5) I2: 175/1,170 (14.95%) (***p*=0.001**) I3: 145/1,169 (12.4%) (***p*=0.039**) I4: 139/1,169 (11.89%) (*p*=0.08) I5: 135/1,169 (11.54%) (*p*=0.125) C: NA
Myers, 2005 (U.S.)	PCa, PSA/DRE	Clinic	**Age:** ≥41 years (M=52) **Ethnicity:** African American **Inclusion:** Men with no history of PCa or BPH; had not undergone a prostate biopsy or prostate ultrasound; had visited one of the	RCT (2 arms) Description: **I: n=121** Mailed PCa informational booklet + decision counseling session with health educator 1 month after receiving the informational booklet **C: n=121** Mailed PCa informational booklet only	Screening uptake: At 6–11 months (Either PSA or DRE) I: 20/108 (18.5%) C: 11/112 (9.8%)

			participating practices within 2 years prior to study initiation; had contact information available at the practice		
Tebb, 2005 (U.S.)	STI (chlamydia), Urine-based test kit	Clinic (Pediatric)	**Age:** 14–18 years **Ethnicity:** White, African American, Latino, Asian American, multi-ethnic, other **Inclusion:** Sexually active male adolescents scheduled for routine health maintenance visits	Cluster RCT (2 arms) Description: **I: clusters n=NA; participants n=121** Clinical practice improvement which each intervention clinic established protocols for gathering confidential sexual histories and collecting urine samples, reviewed the protocols monthly and discussed ways to reduce barriers to screening **C: clusters n=NA; participants n=128** Usual care	Screening uptake: At 18 months I: 59/121 (48.5%) C: 12/128 (9.1%)
Youl, 2005 (Australia)[b]	Melanoma, Whole body skin examination	Community	**Age:** 30–79 years **Ethnicity:** NA **Inclusion:** Men registered on the Queensland State Electoral Roll	RCT (2 arms) Description: **I: n=661** Personalized motivational invitation letter signed by a well-known and popular Australian sportsman + factual mailed brochure containing educational information about melanoma and screening **C: n=661** Only personalized motivational invitation letter signed by a well-	Screening uptake: (Assessment time not specified) I: 128/661 (19.4%) C: 122/661 (18.5%)

				known and popular Australian sportsman	
Partin, 2004 (U.S.)[e]	PCa, PSA	Community	**Age:** ≥50 years (M=68.4) **Ethnicity:** White, non-white **Inclusion:** Male veterans who had no PCa; had scheduled primary care appointments	RCT (3 arms) Description: **I1: n=384** Pamphlet containing educational information on PCa screening, mailed 1 week prior to appointment **I2: n=384** 23-minute video containing same factual content as I1, mailed 1 week prior to appointment **C: n=384** Usual care	Screening uptake: At 1 year I1: 198/295 (67%) I2: 215/308 (70%) C: 200/290 (69%) Intention to screen: Immediate PI I1: 191/295 (65%) I2: 194/308 (63%) C: 214/290 (74%)
Steadman, 2004 (United Kingdom)	Testicular cancer, Testicular self-examination	Community	**Age:** 18–35 years (M=20.6) **Ethnicity:** NA **Inclusion:** Non-psychology undergraduate male	RCT (2 arms) Description: **I: n=93** Implementation intention requiring participant to decide when and where they would perform TSE in the next 3 weeks **C: n=66** Usual care	Screening uptake: At 3 weeks I: 30/46 (65.2%) C: 12/30 (40%) (***p*=0.031**) Intention to screen: Immediate PI I: M=17.70, SD=4.86 (k=44) C: M=19.15, SD=3.42 (k=27) Five items measured on 5-point scales: 1 (strongly disagree) to 5 (strongly agree)
Frosch, 2003 (U.S.)[c,e]	PCa, PSA	Clinic and online	**Age:** ≥50 years **Ethnicity:** African American, Hispanic,	RCT (2 arms) Description: **I: n=114**	Screening uptake: Immediate PI I: 101/110 (91.9%)

			Asian/Pacific Islander, Native American, Caucasian, other **Inclusion:** Any man who made an appointment	47 slides presentation available online prior to appointment. Contains educational information on PCa screening. **C: n=112** Video at clinic 30 minutes prior to appointment, containing same content with I	C: 89/109 (81.5%) (***p*<0.05**)
Gattellari, 2003 (Australia)	PCa, PSA	Clinic	**Age:** 40–70 years **Ethnicity:** NA **Inclusion:** Men who were sufficiently fluent in English; had not been diagnosed with PCa	RCT (2 arms) Description: **I: n=126** 32-page evidence-based booklet delivered at clinic immediately post-consultation. **C: n=122** Conventional informational pamphlet by Australian government immediately post-consultation	Intention to screen: At 3 weeks I: 82/105 (78.09%) C: 82/107 (76.63%)
Volk, 2003 (U.S.)[e]	PCa, PSA/DRE	Clinic	**Age:** 45–70 years **Ethnicity:** African American, white, Mexican American, others **Inclusion:** Men with no history of PCa, who presented for care at the Family Medicine Centre	RCT (2 arms) Description: **I: n=80** Mailed video containing educational information on PCa screening + brochure with similar content **C: n=80** Usual care (brochure containing similar content as intervention 1 were given after follow-up assessment at 2 weeks)	Screening uptake: At 1 year PSA I: 24/70 (34.3%) C: 37/67 (55.2%)
Wilt, 2001 (U.S.)	PCa, PSA	Community	**Age:** ≥50 years (M=71) **Ethnicity:** White, non-white	RCT (2 arms) Description: **I: n=275**	Screening uptake: At 1 year I: 50/163 (31%) C: 66/179 (37%)

			Inclusion: Men who had scheduled clinic appointments	Pamphlet containing educational information about PCa in question-and-answer format, mailed 7–10 days prior to scheduled appointment **C: n=275** Usual care	(p>0.2)
Schapira, 2000 (U.S.)	PCa, PSA/DRE	Clinic (Hospital-based)	**Age:** 50–80 years **Ethnicity:** White, black, Hispanic, other **Inclusion:** Men who had an outpatient encounter in the years 1990 to 1995 **Exclusion:** Men who had history of prostate or other cancer; a previous prostate ultrasound study or biopsy, cystoscopy; prior prostate surgery; active genitourinary symptoms; cognitive impairment (defined by a Mini-Mental State Examination score of 23 or less); an anticipated life expectancy of less than 2 years	RCT (2 arms) Description: **I: n=122** PDA in the form of an 8-page illustrated pamphlet delivered at a visit to the center, with research assistant available to answer participant's question **C: n=135** 5-page written pamphlet containing basic PCa and screening information delivered at a visit to the center, with research assistant available to answer participant's question	Screening uptake: At 2 weeks I: 100/122 (82%) C: 113/135 (84%) (p=0.60)
Myers, 1999 (U.S.)	PCa, PSA/DRE	Community	**Age:** 40–70 years **Ethnicity:** African American	RCT (2 arms) Description: **I: n=192**	Screening uptake: At 1 year I: 97/192 (51%) C: 64/221 (29%)

			Inclusion: Men lived in neighborhoods (defined by ZIP codes) near the university, and had visited the UHS in the previous 2 years. **Exclusion:** Men who had a history of PCa	Enhanced intervention including mailed paper-based educational information inviting participants for screening, with basic telephone contact + additional tailored paper-based information with tailored telephone contacts **C: n=221** Minimal intervention with only mailed paper-based educational information inviting participants for screening, with basic telephone contact	
Volk, 1999 (U.S.)[e]	PCa, PSA	Clinic	**Age:** 45–70 years **Ethnicity:** White, African American, Mexican American, other **Inclusion:** Men with no history of PCa, who presented for care at the Family Medicine Centre	RCT (2 arms) Description: **I: n=80** 20-minute video containing education information viewed at clinic before consultation **C: n=80** Usual care	Intention to screen: At 2 weeks I: 48/78 (62%) C: 64/80 (80%)
Weinrich, 1998 (U.S.)	PCa, PSA/DRE	Community	**Age:** 40–70 years (African Americans); 50–70 years (Caucasians) (M=52.0) **Ethnicity:** African American, Caucasian **Inclusion:** Men with no history of PCa; not currently undergoing	Cluster RCT (4 arms) Description: **I1: clusters n=NA; participants n=455** Combination of "Peer-educator" which included testimony for PCa screening by a man who was of the same race as the majority of the participants, + "Client navigator" in which social worker or nurse called	Screening uptake: (Assessment time not specified) I1: 320/455 (70.3%) I2: 287/409 (70.2%) I3: 232/371 (62.5%) C: 275/482 (57.1%)

			diagnostic evaluation for PCa; mentally oriented	participant and identified barriers to screening and helped each of them to "navigate" the healthcare system **I2: clusters n=NA; participants n=371** "Peer-educator" only **I3: clusters n=NA; participants n=409** "Client navigator" only **C: clusters n=NA; participants n=482** Usual care	
Wolf, 1996 (U.S.)	PCa, PSA	Clinics (University-based general internal medicine clinic, suburban nonteaching group practice, small-town teaching group practice, rural community health center)	**Age:** ≥50 years **Ethnicity:** White, non-white **Inclusion:** English-speaking men visiting their primary care physicians for outpatient appointments **Exclusion:** Men with prior PSA screening; previous history of PCa	RCT (2 arms) Description: **I: n=103** Scripted educational information on PSA testing read aloud by research assistant at clinic **C: n=102** Usual care	Intention to screen: Immediate PI I: 40/103 (38.8%) C: 68/102 (66.7%) Intention to screen=probably interested or definitely interested
Norman, 1993	Smoking, alcohol	Clinic	**Age:** 40–50 years **Ethnicity:** NA	RCT (2 arms) Description:	Screening uptake: At 1 year

(UK)	consumption, exercise, weight, blood pressure		**Inclusion:** NA	**I: n=148** Mailed invitation letter for health check with appointment date **C: n=151** Participants note tagged for primary healthcare team to invite them personally to a health check	I: 79/129 (61.2%) C: 33/125 (26.4%)
Murphy, 1990 (U.S.)[e]	Testicular cancer, Testicular self-examination	Community (High school)	**Age:** 14–16 years **Ethnicity:** White, non-white **Inclusion:** Male 9th and 10th grade students enrolled in one of six family planning and health classes participated	RCT (3 arms) Description: **I1: n=37** Theory-based message in a 12-minute video with educational information about testicular cancer and TSE (theory of planned behaviors) **I2: n=28** Information-based (non-theory-based) educational information delivered in audio-visual presentation containing basic information about testicular cancer and TSE **C: n=34** Pamphlet containing general health information not mentioning testicular cancer or TSE	Screening uptake: At 1 month I1: 15/36 (42%) I2: 6/26 (23%) C: 2/34 (6%) Intention to screen: Immediate PI I1: 0.89 I2: 0.32 C: –0.24 Five-point rating scales: –2 (definitely will not) to +2 (definitely will)

Note: Boldface indicates statistical significance ($p<0.05$). n refers to number of sample size.
[a] Studies with male-sensitive component in intervention group. Included in sub-analysis
[b] Studies with male-sensitive component in intervention and control group. Not included in sub-analysis
[c] Studies with ICT component in intervention group. Included in sub-analysis
[d] Studies with ICT component in intervention and control group. Not included in sub-analysis
[e] Studies with video component in intervention group. Included in sub-analysis
[f] Studies with video component in intervention and control group. Not included in sub-analysis

BPH, benign prostatic hyperplasia; C, control group; DRE, digital rectal examination; ELISA, enzyme-linked immunosorbent assay; GI, gastrointestinal; I, intervention group 1; I2, intervention group 2; I3, intervention group 3; I4, intervention group 4; I5, intervention group 5; MSM, men who have sex with men; NA, not available; ns, not significant; PCa, prostate cancer; pDA, patient decision aid; PI, post-intervention; PSA, prostate-specific antigen; STI, sexually-transmitted infection; TSE, testicular self-examination; DVD, digital versatile disc; FOBT, fecal occult blood test; UHS, University Health Services; ICT, information and communication technology.

Appendix Table 4. Risk of Bias Summary for Each Included Study

	Sequence generation	Allocation concealment	Blinding of participants	Blinding of personnel	Blinding of assessor	Incomplete outcome data	Selective outcome reporting	Other
Bauermeister 2015	?	?	?	+	+	?	+	?
Fuller 2015	+	+	−	+	+	+	+	?
Lewis 2015	?	?	?	?	+	−	+	+
Tran 2015	+	+	+	+	+	+	+	?
Young 2015	+	?	+	+	+	+	+	+
Hong 2014	?	?	?	?	+	+	+	?
Janda 2014	+	+	+	+	+	+	+	+
Orne-Gliemann 2014	?	+	+	+	+	+	+	+
Osoti 2014	+	+	−	−	+	+	+	+
Thomas 2014	+	+	−	?	+	+	+	+
Watts 2014	−	+	+	+	+	−	+	−
Pignone 2013	?	?	?	+	+	+	+	+
Read 2013	+	?	−	−	+	+	+	?
Taylor 2013	+	?	?	+	?	+	+	?
Young 2013	+	+	+	−	+	+	+	+
Hirshfield 2012	+	+	?	+	+	−	+	−
Lee 2012	?	?	?	?	+	+	+	−
Lepore 2012	+	+	?	+	+	+	+	+
Reagan 2012	+	+	+	−	+	+	+	+
Sheridan 2012	+	+	?	+	+	+	+	−
Byamugisha 2011	+	+	−	+	+	+	+	+
Chan 2011	+	?	?	−	−	+	+	+
Ditekemena 2011	?	?	?	?	+	+	+	+
Heverin 2011	−	−	−	+	+	+	+	+
Janda 2011	+	?	?	+	+	+	+	+

Mohlala 2011	+	+	−	−	+	+	+	−
Myers 2011	?	−	?	+	+	+	+	?
Allen 2010	+	?	?	+	+	−	+	+
Blas 2010	+	+	?	+	+	+	+	?
Evans 2010	?	+	?	+	+	−	+	+
Outlaw 2010	+	+	+	−	+	+	+	+
Frosch 2008	+	+	?	+	+	−	+	+
Husaini 2008	?	?	?	−	+	−	+	?
Ilic 2008	+	+	?	+	+	+	+	+
Stamatiou 2008	?	?	?	−	?	−	+	?
Krist 2007	+	?	?	−	+	+	+	+
Scholes 2007	?	?	?	+	+	+	+	?
Taylor 2006	?	?	+	+	+	−	+	+
Watson 2006	+	+	?	+	+	−	+	+
Ferreira 2005	?	?	?	−	+	+	+	+
Gattellari 2005	+	+	+	+	+	+	+	+
Holland 2005	?	?	?	−	+	+	+	?
Myers 2005	?	?	?	−	+	+	+	−
Tebb 2005	?	?	+	−	+	+	+	?
Youl 2005	?	?	?	+	+	+	+	?
Partin 2004	+	?	?	+	+	+	+	+
Steadman 2004	+	?	?	+	?	−	+	−
Frosch 2003	+	+	?	+	+	+	+	+
Gattellari 2003	?	?	+	+	+	+	+	+
Volk 2003	?	?	?	+	−	+	+	?
Wilt 2001	−	?	?	+	+	+	+	?
Schapira 2000	?	?	?	−	−	+	+	+
Myers 1999	?	?	?	−	+	+	+	?
Volk 1999	?	−	?	+	−	+	+	−
Weinrich 1998	?	?	?	?	+	+	+	?
Wolf 1996	?	?	?	−	−	+	?	+
Norman 1993	?	?	?	−	+	?	+	?
Murphy 1990	?	?	−	+	?	?	?	?

+ = Low risk of bias; ? = Unclear risk of bias; − = High risk of bias

Appendix Table 5. Comparison Between Interventions and Comparators/No Intervention in All Studies According to Type of Interventions

Study	Details of intervention	Intervention		Comparator			No intervention		
		n	N	*n*	N	RR (95% CI)	*n*	N	RR (95% CI)
Intervention to increase uptake of screening									
Education - Uptake									
Holland (2005)	Paper-based	51	705				47	413	0.64 (0.44, 0.93)
Hong (2014)	Paper-based	101	230				30	223	**3.26** (2.27, 4.70)
Lee (2012)	Paper-based	19	69				14	125	**2.46** (1.32, 4.59)
Youl (2005)	Paper-based	128	661	122	661	1.05 (0.84, 1.31)			
Weinrich (1998)	Paper-based	541	771				246	429	**1.22** (1.11, 1.34)
Young (2013)	Social network	9	57				2	55	4.34 (0.98, 19.20)
Murphy (1990)	Video/ presentation	21	62				2	34	**5.76** (1.44, 23.09)
Hirshfield (2012)	Video/website	183	881				48	240	1.04 (0.78, 1.38)
Blas (2010) [a]	Video	19	239	10	220	1.75 (0.83, 3.68)			
Janda (2014) [a]	Video	246	436	229	434	1.07 (0.95, 1.21)			
Janda (2011) [a]	Video	153	420	126	411	1.19 (0.98, 1.44)			
Bauermeister (2015)	Website	22	68	8	36	1.46 (0.72, 2.94)			
	Pooled					**1.11** (1.01, 1.21)			1.37 (1.00, 1.88)
	Pooled [a]					1.12 (0.99, 1.27)			
Education - Intention									
Young (2013)	Social network	25	57				11	55	**2.19** (1.20, 4.01)
Blas (2010) [a]	Video	217	239	147	220	**1.36** (1.23, 1.50)			
Counselling - Uptake									
Hong (2014)	Telephone	119	470				30	223	**1.88** (1.30, 2.72)
Lee (2012)	Telephone	4	97				10	97	0.40 (0.13, 1.23)
Weinrich (1998)	Direct	492	737				245	430	**1.17** (1.06, 1.29)
	Pooled								1.21 (0.73, 1.99)
Invitation to testing - Uptake									
Byamugisha (2011)	Through female partner	82	530	68	530	1.21 (0.90, 1.62)			
Ditekemena (2011)	Invitation to test in bar/church	425	1,797	166	909	**1.30** (1.10, 1.52)			

Mohlala (2011)	Through female partner	161	500	57	500	**2.82** (2.14, 3.72)			
Norman (1993)	Mailed	79	129	33	125	**2.32** (1.68, 3.21)			
	Pooled					**1.78** (1.17, 2.68)			
Screening procedure - Uptake									
Osoti (2014)	Home visit + testing	128	150	54	150	**2.37** (1.90, 2.96)			
Read (2013)	Rapid test	161	200				141	200	**1.14** (1.02, 1.28)
Reagan (2012)	Mailed test kit	72	100	48	100	**1.50** (1.18, 1.90)			
Scholes (2007)	Mailed test kit/request card	379	5,880				24	2940	**7.90** (5.24, 11.90)
	Pooled					**1.89** (1.20, 2.97)			2.99 (0.15, 59.60)
Implementation intention - Uptake									
Steadman (2004)	–	30	46				12	30	1.63 (1.00, 2.65)
Heverin (2011)	–	43	53	21	25	0.97 (0.78, 1.20)			
Peer leader - Uptake									
Fuller (2015)	Captain recommendation	25	53	28	45	0.76 (0.53, 1.09)			
Young (2015)	Social network	43	252	16	246	**2.62** (1.52, 4.53)			
	Pooled					1.39 (0.37, 5.18)			
Peer leader – Intention									
Young (2015)	Social network	77	252	36	246	**2.09** (1.46, 2.98)			
Others – Uptake									
Ferreira (2005)	HCP training	182	441				195	602	**1.27** (1.09, 1.50)
Fuller (2015)	HCP recommendation	28	41	28	45	1.10 (0.81, 1.49)			
Orne-Gliemann (2014)[a]	Partner education	267	970				151	973	**1.77** (1.48, 2.12)
Outlaw (2010)	Motivational interviewing	47	96	18	92	**2.50** (1.58, 3.97)			
Tebb (2005)	Clinical practice improvement	10	20				2	21	**5.25** (1.31, 21.06)
Intervention Promoting Informed Decision Making									
Decision aid – Uptake									

Schapira (2000)	Paper-based	100	122	113	135	0.98 (0.88, 1.09)			
Partin (2004) [a]	Paper-based/video	413	603				200	290	0.99 (0.90, 1.09)
Taylor (2013)	Paper-based/website	550	926				281	499	1.05 (0.96, 1.16)
Lewis (2015)	Video	431	1,923				131	627	1.07 (0.90, 1.28)
Sheridan (2012)	Video	11	58				29	70	**0.46** (0.25, 0.83)
Evans (2010)	Website	4	127				13	249	0.60 (0.20, 1.81)
Watts (2014)	Website	29	42	36	48	0.92 (0.71, 1.19)			
	Pooled					0.97 (0.88, 1.07)			1.00 (0.89, 1.12)
Decision aid – Intention									
Allen (2010)	Computer	155	200				182	230	0.98 (0.89, 1.08)
Tran (2015) [a]	Paper-based	331	588				432	582	**0.76** (0.70, 0.83)
Evans (2010)	Paper-based/website	82	175				60	103	0.80 (0.64, 1.01)
Krist (2007)	Paper-based/website	361	422				71	75	**0.90** (0.85, 0.97)
Watson (2006)	Paper-based	119	465				149	512	0.88 (0.72, 1.08)
Gattellari (2005) [a]	Paper-based/video	222	269	116	136	0.97 (0.89, 1.06)			
Partin (2004) [a]	Paper-based/video	406	603				200	290	0.98 (0.89, 1.07)
Sheridan (2012)	Video	26	58				55	70	**0.57** (0.42, 0.78)
Frosch (2008)	Website	273	307	140	151	0.96 (0.90, 1.02)			
	Pooled					0.96 (0.92, 1.01)			**0.86** (0.77, 0.95)
	Pooled [a]								0.86 (0.67, 1.10)
Education - Uptake									
Lepore (2012) [a]	Paper-based	153	244				164	246	0.94 (0.83, 1.07)
Stamatiou (2008)	Paper-based	442	548	227	587	**2.09** (1.87, 2.33)			
Wilt (2001)	Paper-based	50	163				66	179	0.83 (0.62, 1.12)
Husaini (2008)	Video	162	226				74	110	1.07 (0.91, 1.24)
Volk (2003)	Video	24	70				37	67	**0.62** (0.42, 0.92)
Myers (1999)	Paper-based	97	192	61	221	**1.83** (1.42, 2.36)			
	Pooled					**2.04** (1.85, 2.26)			0.91 (0.76, 1.07)
Education – Intention									
Lepore (2012) [a]	Paper-based	174	215				175	216	1.00 (0.91, 1.09)

Gattellari (2003) [a]	Paper-based	82	105	82	107	1.02 (0.88, 1.18)			
Volk (1999)	Video	48	78				64	80	**0.77** (0.63, 0.95)
Wolf (1996)	Research assistant at clinic	40	103				68	102	**0.58** (0.44, 0.77)
	Pooled								0.78 (0.56, 1.08)
Decision counseling - Uptake									
Lewis (2015)	–	297	1,292				265	1258	1.09 (0.94, 1.26)
Myers (2011)	–	96	152	109	153	0.89 (0.76, 1.04)			
Myers (2005)	–	20	105	11	112	1.94 (0.98, 3.85)			
	Pooled					1.23 (0.55, 2.74)			
Decision counseling – Intention									
Chan (2011)	–	41	53				38	52	1.06 (0.85, 1.32)
Others – Intention									
Pignone (2013)	Value clarification - explicit/implicit	458	609	233	302	0.97 (0.90, 1.05)			
Frosch (2008)	Chronic disease trajectory model (website)	274	305	140	151	0.97 (0.91, 1.03)			
Thomas (2014)	Community jury	5	12	11	14	0.53 (0.26, 1.09)			

Note: Boldface indicates statistical significance ($p<0.05$). Lower-case n refers to number of events; upper-case N refers to total sample size.

[a] Studies with high methodological quality.

HCP, healthcare providers; RR, risk ratio

Appendix Table 6. Comparison Between Interventions and Comparators/No Intervention in Male-sensitive, Internet-based, and Video-based Interventions by Studies

Study	Intervention	Intervention		Comparator			No intervention		
		n	N	*n*	N	RR (95% CI)	*n*	N	RR (95% CI)
Male sensitive intervention									
Intervention to increase uptake of screening									
Education - Uptake									
Bauermeister (2015)	Website	22	68	8	36	1.46 (0.72, 2.94)	–	–	
Blas (2010) [a]	Video	19	239	10	220	1.75 (0.83, 3.68)	–	–	
Holland (2005)	Paper-based	51	478	–	–		47	413	0.94 (0.65, 1.36)
Janda (2014) [a]	Video	246	436	229	434	1.07 (0.95, 1.21)	–	–	
	Pooled					1.16 (0.91, 1.46)	47	413	0.94 (0.65, 1.36)
	Pooled [a]					1.19 (0.79, 1.79)			
Education - Intention									
Blas (2010) [a]	Video	217	239	147	220	**1.36** (1.23, 1.50)	–	–	
Peer leader - Uptake									
Fuller (2015)	Captain recommendation	25	53	14	23	0.77 (0.50, 1.20)	–	–	
Young (2015)	Social network	43	252	16	246	**2.62** (1.52, 4.53)	–	–	
	Pooled					1.41 (0.38, 5.21)			
Peer leader - Intention									
Young (2015)	Social network	77	252	36	246	**2.09** (1.46, 2.98)	–	–	
Invitation to testing - Uptake									
Ditekemena (2011)	Invitation to test in bar/church	425	1,797	166	910	**1.30** (1.10, 1.52)	–	–	
Intervention promoting informed decision making									
Decision aid - Intention									
Allen (2010)	Computer	155	200	–	–		182	230	0.98 (0.89, 1.08)
Internet-based intervention									
Intervention to increase uptake of screening									
Education - Uptake									
Young (2013)	Social network	9	57	–	–	–	2	55	4.34 (0.98, 19.20)
Hirshfield (2012)	Website/Video	183	881	–	–	–	48	240	1.04 (0.78, 1.38)

	Pooled								1.75 (0.45, 6.83)
Education - Intention									
Young (2013)	Social network	25	57	–	–	–	11	55	**2.19** (1.20, 4.01)
Intervention promoting informed decision making									
Decision aid - Uptake									
Taylor (2013)	Website	268	452	–	–		281	499	1.05 (0.94, 1.17)
Evans (2010)	Website	4	127	–	–		13	249	0.60 (0.20, 1.81)
	Pooled								1.05 (0.94, 1.17)
Decision aid – Intention									
Evans (2010)	Website	36	89	–	–		60	103	**0.69** (0.51, 0.94)
Krist (2007)	Website	194	226	–	–		71	75	**0.91** (0.84, 0.98)
	Pooled								0.81 (0.55, 1.18)
Education – Uptake									
Frosch (2003) [a]	Presentation on website	101	110	89	109	**1.12** (1.01, 1.25)	–	–	
Education – Intention									
Ilic (2008) [a]	Website	42	54	34	49	1.12 (0.89, 1.42)	–	–	
Video-based intervention									
Intervention to increase uptake of screening									
Education - Uptake									
Janda (2014) [a]	Mailed DVD	246	436	229	434	1.07 (0.95, 1.21)	–	–	–
Hirshfield (2012)	Internet	142	676	–	–	–	24	120	1.05 (0.71, 1.55)
Janda (2011) [a]	Mailed DVD	153	420	126	411	1.19 (0.98, 1.44)	–	–	–
Blas (2010) [a]	Internet	19	239	10	220	1.75 (0.83, 3.68)	–	–	–
Murphy (1990)	Classroom	15	36	–	–	–	2	34	**7.08** (1.75, 28.69)
	Pooled					1.12 (0.99, 1.27)			2.43 (0.36, 16.23)
	Pooled [a]					1.12 (0.99, 1.27)			–
Education - Intention									
Blas (2010) [a]	Internet	217	239	147	220	**1.36** (1.23, 1.50)	–	–	–
Intervention promoting informed decision making									
Decision aid - Uptake									
Partin (2004) [a]	Mailed	215	308	–	–	–	200	290	1.01 (0.91, 1.13)
Decision aid - Intention									

Gattellari (2005) [a]	Mailed	115	138	58	68	0.98 (0.86, 1.11)	–	–	–
Partin (2004) [a]	Mailed	194	308	–	–	–	214	290	**0.85** (0.76, 0.95)
Sheridan (2012)	At clinic	26	58	–	–	–	55	70	**0.57** (0.42, 0.78)
Lewis (2015)	Decision counseling	297	1,292	–	–	–	265	1,258	1.09 (0.94, 1.26)
	Pooled								0.84 (0.63, 1.11)
Education – Uptake									
Husaini (2008)	At church	162	226	–	–	–	74	110	1.07 (0.91, 1.24)
Volk (2003)	Mailed	24	70	–	–	–	37	67	**0.62** (0.42, 0.92)
Frosch (2003) [a]	At clinic	89	109	101	110	**0.89** (0.80, 0.99)			
	Pooled								0.84 (0.49, 1.44)
Education - Intention									
Ilic (2008) [a]	Mailed	32	53	34	49	0.87 (0.65, 1.16)	–	–	
Volk (1999)	At clinic	48	78	–	–	–	64	80	**0.77** (0.63, 0.95)
Taylor (2006)	Mailed	63	87	60	77	0.93 (0.78, 1.11)			
	Pooled					0.91 (0.79, 1.06)			

Note: Boldface indicates statistical significance ($p<0.05$). Lower-case *n* refers to number of events; upper-case *N* refers to total sample size.

[a] Studies with high methodological quality.

RR, risk ratio

4.2.3 Paper 3: Teo, C. H., Ng, C. J. & White, A. (2017). Factors influencing young men's decision to undergo health screening in Malaysia: a qualitative study. BMJ Open, 7(3), e014364.

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Factors influencing young men's decision to undergo health screening in Malaysia: a qualitative study

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ABSTRACT

Objectives: Uptake of health screening is low in men, particularly among those aged <40 years. This study aimed to explore factors that influence health screening behaviour in younger men.

Design: This qualitative study employed an interpretive descriptive approach. Two trained researchers conducted in-depth interviews (IDIs) and focus group discussions (FGDs) using a semi-structured topic guide, which was developed based on literature review and behavioural theories. All IDIs and FGDs were audio-recorded and transcribed verbatim. Two researchers analysed the data independently using a thematic approach.

Participants and setting: Men working in a banking institution in Kuala Lumpur were recruited to the study. They were purposively sampled according to their ethnicity, job position, age and screening status in order to achieve maximal variation.

Results: Eight IDIs and five FGDs were conducted (n=31) and six themes emerged from the analysis. (1) Young men did not consider screening as part of prevention and had low risk perception. (2) The younger generation was more receptive to health screening due to their exposure to health information through the internet. (3) Health screening was not a priority in young men except for those who were married. (4) Young men had limited income and would rather invest in health insurance than screening. (5) Young men tended to follow doctors' advice when it comes to screening and preferred doctors of the same gender and ethnicity. (6) Medical overuse was also raised where young men wanted more screening tests while doctors tended to promote unnecessary screening tests to them.

Conclusions: This study identified important factors that influenced young men's screening behaviour. Health authorities should address young men's misperceptions, promote the importance of early detection and develop a reasonable health screening strategy for them. Appropriate measures must be put in place to reduce low value screening practices.

