PHYSICAL ACTIVITY LEVELS OF MALAY OLDER ADULTS OBJECTIVELY-MEASURED USING TRIAXIAL ACCELEROMETER AND ITS ASSOCIATED FACTORS

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by

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Nurdiana Zainol Abidin
2015

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LIST OF ABBREVIATIONS

PA	Physical Activity
HRQoL	Health-Related Quality Of Life
SF-36	Short-Form 36® Health Status Survey
SPPB	Short Physical Performance Battery
MVPA	Moderate to Vigorous Physical Activity
ACSM	Amercian College of Sports Medicine
AHA	American Heart Association
MET	Metabolic Equivalent of Task
VT	Vertical Axis
AP	Anterior-Posterior
ML	Mediolateral
VM	Vector Magnitude for 3 Axes (VT, AP, ML)
DLW	Doubly Labeled Water
BMI	Body Mass Index
SB	Sedentary Behavior
LTPA	Leisure Time Physical Activity
LTSB	Leisure-Time Sedentary Behavior

CI	Confidence Interval
PF	Physical functioning
BP	Bodily pain perception
GH	General health
VIT	Vitality
SF	Social functioning
EH	Role limitations due to emotional health
PH	Role limitations due to physical health
MH	Mental health
PCS	Physical Component Summary
MCS	Mental Component Summary
NBPF	Norm-based Physical functioning
NBBP	Norm-based Bodily pain perception
NBGH	Norm-based General health
NBVIT	Norm-based Vitality
NBSF	Norm-based Social functioning
NBEH	Norm-based Role limitations due to emotional health
NBPH	Norm-based Role limitations due to physical health
NBMH	Norm-based Mental health
ATP III	The Third Adults Treatment Panel
HDL	High-Density Lipoprotein
LDL	Low-Density Lipoprotein
CHO	Cholesterol
MS	Metabolic Syndrome
PASE	Physical Activity Scale for the Elderly

WHR	Waist-to-Hip Ratio
FPG	Fasting Plasma Glucose
NaF	Sodium Fluoride
SST	Serum Separation Tube
TST	Tandem Stance Test
PAEE	Physical Activity Energy Expenditure
Sys BP	Systolic Blood Pressure

PENILAIAN SECARA OBJEKTIF TAHAP AKTIVITI FIZIKAL WARGA EMAS BERBANGSA MELAYU MENGGUNAKAN ACCELEROMETER TRIPAKSI DAN PERHUBUNGAN KAITNYA DENGAN FACTOR-FAKTOR BERKAITAN

Abstrak

Tujuan kajian ini ialah untuk mengukur tahap aktiviti fizikal warga emas berbangsa Melayu menggunakan *accelerometer* tripaksi dan perhubungan kaitnya dengan status kualiti hidup berkaitan kesihatan, faktor metabolik sindrom dan kemampuan fizikal. Kajian ini juga mengkaji kebolehlaksanaan penggunaan *accelerometer* tersebut dalam kalangan warga emas berbangsa Melayu di Malaysia.

Reka bentuk kajian adalah keratan rentas dan melibatkan 146 orang warga emas berbangsa Melayu yang tinggal di komuniti secara bebas, berumur di antara 60 hingga 85 tahun (67.6 (6.4) tahun). Tahap aktiviti fizikal diukur menggunakan *accelerometer* tripaksi (Actigraph GT3X atau GT3X+) yang dipakai di pinggul sepanjang hari selama 7 hari berturut-turut. Status kualiti hidup berkaitan kesihatan dan keupayaan fizikal diukur menggunakan *Short Form-36 Health Status Survey (SF-36®)* dan *Short Physical Performance Battery (SPPB)*. Sampel darah semasa berpuasa diambil untuk penilaian profil glukosa dan lipid.