Strengths and limitations of this study

- This study focused on the health screening behaviour of young working men in the community, a frequently overlooked population.
- We conducted the study with men in the community rather than those attending clinics as this group of men tend to underuse health services.
- We captured views, experiences, barriers and facilitators to health screening from men across different ethnic groups, age, job positions and screening behaviour.
- Both in-depth interviews and focus group discussions were used to triangulate the data and the study was informed by behavioural theories.
- This study was conducted in an urban setting where men had easy access to healthcare services and most of the participants were from higher level of education. Therefore, the findings may not be transferable to other populations in Malaysia.

INTRODUCTION

Most healthcare systems and policies focus on addressing the needs of children, adolescents, elderly people and women; very few look into the healthcare needs of men, particularly young men.[1–5] This is despite clear evidence showing that men experience significantly more premature deaths than women.[6–11] Statistics have shown that there is a sharp rise in morbidity when men reach 40 years of age. For instance, 10% of men aged 20–35 years have hypertension compared with 40% of those aged 45–54 years.[12 13] Likewise, for diabetes, in 2008 3.7% of American adults aged 20–44 years had diabetes compared with 13.7% of those in the 45–64 age group.[14] The prevalence of diabetes among younger men is rising.[15] This pattern is also observed in other parts of the world.[16 17] In addition, more young men than young women die prematurely across the world.[3] In the USA, young adults, men and Asian Americans are reported to be less health conscious, less likely to seek treatment and have poorer disease control than older adults, women and those from other ethnic groups.[18 19] The increasing disease

burden in young men has resulted in loss of productivity as well as increased healthcare cost.[15 18 20–22]

It is therefore important to identify risk factors and detect diseases in young men while there is still a window of opportunity to intervene before the disease develops or progresses. The US Preventive Services Task Force (USPSTF) recommends screening in younger adults, including men, for hypertension, diabetes, sexually transmitted infections (STIs), HIV, hepatitis, dyslipidaemia, depression, smoking, alcohol and obesity.[23] These recommendations, however, need to be personalised according to individuals' risk factors such as ethnicity, past medical history, family history and lifestyle to avoid medical overuse and overdiagnosis.[24–26]

Currently, health screening uptake in young men remains low in Malaysia as well as globally.[27–31] The American Time Use Survey found that men aged 25–44 years spent most hours in work-related activities and the least time for personal care, including screening.[32] Compared with women, men are less likely to attend health screening,[33–35] which may explain why men have poorer health.[9 10] Many studies have looked at factors that influence screening uptake in older men; however, few have explored young men's decision to go for screening, particularly for non-STI conditions such as high blood pressure, dyslipidaemia, obesity, smoking and alcohol.[36–39]

This qualitative study therefore aimed to explore factors that influence health screening behaviour among young working men in Malaysia. Malaysia has a dual-sector (public and private) healthcare system and her population consists of different ethnic groups including Malays, Chinese, Indians and aboriginal groups. In this era of globalisation with active migration across the world, it is important to understand the health-seeking behaviour of different ethnic groups, and the gender differences within each ethnic group.

METHODS

Study design and context

This study employed the interpretive descriptive approach to explore the health screening behaviour of young men.[40] The interpretive approach was used to gain a deeper understanding of young men's screening behaviour with regard to their age, ethnicity, job position and screening behaviour.[41] Semi-structured in-depth interviews (IDIs) and focus group discussions (FGDs) were conducted in Kuala Lumpur, the capital city of Malaysia, which is a fast-paced city with a highly competitive working environment. In this study, men working in the banking industry were chosen because of the stressful and sedentary nature of their job. They are a group of 'hard-to-reach' men in the community, who are less likely to use health services despite having easy access to them. Most men in this study subscribed to health insurance covered by the bank while those from lower job positions were covered by the worker's union. The company has panel doctors and all the staff are reimbursed for their medical expenses but not for screening. Only staff at higher positions and who have worked for a certain number of years are entitled to health screening reimbursement. All IDIs and FGDs were conducted at their work place.

This study was approved by the University of Malaya Medical Centre Medical Ethics Committee (MECID.NO: 201410701) and the study conformed to the Declaration of Helsinki.

Sampling and recruitment

Men of different ethnicities, job positions, age and screening status were recruited using purposive sampling in order to achieve maximal variation. Approval from the banking institution was sought and the human resource department helped to send invitation emails to all male staff in the organisation. The invitation emails included the purpose of the study and the details of the researchers. Men who were interested in the study contacted the researchers and interview appointments were arranged via emails. Men from the older age group were included in the study to provide triangulation of the data.[42 43] Views from the older men are important as they could share and compare their views and experiences of health screening between now and when they were younger. They could provide input based on actual lived experiences rather than perceptions. This was particularly relevant in the context of colorectal cancer screening which is recommended for men above 50 years of age. The FGDs were delimited by job position so that the participants were comfortable to discuss and disclose their views on health screening without hierarchical influences.

Data collection

Two male researchers (CHT and CJN) trained in qualitative interviewing conducted the IDIs and FGDs. An IDI allows the researcher and the participant to discuss more personal and sensitive issues while an FGD takes advantage of group dynamics to enrich the data by enhancing group interactions. These two methods also serve as a form of triangulation to provide a comprehensive understanding of what influenced men to either attend or avoid health screening.[42 44] Before the interviews, the participants read through the participant information sheet and the researchers encouraged the participants to raise questions about the study, which were answered accordingly. The participants were made aware that their participations were voluntary and that they could withdraw from the study at any time. We also obtained their verbal as well as written informed consent to participate in the study and for audio-recording the interview. All data were anonymised and stored in password-protected computers which could only be accessed by the researchers. During the interview the participants were asked to describe their health screening experiences, particularly the factors that

influence their decision to undergo health screening. The researchers followed the interview guide which was developed based on a systematic review of barriers and facilitators to health screening in men,[38] theories (integrative model, health belief model and masculinity theories),[45–47] experts' opinions and researchers' experiences (see online supplementary appendix 1). It was pilot tested with three participants and revised accordingly. The interviews were conducted in a private room at the participants' workplace and there were no other personnel in the room during the interviews. One researcher led the interview while the other took field notes. The IDIs and FGDs were conducted until data saturation was achieved.

Data analysis

The audio-recorded interviews were transcribed verbatim, checked and analysed using the NVivo 10 software. The transcripts were not returned to the participants for comment. Two researchers (CHT and CJN) first familiarised themselves with the data by reading the transcripts and field notes of the first (IDI) and the second (FGD) interviews repeatedly. They independently assigned codes to each phrase, sentence or paragraph of the transcript based on the study objective (open coding). The codes were merged to form bigger themes interpreted based on the relationship identified between and within the codes (axial coding). Both researchers met to discuss the analysis and any differences in the coding were resolved through consensus. The analysis was also confirmed by a third researcher (AW). CHT subsequently coded the remaining transcripts and discussed any new codes that emerged with the research team. Throughout the analysis, the interpretive description approach was used by performing constant comparison to identify similarities and differences in the views and experiences of health screening among the participants. The data were interpreted in the context of the participants' age, ethnicity, job position, screening status and interview mode (IDI vs FGD). Three researchers, a professor in men's health (AW), a professor in family medicine (CJN) and a health researcher (CHT), were involved in data collection, analysis and writing up. All researchers were trained in qualitative research; CHT was trained in qualitative research and had conducted qualitative interviewing previously; CJN conducts qualitative research workshops and had published qualitative research articles; while AW is an experienced qualitative researcher and had published extensively. The researchers critically examined their own roles and challenged the interpretations of the data throughout the study to reduce potential biases.

RESULTS

Eight IDIs and five FGDs were conducted from July to November 2015. A total of 31 men participated in this study and their characteristics are shown in table 1. The age of the participants ranged from 24 to 64 years and 10 of the 31 were aged ≥40 years old. Two men cancelled the interview appointments due to a busy schedule and feeling unwell. The duration of the interviews ranged from 30 min (IDI) to 90 min (FGD) and there was no repeat interview. This study identified six factors that influenced young men's health screening behaviour: misconceptions, receptivity, life priorities, cost considerations, doctors' influence and medical overuse (figure 1). The italicised subheadings below and in figure 1 indicate factors that are unique to younger men. The participants did not provide feedback on the findings.

Table 1 Participants' characteristics

Characteristic	N	%
Age, years		
20–29	11	35.5
30–39	10	32.3
40–49	5	16.1
50–59	4	12.9
60–69	1	3.2
Ethnicity		
Malay	14	45.2
Chinese	12	38.7
Indian	3	9.7
Others	2	6.5
Job position		
Senior manager	8	25.8
Officer	7	22.6
Sales advisor	9	29.0
Clerk	7	22.6
Education level		
Primary school	1	3.2
Secondary school	4	12.9
Certificate/diploma	8	25.8
Degree	17	54.8
Postgraduate	1	3.2
Regular screening		
Yes	13	41.9

Misconceptions about health screening

Screening is not part of prevention

Young men often did not perceive screening as part of prevention, unlike health promotional activities such as exercise and diet. They could not differentiate between 'screening' and 'diagnosis'. They would go for a medical 'check-up' when they had symptoms, such as pain, or when ill. Some of them mentioned that it was the Asian culture to seek help from doctors when sick, not when they were healthy.

> If I have time, I will go for check-up. If I have no time, I won't. It is fine because I am already exercising regularly. When I suddenly feel like not OK, like feeling weak, then I'll go for a check. If I feel strong, there is no need to check.
>
> (Malay, Clerk)

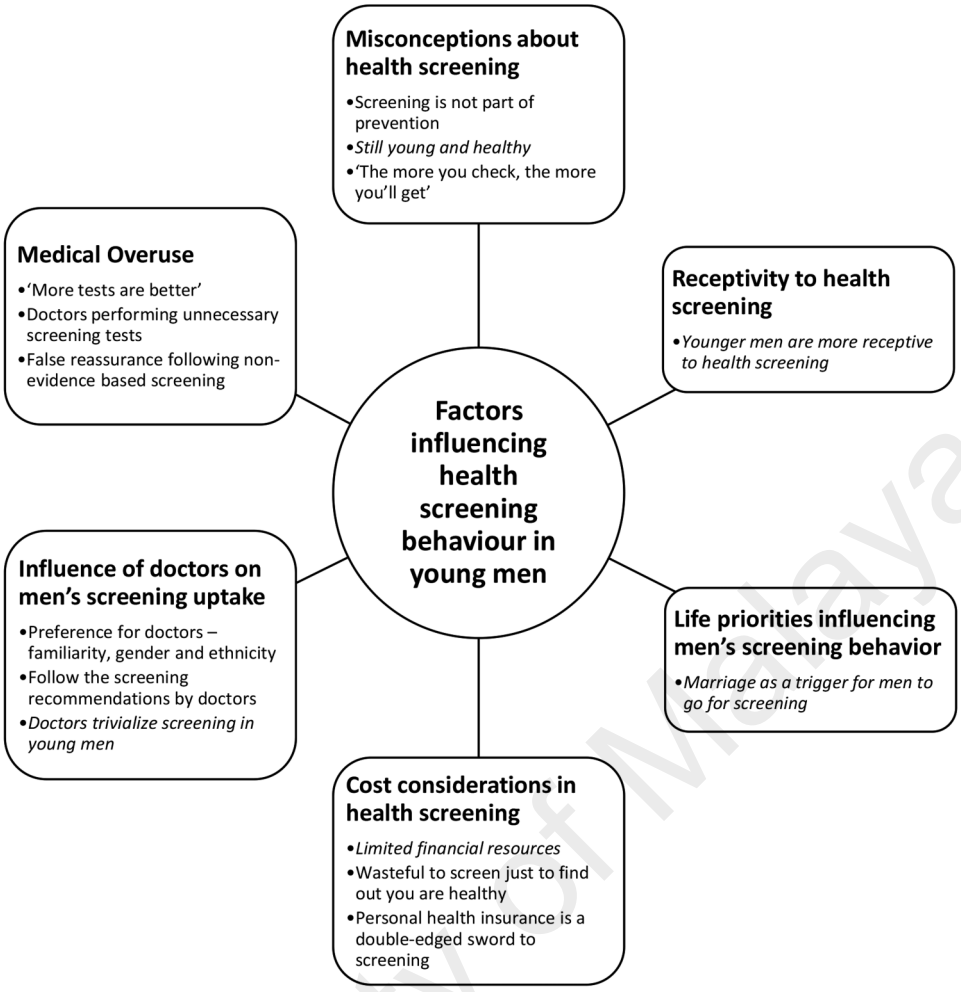

Figure 1 Summary of the factors that influence young men's health screening behaviour.

[Participant's father was diagnosed with serious diseases and he was probed whether that prompted him to go for health screening] "… Not as in like 'you may also fall sick, you got to go and check'. But instead of going for screening, I would take it as 'I need to start living a healthy life', like let's say drink a lot of water, sleep at least about 8 hours a day, something like that."

(Other ethnicity, Senior manager)

It's not like my friends in Australia and in England, they're not afraid of hospitals, they don't have this phobia of going to clinics or hospitals. But for us, even now, until today, I think it's a burden for me to go to the hospital, the thought of 'Oh, tomorrow I got to go to the hospital', you have all these negative things. I think we are in the system where we go to the hospital to get a cure, to find the remedy for it, whereas people in the developed nation, they go there because they want to prevent it (the disease).

(Malay, Senior manager)

Still young and healthy

Most younger men did not bother to go for health screening because they felt that they were still young and healthy. They considered screening as being unnecessary and would delay going for it as long as they were 'able to perform routine activities without difficulties' and leading a healthy lifestyle.

Because we are still young, so we don't bother about screening too much.

(Chinese, Sales advisor)

The test lab sent letters asking me to go (for screening) again but I have been monitoring my diet carefully, and I can sleep, can move and can run, so I did not bother about it.

(Chinese, Sales advisor)

Screening is important but you can delay it because you do not have it [disease] yet, not feeling the pain yet.

(Malay, Officer)

'The more you check, the more likely you'll get it'

On the other hand, some younger men considered it a taboo to talk about screening as they felt that it was self-fulfilling: 'you will get the disease if you keep thinking

and talking about it' and 'the more you check, the more likely you will get it'.

> People go on to live until they're 80 and they die of something else. So, the body fixes itself, you know. So maybe what you don't know won't kill you. Sometimes I think it's self-fulfilling. When someone says you have a disease, you behave that way.
>
> (Chinese, Senior manager)

Receptivity to health screening

Younger generation are more receptive to health screening

The younger participants mentioned that they were more open and receptive to health screening than older men because the younger generation had more access to health information and hence were more health aware.

> I think we [the younger generation] are more open to suggestions. But the older generation, they are a bit resistant to new ideas. Now people have social media, these kind of things at least we got to know about, eg, free health screening campaign, 'Hey why don't we go, since it's for free'. But then for the older generation, they always felt that, 'I am ok, I am healthy, so although it's free why should I do it?' That kind of mindset.
>
> (Malay, Officer)

> But I can see the changes with my daughter. She's not worried about hospital. And anytime that she suffers from something you know, she always insists on going for a check-up and everything. So I can see the changes already. But for my generation and upwards, no. Hospital is the last place you want to go.
>
> (Malay, Senior manager)

Life priorities

Marriage as a trigger for men to go for screening

Some men did not consider screening until they were married. Marriage made them more health conscious because they felt a sense of responsibility and wanted to stay healthy for their family. For those participants who were married, their partners played an important role in motivating them to go for health screening.

> You know when I was younger, the priority was basically you work and work, you want to make more money, so I stayed over time [in the office], sometimes you sleep less, you know. All we think about is that you want more money to go and enjoy yourself. But once you get married and once you are old, the priority changes. I go for regular check-up and things like that. You worry about things, you know. Because whatever you do will impact you, your wife and also your family.
>
> (Indian, Senior manager)

Cost considerations in health screening

Limited financial resources

Young working men, who had limited income and young families, often had financial commitments including servicing loans for their house, car and education. This made health screening a lower priority at that stage of their life. They would only go for screening if it was free or paid by the company.

> I think it also depends on a person's stage of life, like eg, I just bought a house and I need to renovate it. So asking me to go for a health check-up, asking me to spend 300 or 400 or 1000 dollars is out of the question.
>
> (Chinese, Officer)

> If the company doesn't cover for me, I would not go.
>
> (Chinese, Senior manager)

Wasteful to screen just to find out you are healthy

Some younger men considered it 'wasteful to screen just to find out that you are healthy'. Some even reduced the frequency of screening to save cost, especially when the screening test results were persistently normal.

> Because we are sure we're healthy then we don't have to spend our money to go to the clinic. For me, if I don't get a fever, my life is healthy, I can do everything, and I don't feel sick.
>
> (Malay, Sales advisor)

> You don't want to be wasting four, five thousands for a test which ends up telling you that you are healthy. Yeah. Just to fulfil your need of knowing that you are healthy.
>
> (Indigenous, Senior manager)

> I used to do [health screening] annually, then I noticed, every year I see the same report, same result, so, why waste the money? So now I delay 1–2 years and then only I do [go for health screening]
>
> (Chinese, Senior manager)

Personal health insurance is a double-edged sword

Having personal health insurance could be a facilitator or a barrier to health screening. Some participants who had personal health insurance were reassured that the treatment cost would be covered if a disease was picked up during screening. In contrast, some considered screening as an extra financial burden and would, instead, invest in health insurance so that the treatment cost would be covered if they fall sick.

> Some people won't go for check-up. Instead they might opt for insurance and felt that 'let's say anything happens, then I'm covered'. I think most of them feel that way. They considered that as 'preventive measures'.
>
> (Malay, Officer)

Influence of doctors on men's uptake of screening

Doctors' characteristics

When considering whether or not to undergo health screening, most men preferred doctors whom they could trust, especially those with whom they were familiar (eg, a family doctor or personal friend). They also preferred doctors of the same gender, particularly among the Muslim men, because they found it easier to

establish mutual understanding and were more at ease with male doctors, particularly when discussing sexual issues or undergoing genital or rectal examination. They also preferred doctors of the same ethnicity because they shared the same language and culture.

> Well my records are with him, he knows all my history so well. I just talk to him freely on my health issues. If I change to another doctor, then I will need to start all over again. This hospital will need to transfer all my records to other hospital, and then the new doctor has to read through my records again, and trying to get the picture of my health. So it takes time.
>
> (Chinese, Senior manager)

> I prefer a male doctor. It is easier for us to talk; it is about men. If the doctor is a female, you will be shy or … is a barrier if you want to say something personal. You know the [female] doctor is professional, but for us, like us Malay, sometimes we have got 'adat-adat sopan' [polite culture]. You don't want to … you cannot be too rude to ask the female doctor. If you got any disease on your private part, how do you want to tell her? For us … like me, Malays, like sometime, I would not be comfortable. If I have a choice, It's better to see a male doctor, rather than a female.
>
> (Malay, Officer)

> I prefer Chinese because we can communicate easier [in Chinese], easier to understand. If it is Malay, we may not understand.
>
> (Chinese, Sales Advisor)

Doctors' recommendations

Most men would follow their doctor's advice whether or not to take up health screening. Most doctors would recommend screening for cardiovascular disease but few recommended cancer and mental health screening, such as depression.

> It's a full medical check-up, they took my blood test, and then I have to go through the stress test. So, based on the normal graph, everything is ok. But the doctor advised me to go further to angiogram, because that one [stress test] is not accurate according to the specialist, you need to go for angiogram to check.
>
> (Malay, Senior manager)

> I don't remember the doctor asked me whether I am feeling depressed or have little interest in doing things. He is focusing more on my physical health.
>
> (Malay, Senior manager)

> I'm surprised that until now the doctor has not recommended bowel cancer screening to me [this participant is above 50 years old].
>
> (Indian, Senior manager)

Doctors' negative attitudes towards screening in younger men

Some of the younger men in this study mentioned that doctors were disinterested in engaging them in health screening. They felt that the doctors did not listen and explain much about the tests and did not allow them to ask questions. These younger men felt that they were not taken seriously because they were young and assumed to be healthy. One young participant was asked by the doctor 'Why did you screen so much?'

> The questions they asked are quite standard and the doctors seem to be disinterested. So I am not too sure whether that was a proper medical check-up. Some of them have the tendency not to listen to me and they kind of like to jump to conclusion. I wanted to ask more questions but the doctor wasn't in the mood to entertain my questions.
>
> (Chinese, Officer)

Medical overuse

'More tests are better'

Most of the men in this study would let the doctors decide which tests they should go for. Others would choose the packages offered by commercial laboratories. They wanted 'detailed' rather than basic tests, which they felt might not be enough to assess one's health. Most considered 'more tests are better', especially if the cost is covered by the bank.

> It's the completeness. Those normal tests are basically only taking blood and urine for testing. It doesn't include ultrasound, no ECG, no X-ray. Of course, the full one is definitely better.
>
> (Chinese, Senior manager)

> I think those that we have gone through [pre-employment check-up] are very superficial. If you want to do [screening], you must do those [tests] that zoom into detail, very detailed tests that check your organ functions, whether they are ok or not. I think these tests are more important, but they are very expensive.
>
> (Chinese, Sales Advisor)

Doctors performing unnecessary screening tests

Some men lost trust in their doctors when they found out that unnecessary tests were ordered, especially if they were done just for profit. This would not only incur additional costs but might also cause harm.

> These days, the medical field can be quite commercialised. Doctors would advise you to take up certain screening tests, which are expensive and unnecessary. This does prevent people from going for screening, like for some of my friends, after they saw the so-called 'unethical' practice.
>
> (Chinese, Officer)

> I have problems with this because sometimes I doubt the integrity of the physician. This fellow is trying to make money, you know, ordered all kind of things that you don't need.
>
> (Chinese, Senior manager)

False reassurance following screening

Screening may provide false reassurance to men, especially when the test is not accurate to screen for the disease.

> I have a friend, a smoker. He did his tests and everything, when he came out he said, 'Oh sh*t, my report is bad, high cholesterol, all are not good. However, the x-ray showed that my lung is perfect. Yeah! I'm a smoker but my lung is good. Healthy.' Then what can you say?
>
> (Chinese, Senior manager)

DISCUSSION

This study identified some important factors that influenced young men's health screening behaviour. There were misconceptions about health screening, higher receptivity towards screening, life priorities, cost considerations, doctors' influence and medical overuse. Most of these factors are applicable to both younger and older men, but there are a few that are unique to younger men.

Our findings showed that the young men in our sample lacked understanding regarding health screening. They were more aware of health promotional activities such as exercising, maintaining healthy diet and adequate sleep, but did not see health screening as part of prevention. When asked about their past experience in health screening, they misunderstood it for diagnosis. This lack of understanding could be due to lack of awareness of men's health and the fact that current health campaigns often target women.[48 49] When men are targeted, older rather than younger men are often the focus. In addition, younger men tend to have a lower risk perception of diseases as they are still young and healthy, which has also been found in other studies, where healthcare is used only when men have symptoms.[50 51] A participant cited that 'seeing a doctor only when sick' was part of the Asian culture, which is in line with the study by Dryden *et al*[27] who found that this health-seeking behaviour is less prominent among non-whites. These misconceptions about health screening need to be addressed, particularly through public awareness programmes and health education.

Compared with the older generation, the younger men in this study were more aware about health and expressed a desire to take care of their health, especially among Chinese men. The younger men are more exposed to health information and therefore more receptive to health matters, probably due to accessibility to the internet. This is in accordance with the number of internet users in Malaysia, where 72.6% of internet users are aged between 20 and 44 years.[52] A report on activity of internet usage in the USA showed that 35.5% of people who were connected to the internet searched topics related to healthcare.[53] In addition, studies have found that internet-based interventions are effective in changing health behaviours—for example, increased exercise time, nutritional knowledge and screening uptake.[54–56] Thus, the internet could potentially be an effective platform to promote health screening in this group of 'hard to reach' men.

Cost is an important consideration among young men when they make decisions about screening. Young men are at the phase of building their career and family; they often have limited income with many financial commitments. Health screening is therefore not a life priority. This observation holds true in this study, except for those who were married. Marriage was perceived as a significant life event and it changed men's attitude towards health including screening uptake. Men care more about health after marriage as they need to stay healthy to take care of their family. Therefore, marriage may be an important transition point in life to reinforce the importance of health and screening in men. In addition, many studies have found that partners play an important role in motivating men to go for health screening.[27 37 49 57]

Doctors' recommendation is an important factor that influences men's decision to take up screening; however, in this study it was found that doctors were less likely to initiate screening in younger men. Although the USPSTF recommends screening for younger men based on their personal health risks,[23] doctors often do not recommend screening to younger men as they perceive them as a low-risk group. A qualitative study reported that doctors' intention to initiate health check-up discussions with men was related to doctors' perception of men's receptivity to health check-ups.[58] Doctors perceived that older men were more receptive to health screening and thus were more likely to discuss health screening with them. However, this pattern may be changing as young men were found to be receptive to health screening in this study, especially when its benefits had been made clear to them. Doctors' perceptions towards and practice of health screening in young men need to be realigned according to established clinical practice guidelines.

The issue of medical overuse was raised by the participants. When undergoing health screening, young men wanted more screening tests and some doctors tended to promote unnecessary screening tests. This is probably because young men did not realise that some of the tests were inaccurate and not evidence-based. Some doctors also recommended unnecessary tests for profit, which caused men to lose trust in the doctors. In addition, screening tests are often offered in packages rather than tailored according to men's health profile. For example, non-evidence-based screening tests such as a chest X-ray is still mandatory for pre-employment check-up in Malaysia. When the chest X-ray turns out to be normal, men will use it to justify their smoking behaviour. The same observation was also found in high-risk smokers who had low-dose CT for lung cancer screening.[59] Morgan *et al*[24] has outlined several strategies to mitigate medical overuse including constraining resources at the system level, highlighting low-value clinical services to the healthcare providers and involving patients in

shared decision-making. However, these strategies have not been evaluated. More effort and interventions need to be put in place to curb medical overuse, including screening in young men.

Masculinity did not emerge as a main barrier to screening in this group of men, albeit being probed during the interviews. This is unlike studies with communities such as African-Americans, which found that 'machismo' is a common barrier that prevents men from taking up screening.[36] They are expected to be 'staunch', and seeking healthcare is considered a sign of weakness.[48] However, when probed about mental health, a few men in this study cited that they did not want to be screened for mental health problems such as depression. Similar to other studies, men with high levels of gender conflict were reported to be less likely to seek help on mental health issues as opposed to physical health problems.[60–62] Depression conflicts with the masculine norm such as stoicism; it may also increase self and societal stigma, which may explain why these men disfavour mental health screening.[63] Efforts should be taken to address the negative impact of conforming to the masculine norm and to encourage men to be screened and to seek help for depression in view of the high suicide rate among men. This study highlighted the need to address men's misconceptions about health screening; this requires effective interventions that provide accurate information about health screening. Men should be made aware of screening tests which are evidence-based and educated on low-value screening tests which should be avoided. In addition, future screening programmes for men must take into consideration men's life stage when developing an intervention, as men have different priorities and needs at different stages of their lives.

Strengths and limitations of the study

This study has several strengths and limitations. We focused on the health screening behaviour of young working men in the community, an important yet frequently overlooked population. The study was conducted with men in the community rather than those attending clinics as this group of men could provide views of men who tend to underuse health services. This study captured a wide range of views, experiences, barriers and facilitators to attending health screening from men across different ethnic groups, age, job positions and screening behaviour. However, most of the participants had received a higher level of education, resided in an urban setting and were working within a single banking institution. Therefore, the findings may not be generalisable to other populations and employment sectors in Malaysia.

CONCLUSION

This study highlights a number of important factors that influence the health screening behaviour of young men. These include misconceptions about screening, receptivity towards screening, life priorities, cost considerations, doctors' influence and medical overuse. Health authorities need to address young men's misconceptions, promote the importance of early detection and develop a health screening strategy for them. Appropriate measures also need to be put in place to address the issues of medical overuse in order to reduce low-value healthcare and improve the health status of young men.

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PLOS ONE

RESEARCH ARTICLE

What Do Men Want from a Health Screening Mobile App? A Qualitative Study

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Abstract

There is a lack of mobile app which aims to improve health screening uptake developed for men. As part of the study to develop an effective mobile app to increase health screening uptake in men, we conducted a needs assessment to find out what do men want from a health screening mobile app. In-depth interviews and focus group discussions were conducted with 31 men from a banking institution in Kuala Lumpur. The participants were purposely sampled according to their job position, age, ethnicity and screening status. The recruitment was stopped once data saturation was achieved. The audio-recorded interviews were transcribed verbatim and analyzed using thematic approach. Three themes emerged from the analysis and they were: content, feature and dissemination. In terms of the content, men wanted the app to provide information regarding health screening and functions that can assess their health; which must be personalized to them and are trustable. The app must have user-friendly features in terms of information delivery, ease of use, attention allocation and social connectivity. For dissemination, men proposed that advertisements, recommendations by health professionals, providing incentive and integrating the app as into existing systems may help to increase the dissemination of the app. This study identified important factors that need to be considered when developing a mobile app to improve health screening uptake. Future studies on mobile app development should elicit users' preference and need in terms of its content, features and dissemination strategies to improve the acceptability and the chance of successful implementation.

Introduction

Health screening is a key component in disease prevention framework. Through regular health screening, one can detect diseases and identify risk factors early when there is still a window of opportunity for interventions before the disease worsens. Despite the importance of health screening, the uptake remains low, particularly in men [1–4], who face barriers related to individual, social, health system, healthcare professional and screening procedural factors. At the individual level, lack of knowledge, lack of symptom, fear of positive results, masculinity attributes and lack of time are common barriers to health screening in men [5, 6]. Social stigma

and negative peer influence also hindered men from going for screening [7, 8]. Other factors such as poor accessibility to screening services, cost, lack of physician's recommendation and uncomfortable screening procedure also contribute to the low uptake of health screening in men [5, 6, 9]. There is a strong imperative to get men engaged in screening as they have been found to be particularly susceptible to ill-health and premature death as a result of conditions that are readily identifiable and treatable if picked up soon enough [10–14].

Many interventions have been developed to increase the uptake of health screening in men. They are often delivered through health education workshops, partner's involvement, printed messages, reminder call and videos [15–20]. However, these interventions are costly, labor intensive and the dissemination may be limited. Increasingly, information communication technology (ICT)-based interventions, such as web-based decision aids and social media, are being used to improve screening uptake, particularly in hard-to-reach men [21, 22]. To date, few studies have reported on the development and effectiveness of using mobile app to promote health screening.

Health-related mobile apps are increasingly being used and mobile health (mHealth) has become an important tool to improve healthcare. mHealth is able to remove geographical and temporal barriers; it helps to deliver just-in-time healthcare to people at their preferred location [23]. Men, especially the younger group, tend to spend considerable amount of time on their mobile phone. In 2015, on average, both Americans and Malaysians spent about three hours on their mobile devices every day [24, 25]. This creates an opportunity for mobile apps to be used as a platform to potentially improve knowledge and increase uptake of health screening in men.

Several studies have reported that mobile apps are effective in modifying health behavior and improving health status. For example, mobile apps have been found to promote healthy diet and physical activity; improve coping with depression; reduce self-injurious thoughts and behaviors; and reduce medication error [26–29]. Nevertheless, among 165,000 health apps that are available to consumers in 2015, only 12% account for 90% of consumer downloads [30]. Moreover, users have reported that they stopped using some mobile health apps because they had high data entry burden, not interesting, too confusing and did not meet users' needs [31]. Therefore, it is important to identify users' preference and needs before developing a mobile app to improve its acceptability and effectiveness [32, 33].

Recent reviews on mobile health apps did not find any health screening-related app. Most of the health apps were developed for healthcare professional rather than for public or patients [34, 35]. A search in app stores found that most of the health screening mobile apps are disease-specific; few provide a 'one-stop platform' for comprehensive health screening. For example, the Electronic Preventive Services Selector (ePSS) app is a comprehensive screening mobile app which was developed based on the USPSTF's recommendations [36]. However, this app targets clinicians and the content is not written for lay people. As part of the study to develop an effective mobile app to increase men's health screening uptake, we conducted a needs assessment and interviewed men to find out what do they want from a health screening mobile app.

Materials and Methods

Study Design and Context

This qualitative study used the interpretive descriptive approach to explore what men want in a health screening mobile app. We conducted semi-structured in-depth interviews (IDIs) and focus group discussions (FGDs) with young men in Kuala Lumpur (KL), Malaysia. KL is the capital of Malaysia with good healthcare accessibility. It is a fast-paced city with a highly

competitive working environment. Since, the app is mainly intended for the hard-to-reach men (who are less likely to seek healthcare) in the community, we chose healthy working men, specifically men who are working in a banking institution in view of the stressful and sedentary nature of their job. This study was approved by the University of Malaya Medical Centre Medical Ethics Committee (MECID NO: 201410–701).

Sampling and Recruitment

We used purposive sampling to recruit men from different age, ethnicity, job position and screening status in order to achieve maximal variation. The participant must also have a smart phone. We contacted a banking institution and sought approval to conduct this study with the staff. The human resource department helped to send emails to all male staff in the organization to invite them to participate in this study. We then made appointments with the participants and conducted the IDIs and FGDs at their workplace. For FGDs, we delimited the group by job position to ensure homogeneity, so that the participants were comfortable discussing and disclosing their views without hierarchical influences.

Data Collection

Two researchers who were trained in qualitative interviewing and have multilingual ability conducted the IDIs and FGDs. The FGDs trigger interactions and take advantage of group dynamics while the IDI allows the researchers to explore more personal or sensitive issues in depth. The findings from both methods can also be used as a form of triangulation. The IDIs and FGDs were conducted in the language familiar to the group or participant. One of the researchers took field notes while the other led the interviews. To initiate an interview, the participants were first asked whether they were using any health-related mobile app (including health screening) and if so, to describe their experience using the app. We probed for any pros and cons of the app; what characteristics they did and didn't like regarding the app; what made them keep using or deleted the app. Then, we explained our intention to develop an app to promote health screening. We asked their opinions about the idea and their suggestions of what to be included in the app. Lastly, we asked the participants how to spread and make men download and use the app. Written consent was obtained from all participants and the interviews were audio-recorded. The recruitments and interviews were conducted until data saturation was achieved.

Data Analysis

All the recorded interviews were transcribed verbatim and the NVivo 10 software was used to manage the data. All names of the participants were coded in the transcripts to ensure anonymity. We analyzed the data using the thematic approach. First of all, two researchers read and reread the first transcript (IDI), second transcript (FGD) and field notes to familiarize themselves with the data. Then, the researchers independently performed open coding, where codes were assigned to each phrase, sentence or paragraph of the transcripts based on the study objectives. Subsequently, axial coding was performed, where the existing codes were combined to form bigger themes according to the relationship found between and within the codes. All researchers met to compare the similarities and differences in the analysis. Any differences were resolved through consensus and this was confirmed by the third researcher. One researcher then continued to code the remaining transcripts and discussed any newly emerged codes with the research team. The researchers also performed constant comparison throughout the analysis to form the final framework. The researchers constantly reflected on their background and roles throughout all phases of the study to avoid potential biases in the results.

Results

Eight IDIs and five FGDs involving 31 men were conducted from July to November 2015. The summary of participants characteristics are shown in Table 1 and the detailed characteristics with participant code are presented in Table 2. Three themes emerged from the analysis and they were: Content, Feature and Dissemination. There were four sub-themes under each of the theme as illustrated in Fig 1.

Theme 1: Content

Information. The participants did not know much about health screening and the doctors often did not have time to explain to them due to short consultation time. They suggested that the screening health app should include information about their health risks, benefits and risks of health screening as well as screening services available to them. Besides screening, the app should provide additional health information such as advice on fitness and healthy diet.

> "You have to put in what is health and explain it. People know that healthy is no pain or symptom. Most people don't know much about screening."
> (F3, translated from Malay)

> "If you don't provide the explanation, one will be like, 'it [screening] can wait'. I do not know what is the impact and risk."
> (F3, translated from Malay)

Table 1. Characteristics of all participants.

Characteristic	Number	Percentage (%)
Age		
20–29	11	35.5
30–39	10	32.3
40–49	5	16.1
50–59	4	12.9
60–69	1	3.2
Ethnicity		
Malay	14	45.2
Chinese	12	38.7
Indian	3	9.7
Others	2	6.5
Job Position		
Senior Manager	8	27.8
Officer	7	22.6
Sales Advisor	9	29.0
Clerk	7	22.6
Education level		
Primary school	1	3.2
Secondary school	4	12.9
Certificate/Diploma	8	25.8
Degree	17	54.8
Postgraduate	1	3.2
Regular screening		
Yes	13	41.9

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Table 2. Participant code and characteristic.

Participant code*	Age group	Ethnicity	Position	Education	Regular screening
I1	30–39	Indian	Officer	Degree	No
I2	30–39	Other	Senior manager	Postgraduate	No
I3	50–59	Indian	Manager	Certificate/Diploma	Yes
I4	40–49	Malay	Clerk	Primary school	No
I5	20–29	Malay	Sales advisor	Degree	No
I6	30–39	Chinese	Senior manager	Degree	Yes
F1	50–59	Chinese	Senior manager	Degree	Yes
F2	40–49	Malay	Senior manager	Degree	No
I7	60–69	Chinese	Senior manager	Certificate/Diploma	Yes
F3	50–59	Malay	Clerk	Secondary school	No
F4	40–49	Malay	Clerk	Secondary school	No
F5	40–49	Malay	Clerk	Secondary school	No
F6	30–39	Malay	Clerk	Secondary school	No
F7	30–39	Indian	Clerk	Certificate/Diploma	Yes
F8	30–39	Chinese	Officer	Degree	No
F9	20–29	Malay	Officer	Degree	No
F10	20–29	Malay	Officer	Certificate/Diploma	No
F11	20–29	Malay	Officer	Degree	No
F12	20–29	Malay	Clerk	Certificate/Diploma	No
F13	20–29	Malay	Officer	Degree	No
I8	40–49	Malay	Officer	Degree	Yes
F14	50–59	Malay	Senior manager	Degree	Yes
F15	30–39	Other	Senior manager	Degree	No
F16	30–39	Chinese	Sales advisor	Degree	Yes
F17	20–29	Chinese	Sales advisor	Certificate/Diploma	Yes
F18	20–29	Chinese	Sales advisor	Certificate/Diploma	Yes
F19	20–29	Chinese	Sales advisor	Degree	Yes
F20	30–39	Chinese	Sales advisor	Degree	Yes
F21	30–39	Chinese	Sales advisor	Certificate/Diploma	Yes
F22	20–29	Chinese	Sales advisor	Degree	No
F23	20–29	Chinese	Sales advisor	Degree	No

* Note: I = IDI; F = FGD

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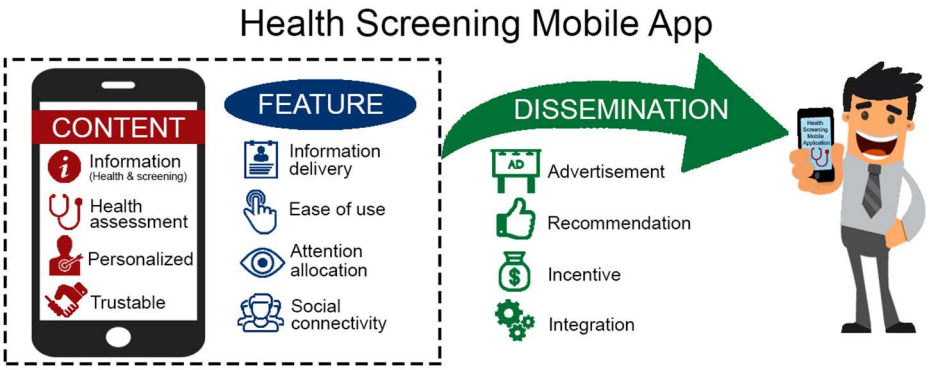

Fig 1. Three main themes of what men want from a health screening mobile app.

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"Some kind of advice or comments saying that if men doing regular check-up, or regular exercise, you would reduce what kind of disease, and by how many percent."
(I6)

"Some kind of a suggestion to select where to go, which one we prefer to go, which one is nearer to our home? Is it a trustworthy doctor or not? Reliable or not?"
(I7)

"I mean you can also instead of just encouraging people to come for health screening, you can also have some other things like talking to people about fitness level, things they can do to keep themselves healthy, you know. So when they look at it, they will also look at some of the health screening that need to be done. So you need to link up food and also fitness. Because I think all these three work hand in hand."
(I3)

Health assessment. The participants in this study felt that an ideal health screening app should have functions that can directly measure and assess their health status. The app should provide the convenience of doing the screening at home in privacy rather than going to the doctor. Most of the participants proposed that the screening app should be able to perform all relevant screening tests, for example heart rate measurement. In addition, this must include assessment of mental and sexual health, which are often not screened by the doctors. Besides for screening purpose, the participants proposed that the app should also include diagnostic function.

"I would love to be able to have that access to do tests on my own, from perhaps at home, like let's say there's a function that, take a deep breath and hold it and then check. What is the heart rate, you know, and then you key in. What's the color of your pee, is it red? or is it yellow or white? And then there should be a button there, 'Diagnosed'. Then the app will feedback and say 'Ok, you are having this, this and this.' Probably can give me an immediate advice that, 'You probably just did not drink a lot of water, you need to drink water' or probably, 'This is a very complicated disease, you need to go and check with the doctor who could advise you further and suggested hospital. . . doctors. . .', you know. That would be very useful. I don't mind paying for an app. Fifty Ringgit (USD 13) for that."
(I2)

"I think I want to check for mental health, stress, depression. These may have an impact when you want to drive, or operate machines. Like sexual health too, sometimes we have problems, not strong. I think this is also important for men. Assess and suggests ways to be stronger or ways to prevent erectile dysfunction. Men like this [kind of assessment], can attract attention."
(F4)

Personalized. The information provided by the app must be tailored. The participants did not want to be overloaded with information but preferred the app to provide individualized feedback and advice on their health. For example, the app should be able to provide information on the user's health risks, recommend which screening tests the user should undergo, where is the nearest screen center and what actions the user needs to take to stay healthy. The app must be gender-sensitive and is developed specifically for men.

"It will give information, but not full of information. We have to input our health profile, then it will feedback to us. You have to go for this screening and that screening. People who use this app will know, I need to do this, this and this."
(F4)

"If want to screen, screen for what, when, how frequent. Like me, I obviously don't know. When do I need to go for screening when I am healthy. What I know now, if healthy, no need, if sick, we go."
(F6, translated from Malay)

"What's the point of telling this person that you have this and this problem but don't give them a solution after that. You have to also give them solutions so that they can use one app for both."
(I3)

"To me, I prefer a male-specific app, because it means that, there must have been some thoughts going into it. To the fact that this is only for men's illness.
(F1)

Trustable. The participants preferred a health screening app that they can trust. It must be able to keep their personal information especially medical data in a secured manner. In addition, the app must contain up-to-date information and come from a credible source such as the government or professional bodies.

"Ok but I will only follow [the advice] if I feel that the source is credible you know, those that have scientific basis."
(F1)

"If like approved by the government or professional bodies, maybe people will download it more."
(F13)

Theme 2: Feature

Information delivery. The participants suggested that the app should provide succinct information and use laymen terms. They also found pictures or video easier to understand compared to text. Some emphasized that health messages must be delivered in a sensitive manner so that it does not cause emotional harm to the users. Language was another important issue raised by the participants. There should be an option to select the language they preferred.

"It cannot be too lengthy you know. You might not have the chance and time to read all the detailed information. Concise and simplified, otherwise, let's say you give me 10 selections, I will be cracking my head, which one should I go? Maybe you reduce it to 4 or 5, then I can make a faster decision on that."
(I7)

"For the explanation, it may be good if there is a video or pictures."
(F3)

"Some people are not good in English, often misinterpreted after translating to Malay, especially the elderly, they don't understand. We have Malay, Chinese and Indian in Malaysia, better make it in two versions, English and Malay."

(F4)

"I think you, you need to start off by saying your benefits first before you even get information from them you know, like 'this app will be able to do this and how it can help you, then in order for us to gauge your health, these are the basic information we need from you.' You don't straight away shoot them with questions as that will demoralize them. You got to use a nicer approach and make sure that your words and all are pleasant. Don't hit a person too hard like telling them 'I think you have diabetes' as that might affect a person emotionally and he or she may never use that app again."

(I3)

Ease of use. Apps that imposed a taxing data entry process are undesirable. The participants suggested that the app should be able to detect health information automatically from devices such as wearables, online account or a hospital database.

"Keying in the data is a hassle for me. I mean unless it can detect automatically. Something that connects to data. It's like connecting GPS data you know; you store somewhere that I don't have to do anything about it. Then fine."

(F1)

"I think for an app, if I need to type so much information, it won't be so convenient. People are most concerned about data entry burden when using app nowadays. People want something fast. Like wristband for sport, it can detect your heart rate, maybe auto-extract data from these things.

(F23, translated from Mandarin)

Attention allocation. The participants suggested several ways to ensure that the app being kept and used by the users. Reminder was the most common method mentioned by them. The app should not only be able to remind the user on upcoming health screening date, it should provide daily or weekly reminder on ways to improve health.

"One more thing is if the app can provide reminder for us, like every six months we have to go for medical check-up. (F3, translated from Malay) Sometime we are busy and forgot. (F5, translated from Malay) Like a reminder for birthday, 'treet treet, today is your birthday'."

(F6, translated from Malay)

"I input my health profile and the app detected that my blood pressure is slightly high. Then, there should be a reminder for me, telling me that you know, let's concentrate on reducing the salty things for today, or sugar or reduce smoking if I'm a smoker, don't take curry, don't take coconut milk, reduce your sweetened drinks or whatever for this week. . . especially when we work we just forget about these."

(F2)

"For me I love the app that can send a reminder to me like I'm using right now. They count your daily steps and they will send you how much calories you burn every day. I think this

is quite interesting."
(F9)

"I think a reminder will be useful because when we work, we don't think of our health, we don't think of drinking water, a simple thing that is so important. So it's simple you know, it just reminds, every one hour or two hours, it just reminds us to drink water, so just go to the pantry and all that."
(F15)

Some suggested that the app should incorporate a health monitoring function and able to store their health data. The participants also suggested ways to improve sustained use of the app, including providing daily short health messages, giving incentives or reward and ability to function offline.

"I think another thing you can do is to store your medical information in the app. So in the apps, when you go inside you can see, 'Ok, my sugar level that time was this, so now is this and this. You can monitor you know. So that alone encourages them to go for more screening test, isn't it?"
(I3)

"So it's like easy, in the train you can just go through short write-ups about health. If you put it in a long paragraph, they won't read it. It's like short, short messages about health and yourself, like about how to take care of your eyes; every morning drink a glass of water; short messages that benefit health."
(I1)

"Maybe you can organize a contest so that they get something, you give them reward if they answered correctly. Maybe you can arrange the questions regarding health. Make it very interesting, like a game."
(I5)

"If it is offline, offline installation, don't need Wifi, is also fine. Because sometime we don't have Wifi or ran out of internet data."
(I4)

Social connectivity. Social connectivity could be another important component of the app. The participants suggested to incorporate a forum or blog into the app and it should also be able to connect to social media. This would help them to share experience, resources and motivate each other to go for health screening.

"So it would be like a forum or something? so that you can just post a question and share with peers."
(F15)

"I think sometimes one of the good ways to expose people is to understand other people's story. Because a lot of the blogs I've seen, they describe people's past experience you know they have this pain and what happened, the reasons and sometimes there are similarities in their story and my story."
(F8)

Theme 3: Dissemination

Advertisement. To increase the uptake of the app, the participants suggested to advertise it in various locations like hospital, gym, shopping complex, café, men's magazine and newspapers. The app can also be spread online especially via social media and messaging app such as WhatsApp. The advertisement must have attractive design and create the need for men to use the app.

"You can just send to one guy to be sent to another guy, it's a chain reaction, you see. Facebook is a good medium nowadays; a lot of people find something from Facebook."
(I7)

"The fastest way is through social media like Facebook. You can also have some simple links you can pass through WhatsApp."
(I3)

Recommendation. Recommendations by the doctors and promotion via celebrities are one of the ways to make men use the app. The participants also suggested that the app can be promoted via health events and health groups. A good review from third parties and encouragement of usage from peers are also good strategies to promote the app.

"My dad [a doctor] shared information on which website to go to with his patients and many of them really went to have a look at it. So in my honest opinion, I think the best way is through the doctor. I think that is a strong influence."
(F8)

"Normally I look at the reviews first, whether it's useful and whether it suits me. If let's say they say it is useful then only will I download it."
(F9)

Incentive. Providing incentives for people who used the app is another method suggested by the participants. Reward like discount voucher, free health screening or even monetary reward might improve the dissemination and usage of the app.

"If you want people to really blast it to more people, you got to reward them. Like I will get a small bonus, commission, points or something if I spread to my friends. That bonus I can translate to a free medical check-up or something like that. The more people you recommend, the more rewards you get out of it, you know."
(I3)

Integration. Rather than making men download the app, the participants suggested that it could be pre-installed and integrated into a new smart phone basic apps package The health screening app can also be integrated into existing successful apps that have huge user base. Some participants suggested that the company should integrate the app into the company healthcare policy to encourage all staff to download and use the app.

"Maybe you may install freely in the phone. Maybe you got co-link with Apple or Samsung that when people buy the package, the app is already installed. And then they must teach the customer how to run and what are benefit of this app."
(I8)

"If you don't key in, you won't get your salary. It is made compulsory. Or maybe as part of Key Performance Index."

(F16, translated from Mandarin)

Discussion

This study identified important characteristics that men want from a health screening mobile app and they are categorized into three key themes: content, feature and dissemination. In this study, men wanted the app to contain information about health screening and health assessment functions. The information and assessment must be personalized and trustable. The app must have user-friendly features in terms of information delivery, data entry burden, sustainability and social connectivity. Regarding dissemination, men proposed that advertisements, recommendations by health professionals, and providing incentive or delivering as part of a package may help to disseminate the app.

Lack of knowledge is often reported as a barrier to health screening [5, 37–39]. Men may not understand the benefits of screening and therefore do not perceive health screening as important. It is, thus, crucial to include information about health and health screening in health screening apps. In addition, men like mobile apps because they are able to assess their health at their own convenience rather than going to a health screening center. This might address the issues of accessibility, which is an important barrier to screening as highlighted in many studies [40, 41]. This study also found that men wanted privacy when screening. This finding concurred with studies which found that men preferred home-based to clinic-based fecal occult blood testing [5, 42]. However, currently, there are no accurate tools on mobile apps to screen for blood pressure and cholesterol. Nevertheless, questionnaire-based screening for mental health conditions such as depression are available in mobile apps [43, 44]. With advancement in biosensor research, future screening apps may be able to incorporate routine screening such as blood pressure and cholesterol measurements. This will likely to improve the uptake of screening using mobile apps.

In this study, men also wanted the health screening app to assess their individual health risk. It must also be evidence-based and come from credible source. Currently, there are several evidence-based risk assessment tools, such as the Framingham Risk Score which can be used to predict individual risk of developing coronary heart disease [45]. Credible organizations such as the United States Preventive Services Task Force (USPSTF) provides evidence-based recommendations on which health screening test should be performed; these can be incorporated into the app. Currently, the USPSTF recommends that men should be screened for hypertension, diabetes, dyslipidemia, colorectal cancer, HIV, sexually transmitted infections, hepatitis, depression, smoking, alcohol and obesity for men [46]. These, however, need to be tailored according to the individual's age, ethnicity, past personal medical history, family history and lifestyle to avoid medical overuse [47–49].

In addition, usability of mobile health apps affects users' decision to use the app. Nielsen states that a product with good usability must be easy to learn, efficient to use, easy to remember, have few errors and subjectively pleasing [50]. A health screening mobile app often contains medical information that may be difficult for users to understand. Therefore, it is important to consider carefully how the information will be delivered when developing the app. Another important barrier to using and sustaining a mobile health app is data entry burden, which was found to be the main factor for deleting a downloaded app [31]. Thus, when designing a health screening app, the developer should strike a balance between information accuracy and data burden, and only include essential information in the app.

Sustainability is another important factor raised by the participants. Although regularity is an important component of health screening, screening interval of some of the health

conditions, such as colorectal cancer, can be long up to once every five years [46, 51]. Therefore, men may not be accessing the app regularly and this increases the chance of the app being deleted. This is compounded by the fact men may not be aware of the regularity concept of health screening. Men tend to procrastinate, forget or ignore subsequent health screenings [52–54]. It is, hence, important to incorporate additional features in the app, such as reminders and alerts, health monitoring, daily brief health messages and rewards to attract men's attention so that they would continue using the app regularly.

Men also wanted social connectivity function in the health screening app. Social networks, specifically family and friends, were found to have a strong influence on men's decision to go for health screening [55, 56]. Through social networking, men are able to share resources, experience and motivate each other to go for screening. This finding concurs with those of weight control and HIV testing apps, where users desire social networking as part of the app [57, 58]. A randomized controlled trial using social media as an intervention has been found to be effective in increasing HIV testing among men who have sex with men in Peru [21]. This reaffirms the increasing importance of including social media as a feature when developing mobile health apps.

Dissemination is often not considered in the development of health interventions such as a mobile health application [59]. The impact of a health intervention does not just depend on its effectiveness but the extent of its reach [60]. Therefore, a useful and well-designed app will remain unused if there is a lack of effective dissemination strategy. This is particularly relevant to health screening apps, where, unlike mobile health apps for fitness and diet, men often do not seek mobile apps on health screening [31]. This is partly due to low awareness of health screening. In this study, men proposed several useful ways to disseminate the app, including advertisement, recommendation by healthcare professionals, providing incentives and integration of the app. These suggestions are not unique to health screening and can be applied to most health-related mobile app. These proposed strategies are crucial to reach out to targeted populations to ensure maximal benefits gained from the app.

This study has several strengths and limitations. We interviewed men in a banking institution consisting of a broad range of socio-demography using purposive sampling. Most of the studies on mobile app development are based on experts' opinions. This study explored the potential users' experience at the pre-development phase. We also incorporated the dissemination concept in this study which is lacking in the current literature on mobile health. However, most of the participants were from a higher level of education and resided in an urban setting. Therefore, the findings may not be transferable to the other populations in Malaysia. Future studies should explore the opinions of experts from various backgrounds needs to be incorporated when developing the app to ensure high acceptability and effectiveness [61].

Conclusions

This is one of the few studies that explored users' need before a mobile app is developed. We found that men wanted the app to contain personalized and credible information to guide them in making decision about health screening. They preferred a mobile app to conventional screening services because of its convenience and privacy. They also offered insights into ways to ensure sustainability, increase social connectivity and enhance dissemination of the mobile app. Future studies on mobile app development should elicit users' preference and need in terms of its content, features and dissemination strategies. We believe this will help to improve acceptability and increase the chance of successful implementation of a mobile app.

Author Contributions

Conceptualization: CHT CJN AW.

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Project administration: CHT CJN.

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Visualization: CHT.

Writing – original draft: CHT CJN.

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4.3 Development Phase

4.3.1 Paper 5: Teo, C. H., Ng, C. J., Lo, S. K., Lim, C. D. & White, A. (2018). A systematic and user-centered approach to developing a web-based mobile health intervention (ScreenMen) to improve evidence-based health screening uptake in men. (Under review)

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A SYSTEMATIC AND USER-CENTERED APPROACH TO DEVELOPING A WEB-BASED MOBILE HEALTH INTERVENTION (SCREENMEN) TO INCREASE UPTAKE OF EVIDENCE-BASED HEALTH SCREENING IN MEN.

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ABSTRACT

Objective: The objective of this paper is to describe the software development model used to develop ScreenMen, a mobile web app which aimed to improve evidence-based health screening uptake in men.

Materials and Methods: A multi-disciplinary team was convened. Theories were sought; evidence were reviewed; and needs assessment were conducted to inform the requirement of the web app. To form a development model, various software development process model, software prototyping and testing methods were searched. The researchers then met to agree on the methods used in the model.

Results: The development model consisted of four agile cycles: pre-alpha, alpha, beta and post-beta, with each agile cycle consists of five steps: requirement, design, build, test and review. Firstly, the theories, evidence and needs were synthesized to form the initial web requirement using a working sheet. Then, mock-ups were produced using rapid prototyping, which were reviewed by the experts. In the alpha cycle, the web prototype was built and tested by experts. The revised prototype was subsequently tested with end-users in the beta cycle. ScreenMen was finalized in the post-beta cycle. The final ScreenMen contains three modules: health screening educational video, health assessment and frequently asked questions.

Conclusion: ScreenMen was successfully developed using this development model. This model is agile and pragmatic, and can be used by researchers to develop mobile web-app in the future.

INTRODUCTION

Mobile health (mHealth) is an important means to improve health care; it makes healthcare possible for people at anytime and anywhere.[1] In 2016, 88% of Americans have access to the internet, 77% own smart phones and Americans spend about three hours of non-voice time on their mobile phones every day.[2-4] These numbers are increasing every day due to the rapid advancement of mobile technologies. In view of this, many mHealth interventions have been developed. While mobile app is gaining most attention, there are other types of mHealth intervention such as those using text messaging, phone call, voice-response technology and web-based technology, which may be more appropriate to be used depending on the needs of the targeted context and the relevance of the targeted health conditions.[5-10] Among these, mhealth interventions that employed web-based technology (mobile web app) have considerably high impact due to its wide dissemination as mobile web apps can be easily shared (such as using Facebook or WhatsApp), is compatible across devices (iOS vs android) and is immediately accessible without needing to download and install, unlike mobile app.[11]

Other than that, delivering health interventions via mobile web app has lower development cost and easier to maintain.[12, 13] Many mobile web apps have been reported to be effective in reducing depressive symptoms, preventing low back pain and improving knowledge on psoriasis.[14-16] This may be because web-based technology is interactive and able to give personalised feedback.

In view of the ability of mHealth in reaching out, educating and delivering healthcare to hard-to-reach people, ScreenMen, a mobile web app which provides personalized advice on health screening and empowers men towards undergoing evidence-based health screening was developed. Currently, the uptake of health screening is suboptimal especially in men and those of younger age.[17, 18] Existing interventions to improve

screening uptake such as printed message, reminder call, health education workshops, videos and partner's involvement are labor- and resource-intensive. Only a few evaluated web-based health screening interventions were evaluated but they were non-mobile responsive and focused on specific diseases such as prostate cancer or HIV instead of promoting comprehensive health screening.[19, 20]

To ensure a web app is useful to the users, it is important to follow a systematic software development model. Web-based health interventions that engage end-users during development, adopt theories and consider implementation issues often have fewer usability issues and tend to be more effective.[21-23] ScreenMen was developed based on the United Kingdom Medical Research Council Complex Intervention Framework (UKMRC-CIF).[24] The UKMRC-CIF provides guidelines on the development, piloting, evaluation and implementation of a complex intervention. In terms of development, the UKMRC recommends that it is best to develop an intervention systematically, using best available evidence, appropriate theory and based on the needs of the target group, which were conducted before the development of ScreenMen (exploratory phase). However, the UKMRC-CIF focuses on developing the content of intervention; there is a lack of information to guide the development of intervention delivery mode such as websites. In the literature, few studies reported in details the web development process such as prototyping and software testing. Studies often described the content development but not the technical aspect. Thus, this paper aimed to describe systematically the development model used to build ScreenMen, including the web requirements; the development cycles; and the finalized ScreenMen mobile web app.

METHODS

Multi-disciplinary and User-centered Approach

The main research team in this study were the content experts, which consisted of a health researcher (C.H.T.), a clinician and professor of family medicine (C.J.N.) and professor of men's health (A.W.); an interaction designer (C.D.L.); and a software developer (S.K.L.). This study also involved local and international experts from various disciplines including health screening, general practice, men's health, decision making, psychology, health innovation, heuristics and mHealth. Feedback from these experts helped to improve ScreenMen throughout the development phase. End users were also involved in this study specifically in the needs assessment and web testing. This study was approved by the University of Malaya Medical Centre Medical Research Ethics Committee (MRECID.NO: 201610144372).

Exploratory Phase

The development process of the intervention was divided into two phases: exploratory (content) and development (delivery) phase. Prior to the development of ScreenMen, the research team organized an exploratory phase to understand the scope of the problem in a greater depth. The researchers searched for theories related to health screening behavior as well as barriers and facilitators to health screening in men. ICT development theories were also sought to guide the development of ScreenMen web app. The research team also conducted literature review to identify the evidence on health screening and intervention that used mobile web apps to improve health behavior. A systematic review of interventions that aimed to improve health screening behavior of men was conducted to determine the range effective interventions. Subsequently, a needs assessment was conducted to explore the factors that influence men's decision to undergo health screening

in the local context as well as what men wanted in a health screening mHealth intervention. The findings from this exploratory phase were synthesized to form the initial requirements (content) of ScreenMen.

Development Phase

Software Development Life Cycle

To develop a web, it is crucial to understand the software development life cycle (SDLC). SDLC is an established common framework for software life cycle processes, with well-defined terminology, that can be referenced by software industry (ISO/IEC 12207:2008). In this study, the term 'software' refers to the web app. SDLC comprises planning, analysis, design, implementation and maintenance. The research team searched and identified five main software development process models, which are the waterfall model, V-model, spiral model, iterative model and agile model. The details of each of these models are shown in Table 1.[25-27] The research team then met to discuss and choose a model according to the suitability and needs of the projects.

Table 1: The details of the five main software development process models

Criteria	Waterfall model	V-model	Spiral model	Iterative model	Agile model
Requirement	Fixed in the beginning	Changing in early stage is possible	Finalize in the beginning with risk analysis	Adding in through many iteration	Changing is possible throughout the process
Prototype	No	No	Yes	Yes	Yes
User-Involvement	Only during the requirement gathering stage	Only during the requirement gathering stage	Yes	Yes, but not compulsory	Throughout all phases, short meeting everyday
Documentation	Full	Full	Full	Yes	Minimal
Suitability	Big project	Big project	Big, complicated project	Small – medium project	Small – medium, short duration project which requirement is not fully known
Implementation of the model	Easy and straight forward	Easy and straight forward	Complicated and need experienced developers	Complicated and need experienced developers	Complicated and need experienced developers

Software Prototyping

Other than deciding on the development model, the researchers also searched for software prototyping method to be used in this study. Software prototyping is a rapid software development method to validate requirements.[28] It reduces overall development effort, helps to achieve what the stakeholders want and improves usability of the software. Two types of prototyping methods were identified: rapid prototyping and evolutionary prototyping. Rapid prototyping (which is also known as thrown-away prototyping) is normally a paper- or visual-prototype that is produced to identify requirements problems and then discarded.[28] Evolutionary prototyping is when an initial prototype is produced and refined through a number of stages to reach the final system.[28] Based on the timeline and resources available, the research team discussed and decided upon the prototyping methods to be used.