Semua peserta kajian mematuhi arahan memakai *accelerometer* selama 10 jam atau lebih setiap hari (15.3 (1.3) jam sehari) selama sekurang-kurangnya 3 hari (6.5 (1.2) hari). Secara keseluruhan, peserta kajian menghabiskan 52% daripada masa seharian (7.9 (2.1) jam sehari) dalam keadaan sedentari dan 24 minit digunakan dalam aktiviti intensiti sederhana. Bilangan aktiviti seharian secara keseluruhan adalah Vektor Magnitud 558.5 (223.5) per minit dan bilangan langkah seharian adalah 12,542 (4,857) setiap hari. Tiada perbezaan jantina didapati dalam

kedua-dua pembolehubah. Bagi aktiviti yang berkhususkan intensiti, lelaki didapati menggunakan lebih masa dalam aktiviti intensiti sederhana berbanding wanita (30 *vs* 18 min, $p<0.05$). Walau bagaimanapun, wanita didapati menggunakan lebih masa dalam aktiviti intensiti ringan berbanding lelaki (7.3 *vs* 6.5 jam, $p<0.05$). Bagi keputusan *SF-36*®, lelaki mendapat keputusan lebih baik untuk *physical functioning* ($p<0.05$) dan *vitality* ($p<0.05$) berbanding dengan wanita dan aktiviti fizikal intensiti sederhana menunjukkan hubungan positif yang signifikan dengan *bodily pain* untuk lelaki ($p<0.05$). Wanita didapati mempunyai keputusan *BP* sistolik ($p<0.05$) dan tahap kolesterol *HDL* ($p<0.001$) yang lebih tinggi berbanding lelaki dan aktiviti fizikal intensiti tinggi menunjukkan hubungan positif yang signifikan dengan *BP* sistolik bagi kedua-dua jantina ($p<0.05$). Keputusan *SPPB* menunjukkan peserta kajian mempunyai limitasi fizikal di tahap antara ringan dan sederhana (7/12) dan hubungan songsang didapati antara aktiviti fizikal intensiti ringan dan skor untuk *balance* ($p<0.05$).

Mengikut bilangan aktiviti, tahap aktiviti fizikal warga emas berbangsa Melayu adalah di tahap rendah dan hubung kait terhad didapati dengan pembolehubah yang diukur. Walau bagaimanapun, tahap kepematuhan yang tinggi menunjukkan kebolehupayaan menggunakan *accelerometer* dalam populasi warga emas berbangsa Melayu tempatan.

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Abstract

The aims of this study were to measure the physical activity levels of Malay older adults using triaxial accelerometer, and its associations to health-related quality of life, metabolic syndrome factors and physical capability. This study also examined the feasibility of using the device on the Malay elderly.

The study design was cross-sectional involving 146 community-dwelling Malay older adults aged 60 to 85 years old (67.6 (6.4) years). Physical activity (PA) levels were measured using accelerometers (Actigraph GT3X or GT3X+) worn around the hip during waking hours for consecutive 7 days. Health-related quality of life and physical capability were measured using the Short Form-36 Health Status Survey (SF-36®) and the Short Physical Performance Battery (SPPB) test, respectively. Fasting blood samples were collected to determine the glucose levels and lipid profiles.

All participants in the study were compliant in wearing the accelerometer for 10 hours or more per day (15.3 (1.3) hours per day) for at least 3 days (6.5 (1.2) days). On average, participants spent 52% of the wear time (7.9 (2.1) hours per day) being sedentary and 24 minutes at a moderate intensity of PA per day. Overall daily activity count was Vector Magnitude 558.5 (223.5) counts per minute and step counts was 12,542 (4,857) steps per day. No difference between the sexes were observed for both variables. For intensity-specific PA, men accumulated significantly more minutes of daily moderate PA compared to women (30 vs 18 min, $p<0.05$). However, women accumulated significantly more time in daily light intensity PA

compared to men (7.3 vs 6.5 hours, $p<0.05$). For the SF-36®, men scored significantly better in physical functioning ($p<0.05$) and vitality ($p<0.05$) compared to women and moderate PA showed significant positive association with bodily pain for men ($p<0.05$). Women were found to have higher systolic BP ($p<0.05$) and HDL cholesterol level ($p<0.001$) compared to men and vigorous PA showed significant positive association with systolic BP for both sexes ($p<0.05$). The score for SPPB indicated mild to moderate functional limitation (7/12) and inverse association was found between light intensity PA and balance score ($p<0.05$).