Software Testing

Once a software has been developed, testing is crucial to reduce errors and meet users' requirements before it is being released. The research team searched and found many concepts of software testing such as usability, utility, feasibility, acceptability, alpha, beta, compatibility and performance testing.[29] The research team discussed and decided on the types of testing to be conducted.

RESULTS

Overall development process model

The development process model of ScreenMen is shown in Figure 1. The agile model was chosen as the ScreenMen project is considered as small scale and that the web requirements were subjected change and expansion based on experts' and users' review. During the development of ScreenMen, there were four agile cycles and each agile cycle consists of five steps: requirement, design, build, test and review. Generally, the 'requirement' includes gathering of web contents and features from users and experts; the 'design' step involves producing sketches of the web in a mobile phone format; the 'build' step comprises development of the mockup/web; the 'test' step encompasses testing the product by the research team; and the 'review' step involves testing the web by external reviewers (experts or users). This cycle repeats when new requirement emerged from the external reviewers.

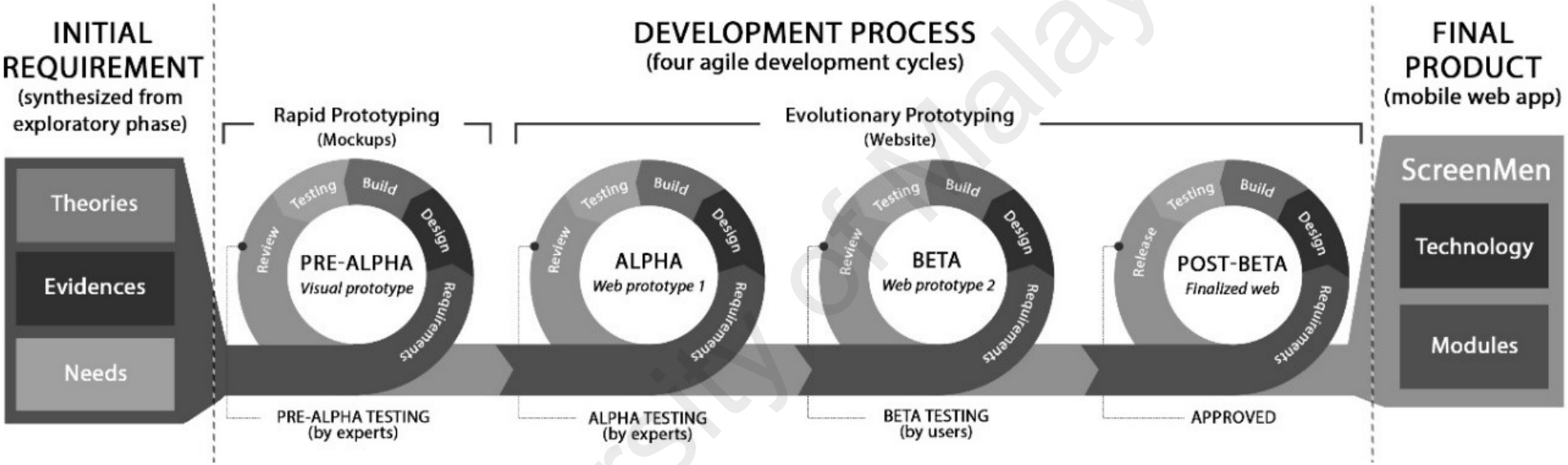

Figure 1. The development process model of the ScreenMen.

A. Initial requirement (Synthesis of exploratory phase findings)

Before the development commenced, the findings from the exploratory phase (theories, evidences and needs) were synthesized to form the initial requirement of ScreenMen. These findings had been published elsewhere.[30-33] The detailed synthesis workout sheet which formed the characteristics of ScreenMen can be found in Appendix 1. In summary, men wanted the app to be trustable and provide personalized information about health screening; able to assess can assess their health; deliver information using multiple modalities; have low data entry burden; reminder and social connectivity functions.[32] These contents and features formed the basis of ScreenMen. In addition, the needs assessment found that lack of knowledge on health screening and diseases is a key barrier to screening in men.[33] Misconceptions such as 'there is no need for screening except when sick', 'screen once is already sufficient', 'men who are young, taking healthy diet and exercise regularly do not need to be screened' and 'the more the screening tests the better' emerged from the needs assessment. In addition, men did not know the health screening tests they should go for, costs of screening and other logistics information such as where and when to go for screening. These gaps in knowledge formed the main contents to be addressed in ScreenMen.

As 'lack of knowledge' was the main barrier, ScreenMen was planned with the aim to educate men about their health and screening. This is in accordance with the Integrative Model which suggests that knowledge affects one's intention and subsequently his/her behavior, in this case to undergo health screening.[34, 35] Since this study was targeting men specifically, the research team also adopted Christy's framework to explain men's colorectal cancer screening behavior which have incorporated four key masculinity variables. To better understand the mechanism of action in the context of health screening, the research team conducted a systematic review and formed a comprehensive framework

on the barriers and facilitators to health screening in men.[31] Factors delineated in the framework were incorporated and addressed in ScreenMen wherever relevant.

Apart from that, review of existing interventions which aimed to promote health screening in men found that educational interventions were effective in improving screening uptake, which reaffirmed the relevance of developing a web-based educational intervention proposed in this study.[30] Through the review, we have also identified characteristics of male-sensitive intervention which can be incorporated into ScreenMen. Other e-learning and software development guidelines found were also used to guide the development of ScreenMen.[36-43]

B. Development process (four agile development cycles)

There are two key stages in the development of ScreenMen. The first stage used the rapid prototyping method which only involved the development of mock-ups. The second stage employed the evolutionary prototyping method where the web was developed and progressively revised. There was only one agile cycle (pre-alpha) involved in the rapid prototyping stage while there were three agile cycles (alpha, beta and post-beta) in the evolutionary prototyping stage. Pre-alpha and alpha testings involved testing by experts at the developer or researchers' site while beta testing involved user testing at the users' setting. The testings focused on mainly the utility (whether the web provide appropriate contents and functions to improve health screening uptake) and usability (how easy and pleasant is the web to be used).[44]

B.1. Rapid prototyping stage (pre-alpha agile cycle)

The aim of the rapid prototyping stage was to develop a visual prototype (mock-ups) of the web to be reviewed by a group of experts using the rapid prototyping method. Rapid prototyping was used at the initial phase as requirements tend to change in the early design phase. This method saves time as illustrating how the web would look like using images is less time consuming and labor-intensive than developing the web directly. This approach is more efficient especially when extensive changes are expected.

In this pre-alpha cycle, the requirements were the synthesized findings from the exploratory phase. The proposed contents and features were listed by the contents experts and discussed with the interaction designer and software developer regarding the feasibility of developing them. Once the proposed contents and features were agreed upon, the content experts drafted the content of the web. The drafted content was subsequently used by the interaction designer to produce sketches (low-fidelity) of the web, page by page. This was done with the content experts who constantly feedback to the interaction designer to reach the desired design of the pages. Once the low fidelity sketches were agreed upon, the interaction designer developed the mock-ups (high-fidelity) in digital format using designing software such as Adobe Illustrator and Sketch App. The content experts reviewed the high-fidelity mock-ups which were revised iteratively before finalizing it.

Once ready, the mock-ups were then presented to five experts (clinical and health screening experts) to obtain their feedback and suggestions for improvement. The mock-ups were presented in a computer using a prototyping tool (Marvel) which turned the mock-ups into an interactive prototype. This prototyping tool linked all mock-ups together and allowed the interface to react according to the areas clicked. This as well as the realistic transitions between screens such as fades, slides, flips and pops give the experts a closer feel of how the web would work. When going through the mock-ups, the

experts were asked to prospectively think aloud, while being audio-recorded. The researchers probed the experts using a topic guide and took notes of the experts' suggestions. The feedback obtained were analyzed with the aid of the audio-recording and incorporated into the web prototype.

B.2. Evolutionary prototyping stage (alpha, beta and post-beta agile cycles)

The aim of this evolutionary prototyping stage was to develop and improve the prototype based on the feedback from experts (alpha testing) and end users (beta testing). At this stage, the major requirements of the web were fixed. New requirements based on feedback from experts and users were progressively added to the core of the web until the web is finalized.

In the alpha cycle, the contents and features drafted in the pre-alpha cycle formed the basis of the requirements in this cycle. Suggestions from experts in the pre-alpha testing were extracted and incorporated into the visual prototype by the interaction designer. The content experts constantly feedback to improve the visual prototype. Once the visual prototype was finalized, the team began to develop the web prototype (web prototype 1). The prototype was tested by the content experts exhaustively to identify errors, especially in the health assessment to ensure the algorithms were correct. It was also tested using several smart phones of different display resolutions, browsers and operating systems. The prototype was revised iteratively before alpha testing. Then, the web prototype was tested using a mobile phone by five local experts (men's health, screening, decision making, psychology and heuristics) and three international experts (men's health, health innovation and mHealth). Similar to the pre-alpha cycle, the prospective think aloud method was used and notes were taken by the researchers during the session. The experts

were asked to feedback on the utility and usability of the web; their feedback were used to revise the web.

Similar agile cycle was repeated in the beta cycle. The contents and features in the alpha cycle and the feedback obtained during alpha testing formed the basis of requirement in this cycle. The interaction designer incorporated the experts' feedback and illustrated the revised version of the prototype (web prototype 2). The content experts constantly feedback to improve the prototype. Once the proposed revisions were agreed upon, the team proceeded to revise the prototype of the web. The content experts performed exhaustive testing on the prototype especially the 'Health Assessment' since changes had been made to the algorithm. Errors were identified and rectified by the software developer before the commencement of beta testing. In this cycle, the web prototype 2 was tested with 24 healthy men recruited from a banking institution. These men were purposively sampled according to job position, screening status, age and income. We stopped data collection after recruiting 24 men because data saturation was achieved. After obtaining consent, demography data were obtained and men were asked to access ScreenMen using the project's smart phone. When using ScreenMen, the screen activities were recorded using a free screen recording software (AZ Screen Recorder). After finished using ScreenMen, the participants answered a post-intervention questionnaire (13 questions including the System Usability Scale and 'intention to undergo screening'). Subsequently, while watching the playback, men were asked to think aloud retrospectively and provide their comments on the webpages. They were probed using a topic guide and their feedback were audio-recorded and were used to improve the web prototype 2.

The requirements in post-beta cycle were obtained from users in the beta testing after discussion within the research team. The interaction designer then incorporated the users'

feedback into the revised version of the prototype. The content experts feedback constantly to improve the prototype. Once the proposed revisions were agreed upon, the team proceed to revise the web prototype 2. The prototype was exhaustively tested by the research team to identify and rectify errors in the web. Finally, ScreenMen was released for evaluation of feasibility and effectiveness.

C. Final product (The ScreenMen mobile web app)

C.1. Technology used to develop ScreenMen

In order to save more time and resources to expedite the development, a free and open-source front-end framework, Bootstrap, was used to develop the ScreenMen web app. The reasons are as follows:

1. Mobile-responsive: To ensure ScreenMen is accessible to men using different devices, it is critical to ensure that ScreenMen is able to adapt the same interface to multiple screen sizes on desktops, tablets and handhelds. Bootstrap has a responsive 12-column grid system that resolves this issue.

2. Reusable components & consistency: ScreenMen has a unique branding identity to connect and build trust with men. Instead of coding HTML and CSS from scratch, Bootstrap makes the customization of essential and reusable components (typography, forms, buttons, navigation) easier and helps maintain a consistent, cohesive and captivating experience across the web application. The designer and developer can spend more time on designing and developing the user experience and less time on understanding the underlying technology, such as HTML5, CSS, and JavaScript.[45]

3. Maintenance: Since Bootstrap balances between design and implementation, it empowers the developers to create better styled and easily maintainable webs as the brands and visual design assets evolve in the future.[45]

C.2. Modules of ScreenMen

The final ScreenMen web app (can be accessed at screenmen.org; passcode:2016) contains three main modules: 1) health screening education video; 2) health assessment; and 3) frequently asked questions (FAQs). ScreenMen uses a 'Superman-like' figure with a stethoscope as the avatar to mimic a consultation experience with a doctor (Figure 2). The detailed description of the ScreenMen web app with screenshots can be found in Appendix B.

The first module was developed to demystify the four misconceptions identified in the needs assessment. This is placed as the first module as it is important for men to learn the basic concepts of screening in order to address the misconceptions. To achieve this, a video using the analogy of car maintenance was produced to explain the concept of health screening. The short video was developed using Adobe After Effect and is only slightly more than two minutes to avoid loss of users' attention. There are four key messages in this video: 'Screen now, not when you are sick'; 'Screen regularly, not just one-off'; 'Screen, despite being young and living health'; and 'Screen, appropriately'.

The second module (Health Assessment) contains an expert system (artificial intelligence), which is used to assess users' health, provide tailored advices on their health status as well as recommend evidence-based health screening tests to go for based on their health profile. The expert system was built using the PHP programming language where the algorithms were developed based on several health screening clinical practice

guidelines and set up using the IF-THEN-ELSE rules.[46] This module, which made up the main bulk of ScreenMen, consists of several sub-modules: 1) health assessment (detailed or quick version); 2) health status summary; 3) health screening test recommendation; 4) logistic information; 5) reminder function; and 6) 'share the web' function.

The third module is the FAQs modules. Since users have limited attention span, this module was placed the third. This module contains most of the factors attributed in the barriers and facilitators to health screening in men comprehensive framework described earlier. The comprehensive list of barriers and facilitators were converted into question and answer format to ease learnability. Users who have queries about health screening can refer to the list of FAQs and submit a question to the research team if the question they look for is unavailable.

Figure 2. Home page and random screenshots from the ScreenMen mobile web app.

DISCUSSION

This paper presented a systematic approach to develop a mobile-responsive web-based health intervention (ScreenMen) to promote evidence-based health screening in men. ScreenMen was developed with engagement of experts from various disciplines and end-users, guided by the UKMRC-CIF, which emphasizes the importance of using theories, evidence and users' needs when developing a complex intervention. Although the UKMRC-CIF provides guidance on the development process of an intervention, it does not describe in detail how it can be operationalized and the methods to be used. This paper expanded the development guideline of the UKMRC-CIF by elaborating the steps used

to develop a web-based health intervention. In addition, we also introduced some computer science concepts such as the SDLC, software prototyping and software testing in the ScreenMen development framework. Although many available studies described the 'iterative process' in their development framework, it is crucial for health researchers to understand computer science terms such as the 'agile development model' as eHealth is a multi-disciplinary field beyond healthcare. There is vast knowledge in the field of computer science that can be used and applied by health researchers. Therefore, in this paper, we presented important information on the development process of a mobile web app, which were decided based on the research team's experience and in-depth discussion with computer scientists.

There are many other development frameworks that recommend user-centered approach when developing web-based health interventions such as the Website Developmental Model for the Healthcare Consumer and the Information System Research.[47, 48] However, these frameworks are often presented in a conceptual manner and do not describe the operationalization of the development process in a complete and detailed way. The Centre for eHealth Research (CeHRes) roadmap is a comprehensive and user-centered framework which covers up to dissemination and impact evaluation of eHealth technologies.[23] In terms of development, the CeHRes roadmap describes the process and presents a list of methods for evaluation. This paper adds by detailing the development process of a mobile web app.

As illustrated by the CeHRes roadmap as well as recommended by the UKMRC-CIF, it is crucial to consider implementation from the start of a project so that the intervention is more likely to work and implementable at the later stage. Though we have considered the implementation criteria when developing this web app, it is not presented in this paper as this paper focuses on the development process. The implementation strategies were

explored in the needs assessment and several strategies were proposed by the users such as using social media, doctors' recommendation or made as part of employee's key performance index.[32] Specifically, a mobile web app instead of a mobile app was developed in this study after taking into consideration the dissemination and implementation factor. However, many web development frameworks and guidelines are not designed for mobile web app. Special considerations need to be given when developing mobile-responsive web app as there is a huge range of display resolution of smart phones available in the market. Although only sketches in one mobile phone resolution were produced during the 'Design' step, the research team often have to test the web app in various mobile phones with different resolutions and operating systems to ensure the web presentation is acceptable across all platforms. Besides, instead of testing with experts using prospective think aloud method, we recorded the phone screen activities in the beta testing. Retrospective think aloud with screen recording method was used in the beta testing to capture users' actual experience without disruptions. Ideally, the users should use their own phone for familiarity reason and to maximize usability issues identified from different mobile phones. However, for screen recording purpose, it is only feasible and ethical to use the project's mobile phone. These are the additional challenges and limitations faced when developing a mobile web as compared to a desktop web.

There are other limitations to the ScreenMen development process model. The development of the ScreenMen web took about two years, mainly due to the conducts of the needs assessment and two systematic reviews. Although it provided in-depth understanding of the research problem, it may not be practical for projects with a limited timeline. However, the development phase of this project only took about 6 months, as this would be attributed to the systematic and agile development approach taken during the development. This development model may be useful for health researchers, provided

if the exploratory phase is shortened. Besides that, we did not involve users in the alpha testing due to feasibility factor. Involving users in the alpha testing may help to identify usability issues before the web is released for beta testing. Future web development should consider the involvement of end users earlier at the alpha testing phase.

CONCLUSION

This study described a systematic and pragmatic approach to develop a mobile web app which aimed to increase evidence-based health screening uptake in men. This mobile web app was built using a rigorous process which employed theories, findings from a needs assessment study and best available research evidence, supplemented by inputs from experts across multiple disciplines as well as users themselves. The development process model described can be used as a guide by health researchers to develop web-based mhealth interventions in the future. It also expands on the intersection between health and ICT (eHealth) by advocating effective communication among individuals across different disciplines.

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COMPETING INTERESTS

None

ETHICS APPROVAL

This study was approved by the University of Malaya Medical Centre Medical Research Ethics Committee (MRECID.NO: 201610144372).

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Paper 5 - Appendix 1: The characteristics of ScreenMen developed based on theories, evidences and needs.

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
Overall							
Education-based intervention	Knowledge affect men's intention and subsequently action to screen.	Having knowledge and education programmes are facilitators to screening.	-	Educational interventions are effective in improving screening uptake.	-	-	-
Using mobile web app as the intervention delivery platform	-	-	-	Lack of mobile health intervention to improve screening uptake	Mobile web apps were found effective in improving health behaviour. Web app achieved the needs of this study instead of an app.	Men are more receptive to screening due to information exposure from the internet.	Men like the idea of a health screening mobile app.
List of evidence-based health screening	-	-	-	-	United States Preventive Services Task Force and Malaysian Consensus Guide to Adult Health Screening for General Population	-	-

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
					Attending Primary Care Clinics		
Simple name of modules	-	-	Match between system and the real world	-	-	-	-
Use of same words consistently such as health screening instead of health checkup.	-	-	Consistency and standards	-	-	-	-
Use of colourful design and images	-	-	Recognition rather than recall	-	-	-	Men want information to be delivered using multimedia.
Simple and laymen language	-	-	Minimalist design	-	-	-	Men want short and simple messages.
Availability in three languages	-	-	-	-	-	-	Men want multiple languages.
Use of Dr ScreenMen figure	-	Doctors' recommendation is a facilitator to screening.	-	Male-sensitive characteristic	-	Men trust doctors' advice.	-
Home							
Display of university logo	-	-	-	-	-	-	Men want a trustable app.

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
Short message about the benefits of ScreenMen	-	-	Minimalist design	-	-	-	-
Simple navigation (Back and next button)	-	-	Minimalist design User control and freedom	-	-	-	-
What is screening?							
Addressing four misconceptions	-	Lack of knowledge is a barrier to screening.	-	-	-	Men screen only when they are sick. Men screen only once. Men don't think they need screening because they are young, eating healthy and exercise regularly. Men think 'more tests are better'.	-
Using a video to explain health screening	Perceived benefits of screening (health belief model)	-	-	-	-	-	Men want information about health and screening. Men want video and multimedia to help them learn.

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
Using the car analogy to explain health screening concept	-	-	-	Male-sensitive characteristic	-	-	-
Check my health							
Assessment function	-	-	-	-	-	-	Men want a health assessment function.
Consultation-mimicking assessment (question and advice by topic)	-	Doctors' recommendation is a facilitator to screening.	-	-	-	Men trust doctors' advice.	Men want information to stay healthy. Men want low data entry burden app.
Quick assessment mode	For men in the 'Unaware stage' of Precaution Adoption Process Model	-	-	-	-	-	Men want short and simple information.
Assessment does not capture identifiable information	-	-	Confidentiality and security	-	-	-	Men want a trustable app.
Progress bar to show current status	-	-	Visibility of system status	-	-	-	-
Back and next button	-	-	User control and freedom	-	-	-	-

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
Instructions on how to input answers	-	-	Error prevention	-	-	-	-
Error pop up box	-	-	Help users recognize, diagnose and recover from errors.	-	-	-	-
Hyperlinks for detailed explanation	-	-	Flexibility and efficiency of use	-	-	-	Men want short and simple messages.
Health summary and advice	To increase perceived risk (health belief model)	Perceived self at risk is a facilitator to screening.	-	-	-	-	Men want personalised health advice.
Personalised screening recommendation including explanation of screening procedures	-	Lack of understanding on screening procedures is a barrier	-	-	-	-	Men want personalised advice on screening.
Logistic information describing the cost, where and when to screen	-	Low cost, convenient screening venue and time are facilitators to screening.	-	-	-	Men don't know the cost, where and when to screen.	Men want to know where to get cheap screening.
Reminder function	-	-	-	Reminder should supplement	-	-	Men want a reminder

Characteristics	Theories			Evidences		Needs	
	Behavioral theories	**Paper 1 (barriers and facilitators to screening)**	**ICT development theories**	**Paper 2 (effectiveness of existing interventions)**	**Literature review**	**Paper 3 (factors to undergo screening)**	**Paper 4 (needs from a mobile application)**
				education to increase effectiveness.			
Message to stay healthy to take care of family	-	'Stay healthy to take care of family' is a facilitator to screening in men.	-	-	-	Men will go for screening to stay healthy so that they can take care of their family.	-
Share function	-	-	-	-	-	Men want their family to be healthy.	Men want social connectivity in the app.
Frequently asked questions							
A long list of questions and answers including individual, social, health system, healthcare professional and screening procedure factors.	Theory of planned behaviour, health belief model, traditional masculinity	Developed based on the comprehensive framework	-	-	-	-	-
Optional module for advanced users.	-	-	Flexibility and efficiency of use	-	-	-	Men want short and simple messages.
Non-screening men's health contents	-	-	-	-	-	-	Men want information to stay healthy.

Paper 5 - Appendix B: The Finalised ScreenMen Mobile Web App

ScreenMen was eventually finalised as a synthesised outcome from all study phases. ScreenMen uses a 'Superman-like' figure with a stethoscope as the avatar to facilitate the browsing experience throughout the web (Figure B.1). There are three available languages in ScreenMen where users can choose to either use the English, Malay or Mandarin version. ScreenMen has a simple but colourful user interface and a linear navigation system. Not only it fits into various mobile phone screen resolutions, ScreenMen is also usable in a desktops or laptops (Figure B.2). The finalised ScreenMen mobile web app contains three main modules, which are: 1) What is screening?; 2) Check my health; and 3) Frequently asked questions (Figure B.3).

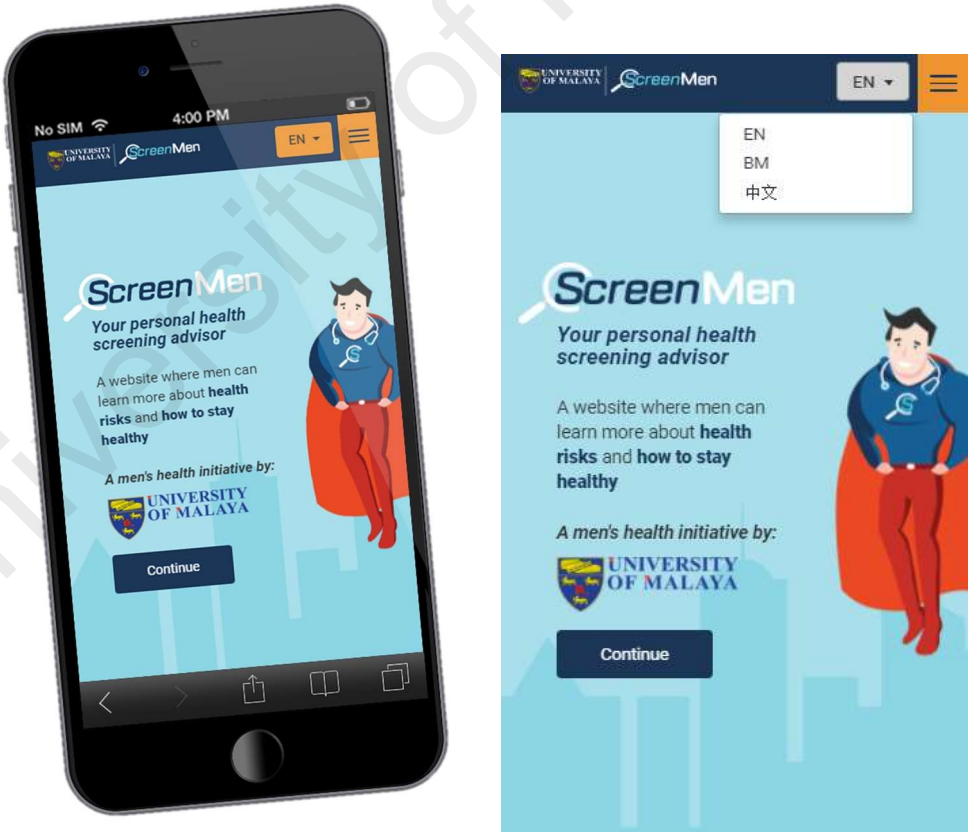

Figure B.1: Home page of ScreenMen showing the three language options and the modules of ScreenMen as display under the menu tab.

Figure B.2: Home page of ScreenMen in a desktop resolution with the modules at the top.

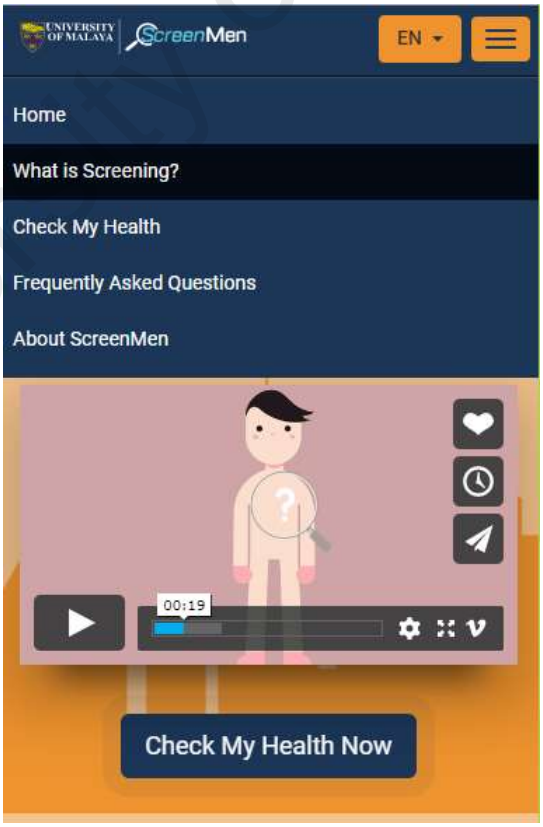

Figure B.3: The modules of ScreenMen as displayed under the menu tab.

The first module (What is screening?) was developed mainly to debunk the four misconceptions identified in the needs assessment. This is delivered via a bite-size video which is about two minutes to avoid loss of users' attention (Figure B.4). There were four key messages that were delivered via this video: 'Screen now, not when you are sick'; 'Screen regularly, not just one-off'; 'Screen, despite being young and living health'; and 'Screen, appropriately'. In order to address the misconceptions in a short, simple and easy to understand manner for men, the video was developed incorporating the car maintenance analogy to explain the concept of health screening. This video was placed as the first module because it is important for men to learn the basic concept of screening before learning in-depth about their health risks and recommended screening, which is in the next module.

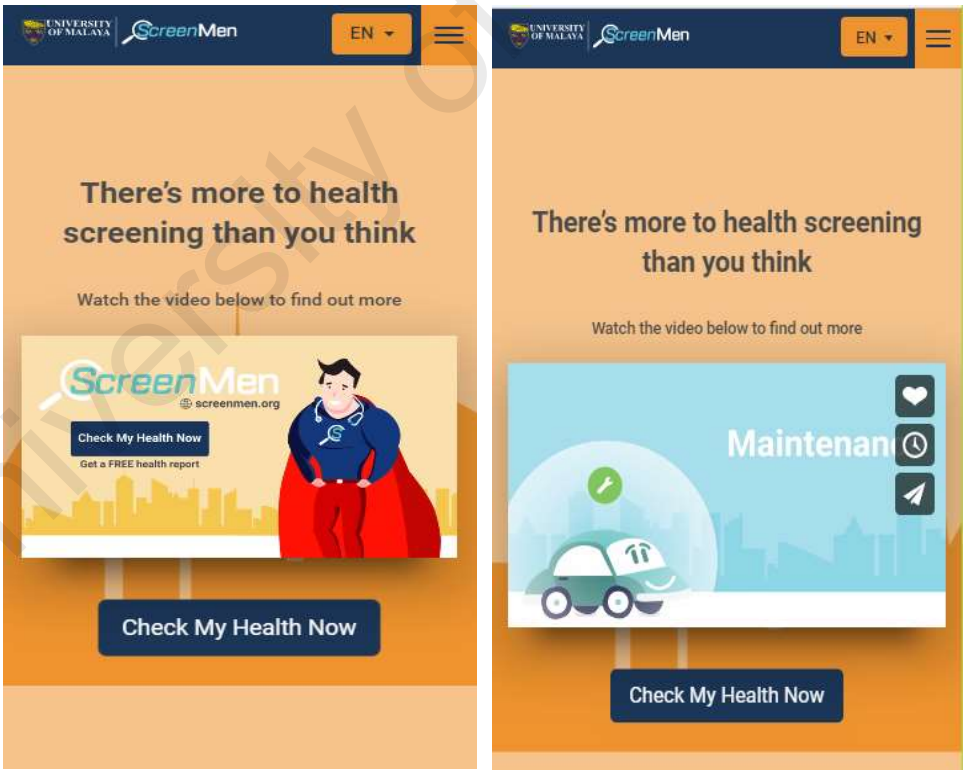

Figure B.4: Video about health screening using the car analogy to debunk the four misconceptions identified in needs assessment.

The second module (Check my health) contains an expert system (artificial intelligence), which is used to assess users' health, provide tailored advices on their health status as well as recommend all relevant health screening tests to go for based on their health profile. The expert system was built using the PHP programming language where the algorithm were developed based on several evidence-based health screening clinical practice guidelines and set up using the IF-THEN-ELSE rules. The detailed algorithm can be found in Appendix x. This module, which made up the main bulk of ScreenMen, consists of several sub-modules: 1) health assessment (detailed or quick version); 2) health status summary; 3) health screening test recommendation; 4) logistic information; 5) reminder function; and 6) 'share the web' function.

There are two modes that can be used in the health assessment sub-module (Figure B.5). In the consultation mode, users are able to 'converse' with Dr ScreenMen topic by topic. Dr ScreenMen will ask a question with some explanations, which requires an answer from the users (Figure B.6). Once answered, Dr ScreenMen would provide advice on the topic based on the answer provided. There are several 'questions and advice' sections which are categorised according to Intro, Lifestyle, Heart, Cancer, STD and Mind as shown on the progress bar. For the quick assessment mode, instead of 'questions and advice', all questions are presented in a form format, but chunked into five categories such as Intro, Profile, Lifestyle, Heart & Cancer and STD & Mind (Figure B.7).

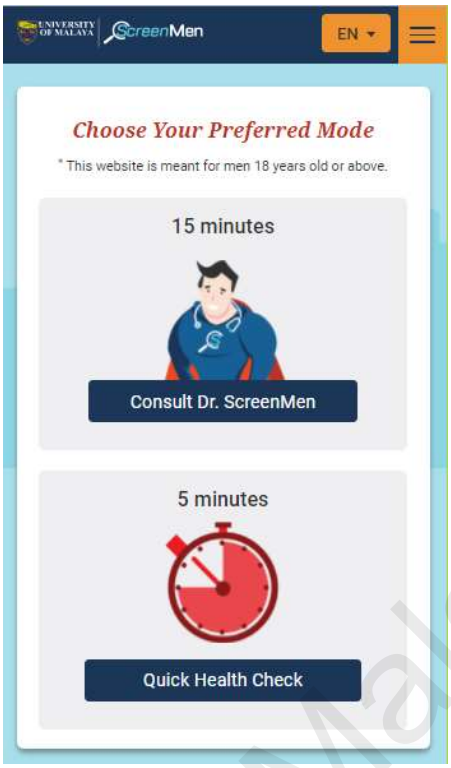

Figure B.5: The options of consultation and quick mode for health assessment.

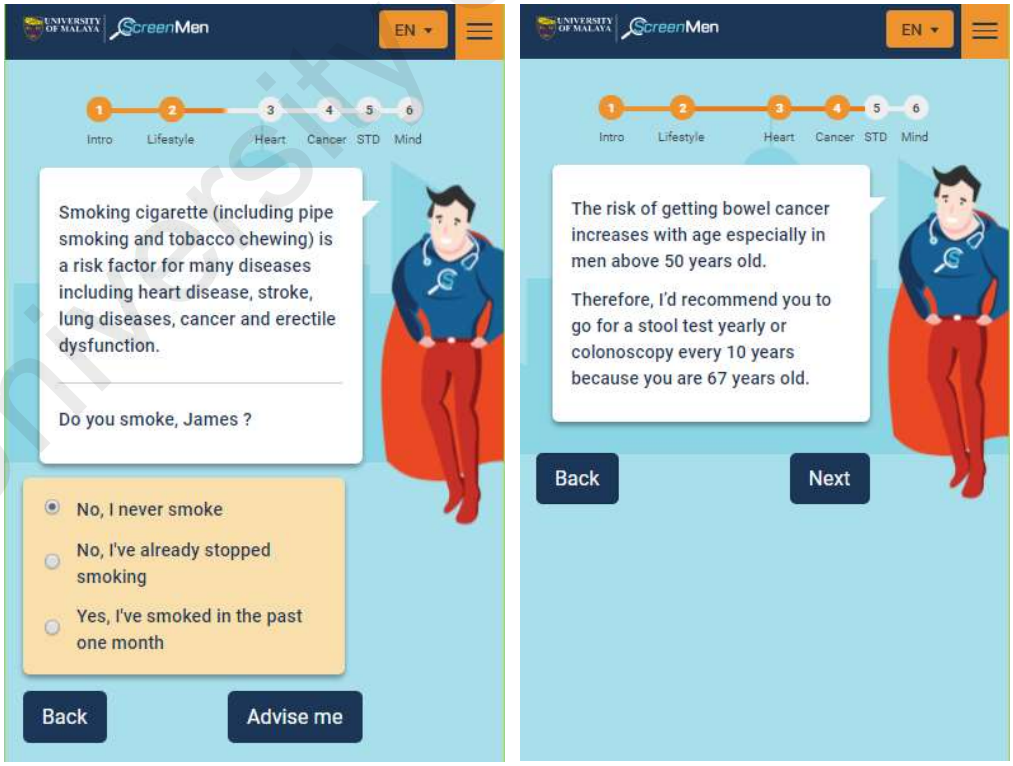

Figure B.6: Example of conversations with Dr ScreenMen (question and advice).

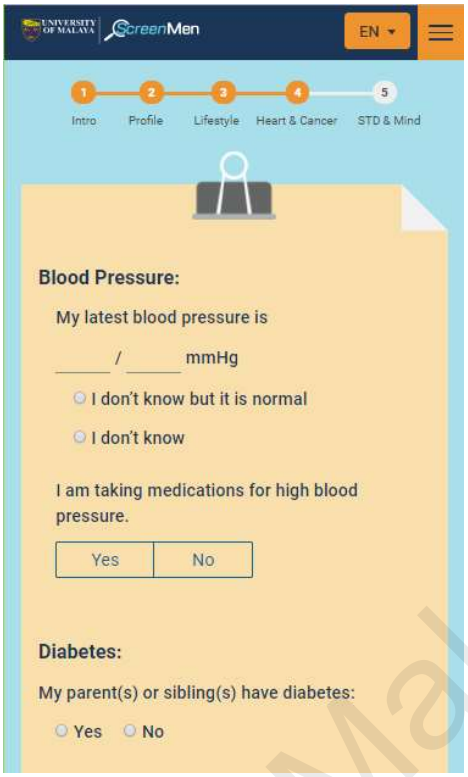

Figure B.7: Example of questions in the quick assessment mode.

Once the assessment is completed, the users will be presented with a health summary, where the good health status are presented at the 'You have done well'(green) section while the health conditions that need attentions at the 'You can do better'(red) section (Figure B.8). This is useful for users to have a quick glance of their overall health status. They can also click on the respective health conditions to view more about the advice provided by Dr ScreenMen. Next, users will be provided with the list of health screening they should (blue) and should not go for (orange) (Figure B.9). The screening procedure for each of the screening can also be viewed by clicking on the respective health conditions. Apart from that, below the recommended list of screening, users are also presented with the examples of unnecessary screening tests to empower them to avoid unnecessary screening (Figure B.10). They are also encouraged to ask the doctor three questions when choosing screening tests.

Figure B.8: Health summary with advice divided into 'You have done well' and 'You can do better'.

Figure B.9: The personalised screening recommendation with screening procedure.

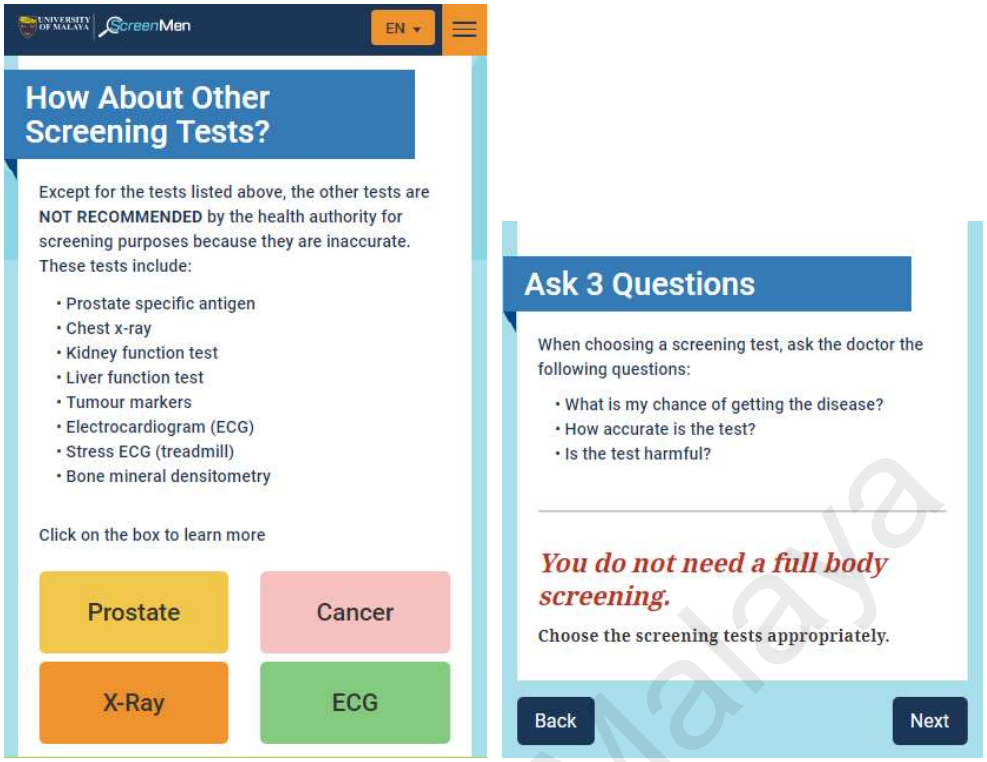

Figure B.10: Empowering men to avoid unnecessary screening.

Subsequently, men are provided with basic logistic information such as the cost of screening, where to screen and when to screen (Figure B.11). At this page, users are also provided with the button to read the frequently asked questions if they have more questions. Next, users will be asked if they would like to set up a reminder in their online calendar by providing their email (Figure B.12). An event (My checkup day) will be automatically added to their online calendar, where the date will be based on the day they used ScreenMen and the past health screening date they attended (captured in the health assessment sub-module). If they have not gone for screening for more than one year, the event will be set one month from the day they use ScreenMen.

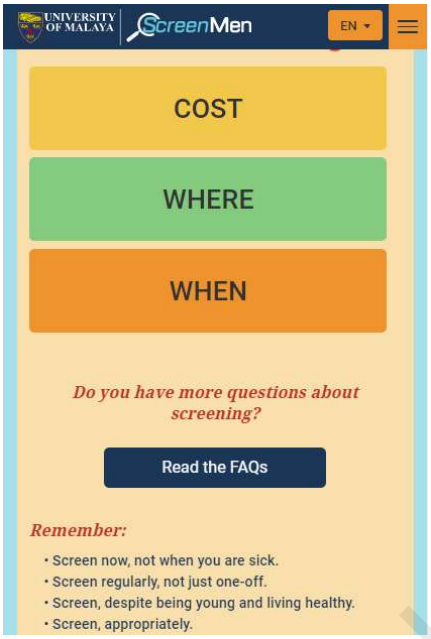

Figure B.11: Providing logistic information on cost, where and when to screen.

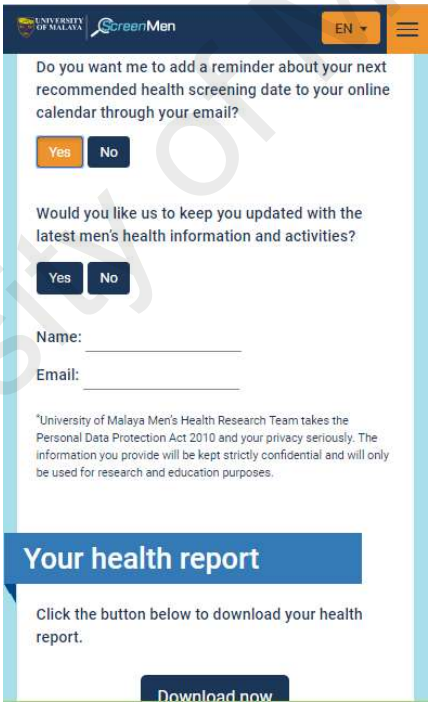

Figure B.12: Option to set up a reminder by creating an online calendar event.

Later, users are provided with a button where they can download their health report (in A4 format), to keep a copy and even to bring along when seeing the doctor (Figure B.13). Last but not least, users will reach a thank you page with a function to share the web with their family and friends. The web can be shared via Facebook, Twitter, WhatsApp, Google+ and email (Figure B.14).

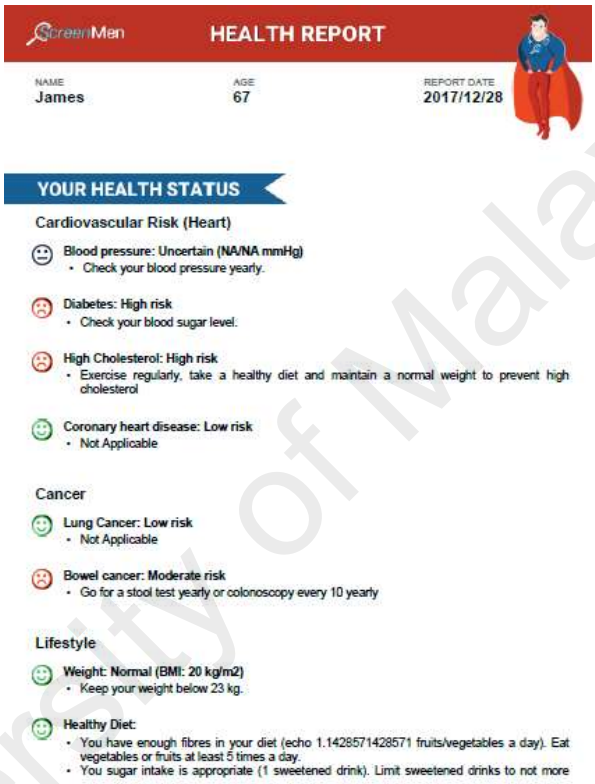

Figure B.13. The downloadable health report in A4 format.

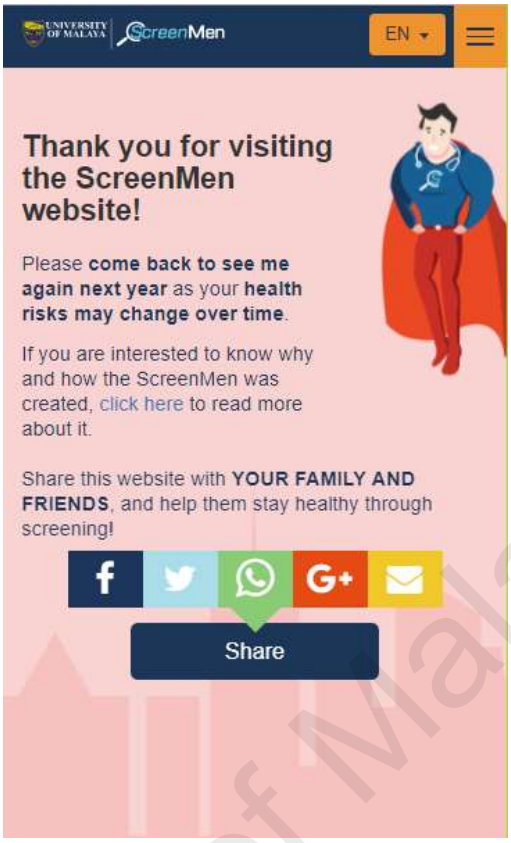

Figure B.14: A function to share the web with family and friends.

The third module (Frequently asked questions) is placed third and made optional after pilot testing (Figure B.15). This is due to users' limited attention span, especially those of lower literacy level. This module contains most of the factors attributed in the barriers and facilitators to health screening in men comprehensive framework developed in Paper 1. The comprehensive list of barriers and facilitators were converted into question and answer format to ease learnability. Users who have more queries about health screening can refer to the list of FAQs posted. Though not related to screening, this section also contains information on erectile dysfunction and urinary symptoms as requested by men and proposed by experts. Users can also submit a question to the research team if the question they look for is unavailable in this module.

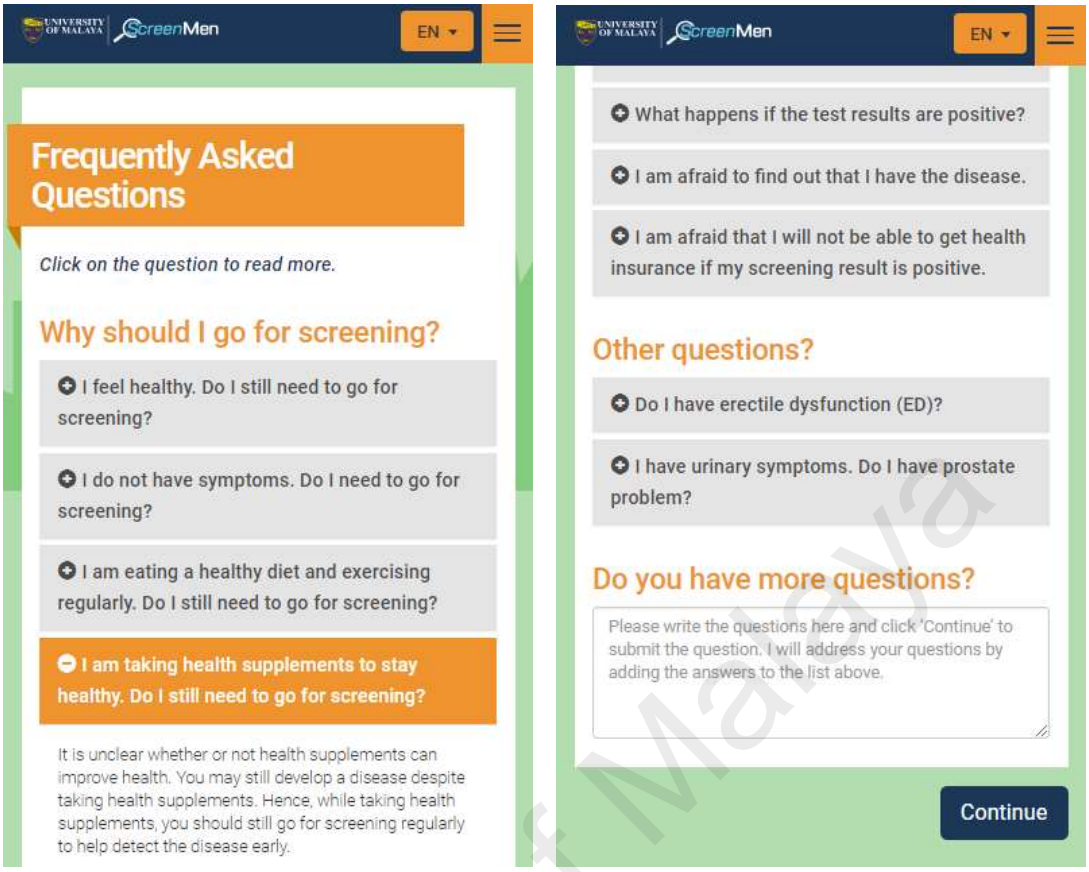

Figure B.15: The frequently asked questions module.

4.3.2 Paper 6: Teo, C. H., Ng, C. J., Lo, S. K., Lim, C. D. & White, A. (2018). Utility and usability testing of a mobile web app (ScreenMen) to improve health screening uptake in men. (Under review)

Statement of Authors' Contribution:

Teo, C. H., Ng, C. J., Lo, S. K., Lim, C. D. & White, A. have contributed substantially in this paper. Teo, C. H., Ng, C. J. and White, A. first conceptualised this study and developed the protocol of this study. The subject recruitment as well as data collection were done by Teo, C. H. and Ng, C. J.. All co-authors were involved in the data analysis as well as revision of the intervention, which were led by Teo, C. H.. The first version of the paper was drafted by Teo, C. H.. All co-authors reviewed the paper critically and provided comments on the intellectual contents of the paper. The finalised paper was read and approved by all authors for publication.

UTILITY AND USABILITY TESTING OF A MOBILE WEB-APP (SCREENMEN) TO IMPROVE HEALTH SCREENING UPTAKE IN MEN

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ABSTRACT

Background: ScreenMen, a mobile web-app which aimed to improve health screening uptake in men was developed based on theories, evidence and needs.

Objective: This study aimed to evaluate ScreenMen for its utility and usability with men from the community.

Methods: This study used a mixed-method approach. Healthy men who are working in a banking institution were recruited to participant in this study. They were purposively sampled according to job position, age, education level and screening status. Men were asked to use ScreenMen independently while the screen activities are being recorded. Once completed, retrospective think aloud with playback was conducted with men to obtain their feedback. They were asked to answer the System Usability Scale. Intention to undergo screening pre- and post- intervention were also measured. Qualitative data were analysed using a framework approach and followed by thematic analysis. For quantitative data obtained, the mean SUS score and change in intention to screening were calculated and analyses using McNemar test.

Results: Twenty-four men participated in this study. Based on the qualitative data, men found ScreenMen useful as they could learn more about their health risks and screening. They found ScreenMen convenient to use and might trigger men to undergo screening. In terms of usability, men thought that ScreenMen was user-friendly and easy to understand. The key revision done on utility was the addition of a reminder function while for usability, the revisions done were in terms of attracting and gaining users trust; improving learnability; and making ScreenMen usable to all types of users. To attract men to use it, ScreenMen was introduced to users in terms of 'improving health' instead of 'going for screening'. Another important revision made was emphasising the screening

tests the users do not need instead of just informing them the screening tests they need. A 'Quick Assessment Mode' was also added for users with limited attention span. The quantitative data showed that eight (34.8%) out of 23 men planned to attend screening earlier than intended after using the ScreenMen. Out of 12 men who were in pre-contemplation stage, 4 (33.3%) changed to either contemplation or preparation stage after using ScreenMen. In terms of usability, the SUS score of 76.4 indicated that ScreenMen had good usability.

Conclusions: This study showed that ScreenMen was acceptable to men in terms of its utility and usability. The preliminary data suggested that ScreenMen might increase men's intention to undergo screening. This paper also presented key lessons learnt from the beta testing, which would useful for public health experts and researchers when developing a user-centered mobile web-app.

KEYWORDS: Internet; mHealth; eHealth; mass screening, health behaviour, men's health

INTRODUCTION

In the past decade, many web-based interventions have been developed to improve health outcomes of the public. Web-based interventions not only have a wider reach, less labour intensive and less resource exhaustive, they can be interactive, personalisable and fun, which make learning more effective and may ultimately improve users' health behaviour. In addition, the impact of web-based health interventions is further amplified with the flux of mobile technology into healthcare. Smartphone, which is a good platform to deliver healthcare to the people, at anytime and anywhere, is widely available and affordable these days including in developing countries. Many studies have shown that web-based interventions, including mobile web-apps, are effective in improving health outcomes such as improving physical activity level, asthma treatment knowledge, psoriasis knowledge and weight loss as well as reducing depression symptoms and preventing low back pain [1-9].

Sub-optimal health screening uptake rate, especially in men and those of younger age, is a global public health concern [10-12]. Many types of intervention to improve the uptake of health screening in men including those using partners' involvement, educational workshop, reminder phone call and letter have been evaluated [13]. However, only educational interventions were found to be effective in improving men's intention to undergo screening and increasing the actual screening uptake; while others were inconclusive due to poor study design. There are also more web-based interventions on health screening in men that have been evaluated such as web-based patient decision aid on prostate cancer screening as well as educational web and social media to encourage HIV screening in men [14-16]. However, these interventions are disease-specific and there is a lack of intervention that promotes comprehensive health screening in men, which is crucial in ensuring holistic care for men [13]. Among the recommended health

screening for men by the United States Preventive Services Task Force (USPSTF) are hypertension, diabetes, dyslipidaemia, colorectal cancer, lung cancer, HIV, hepatitis, sexually transmitted infections (STIs), depression as well as lifestyle risk factors including smoking status, alcohol usage, obesity, diet and physical activity [17]. These recommendations should be applied based on men's health profile such as age, ethnicity and family history.

In view of the increasing internet access and smartphone ownership in Malaysia as well as in the world, ScreenMen, a mobile web-app which aims to promote comprehensive health screening in men, was developed. ScreenMen is mobile-responsive and aimed to be disseminated via smartphone to all Malaysian men. It was developed based on theories, evidence as well as the needs of users [13, 18-20]. Prior to the development of ScreenMen, a need assessment was conducted with working men from a banking institution in Kuala Lumpur to identify their needs on health screening and to find out what do men want in a health screening mobile application. During development, the prototype of ScreenMen was tested with experts from various backgrounds (alpha testing) and was revised iteratively to improve it. The detailed development process of ScreenMen was published elsewhere (P5).

Before ScreenMen is finalised, a beta testing will be conducted. Beta testing is also called user acceptance testing. It aims to test a software with end users in a real-world setting to identify and rectify any potential issue before it is being released. This is particularly important for a mobile web-app as web-based technologies are growing and changing rapidly. Poor usability is often reported as one of the main reasons why users stopped using a mobile web-app, as a consequence of inadequate user testing [21]. In order to ensure that a mobile web-app is useful, experts recommend that it should be evaluated in terms of its utility (whether a website provides the features the users need)

and usability (how easy and pleasant the features are to be used) with users [22]. Thus, this current study aims to evaluate ScreenMen with men from the community in terms of its utility and usability. The findings including the key revisions made to address the utility and usability issues in ScreenMen were also presented in this paper.

METHODS

Study Design Overview

This study used a mixed-methods design to evaluate the utility and usability of ScreenMen with end users. The qualitative assessment was done using the retrospective think aloud method with the aid of a topic guide which contained questions on utility and usability. A questionnaire was also used to score and evaluate ScreenMen in terms of utility and usability quantitatively. This study was approved by the University of Malaya Medical Centre Medical Research Ethics Committee (MRECID.NO: 201610144372).

Study Setting, Sampling and Recruitment

This study was conducted with healthy men from a banking institution in Kuala Lumpur, the capital of Malaysia. Unlike alpha testing with experts which was done at the developer's site, beta testing is conducted at the users' settings, which was men's working place in this study. Men from a banking institution were chosen due to the stressful and sedentary nature of their job. They represent a group of 'hard-to-reach' men in the community, who often do not seek healthcare services despite having easy access to them.

The same banking institution where the needs assessment was conducted in the earlier phase was selected as the recruitment site for this beta testing. This study was approved by the banking institution. Men who have a smartphone and from the banking institution were recruited to participate in the beta testing. They were purposively sampled

accordingly to their job position, age, education level and screening status in order to achieve maximal variation of the feedback on ScreenMen. Men who participated in the needs assessment phase were first contacted and arranged for interviews. Then, the snowballing method was used to recruit new participants where the recruited participants were asked to recommend their colleagues to participate in the study. New participants were also included in addition to those who have participated in the needs assessment phase to gather more feedback on ScreenMen. All participants were reimbursed for their time participating in this study.

The sample size of a usability study is often small. Studies have shown that the optimum sample size to detect sufficient usability problem is 10 users [23]. Since this study involved quantitative evaluation, at least 20 participants were aimed to be recruited to obtain statistically significant number [24]. The recruitment was stopped once data saturation was reached.

The ScreenMen Web-app (Beta Testing Version)

ScreenMen is a mobile-responsive web and aimed to be disseminated via smart phone. It aims to educate men, empower men and improve men's behaviour on health screening. ScreenMen was developed to contain male-sensitive attributes (such as using car maintenance analogy) as well as evidence-based information on health screening. Apart from that, four key sections of ScreenMen was developed following a framework modified from the health literacy principle, to guide the learning process in ScreenMen [25]. The four sections are:

- Learn – This section contains a short educational video to demystify the misconceptions on health screening which were identified in the needs assessment.

- Assess – This is an interactive section where users can interact with ScreenMen to assess their health risks and obtain personalised health advice as well as the evidence-based health screening they need based on their health profile. A health report can be generated at the end of this section. This section is algorithm-driven and attempts to mimic a real-life clinical consultation with a doctor.
- Ask – In this section, there is a list of frequently asked questions about screening where men can read up if they would like to have further clarifications about screening.
- Prepare – This section aims to prepare the users to undergo health screening by providing basic logistic information such as where to screen, when to screen and cost of screening.

Data Collection

In-depth interviews (IDIs) and focus group discussions (FGDs) were conducted for data collection. During the appointment, the researchers first briefed the participants about the study using a participant information sheet. The participants were encouraged to ask questions and informed that they could stop the study at any time. Once agreed to participate, the participants were asked to sign a consent form and fill up the demography form including intention to undergo screening. Then, the participants were given a smart phone with ScreenMen activated on the screen. They were asked to use it themselves and to notify the researchers once they have finished using it. All on-screen activities were being recorded. The researchers were present in the same room to observe the participants behaviour when using ScreenMen and take field notes as well as to assist the users when necessary.

Once finished using ScreenMen, the participants were asked to answer the post-intervention questionnaire which contains 10 System Usability Scale (SUS) questions, four utility questions including intention to undergo screening (Table 1). Regarding the Likert scale of the intention to undergo screening question, one month represent the preparation stage; six months represent the contemplation stage; while the remaining represent pre-contemplation stage as defined in the Transtheoretical Model of Health Behaviour Change [26].

Table 1: Post intervention questionnaire

No	Questions	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
1	I think that I would like to use this website frequently	☐	☐	☐	☐	☐
2	I found the website unnecessarily complex	☐	☐	☐	☐	☐
3	I thought the website was easy to use	☐	☐	☐	☐	☐
4	I think that I would need the support of a technical person to be able to use this website	☐	☐	☐	☐	☐
5	I found the various functions in this website well integrated	☐	☐	☐	☐	☐
6	I thought there was too much inconsistency in this website	☐	☐	☐	☐	☐
7	I would imagine that most people would learn to use this website very quickly	☐	☐	☐	☐	☐
8	I found the website very cumbersome to use	☐	☐	☐	☐	☐
9	I felt very confident using the website	☐	☐	☐	☐	☐
10	I needed to learn a lot of things before I could get going with this website	☐	☐	☐	☐	☐
11	Does the website help you to understand more about your health risks?	☐ Yes ☐ No				
12	Does the website help you to understand more about health screening?	☐ Yes ☐ No				
13	Do you intend to go for health screening in the future?	☐ Yes, in the next 1 month ☐ Yes, in the next 6 months ☐ Yes, in the next 1 year ☐ Yes, in the next 2 years ☐ Yes, in the next 5 years ☐ No, I do not intend to go for health screening				
14	Would you recommend this website to your family or friends?	☐ Yes ☐ No				

Then, using a topic guide, the researchers started the interview by asking the participants to provide their overall opinion on the web-app; to comment on its contents and layout (usability); to explain how if the web-app help them to understand more about health and screening; and to suggest any other part of the web-app that can be improved. The on-screen recording was played to assist the participant in the retrospective think aloud process. They were probed to comment on the content and layout when going through each section of ScreenMen. All conversations during the retrospective think aloud were audio-recorded. For FGDs, all of the procedures are similar to those of IDIs except that the ScreenMen was projected on the screen and navigated by the researcher page by page to assist the retrospective think aloud instead of playing the on-screen recording of each participant.

Data Analysis

The qualitative data obtained was analysed using a framework approach to smoothen the web-app revision process. After each session, the researchers compiled a list of comments and issues on ScreenMen by extracting the data from the field notes and listening to the audio recording. These data were coded under utility or usability and by section (Table 2). The researchers then met to discuss the issues and proposed the revisions to be done on ScreenMen. Apart from that, to present the data in a more meaningful way in this paper, the comments and issues identified were grouped and categorised according to common themes. This was done by the first author and discussed and agreed by all authors.

Table 2: The framework used for data analysis

Section		Utility		Usability	
		Comment	**Solution**	**Comment**	**Solution**
Home	Participant				
	Observer				
Learn	Participant				
	Observer				
Assess	Participant				
	Observer				
Ask	Participant				
	Observer				
Prepare	Participant				
	Observer				
About us	Participant				
	Observer				

For the quantitative data, all data were managed and analysed using the Statistical Package for Social Science version 21. First, the SUS score from each participant and a mean SUS score for all participant were calculated. The SUS score was interpreted using the adjective rating scale developed by Bangor [27]. The utility questions were analysed using descriptive statistics (% of Yes). For intention to undergo screening, the percentage of participants who plan to screen earlier than intended; later than intended; and no change in intention after using ScreenMen was calculated by comparing the intention to screen pre- and post-intervention. Intention to screen was also analysed according to stage of behaviour change, specifically by comparing the number of participants in the pre-contemplation stage (more than 6 months) with the number of participants in either contemplation and preparation stage (6 months or less) after using ScreenMen, using McNemar test.

RESULTS

There were 24 men who participated in the beta testing and14 IDIs and 2 FGDs (n=10) conducted from February to March 2017. The details of the participants are shown in Table 3.

Table 3. Characteristics of participants in the beta testing

Characteristics	**n (N=24)**	**(%)**
Age		
20-29	7	29.2
30-39	10	41.6
40-59	7	29.2
Mean (Range)		*37 (23 – 56)*
Ethnicity		
Malay	10	41.6
Chinese	10	41.6
Indian	3	12.6
Others	1	4.2
Position		
Senior manager	7	29.2
Officer	5	20.8
Sales advisor	5	20.8
Clerk	7	29.2
Education		
Secondary school	5	20.8
Certificate/diploma	4	16.7
Degree	13	54.2
Postgraduate	2	8.3
Marital status		
Unmarried	10	41.7
Married	14	58.3
Screened in the past 1 year		
Yes	9	37.5
Smartphone Operating System		
iOS	11	45.8
Android	12	50.0
Windows	1	4.2
Participated in Needs Assessment		
Yes	13	54.2

Qualitative evaluation (Observation and retrospective think aloud)

Utility

The users found the ScreenMen useful as they could learn more about their health risks, what screening to go for and what they can do to improve their health.

I like all of it, it tells you your health, everything about where you are (in terms of health) and what you should do to improve it. (40-59 y/o, Senior Manager)

Using this web, people know what diseases they should check. (40-59 y/o, Clerk)

Now I understand about the importance of health screening. We don't know that our lifestyle could actually affect our health. Using this website, you know what to be improved upon. (20-29 y/o, Sales Advisor)

Some mentioned that they were glad to learn about the unnecessary screening tests. He suggested to highlight this more to ensure all users get it.

My key take home message from this website is some of the tests are unnecessary, for example the liver or kidney test as it may over or under detect the disease. Nowadays, there are a lot of external blood test centres, they normally package ECG, heart stress test and everything together and sell you thousands of Ringgit (Malaysian currency). I didn't know that those are actually unnecessary. So, this is something I got to know now. It's good to know that those are actually not useful for screening. This information is a little secluded and need to be highlighted better. (20-29 y/o, Officer)

A participant was glad that '*it contains localised contents for us (Malaysian) unlike the UK or US websites*'. (20-29 y/o, Officer)

One participant mentioned that using ScreenMen may trigger men to take care of their health.

ScreenMen is easy to use, can add more knowledge and act as a trigger to take care of health when going through the website, unlike those who do not receive anything and do not do anything about health. (30-39 y/o, Clerk)

Men also felt using ScreenMen was convenient to use.

We have limited time for screening. With this, we can check at anywhere, we can have the information and what can we do (to improve health). It is just like talking to a doctor or consultant. (30-39 y/o, Clerk)

It is good for people. People are always with handphone. With application like this, one doesn't need to go anywhere, at home also can do, at office also can do. (30-39 y/o, Clerk)

They *will share this website with friends via Facebook Group*. (40-59 y/o, Clerk)

On the other hand, one raised the issue that users may not use ScreenMen again after using it once.

It's good. Will I use the website, yes. But subsequently will I continue to use it repeatedly again, it remains a question mark. (30-39 y/o, Senior Manager)

The participants also suggested that a reminder function may be useful as users may not take action instantly after using ScreenMen. Thus, the research team has added a function where users can input their email and an event entitled 'My Check-up Day' would appear in their email calendar, calculated based on their past screening date. It will

serve as a reminder for users as they usually check their calendar daily and will come across that added event.

Some participants suggested that it would be good to have a list of screening centres with phone number to make appointments on the website as that may facilitate users to take action to screen. However, the research teams decided not to include the list to avoid being perceived as using it for commercial reason.

Usability

In overall, participants mentioned that ScreenMen is quite user-friendly, comfortable to look at and not too cluttered. The interface is easy to understand, not too complicated. (20-29 y/o, Officer) The participants also felt assured to use the web-app as it was stated upfront that the web-app does not capture any identifiable information from them.

There were several key issues with revisions to improve ScreenMen and they were grouped under three themes: 1) attracting and engaging users; 2) ensuring effective learning; and 3) catering for the widest range of users' characteristics.

Theme 1: Attracting and engaging users

A. Designing a simple and focused home page

The home page of ScreenMen outlined the four key sections of the web-app. Some participants found that the home page contained too much information to read and felt that it may put off users. Thus, the home page was simplified to include only the main objective of what users may gain from this web-app (Figure 1).

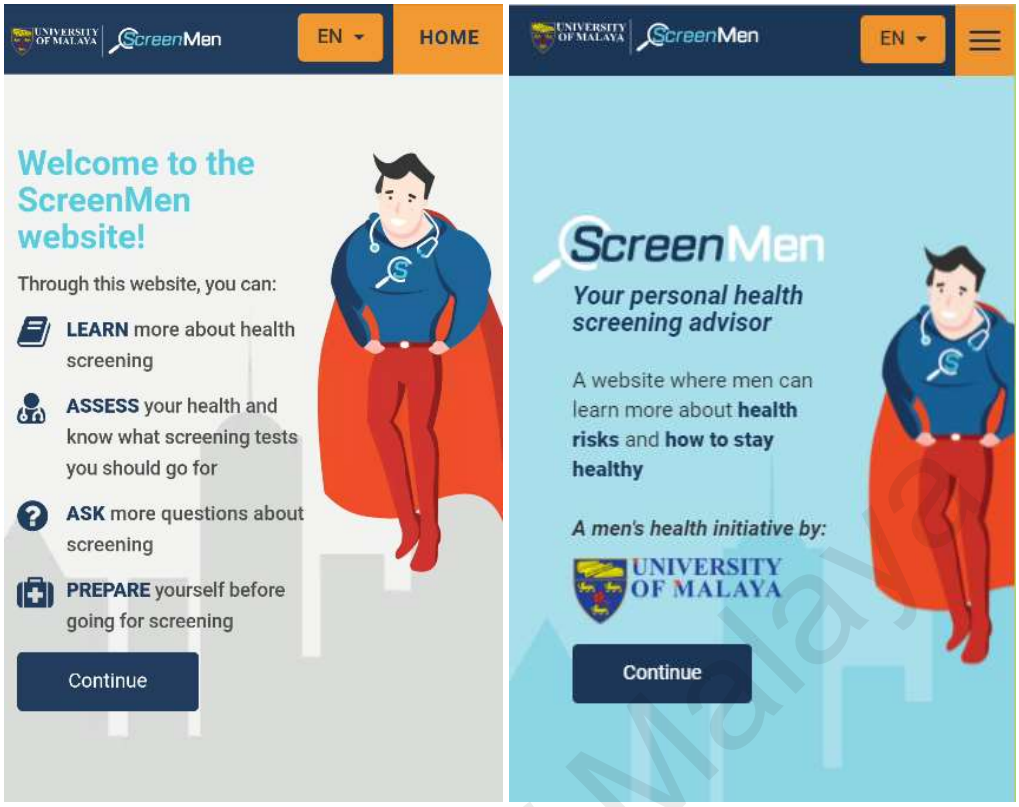

Figure 1. The home page of ScreenMen before and after revision.

B. Promoting the concept of 'health' instead of just 'screening'

Men were less interested in screening as they did not understand about screening and its importance. Describing the web-app as a platform to learn about screening did not interest the users. However, men wanted to be healthy and they are more readily to receive information which can keep them healthy. Thus, the objective on the home page was framed in terms of learning about users' health risks and ways to stay healthy instead of learning about health screening. Additional health information such as erectile dysfunction and urinary symptoms were also added as requested by men to provide more information than just screening.

C. Highlighting the credibility of the web-app

The participants felt that there was a lack of credibility on the home page. They mentioned that the credibility of web-app is crucial to gain users' trust so that they continue to use the web-app. To address this issue, they suggested to enlarge the university's logo at the home page.

D. Incorporating a male-favoured avatar

The ScreenMen web-app attempted to attract men using Dr. ScreenMen, a Superman-resembling doctor avatar at the home page. However, while some liked Dr. ScreenMen figure as it encourages them to be strong, especially those from lower educational level, others have no comment on the Dr. ScreenMen figure. One participant suggested to make Dr. ScreenMen provide more different types of reaction but this was not done due to technical complexity and the potential impact on web loading time.

Theme 2: Ensuring effective learning

A. Using practical terms instead of theoretical concepts

From the researchers' observation, the Learn, Assess, Ask and Prepare menus were unclear and participants were confused about these concepts. For example, some thought that they could ask questions to a doctor at the 'Ask' section and were lost looking for that function. Theoretical concepts were difficult to be understood by users and thus the menus 'Learn', 'Assess' and 'Ask' were revised to 'What is screening?'; 'Check my health'; and 'Frequently asked questions' to more accurately represent the contents of each web-app section (Figure 2). The 'Prepare' section was removed and merged into 'Check my health'.

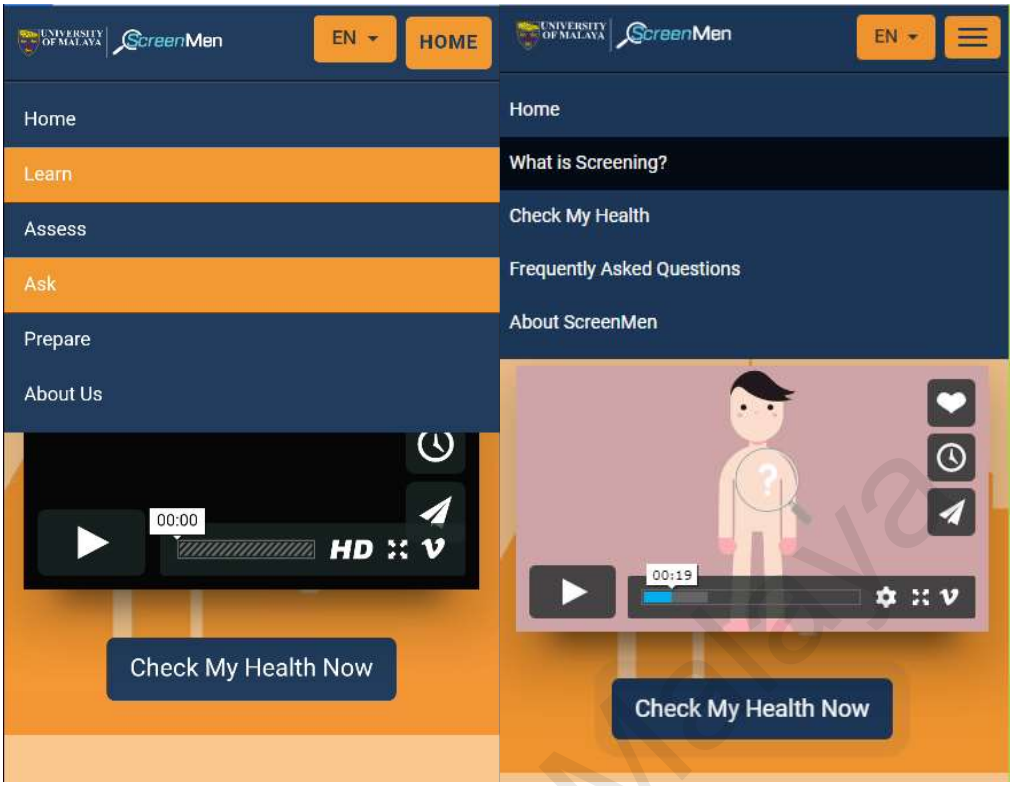

Figure 2. The menus of ScreenMen before and after revision.

B. Using linear learning design for a more structured learning

Users are allowed to navigate freely to any section of ScreenMen by using the icons on the home page. This was done to cater for users who have already understood the basic of health screening and the repeat users. However, some users were confused as they went to the third section directly from the home page and did not go through the first and second section. Thus, the navigation links on the home page was removed. Users who would like to skip any section can use the 'hamburger' button.

C. Incorporating concepts that are familiar to men

Most participants agreed that the car maintenance analogy was very useful in helping them learn about health screening. The only comment on this was to use the word 'car service' instead of 'car maintenance' as the term is more commonly used among men. However, this change was not made as 'maintenance' is closer to health screening

concept, where maintenance is about routine schedule for service while service is about the task performed on a vehicle.

D. Showing important information first instead of optional information

During the usability testing, it was found that some users lost their attention at the third section (Ask). The 'Ask' section contains a long list of frequently asked questions and most users only skimmed through them. The fourth section contains a short amount of information to prepare users for screening, which are crucial for them to learn. In order to ensure that users learn this crucial information before losing attention, they were brought forward and merged into the last part of the second 'Check my health' section. The 'frequently asked questions' section was made optional as most information in this section were presented in the earlier sections.

E. Emphasising the 'negatives' when addressing misconceptions

ScreenMen advocates evidence-based screening and encourages users to avoid unnecessary screening. To fulfil the 'personalised content' factor as suggested by the users during needs assessment, ScreenMen only states the screening tests users need to undergo based on their health profile. However, after using the web-app, it was found that the users still have the mindset of 'undergoing more screening tests or full body screening is better'. It is insufficient to inform men only the screening tests they need but also to emphasise the screening tests they do not need especially when addressing misconceptions. In order to more effectively educate men to avoid unnecessary health screening, ScreenMen was revised to emphasise the tests which they do not need to go for (figure 3). Some of the unnecessary screening tests which was commonly done were highlighted with reasons (figure 4). ScreenMen also empowers men to avoid unnecessary

screening by encouraging them to ask the doctors three questions when choosing screening tests.

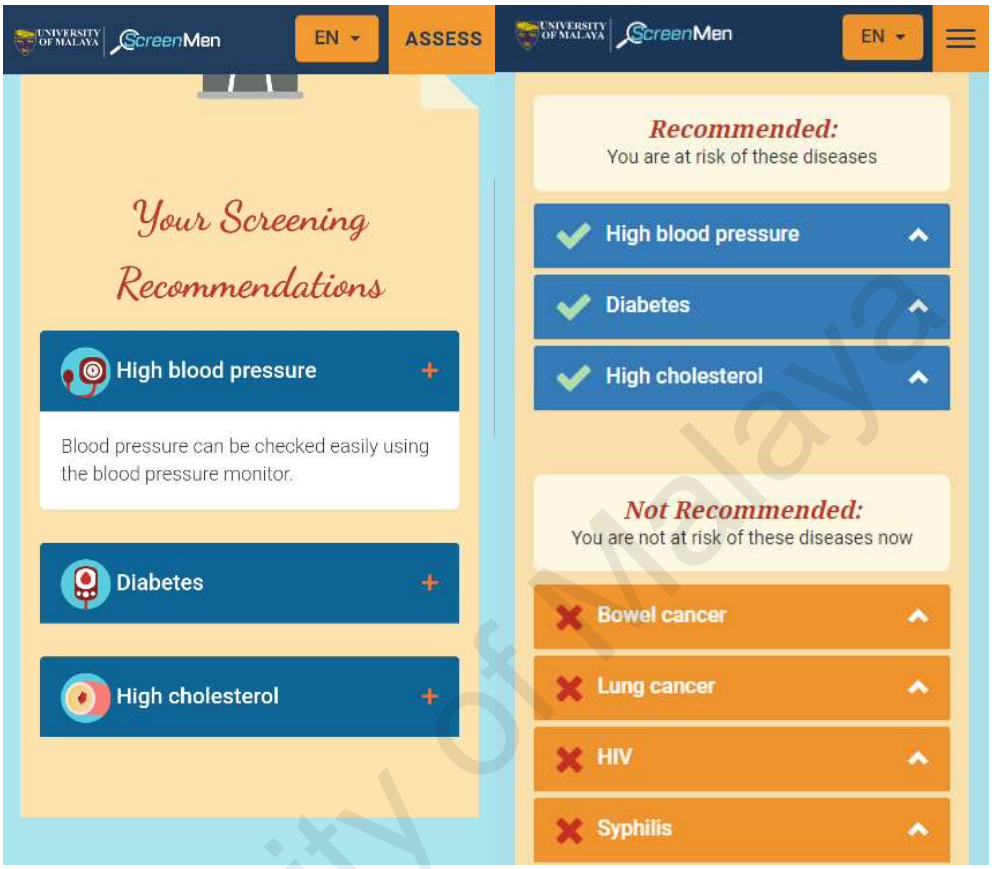

Figure 3. User's list of screening recommendation without and with emphasis of not recommended screening.

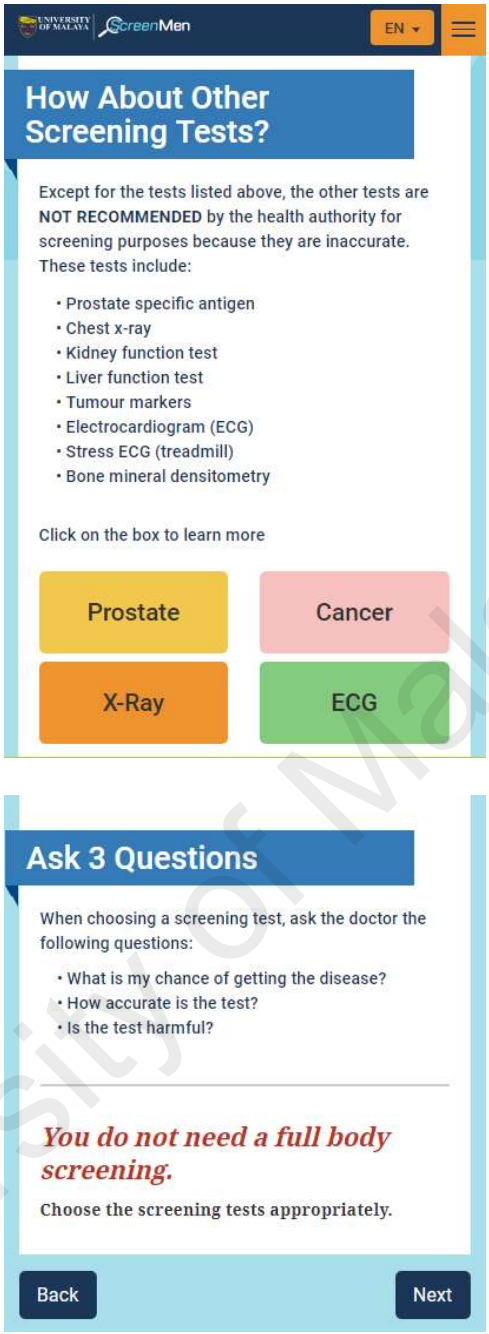

Figure 4. Newly added section to avoid unnecessary screening.

Theme 3: Catering for the widest range of users' characteristics

A. Suiting lower literacy users

Some participants commented that there was too much information to be read in ScreenMen especially for people with lower literacy level. The information in ScreenMen was thus simplified to present only relevant and short information. Links for additional

information were incorporated throughout the web-app for users who may want more information about certain topics.

B. Anticipating the lowest level of users' health behaviour

Developed from the medical perspective, users had problems answering some of the questions in ScreenMen. For example, some participants have difficulties answering 'I take fruit __ time(s) a day' as they do not eat fruit every day. This question was developed partly for the recommendation of '5 servings of fruits and vegetables per day'. Due to the problem, this question was revised to 'weekly' instead of 'daily' as weekly fruit intake was more prevalent among users. The algorithm was also revised to recalculate the users' input to compare against the recommended level.

Another example was the blood pressure reading. Most users could not remember their blood pressure reading but remembered that their blood pressure was normal from the previous health screening. In order to provide a more accurate advice, an option of 'I don't know but I know my BP is normal' was added instead of letting these users select 'I don't know'.

C. Providing a quick mode option for busy men

The health assessment section was developed to mimic a real-life clinical consultation with a doctor. This section starts with Dr ScreenMen greeting the users, obtaining users' age and followed by health assessment topic by topic. Dr ScreenMen asks question and provides advice on each health condition based on users' answers. At the end of this section, users can view the summary of their health status with screening recommendation.

However, some participants commented that men who are busy may not like to go through this process and would prefer a shorter mode. Though the consultation mode is more ideal for learning as it breaks the session into chunks, a 'Quick Health Check' mode was added as an alternative to cater for 'busy users' (Figure 5).

Figure 5. Options of consultation or quick mode for health assessment.

D. Accommodating female users

Though ScreenMen was developed for men, some participants suggested that it could also be used by women as women might be the person taking care of their husband or father in a family. Some of the sentences were thus rephrased to accommodate female users for example: 'Only men 18 years old or above should use this website' to 'This website is meant for men 18 years old and above'.

E. Taking into account the difference in culture

Malaysia consists of three main ethnic groups: Malay, Chinese and Indian. There were only two languages available in ScreenMen for beta testing (English and Malay). Some Chinese participants mentioned that their parents may need the Mandarin version as they are not literate in English and Malay languages. The Mandarin language was thus added to ScreenMen. No issue was raised regarding having Tamil language on ScreenMen as Indians are usually literate in English and Malay.

Apart from language, some sections of ScreenMen might be sensitive to certain ethnic groups. For example, all users were assessed in terms of alcohol intake, which may not be relevant to Muslim users as alcohol intake is prohibited in the religion. However, the Muslim participants reassured the research team that it is not an issue as the option 'I never drink alcohol' was already in place.

Another concern was the sexually transmitted disease assessment. Personal information such as having multiple sexual partners, having sex with men and injecting drugs were being asked to the users. However, the participants mentioned that they have no hindrance in answering these since no identifiable information is being recorded and these are important for them to know.

Quantitative evaluation (Questionnaire)

Only 23 answered the post-intervention questionnaire as one participant was called for work urgently. The details of the post-intervention quantitative evaluation are shown in Table 4. The SUS score obtained (mean=76.4; SD=68.9 – 83.9) indicated that the ScreenMen had good usability (Good usability score range: 71.4 – 85.5).[27] All

participants agreed that they understand more about their health risks, understand more about health screening and will recommend ScreenMen to others.

For intention to undergo screening, eight (34.8%) out of 23 men planned to attend screening earlier than intended after using the ScreenMen (no intention to 2 years, n=1; 5 years to 1 year, n=1; 2 years to 1 month, n=1; 1 years to 6 months, n=3; and 6 months to 1 month, n=2); 14 (60.9%) did not change; while one (4.3%) planned to screen later (1 month to 6 months). In terms of stage of behaviour change, out of 12 men who were in pre-contemplation stage, 4 (33.3%) changed to either contemplation or preparation stage after using ScreenMen (Table 5). However, the change from precontemplation (more than 6 months) to either preparation or contemplation stage (six months or less) after using ScreenMen was not statistically significant different since McNemar test revealed a p-value of 0.125.

Table 4. Quantitative evaluation after using the ScreenMen.

Post-intervention Evaluation	**n (%) [n=23]**
SUS Score – Mean (SD)	76.4 (68.9 – 83.9)
Understand more about their health risks	23 (100%)
Understand more about health screening	23 (100%)
Will recommend ScreenMen to others	23 (100%)
Intention to undergo screening	
• **Change in intended time to screen** - Earlier - No change - Later	 8 (34.8%) 14 (60.9%) 1 (4.3%)

Table 5. Intention to screen by stage of behaviour change before and after using ScreenMen.

Stage of behaviour change		Post-intervention		
		Precontemplation (>6 months)	Preparation/ contemplation (≤6 months)	Total
Pre-intervention	Precontemplation (>6 months)	8 (66.7%)	4 (33.3%)	12 (100.0%)
	Preparation/ contemplation (≤6 months)	0 (0.0%)	11 (100.0%)	11 (100.0%)
	Total	8 (34.8%)	15 (65.2%)	23 (100.0%)

DISCUSSION

This study found that ScreenMen is acceptable to men in terms of its utility and usability. The participants found ScreenMen useful as they could learn more about their health risks and the evidence-based health screening they should go for. They also felt that ScreenMen was convenient to be used and may trigger men to undergo screening. The quantitative data showed that many had increased intention to undergo screening after using ScreenMen. The participants also felt that ScreenMen was user-friendly and comfortable to look at. The SUS score also indicated that ScreenMen has good usability.

Though the initial version of ScreenMen was acceptable to men, many revisions were done to further improve ScreenMen. The key improvement in terms of utility was the addition of a reminder function. Reminder interventions including those using letter, email and short message service were found to be effective in increasing screening uptake [28, 29]. Though the effect of a reminder is well-established, it was not incorporated in the initial version of ScreenMen as it is challenging to incorporate a reminder function in a web-app. Due to the request by the participants in the beta testing, the research team had further explored and incorporated a reminder function via users' email calendar.

In terms of usability, the key revisions done were in terms of attracting and gaining users trust; improving learnability; and making ScreenMen usable to all types of people. To attract men to use it, ScreenMen was introduced to users in terms of 'improving health' instead of 'going for screening' as men generally do not see the importance of health screening but would like to know more about staying healthy. This is particularly important to be considered by policy makers and researchers when developing web-based interventions to improve health behaviour, especially in a health topic that men are not interested in. The interventions should be presented in a way that links to users' needs, to catch their attention and to ensure they continue using the web.

Another important revision made was emphasising the screening tests the users do not need instead of just informing them the screening tests they need. Men believe that 'more screening tests are better' [19]. This belief is further reinforced by the widely-practiced non-evidence-based health screening by healthcare professionals in the community. Hence, emphasising the 'negatives' was necessary so that users are more convinced and would internalise the message of avoiding unnecessary screening. This is crucial to be considered when developing interventions particularly in topics that are surrounded with misconceptions.

ScreenMen was also revised to cater to all types of users. Generally, the revisions were more of 'downgrading' or simplifying the contents to suit users from lower literacy level including the addition of the 'Quick Assessment Mode' as some participants want a quicker option due to limited user attention span. Future web-based interventions should be designed in a shortest and simplest manner or by segmenting the contents into separate sections to ensure effective learning.

This study has taken the male-sensitive approach to improve men's behaviour. ScreenMen was developed specifically for men and incorporated with male-familiar

contents such as the car maintenance concept and the 'Superman-like' figure. Though gender-sensitive approach has been recognised as the way forward in the past two decades since the release of the Madrid Statement: Mainstreaming gender equity in health, the Vienna Declaration on the health of men and boys in Europe and the continuous call by experts, evidence on male-sensitive interventions is still scarce to date [30-34]. The lack of proper male-sensitive definition and guidelines to develop male-sensitive interventions may be the reason for this. Gender and men's health experts should put more focus into this.

The outcomes of this utility and usability testing may appear differently if ScreenMen was developed as a mobile app instead of a mobile web-app. The reminder function would be easily built and more interesting functions such as alert, monitoring function, daily health messages and integration with social media can be included. However, the research team decided to develop ScreenMen in the form of mobile web-app due to the dissemination reason. Though this hindered having more useful functions in ScreenMen, reaching out to men is seen as a more important factor because health screening mobile web-app or mobile app is not something being sought after by men as they do not see the importance of health screening, unlike for exercise or diet apps. Web-app has a broader dissemination than app as it can be accessed instantly without needing to download and install; can be shared quickly among friends; and can be viewed in computer as well. This factor is important to be considered by public health experts and researchers especially when addressing health issues that are not seen to be important by the public.

The findings from this beta testing reinforced the importance of conducting testing with end users. Though many iterations of testing were done with experts during alpha testing, some of the issues were not captured. For example, the fruit intake per day question was not seen as a problem to experts but posed difficulties for users to answer.

Other than that, the experts felt the amount of texts were just nice but it was still too much for some participants. Apart from testing with experts, the development team has also considered many usability guidelines such as the ISO/IEC25010 software product quality model and Nielsen Usability Diagram [22, 35]. Despite that, many usability issues still emerged. The nuance of usability issues would only emerge during the in-depth beta testing with end users.

There are several strengths and limitations in this study. The strength of this study was that we managed to sample men from a wide demographic range, which give rise maximal variations of the qualitative findings. The multi-faceted approach used (quantitative and qualitative; observation and retrospective think aloud with playback; in-depth interview and focus group discussion) allowed the study to gather a rich amount of data and enabled data triangulation. For limitation, the design of the utility section in the questionnaire limited the data analysis. The questions on 'understand more about health risks', 'understand more about health screening' and 'recommend this website to family and friends' should provide a Likert scale instead of 'Yes' and 'No' to enable a more meaningful analysis. For the intention to screen question, instead of fixing the options based on the stage of behaviour change, an open-ended field which allow participants to enter their actual number of months to screen would also allow better analysis. The sample size for quantitative analysis, though is sufficient for the SUS as recommended by experts, was inadequate for the utility questions especially the McNemar test for intention to screen. On top of that, due to purposive sampling reason, about half of the participants were already in the contemplation or preparation stage even before using ScreenMen, which further diminished the analysable sample size. Nevertheless, this study's main focus was on the qualitative findings, which aimed to identify issues so that ScreenMen can be improved. The quantitative data was just the preliminary effectiveness findings, which will be measured more definitively in a trial. For the qualitative part,

although ScreenMen was meant to be tested in a 'real-world' setting, the researcher was present in the same room to observe and to assist the users in case any technical issue occurred, which may affect how the users used ScreenMen. However, this gave more gain than loss as observation on users' behaviour provides very important data for probing during interview while solving technical issues are also important to prevent error in the future.

CONCLUSION

This study showed that ScreenMen is acceptable to men in terms of its utility and usability. Men are able to learn more about their health risks and screening via ScreenMen. The preliminary data suggested that ScreenMen might increase men's intention to undergo screening and may potentially improve the actual uptake of health screening as well. Further evaluation in the form of randomised controlled trial should be conducted to determine the effectiveness of ScreenMen in improving the uptake of evidence-based health screening. Apart from that, this study also allowed further refinement of ScreenMen to improve its utility and usability. We have shared the key lessons learnt from this beta testing, which might be useful for public health experts and researchers who are developing user-centered mobile web-apps in the future.

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CONFLICT OF INTEREST

The authors declared that there is no conflict of interest in this study.

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CHAPTER 5: DISCUSSION

5.1 Introduction

This chapter describes the cumulative effect of the papers on how they lead to the finalisation of ScreenMen. ScreenMen was developed to tackle many of the barriers to health screening in men using a theory-based educational approach. The importance of tackling knowledge, which is crucial to ensure long term sustainability is discussed. Other than knowledge, the masculinity issue as well as the male-sensitive approach used in ScreenMen are elaborated. In addition, this chapter further discusses ScreenMen's role in advocating evidence-based health screening. The potential of ICT in addressing knowledge, masculinity-related screening barriers and medical overuse issues in men are also discussed. Last but not least, this chapter describes the strength and limitations of this study.

5.2 Cumulative Effect of the Papers

In view of the low health screening uptake in men and the potential of eHealth in improving men's health behaviour, this study aimed to develop and pilot test an innovative eHealth intervention to improve the uptake of evidence-based health screening in men. Figure 5.1 shows the complete flow of study and the cumulative effect of the papers which leads to the finalisation of ScreenMen.

The UKMRC Complex Intervention Framework was used as the overarching framework to guide the development of the intervention (Craig et al., 2008). As recommended by the framework, an exploratory study which consisted of searching for theories, identifying existing evidences and exploring users' needs was conducted. This was crucial, so that the intervention developed is more effective and implementable.

Before addressing the problem, it is important to first explore the reasons underlying the low health screening uptake in men. Several behavioural change theories such as the

integrative model, theory of planned behaviour, health belief mode, transtheoretical model and precaution adoption process model were found to explain men's health screening behaviour. Subsequently, to understand the problem in a more specific manner in the context of health screening, a systematic review on the barriers and facilitators to health screening in men was conducted (Paper 1). A comprehensive framework on the barriers and facilitators to health screening in men was formed using the best-fit meta-synthesis approach as a result from this systematic review. The barriers and facilitators to screening in men were divided into five domains: individual, social, health system, healthcare professional and screening procedure. Subsequently, to further understand the specific needs of young men from Malaysia in terms of attending health screening, a qualitative study was conducted (Paper 3). The key factors that influenced young men's health screening behaviour emerged from this study were: misconceptions about health screening, receptivity to screening, life priorities, cost consideration, doctor's influence and medical overuse.

Before developing the intervention, it is also important to review the existing interventions to improve health screening uptake in men. The systematic review on the effectiveness of interventions to improve health screening uptake conducted suggested that an educational intervention is effective in improving screening uptake in men (Paper 2). There are only a few web-based interventions that promote screening uptake but only focusing on specific diseases instead of comprehensive health screening. Furthermore, no intervention using mobile app nor mobile web app was found in this systematic review, although they have wide dissemination and were found effective in improving health behaviour. These justified the need for developing ScreenMen.

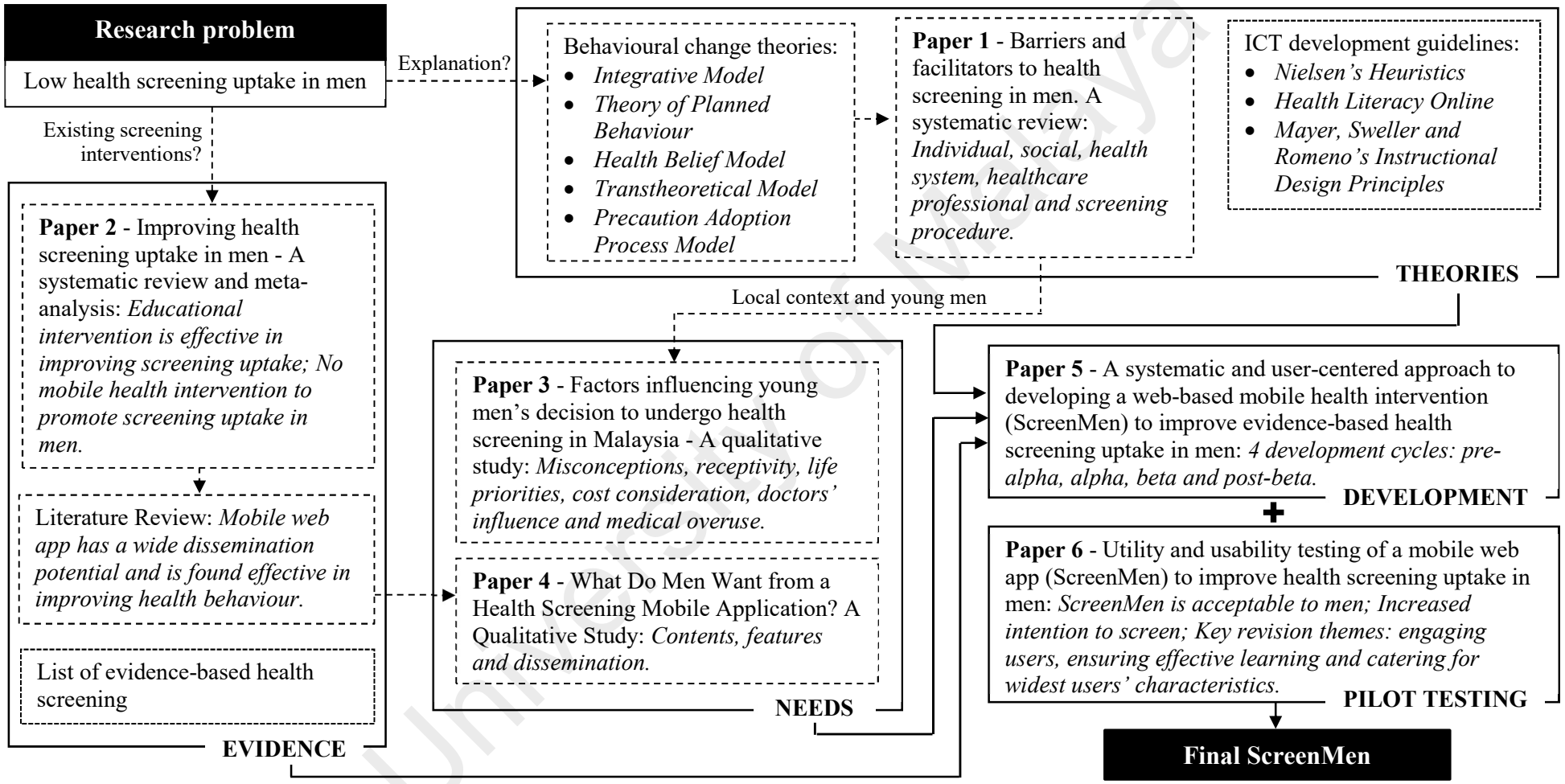
As a part of justifying the need for ScreenMen, it is crucial to explore how ScreenMen can be used to improve health screening uptake in men. Paper 4 presented what men want

from a health screening mobile app. As a result of this qualitative study, three themes were formed which are content, feature and dissemination. The participants have proposed a lot of content and features to be considered when developing the mobile application. The dissemination factor also emerged. Though this study focusses mainly on the development of ScreenMen, it is crucial to explore how to disseminate it, which is the ultimate aim of developing ScreenMen. When conducting this needs assessment, the research team had not decided whether to choose a mobile app or mobile web app as the intervention delivery platform. During the interviews with men, the idea of a 'mobile app' was used (as published in Paper 4) instead of asking what do they want from a 'mobile web app'. This is because generally, men are more familiar with mobile apps and not many are used to the term 'mobile web app'. Using 'mobile app' in the interview may stimulate more ideas in men due to its capability to include more interesting features, instead of restricting participants' imagination to a website. Furthermore, the eHealth intervention is aimed to be delivered via a mobile phone. Regardless of mobile app or mobile web app, it will be designed in a user-centered way with a user interface that gives highest possible user experience.

Once the exploratory phase was completed, the research team discussed and finalised the delivery platform to be used as the delivery the intervention, taking into account the theories, evidence and needs gathered, including the ICT development guidelines as well as the list of evidence-based health screening. Mobile web app was decided upon in view of the need to first reach out to men in this neglected and unrecognised health topic instead of developing an intervention with sophisticated functions but not being taken up by users. Subsequently, to develop the intervention, a development process model was created to guide the development of ScreenMen, which was presented in Paper 5. Though the UKMRC Complex Intervention Framework describes the necessary steps to develop the contents of the intervention, the steps to develop the delivery component of the

intervention which is a mobile web app in this study, was not described. In this paper, the development process model used to develop ScreenMen, including the synthesis of the exploratory phase's findings (theories, evidence and needs) to form the initial requirement of ScreenMen, four development cycles (pre-alpha, alpha, beta and post-beta), prototyping methods, tools used, stakeholders involved, testing methods, technology used as well as modules of ScreenMen were described in detail.

Before ScreenMen was finalised, it was pilot tested with end users in terms of its utility and usability to determine its acceptability by men. This pilot testing is one of the stages or sub-sets of the development process model (beta testing) as described in Paper 5. Due to the extensiveness of its outcome, this pilot testing was presented in Paper 6. In Paper 6, the utility and usability of ScreenMen were found to be acceptable to men. The preliminary findings showed that ScreenMen increased participants intention to undergo screening. The pilot testing participants also suggested more revisions to further improve ScreenMen. The key lessons learnt in developing ScreenMen in terms of engaging users, ensuring effective learning and catering for widest possible user range were described, which are useful to be considered in the future development of interventions. ScreenMen was eventually finalised and ready for effectiveness evaluation.



Note: Italicized words are key findings.

Figure 5.1: The flow of study and cumulative effect of papers towards the finalisation of ScreenMen

5.3 Refocusing on the Importance of Knowledge

5.3.1 Lack of Knowledge Emerged as the Main Barrier to Screening in Men

Male dominant barriers can inhibit men's access to health screening in their early years, with the most important being a lack of knowledge of their own health needs and the benefits of screening. In the exploratory phase, of the many factors found, a lack of men's knowledge emerged as the key barrier to screening from many of the sub-studies. The systematic review conducted (Paper 1) found knowledge to be among the top ten most commonly reported barriers and facilitators to screening in men.

Apart from this systematic review, the needs assessment conducted (Paper 3) also found that young men in Malaysia have poor understanding of health screening. Many men admitted that they do not know much about screening and they want more information about health and screening (Paper 4). This lack of knowledge issue is also found in many quantitative studies conducted globally. Men are more likely to cite lack of knowledge as a barrier to screening and men have lower level of knowledge about health screening than women, though it may not be statistically significant (Al-Naggar & Bobryshev, 2013; Elnicki, Morris & Shockcor, 1995; Harmy et al., 2011; Jones et al., 2010; Ramos et al., 2011; Santos-Hovener et al., 2015; Wong et al., 2013). The difference in health knowledge in men and women are often linked back to how boys and girls are brought up since schooling time for example during Physical Education, girls are exposed to information about health and their body while boys often spend time in sports (Smith, Lounsbery & McKenzie, 2014). Women are also more exposed to healthcare system where they often seek health care particularly in antenatal check-ups unlike men who are less likely to utilise health care (Leone et al., 2017). Other than that, the lack of awareness might be due to the fact that men are systematically marginalised where health campaign conducted are often targeting women instead of men (Ilic, Risbridger & Green, 2005; Thompson, Reeder & Abel, 2012).

Many qualitative studies also found lack of knowledge as a barrier to screening in men. However, these studies only report lack of knowledge superficially such as "don't know enough about it to get tested" or "I think lack of knowledge is a barrier for most men" (Odedina et al., 2004, p. 479; Plowden, 2006, p. 782). On the contrary, the needs assessment conducted in this study offered a deeper insight on the 'lack of knowledge' issue in young men from the local context, where misconceptions on screening emerged such as 'screen only when having symptoms'; 'screen once is sufficient', 'there is no need to screen when young, exercising regularly and eating healthy'; and 'more tests are better' were described in nuance. This enabled the 'lack of knowledge' issue to be tackled in a more precise manner.

Besides the findings from these studies, established theories such as the Theory of Planned Behaviour (Figure 5.2) and its expanded version, the Integrative Model also infer that knowledge is one of the background factors that affects one's intention and subsequently their behaviour (Fishbein & Ajzen, 2010). Other than these, the components in the Health Belief Model (Figure 5.3) such as perceived susceptibility and perceived benefits are very much influenced by having or not having knowledge as modelled by Fort et al (Fort et al., 2011). The Precaution Adoption Process Model (PAPM) theorises that 'unaware of issue', which is due to lack of knowledge, is the first stage of decision deliberation stages before taking an action. Only when one learnt or obtained knowledge about the issue, he/she will proceed to the next stage of decision deliberation. This shows that knowledge is the first and crucial thing to be addressed when attempting to change men's behaviour. Apart from that, experts also argue that health literacy, which is linked to one's competency to access, understand, appraise and apply health knowledge, affects his or her ability to make decision and take action on their health (Sorensen et al., 2012).

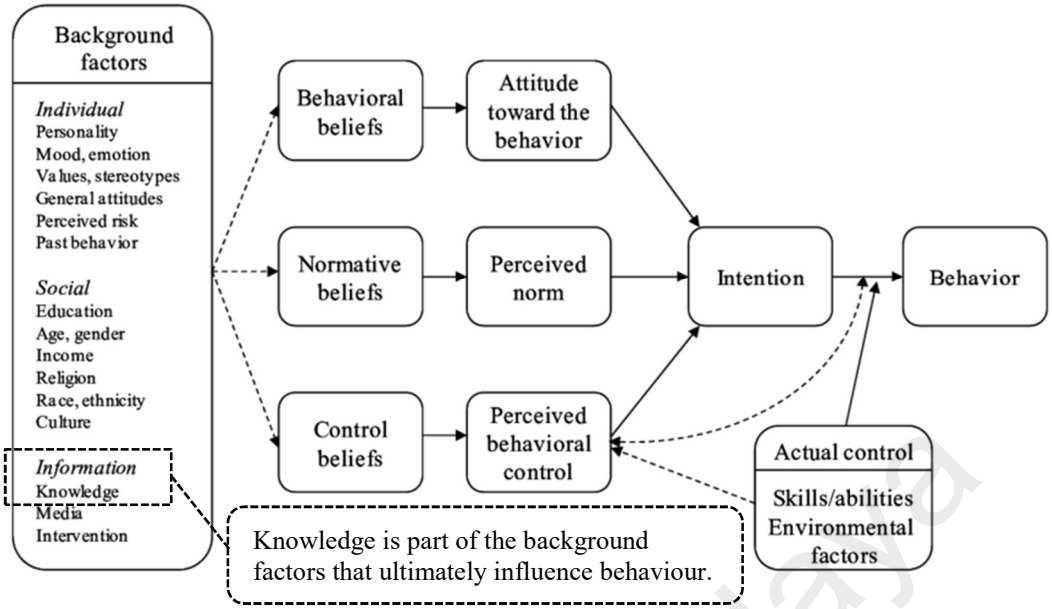


Figure 5.2: The theory of planned behaviour. Adopted from (Fishbein & Ajzen, 2010)

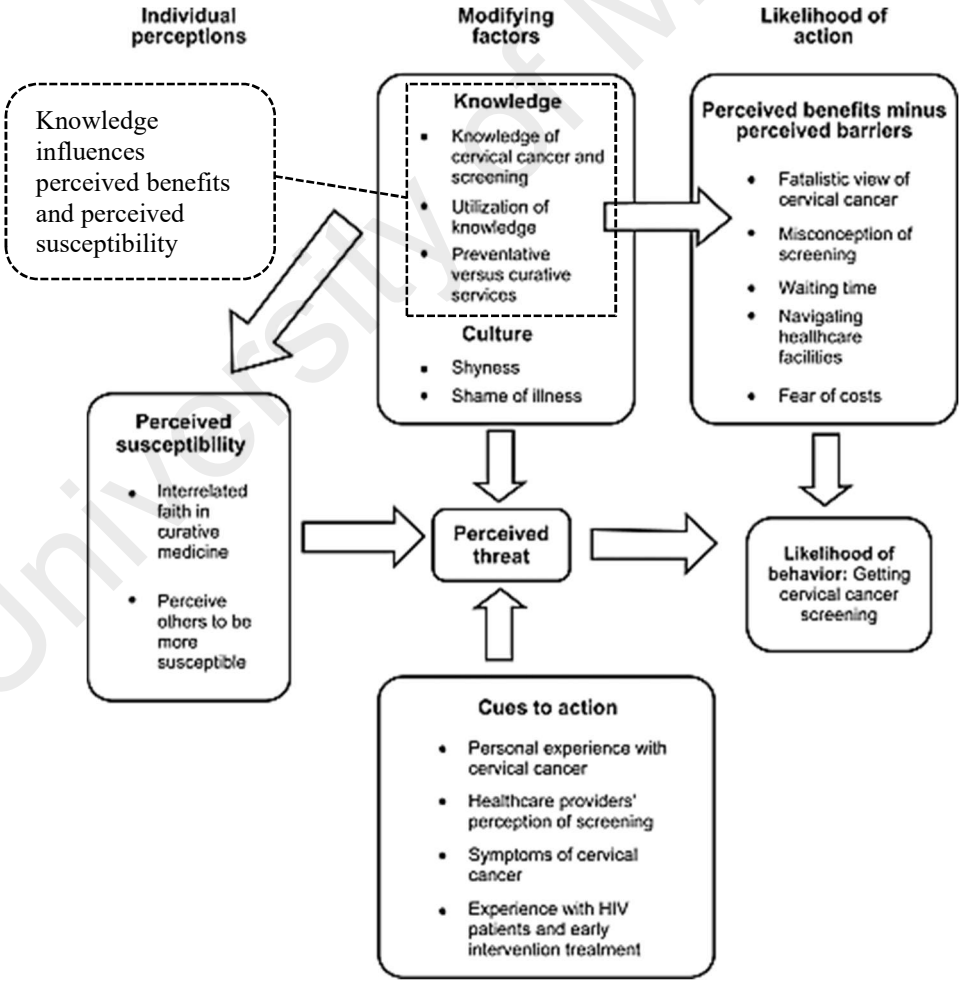


Figure 5.3: The interaction of knowledge with the components in health belief model in getting cervical cancer screening. Adopted from (Fort et al., 2011)

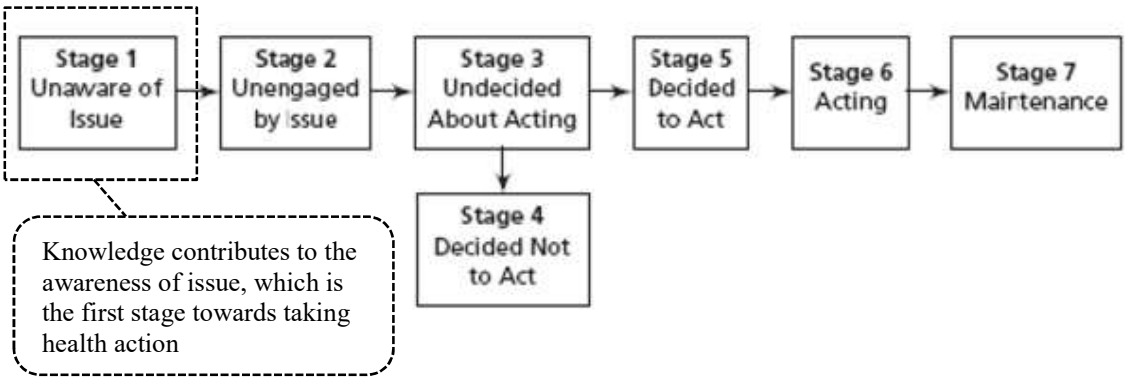


Figure 5.4: 'Unaware of issue' is the first stage towards taking health action in the precaution adoption process model

5.3.2 Employing a Theory-based Educational Approach in ScreenMen

The emergence of the prominent lack of knowledge issue reinstates the importance of focusing on imparting knowledge in the intervention. Strategically, in terms of intervention, the systematic review conducted (Paper 2) found that educational interventions were effective in improving health screening uptake in men. Thus, ScreenMen was developed to address many of the barriers to health screening in men using an educational approach.

This study acknowledged that human behaviour is a dynamic and complex ecosystem which may require a multi-faceted approach to induce behaviour change, as argued by experts where knowledge itself does not translate to action (Corace & Garber, 2014; Kelly & Barker, 2016). Although ScreenMen is considered an educational intervention which imparts knowledge, the approach used actually followed the guidance of theories. ScreenMen first acts to fill the knowledge gap and increase awareness of screening in men as guided by the Precaution Adoption Process Model. ScreenMen does not aim to only get the message across, it challenges men's existing belief and demystifies the concept of health screening in men. The short video on health screening realigns men's understanding on what health screening is all about and increases the perceived benefit

of screening in men, which is a key factor to drive behaviour change according to the Health Belief Model. Similarly, ScreenMen also assesses men's health status and explains their own health risks (such as increased age, having family history of diseases, unhealthy lifestyle), which may lead to increased perceived susceptibility (Health Belief Model) in men and increasing the likelihood of men taking action on their health. These two facilitators, 'perceived benefits of screening' and 'perceived at risk' are the most, and second most, commonly reported facilitators to screening in men as reported in Paper 1, which justified the endeavour of using these to tackle men's screening behaviour.

Perceived benefits of screening and recognition of risk may improve men's attitude towards screening but they may not be sufficient to drive behaviour change in men. As described in the Theory of Planned Behaviour and Integrative Model, behaviour change is a result of intention change which is influenced by attitude, subjective norm and perceived behaviour control. Not only improving attitude, ScreenMen attempted to address the subjective norm by including sentences addressing the social stigma on screening in the web such as "Health screening is now considered an important part of health prevention and is acceptable to most people. Going for health screening is not a sign of weakness; rather it means that you are a responsible person who takes action to maintain your health." to realign men's perception and belief on health screening. Apart from that, ScreenMen encourages the users to share it with family and friends. It will also be disseminated widely to the public in the next phase of the study. This effort will realign the society's knowledge and perception on health screening, and hopefully eventually lead to health screening being a norm across the whole country.

Apart from improving attitudes and subjective norms, ScreenMen also attempted to improve perceived behaviour control in men by imparting basic logistic knowledge such as screening location, appropriate time to undergo screening and cost of screening tests,

which were lacking in men. In the needs assessment, cost also emerged as a key barrier to screening, though not as prominent as knowledge. In ScreenMen, men are educated and empowered to go for evidence-based health screening and avoid unnecessary screening tests. This is indirectly linked to cost where the reduction in the number of unnecessary screening tests will lead to a reduction in the cost of screening. This newly-perceived lower cost of screening may subsequently increase the likelihood of men in attending health screening. Apart from that, ScreenMen also inform men where they can get cheap health screening such as in the public health clinics. Other information such as details of screening procedure such as what to expect before, during and after the screening are also provided to men in ScreenMen. With this new knowledge, men's perceived behaviour control will be improved, where men will be more prepared and are able to plan better about attending health screening. Eventually, these increase the likelihood for men to undergo health screening.

ScreenMen also attempted to avoid being biased towards the pros of health screening. Although it is established that evidence-based screening gives clear benefits over harms, ScreenMen states the possible harms of screening including pain, discomfort, anxiety and social stigma and how to deal with these complications. It is crucial to present all pros and cons of screening so that users can weigh the benefits and harms themselves in deliberating their decisions. This is also in tandem with the recommendation by the International Patient Decision Aids Standards Checklist that positive and negative information needs to be presented in an unbiased manner when aiding patients to make a decision (International Patient Decision Aids Standards Collaboration, 2006). Being transparent to the users is important to gain their trust, which may lead to making more informed decisions and taking action.

In addition, a reminder function was also added to ScreenMen. Low knowledge retention is a well-recognised issue and people tends to forget information especially something that may not be a priority to them, which is health screening in this case (Gadler et al., 2016; Murre & Dros, 2015; Sanders et al., 2014). This reminder function serves as a support tool for users to recall knowledge (about the importance of health screening and their health risks) and nudge them to take action and undergo health screening.

In a summary, ScreenMen attempts to improve health screening behaviour of men by imparting knowledge and addressing many barriers to screening, based on the guidance of theories. Unbiased information giving is crucial in building trust as well as a reminder function to support knowledge maintenance is important to increase effectiveness.

5.3.3 The Importance of Addressing the Knowledge Gap

Some experts argued that knowledge-based intervention may not work (Corace & Garber, 2014; Kelly & Barker, 2016). However, based on the findings from the systematic reviews, needs assessment and the theories found, knowledge seem to be a crucial component towards behaviour change in men. Without first having knowledge, particularly in relation to perceived benefits of screening and perceived susceptibility to disease, men may not bother at all even when screening is brought to them. One example to be highlighted at this point is the health screening programme conducted by the Social Security Organisation under the Ministry of Human Resource Malaysia, where free health screening vouchers were provided to all workers aged 40 years old and above in Malaysia. Though free vouchers for screening are provided, out of 1,501,527 men who received the vouchers from 2013 to 2016, only 224,484 (15.0%) men attended health screening (Health Prevention and Promotion Unit, 2017). This made many ponder the actual

underlying factor behind the low health screening uptake in men, which may be the lack of knowledge as suggested in this study.

Imparting knowledge and realigning men's perception about screening, which ScreenMen employs, is crucial as it involves changing the core of behaviour. This is a more sustainable approach for the long run unlike interventions that use the carrot or stick approach (rewarding or punishing a behaviour), where good behaviours are usually not maintained once the reward or punishment are put away (Soni, 2014). Though this method may be a good approach to start-off a change, it may not be sustainable when the resource has depleted (Gachter, 2012; Hilbe & Sigmund, 2010). The key ingredient to a long-term sustainability of the carrot or stick approach may be to complement it with education. This not only gets people engaged in the short term but changes their belief and behaviour for the long run.

Nevertheless, this study recognised that solely depending on a theory-based educational approach, which ScreenMen employs, may not be sufficient to improve health screening uptake in men as every individual is unique and has different values. ScreenMen acts to fill the knowledge gap in men; it may or may not tip men over towards attending health screening. In the best scenario, ScreenMen may cause men who have never intended to screen to actually undergo screening. For men who have contemplated to screen but have been procrastinating it, ScreenMen may act as a nudge for them to take action to screen (Li & Chapman, 2013). In the worst scenario where ScreenMen does not successfully make men undergo screening, with the increased knowledge, ScreenMen may at least move them to the next stage of behaviour change, which increases their likelihood to act when opportunities arise or when other facilitators are present in the future. Though ScreenMen attempted to address most of the issues, there are still barriers that cannot be solved by ScreenMen for example 'lack of time' or 'lack of money' to

undergo screening. An integrated programmes or multifaceted approach combining multiple facilitators such as providing free health screening in complement with ScreenMen may be more effective when addressing the multi-factorial barriers in health screening (Barker et al., 2010).

In a nutshell, the approach employed by ScreenMen, which tackles the fundamental of behaviour change by imparting knowledge and realigning men's attitude towards screening, is crucial to ensure the sustainability of its impact in the long run. Supplementing this with other facilitators such as removing the cost and distance barriers to screening may be a better strategy to further boost men's propensity to change and eventually lead to the increased health screening uptake in men.

5.4 Masculinity as a Barrier to Health Screening

5.4.1 Sequential Manifestation of Masculinity Attributes in Health Screening

Poor health status in men is often associated with masculinity issues in men. In the context of health screening, masculinity attributes such as avoidance of femininity, self-reliance, heterosexual self-presentation, risk taking and invincibility belief were reported as the barriers to health screening in men globally as identified in Paper 1 and Christy's proposed framework for men attending colorectal cancer screening (Christy, Mosher & Rawl, 2014). These five masculinity attributes were often discussed as parallel factors that influence screening uptake. However, based on reflections in this study, there seems to be a sequence of these five masculinity attributes in acting as a barrier to screening in men (Figure 5.5).

Before these masculinity attributes can act as a barrier to screening, men must be aware and have knowledge about diseases and screening. For men who are aware about diseases and screening, invincibility belief (where men deny or do not think they will get the disease) is seen to be the first barrier to screening among the five masculinity attributes.

Only when men do not have invincibility belief, the risk taking can act as the reason for men not taking up screening. In other words, men can only be said as taking risk when they know and accept that they have the risk. If they do not think they are at risk, then there is no risk to be taken. For men who do not want to take risk and want to go for screening, they may be stopped by the perception 'seeking help is considered as weak'. For men who do not think seeking help is weak, the self-reliance attribute where men do not like to listen to others (doctors in this case) on what to do, may be the barrier to screening. Self-reliance is proposed to come after avoidance of femininity because one has to be open to the concept of seeking help from someone before the issue of listening to someone may come into play. Finally, for men who think it is important to listen to doctors' advice, screening procedures which have a gay connotation such as colonoscopy may act as a barrier for them to undergo screening.

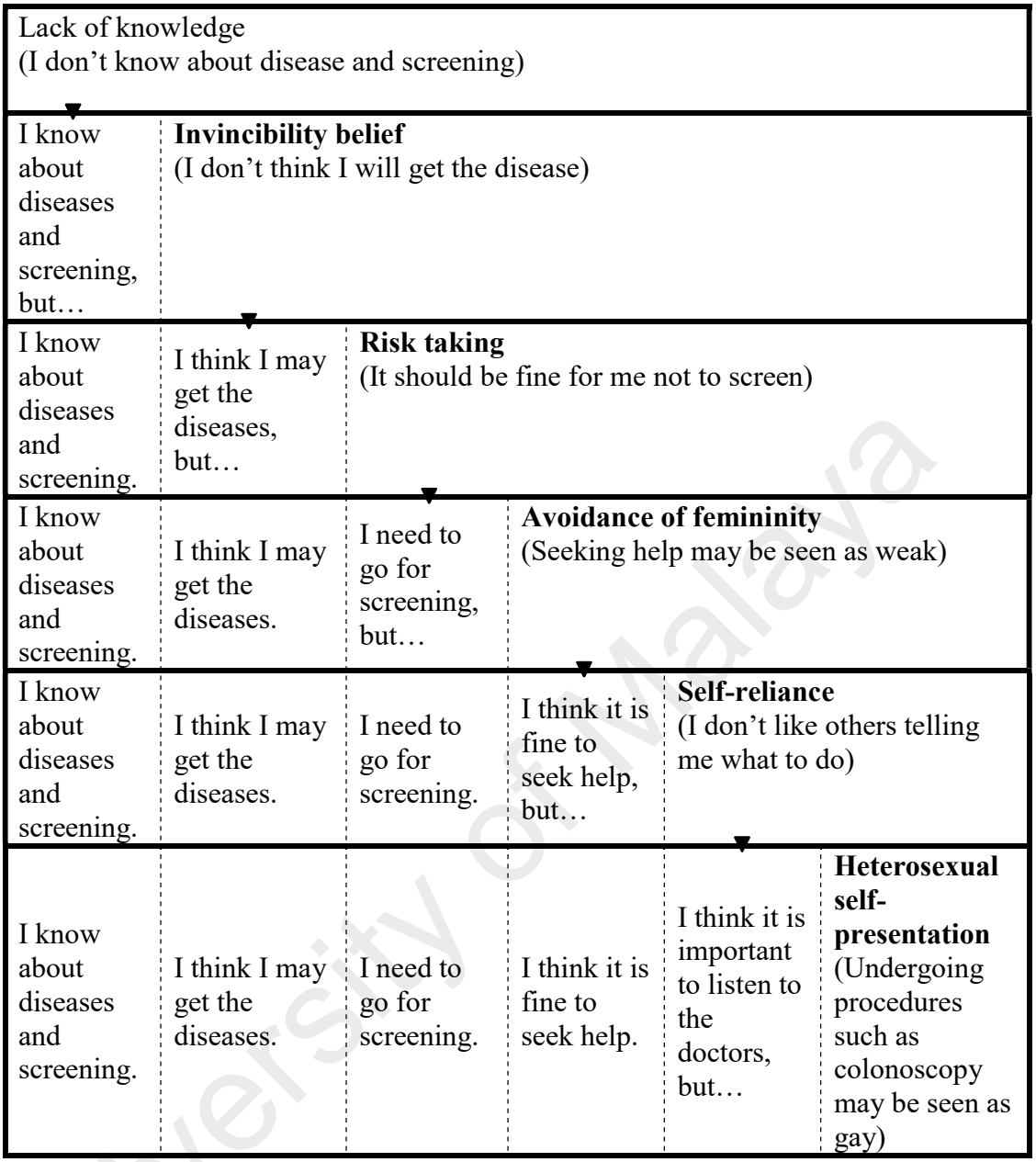


Figure 5.5: The sequence of the five masculinity attributes manifestation in acting as a barrier to screening

This proposed model expands the existing framework in explaining how masculinity act as a barrier to health screening in men. It shed lights on the nuance between each masculinity attribute and describe how they precede and succeed each other. This proposed model is open for critique and may require further fine-tuning in the future.

5.4.2 Masculinity Not Being a Prominent Barrier in Health Screening

Putting the proposed model aside, masculinity has been reported as a barrier to screening in many studies globally. The systematic review conducted (Paper 1) found that avoidance of femininity (seeking help or talking about health is considered feminine or weak) and heterosexual self-presentation (undergoing colonoscopy may be perceived as gay) are among the top ten most commonly reported barriers to screening in men. However, in this study, masculinity did not emerge as the key factor to screening in men based on the needs assessment conducted.

It is important to note that exploring the masculinity factor in a qualitative study is challenging, as masculinity is a difficult concept for laymen and men may not realise or admit if they exhibit masculinity attributes. During the needs assessment, masculinity only emerged when the participants talked about their father, who did not go for screening due to the 'ego' factor. Several questions on masculinity were also prepared in laymen terms to guide the exploration of masculinity issue in a greater depth. When exploring the risk-taking masculinity attribute, most men disagreed that 'men do not care as much about their health as compared to women'. They felt that men care about health as much as women especially when it comes to sports and body image.

Men also refuted the invincibility belief that 'men are strong that they will not get disease, thus there is no need for health screening'. They acknowledged that everybody will get sick sometime and will seek help when sick, though not screening when healthy. The avoidance of femininity attribute (men will be perceived like a woman by others if they go for a check-up) was also rebutted by most men, though some agreed that men often talk about cars, sports and sex instead of health. Apart from that, men also disapproved the self-reliance masculinity attribute where men do not like to depend on a doctor to tell them what to do with their health. In fact, they mentioned that it is the

doctors whom people should listen to as doctors spent years training in the medical school to be the certified professional in regards to health matter.

The lack of presence of the masculinity factor in this study may be due the study sample who are younger, have higher educational level and from an urban setting. As discussed in the literature review, masculinity is dynamic and may vary according to age, socioeconomic status, educational level as well as locality which is linked to culture (Alam, 2016; Courtenay, 2000; Hasan, Aggleton & Persson, 2015; Houle et al., 2015; Lohan, 2007; Mansor et al., 2014; Oliffe, 2009; Rochelle, 2015). The needs assessment conducted found that young men are more receptive to healthcare, which may be due to the explosion of information via the internet especially the social media, which young men use a lot. This is also triangulated by a senior participant who mentioned that his children would seek help when sick, unlike his generation where hospital is considered a taboo. Similar to the study conducted by Coles et al, it was found that men were keen to engage with health services, welcomed the opportunity to discuss their health care needs and were receptive to health information (Coles et al., 2010). A qualitative study on the feedback from participants in the Well Men Service programme which aims to improve men's health also challenged the notion that men are disinterested in their health (Douglas et al., 2013). If based on the proposed sequential masculinity attributes manifestation model, the lack of presence of a masculinity factor could be due to the men's lack of knowledge, which emerged as the primary barrier emerged in this study. Masculinity attributes may not manifest when lack of knowledge is present.

5.5 Male-sensitive Approach to Promoting Health Screening in Men

Many experts have emphasised the importance of using a male-sensitive approach when attempting to improve men's behaviour. However, there is no globally-agreed

definition of male-sensitive intervention. Based on the review conducted, the synthesised characteristics of male-sensitive interventions comprises the following:

1. Using male-friendly settings such as sports club, workplaces or virtual space
2. Organising men-only groups instead of mixed-gender groups
3. Focusing on male-specific interests such as football, car or drumming activities
4. Listening to the voice of the local targeted men
5. Providing individually tailored feedback
6. Using male-oriented terms such as 'regaining control' instead of 'seeking help'
7. Discussing men's adherence to masculine norms
8. Emphasising the father's role
9. Ensuring personnel delivering the programme take a non-judgemental and male positive approach
10. Expanding social support using male-interested activities and collaborating with local community groups
11. Designing the contents specifically addressing men's concerns

5.5.1 Masculinity as a Positive Attribute in Health Screening

ScreenMen embraced the strength-based approach as recommended by men's health experts to promote health screening in men (MacDonald, 2016; Robertson et al., 2015). The main approach used in ScreenMen was emphasising the importance to be healthy in order to take care of the man's family. 'Staying healthy to take care of family' was found as a facilitator to screening in the systematic review (Paper 1) as well as in the needs assessment (Paper 3). Men would undergo health screening in order to be healthy so that they can take care and provide for their family, especially after getting married, for young men. Many studies have shown that being a family man and men who are able to take care of family as well as being a good father are considered as being masculine (Fazli

Khalaf et al., 2013; Ng, Tan & Low, 2008). This facilitator will hopefully remind and act as a motivation for men to screen and take charge of their health on top of the increased perceived benefits of screening as well as perceived susceptibility to disease.

Another example of intervention that incorporated masculinity concepts in the intervention was the 'Take the Wheel' prostate cancer screening decision aid study (Allen et al., 2010). This name gives the sense of men's independent as well as active role in making decisions about their own health care and 'steering their own course'. It also reflects the 'in control' masculinity attribute where men are guided towards staying healthy and subsequently being in control, which is seen as masculine.

5.5.2 Using Male-sensitive Concepts in Health Interventions

Besides that, ScreenMen also used the concept of car maintenance to facilitate learning about health screening in men. This concept has been used in several programmes globally to encourage health screening such as the Man MOT, which is a suite of online health information and advice services where men can chat with an NHS GP service anonymously on any health topic (Baker, 2017). MOT stands for the Ministry of Transport, which was the responsible Ministry for the road worthiness test in the UK. It was used to name this programme due to men's familiarity with it. Another programme which is related to car maintenance concept is the Pit Stop Health Check (Alston & Hall, 2001; MENGAGE, 2010). Unlike ScreenMen and Man MOT, this is a mobile health screening programme that is set up in a comfortable and non-medical environment to run quick and simple health check for men. It is run in a series of mechanical tune-up stations where each station resembles a body part or health condition such as chassis check (waist circumference), oil pressure (blood pressure), fuel additives (alcohol consumption) and extractor (colorectal cancer) stations.

Besides the car maintenance concept, the ScreenMen web used a friendly-looking Superman-like figure with a stethoscope around the neck as the main avatar of the website. This figure was named as Dr ScreenMen. The use of Dr ScreenMen was in sync with the literatures found, where interventions that utilised something men like or are familiar with are considered as gender sensitive. Though in other health related studies, the concept of Superman is often linked to muscular body image as well as the strong and invincibility belief, Dr ScreenMen's implicit intention was to encourage men to undergo screening in order to stay strong and healthy, just like Superman (Allen et al., 2007; Baghurst et al., 2006; Frederick et al., 2007). Apart from that, Dr ScreenMen also attempted to portray Superman's attribute which is kind and ready to help others (in this case providing health advice). This is also supported by a study on the Return of Superman reality show in South Korea, which found that the show was not only trying to convey Superman's masculinity in terms of strength and power but also about helping others and respecting women in their gender role (Praptika, 2016). The study also suggested that this may be part of the government's effort in promoting gender equality in South Korea.

Experts may argue that using this Superman-like figure may reinforce masculinity in men. However, from the pilot testing with men, most did not have any comments on the Dr ScreenMen figure while some liked it, especially those in lower job positions and education groups. Existing health webs often use a formal layout and design with images of doctors and hospitals, which is often seen as boring and too serious. ScreenMen attempted this unconventional approach in order to increase the likelihood of attracting and engaging men to use the web as well as to increase their interest and propensity to keep using the web. This uniqueness in the design and delivery will give men a fresh view of a health web (ScreenMen), which prevent them from thinking that it is just another health web.

5.5.3 Creating Male-friendly Environment for Health Interventions

In order to be male-sensitive, ScreenMen is developed to cater for men only. This approach is supported by studies which showed that men-only interventions may have an increased effectiveness (Robertson et al., 2014). However, when asked, men in this study, most did not see the need for a male-only intervention but thought from a gender equality perspective that if an intervention is to be developed, it has to benefit both men and women. Only some men saw the benefits of having a male-only intervention as they felt it would be more effective as much more effort has been put in specifically tailor it for men when developing it. This is similar to the feedback from men on the Well Men Service where they were ambivalent about the need for gender specific services. Despite the ambivalence, the users expressed positive satisfaction with the male sensitive programme in general (Douglas et al., 2013). Using the ICT platform is also seen as male-friendly. Studies have reported that virtual space is considered friendly to men as there is no need to adhere to masculinity norm there.

In summary, ScreenMen was developed to incorporate many male-sensitive characteristics, which includes using male-friendly setting (online); catering for men only; using male-specific interests such as a car maintenance concept and a Superman-like figure; listening to men's voice; providing tailored feedback as well as encouraging men to stay healthy to take care of their family which is seen to be masculine. ScreenMen embraced the strength-based approach and attempted to address the issue of masculinity positively. In spite of that, the effectiveness of these remain unproven until an evaluation using a randomised controlled trial (RCT) design proved otherwise. A simple RCT comparing ScreenMen with a control group may be insufficient to conclude whether this male-sensitive approach is more effective than a general approach as ScreenMen is a complex intervention with multiple working components. It should be coupled with a process evaluation to explore if the male-sensitive component of the interventions that

actually works. The ideal approach to evaluate the true effect of the male-sensitive characteristics is to compare a male-sensitive ScreenMen with a non-male-sensitive ScreenMen (which needs to be re-developed) using a trial design.

5.6 Advocating Evidence-based Health Screening

5.6.1 Medical Overuse in Health Screening

Apart from addressing knowledge and employing the male-sensitive approach, ScreenMen also advocates evidence-based health screening in men. The issue of medical overuse or the offering of low-value health services were increasingly being recognised over the past decade. An analysis done on a random 5% sample of the 2008-2009 United States (US) Medicare beneficiaries claims data found that about 24% to 41% of Medicare beneficiaries received one or more measured low-value health services (for example, PSA testing for men over 75 years old; bone mineral density testing at frequent intervals; and screening for carotid artery disease in asymptomatic adults) which provide little to no clinical benefit on average (Schwartz et al., 2014). The authors also reported that the wastage of resource based on the sample in this study accounts up to USD8.248 billion. Beyond this study, a report published by the Institute of Medicine (US) Roundtable on Evidence-Based Medicine in 2010 stated that more than USD750 billion of health care spending in a year represents waste (Olsen & Young, 2010).

Similarly, evidence-based health screening is not strictly practiced in Malaysia. Screening tests are often offered in packages that include unnecessary tests. This practice is very much embraced especially by the private health institutions. A simple search on the Google using the keywords ‘health screening’ will result in a handful of health screening packages offered by various private health institutions. These screening packages often include lung function tests, electrocardiogram (ECG), urine analysis, tumour markers, prostate specific antigen (PSA) and chest x-ray which are non-evidence-

based screening tests, even in the most basic package. When evidence-based screening tests are found, the packages are offered homogenously for all and not to the correct group of patients, for example screening for Syphilis, Hepatitis B and HIV which should be done for high risk groups while lipid profile is for people above 40 years old unless they have a family history.

5.6.2 Causes of Unnecessary Health Screening

Despite the growing evidence and increase emphasis globally, this non-evidence-based screening practice persists, which could be due to several reasons. A survey conducted on the knowledge and practice of prostate cancer screening among general practitioners (GPs) in Malaysia found that about half of the participants would routinely screen asymptomatic men for prostate cancer and about 95% of them would use PSA to screen, though the evidence of prostate cancer screening using PSA remains weak (Tun Firzara & Ng, 2016). This suggests the lack of knowledge about the evidence of health screening in the GPs. When exploring evidence-based practice in primary care doctors, it was found that evidence-based medicine was also seldom practiced due to the lack of knowledge and skills in searching for and applying evidence (Hisham, Ng, et al., 2016). Doctors' reluctance to embrace evidence-based medicine where it is perceived as limiting good clinical practice, preference to follow clinical practice guidelines which may not be updated and the lack of support from the management were also seen as barriers for doctors to adopt evidence-based practice including for health screening (Hisham, Liew, et al., 2016; Hisham, Ng, et al., 2016). Apart from that, patient's preference for non-evidence-based treatment was also found to be a factor which limited evidence-based practice in doctors (Hisham, Ng, et al., 2016).

In the needs assessment study (Paper 3), medical overuse also emerged as a key factor which influence health screening behaviour in young men. Although part of this issue

was accounted for by men who think that 'more tests is better', it also emerged in the context of healthcare professional where some participants mentioned that they doubted the doctors' integrity due to their unethical profit-based practice which often order many tests that men don't need. This not only created a loss of trust and an increased cost of screening, healthcare professionals also trivialised young men and discouraged them to undergo screening as they are still young, which is not in accordance with the evidence of screening.

On top of these, there has been insufficient policy or enforcement by the health authority to promote evidence-based health screening, though this is increasing nowadays. A classic example is the screening using chest x-ray, particularly for pre-employment medical screening. Literatures over the past three decades have repeated showed that routine pre-employment chest x-ray is unnecessary and wasteful due to the little gain over the loss (radiation harm, cost and time) it brought about, but it is still widely practiced nowadays (Jachuck et al., 1988; Lohiya et al., 2006; Naz et al., 2014; Pachman, 2009; Samuel, Gibikote & Kirupakaran, 2016).

5.6.3 Initiatives to Promote Evidence-based Health Screening

As part of the efforts to reduce low-value health services in the US, the Choosing Wisely campaign was organised to promote conversations between clinicians and patients by facilitating patients to choose care that is based on evidence; not duplicative of procedures already received; free from harm; and truly necessary. The organisers, with collaborators, developed and disseminated a list of low-value services to be avoided for physicians as well as patient-friendly materials for the public. Recent studies have shown that Choosing Wisely has produced positive impact in increasing awareness about low-value health services, empowering doctors and reducing unnecessary tests and procedures (Colla et al., 2016; Lin et al., 2017; Morgan et al., 2016). This campaign has expanded

beyond the US to many countries in other continents globally. However, in Asia, only Japan, India and South Korea have adopted this campaign.

In Malaysia, the existing efforts in promoting evidence-based practice in healthcare professionals and providers have not been very successful. Instead of targeting the healthcare professionals, ScreenMen was developed to promote evidence-based screening from the patients or users' perspective, specifically by educating men about what is necessary for them and empowering them to ask 3 questions when choosing screening tests. The contents in ScreenMen, which are evidence-based and tailored to Malaysian context, was developed based on the synthesis of international and local guidelines as well as experts' consensus. The pre-appraised information presented in ScreenMen eliminate the need for men to appraise online health information, avoiding the internalisation of inaccurate information due to the public's questionable ability in appraising the quality of information.

As shown by evidence globally, it seems wise for Malaysia to adopt the Choosing Wisely initiative to curb medical overuse in the country. In fact, if adopted, ScreenMen can be used in complement or being part of the initiative since it shares the similar aim. This multi-faceted approach may also result in an increased impact in reducing low-value health services in Malaysia. However, while waiting for Malaysia to adopt or organise similar initiatives to curb medical overuse, which requires some time for development and preparation, ScreenMen will champion and kick-start this evidence-based practice advocacy in Malaysia.

5.7 Using ICT to Improve Health Screening Uptake in Men

5.7.1 Potential Impact of ICT in Health Screening

This study used ICT, specifically mobile web app to address knowledge, masculinity and medical overuse issues. Many internet-based interventions have been shown to be

useful for healthcare as reported by Rogers et al who have compiled 268 RCTs of self-help internet-based interventions that have demonstrated health benefits (Rogers et al., 2017). Though internet-based interventions have been blooming over the past decade, there is a lack of intervention that promote comprehensive health screening using the internet as identified in the systematic review conducted (Paper 2). This is where ScreenMen fills in the gap.

ScreenMen was developed to be delivered in a mobile web app format in view of the high internet users (24 million people) in Malaysia where smartphone is the most popular means of internet access (89.4%) as published in the Malaysian Internet Users Survey 2017 (Malaysian Communications and Multimedia Commission, 2017). According to the report, among people who used the internet to look for information, 77.2% of them searched for health-related information such as symptoms and disease as well as healthcare tips. In addition, men outnumbered women in the distribution of internet users (57.4% vs 42.6%) although there is no significant difference within gender in terms of adoption rate. This serves as a good opportunity, as men prefer to use websites and mobile apps to access health information and as a means of seeking help due to its benefit of privacy, which does not compromise their masculinity norms (Pollard, 2007; Robertson & Williams, 2010). One of the examples for this is the high usage of Man MOT by men in the United Kingdom (Baker, 2017). Men reported that they felt empowered using it and would likely to use it again, especially as the first port of call for non-emergency health issues.

To further increase the impact in terms of dissemination, ScreenMen was developed in a mobile web app format instead of a mobile app. A web app has a broader dissemination than app as it can be accessed instantly without needing to download and install; can be shared quickly among friends; and can be viewed on a computer as well.

Other than that, a health screening mobile app is not something being sought after by men, unlike diet or exercise apps. Thus, the ability to penetrate the internet and reach out to men, which is found more superior in a web app than an app, is the key factor to the success of promoting health screening in men.

5.7.2 Innovations in ScreenMen

In the ScreenMen mobile web app, the Dr ScreenMen figure was used as the avatar to interact with men, which attempted to mimic the embodied conversational agents (ECA) concept, though only two-dimensional and not as dynamic. There is an increasing use of Embodied Conversational Agent (ECA) in health interventions which allow users to interact with the agent in the intervention. Preliminary studies showed promising results where ECA is capable in engaging and motivating users in terms of learning and behavioural change, though more robust evidence is required (Martinez-Miranda, 2017; Provoost et al., 2017; Scholten, Kelders & Van Gemert-Pijnen, 2017). Apart from this, Dr ScreenMen avatar was used because doctors' recommendation was found to be a key facilitator for men to undergo screening according to the systematic review (Paper 1) and needs assessment conducted (Paper 3). Dr ScreenMen attempted to mimic a real-life consultation between men and the doctor, making use of the facilitator to increase the likelihood of men undergoing screening.

Another strength of ScreenMen is the built-in expert system (artificial intelligence), which assesses users' health, provides tailored advices on their health status as well as recommends all relevant health screening tests to go for based on their health profile. The algorithm developed in the expert system is of a high level of complexity as it covered a wide range of health prevention conditions such as lifestyle risk factors, cardiovascular diseases, cancers, sexually transmitted diseases and mental health. The algorithm also attempted to consider all possibilities of men's conditions, not to mention developed

based on high quality clinical evidence. Unlike the Man MOT which is a manned online health chatting service that requires additional manpower and only available for during specified hours, ScreenMen is algorithm-driven, which does not restrict usage by users at any time or anywhere they are (Baker, 2017).

There is, however, a limit to the extensiveness of health assessment that is able to be provided via a smartphone. In the needs assessment (Paper 4), men mentioned that they like the idea of using their mobile phone for screening and even proposed checking of blood pressure, blood sugar as well as blood cholesterol using their smartphone. This would be most ideal for men as they do not need to go to a health centre for screening anymore. However, due to technological limitation to date, these are not possible. So far only pulse rate measurement using smartphone app that has been validated, though cautions need to be given as the outcome may vary depending on the quality of smartphones (Chan et al., 2016; Lee et al., 2017; Mitchell et al., 2016; Poh & Poh, 2017). Although this poses a challenge now, research should not stop exploring the possibility of using smartphone as a primary tool for screening as it may be a better way of health prevention in the future.

5.8 Strengths and Limitations

There are several strengths and limitations in this study. First of all, the intervention was developed in a mobile web app format as reaching out to men is a more crucial when promoting health screening. The UKMRC also emphasised the importance of considering the implementation of the intervention at a later stage, which contributed to the decision of developing a mobile web app instead of mobile app. This, however, has restricted the intervention of having more interesting functions such as the health monitoring function, reward system, 'talking' Dr ScreenMen, automatic health parameter detection, daily notification, game and contests as well as integration with social media, which are not

feasible to be developed in a mobile web app. This limits the utility and usability of the intervention.

Other than that, the development process model published in Paper 5 was created to supplement the UKMRC Complex Intervention Framework in this study. It may be useful for other health researchers to follow. Despite the whole study took about two years the development phase was completed in about six months. When time is a constraint, health researchers could modify and simplify the exploratory phase, instead of conducting systematic reviews and in-depth exploration of needs. eHealth specific frameworks such as the Centre for eHealth Research (CeHRes) Roadmap could also be considered in the future (van Gemert-Pijnen et al., 2011).

This study was done with participants from one huge banking institution in Kuala Lumpur (KL). KL is an urban and fast-paced city. The participants from KL may have more 'modern thinking' and are more technology savvy. The educational levels of participants are also skewed towards more from a higher educational background. These may limit the transferability of findings to other populations in Malaysia. To reduce the impact of this limitation, this study has attempted to include men from various backgrounds in the banking institution by using purposive sampling according to age, ethnicity, educational level and job position in the company. This was done to ensure produce a maximal variation of findings, which is hopefully transferable to more populations in Malaysia. This study was also conducted with men in the community rather than sampling those attending clinics, which resulted in higher generalisability to men in the community which ScreenMen aims to intervene.

CHAPTER 6: CONCLUSION

6.1 Thesis Conclusion

This study is the first to explore from a Malaysian perspective how to reach out and target men who may be at risk of premature death and morbidity through undiagnosed ill-health. The overarching finding from this study was that male dominant barriers can inhibit men's access to health screening in their early years, with the most important being a lack of knowledge of their own health needs and the benefits of screening.

ScreenMen was therefore developed to address this fundamental component of behaviour change using a theory-based educational approach. The rigorous process used in its development, which involved multidisciplinary experts and end-users, is useful to guide future development of eHealth interventions. Using the platform of eHealth makes ScreenMen one of the first few user-centred and theory-guided interventions that promotes comprehensive and evidence-based health screening in men. This study concludes that through the use of a co-produced mobile web app that utilises male appropriate design and content, men can be encouraged to engage in early prevention and screening activity. A more definitive evaluation of ScreenMen using a randomised controlled trial is required to confirm its effectiveness in modifying men's health screening behaviour.

6.2 Directions for Future Research

6.2.1 Evaluation of the Effectiveness of ScreenMen

This thesis is part of a bigger study which include development, pilot testing and evaluation phases. This thesis only focuses on the development and pilot testing of the intervention. At the current stage, the ScreenMen mobile web app has been finalised and is ready for the effectiveness evaluation. It will be evaluated in the form of randomised controlled trial, conduct with men from the same banking institution.

About 220 men will be recruited to participate in this study, where half of them will be randomised to the intervention and half will be in the control group. Men in the intervention group will receive a one-time access code to use ScreenMen while men in the control group will receive nothing and proceed to answer the post-intervention questionnaire directly. They will be offered the use of ScreenMen after the study has completed. Knowledge of health screening, intention to screen and uptake of screening will be the main outcome measures of this evaluation study. On top of that, a process evaluation will also be conducted with selected participants to explore the feasibility the active components that improved men's behaviour. An ethics approval has been granted to conduct this RCT, which will commence in February 2108.

6.2.2 Regular Updates of ScreenMen's Contents

One of the important tasks in ScreenMen is the maintenance of contents. Health screening evidences change rapidly over time. The USPSTF reviews the evidence on health screening regularly and update the screening recommendations. It is thus crucial to update the health recommendation provided in ScreenMen so that it is accurate according to the latest evidence. The University of Malaya Men's Health Research (UMMHR) group (https://menshealth.um.edu.my) receives consistent updates on health screening evidence and recommendation. The UMMHR team will review the app on a yearly basis and perform content update when significant change in recommendation is announced.

6.2.3 Expanding the Evidence of Male-sensitive Interventions

The effectiveness of male-sensitive interventions remains uncertain due to the lack of evidence to produce a solid conclusion using meta-analysis. ScreenMen has employed the male-sensitive approach to improve health screening uptake in men as increasingly recommended by experts. However, the effectiveness of the male-sensitive ScreenMen

mobile web app remains unproven until an evaluation using a randomised controlled trial (RCT) design has been undertaken. It is hoped that ScreenMen could contribute and shed some light on the effect of male-sensitive interventions in the future.

6.3 Implication for Use and Practice

6.3.1 Potential Use in The Public Health Clinic

The ScreenMen can be potentially disseminated and used in a health clinic. A survey on the health screening programme in the public health clinic found that the screening programme is useful but has huge implementation challenges. It is booklet-based, contains eight pages of questions and items and is very time consuming to be used. Apart from that, it is also very labour-intensive as several staff need to be allocated to guide men to complete the booklet. This survey (https://menshealth.um.edu.my/screen-m-bssk-survey) is currently under review by a journal for publication.

ScreenMen is a very strategic solution to this problem. It is a quick, interactive and evidence-based screening tool, which can be accessed easily in the internet browser in men's smart phones. A poster about ScreenMen with its link can be put up at the waiting area of the clinic to encourage men to access the web. It is also not labour-intensive as there is no need for a staff to guide men to use ScreenMen. If additional resources are available, a kiosk can be setup in the public health clinics with ScreenMen pre-loaded in it. This is to cater for the 20% of Malaysian population who do not have internet access as part of the efforts to minimise health inequalities that arise due to the implementation of this eHealth intervention.

6.3.2 Dissemination and Implementation of ScreenMen

Apart from implementing in health clinics, ScreenMen will also be disseminated to all men in the wider community. Several approaches as described in Paper 4 such as using physical advertisement, online advertisement, recommendation by doctors, provide

incentive to use and share the web as well as make compulsory in workplace can be used to achieve this. Kiosks can also be set up in public area such as in the shopping malls and specific computers can be allocated in workplace such as in a factory or a resting area in construction site to cater for men who do not have access to the internet. However, ScreenMen should only be disseminated after the evaluation to ensure its effectiveness before spending too much efforts in disseminating it.

The ultimate aim of ScreenMen is to reach out and impact all men in the community, by educating, empowering and making men take charge of their health. The improved health behaviour of men, in terms of health promotion and prevention, will eventually lead to better health outcomes, quality of life as well as a healthier society.

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LIST OF PUBLICATIONS AND PAPERS PRESENTED

JOURNAL PUBLICATIONS:

1. Teo, C. H., Ng, C. J., Booth, A., & White, A. (2016). Barriers and facilitators to health screening in men: A systematic review. Soc Sci Med, 165, 168-176.
2. Teo, C. H., Ling, C. J. & Ng, C. J. (2018). Improving health screening uptake in men. A systematic review and meta-analysis. Am J Prev Med, 54(1), 133-143.
3. Teo, C. H., Ng, C. J., & White, A. (2017). Factors influencing young men's decision to undergo health screening in Malaysia: a qualitative study. BMJ Open, 7(3), e014364.
4. Teo, C. H., Ng, C. J., & White, A. (2017). What Do Men Want from a Health Screening Mobile App? A Qualitative Study. PLoS One, 12(1), e0169435.
5. Teo, C. H., Ng, C. J., Lo, S. K., Lim, C. D. & White, A. (2018). A systematic and user-centered approach to developing a web-based mobile health intervention (ScreenMen) to improve evidence-based health screening uptake in men. (Under review)
6. Teo, C. H., Ng, C. J., Lo, S. K., Lim, C. D. & White, A. (2018). Utility and usability testing of a mobile web app (ScreenMen) to improve health screening uptake in men. (Under review)

OTHER RELATED PUBLICATIONS:

1. Ng, C. J. Empowering men to screen: The ScreenMen mHealth project. Malaysian Research University Network (MRUN) Bulletin. (2017)
2. Ng, C. J. & Teo, C. H. Men's Health Special Bulletin: A Matter of Life and Death. Urban Health. Nov 2016 (141). 36-37.

PAPERS PRESENTED:

Oral Presentations:

1. Teo, C. H., Ng, C. J. & White, A. What are the healthcare professional factors that influence men's decision to attend health screening? A qualitative study. 10th Men's Health World Congress (MHWC); 26-28 February 2016; New Delhi.
2. Teo, C. H., Ng, C. J. & White, A. How does 'being a man' affect men's decision to go for health screening? A qualitative study. 10th Men's Health World Congress (MHWC); 26-28 February 2016; New Delhi.
3. Teo, C. H., Ng, C. J., Booth, A. & White A. Barriers and Facilitators to Health Screening in Men: A Systematic Review. 5th Asia Pacific Primary Care Research Conference (APPCRC); 4-6 December 2015; Putrajaya. (Published in the Malaysian Family Physician journal)

Poster Presentation:

1. Teo C. H., Ng CJ, White A. What Do Men Understand About Health Screening? Preliminary Results from A Qualitative Study. 5th Asia Pacific Primary Care Research Conference (APPCRC); 4-6 December 2015; Putrajaya. (Poster) (Published in the Malaysian Family Physician journal)

OTHER PRESENTATION/INTERVIEW:

1. Teo C. H. (2017) ScreenMen: Empowering men to go for health screening via mobile Health (mHealth). University of Malaya Three Minutes Thesis (UM3MT) Competition; 2 Mar 2017; Faculty of Medicine, University of Malaya, Kuala Lumpur.
2. Teo C. H. (2018) Lelaki Mental. Apa Kata Wanita; 13 Jan 2018; Radio Televisyen Malaysia (RTM), Kuala Lumpur. (Promoting Screening for Depression)

AWARD:

1. Merit Prize for Oral Presentation: Teo, C. H., Ng, C. J., Booth, A., White, A. Barriers and Facilitators to Health Screening in Men: a Systematic Review. Asia Pacific Primary Care Research Conference; 2015 Dec 4-6; Putrajaya., Asia Pacific Primary Care Research Conference, 2015, (Oral)