According to the physical activity counts, the PA level of Malay older adults is low and limited associations found against measured variables. However, the high level of compliancy suggests the feasibility of using the device within local Malay elderly populations.

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The number of aging population – defined as aged between 60 and 80 years old (Vosylius et al., 2005) - is increasing especially in developed countries due to the advances in public healthcare, social, economy and lower fertility and mortality rates. According to the United Nation, an estimated of 737 million individuals in the world were aged 60 or over in 2009 and the number is projected to increase to 2 billion by the year 2050 (Department of Economics and Social Affairs (DESA), 2012). In Malaysia, according to the Department of Statistics, 6.3% of the total population or 1.4 million were 60 years and above in the year 2000 (Department of Statistics, 2005). This had increased to 1.7 million (6.6% of the total population) in 2005 and by 2020, this number is expected to grow to more than 3.4 million (UNESCAP, 2011).

Substantial increase in life expectancy has led to great interest in promoting healthy and successful aging. Past epidemiological studies have discovered that few, obvious factors help healthy aging, namely education, not smoking, good dietary habits and money (Britton et al., 2008). A study found that individuals with higher income tend to have better health at advanced age compared to individuals who are from low income (Britton et al., 2008). However, exercise or physical activity have been proven to be one of the most beneficial factors to the aging process. There is robust observational and trial evidence to support the fact that physical activity decreases the incidence of type 2 diabetes mellitus and cardiovascular events, which are common diseases of older age (Lindström et al., 2006). In one population-based

study involving more than 12,000 Australian men aged between 65 and 83, compared to those who were sedentary, the individuals who spent at around 30 minutes of physical activity, five days per week were much healthier and less inclined to be deceased 11 years after the beginning of the study, even when smoking habits, education, body mass index were adjusted (Osvaldo et al., 2014).

In an effort to promote exercise and physical activity in the elderly, American College of Sports Medicine (ACSM), in conjunction with American Heart Association (AHA) has published physical activity and public health recommendations for older adults in 2007 (Nelson et al., 2007). The recommendation basically detailed the frequency, intensity and duration of exercise and physical activity appropriate for older adults (at least 30 minutes of moderate to vigorous physical activity level, 5 days per week or 20 minutes of vigorous physical activity, three days per week). In 2009, ACSM has also published an updated version of 1998 Position Stand "Exercise and Physical Activity for Older Adults" (Mazzeo et al., 1998) to promote physical activity in the age groups (Chodzko-Zajko et al., 2009). The new version had included a comprehensive review on the latest evidence regarding the benefits of exercise and physical activity in aging and introduced a new guidelines where physical activity can be built-up toward the minimum of 30 minutes by doing the activities in bouts, each lasting 10 or more minutes to obtain optimal health benefits (Becker et al., 2004, Physical Activity Guidelines Advisory Committee, 2008, Chodzko-Zajko et al., 2009). When it was evidenced that walking is the commonly cited physical activity among the elderly (Chau et al., 2008, Merom et al., 2009), Tudor-Locke and Basset proposed a new guidelines to classify physical activity in adults based on step counts in 2004 and the study proposed that adults

including older adults should have 10,000 steps or more per day in order to be classified as 'Active'.

In 2005, a World Health Organization report stated that more than of 40% of cancer and at least 80% of all coronary diseases, stroke and type-2 diabetes could be counteracted if the modifiable risk factors for age-related chronic diseases such as physical inactivity were eliminated (WHO, 2005). It is believed that by keeping these diseases at bay, longer period of health span and lifespan could be attained and age-related disability and health care expenses could be reduced (Eyre et al., 2004, WHO, 2005, Steenhuysen, 2007). Although some might argue that older adults have past the stage where preventive measures are the most beneficial, studies have proven that exercise and physical activity could exert health improvements at any age (Chodzko-Zajko et al., 2009). There were various studies that linked physical activity to health improvements, particularly in the aging demographics. A study by Laubach et al. (2009) found that a modest increase in weekly step counts (9,372.3 (2,799.0) steps per day) improved cardiovascular function in healthy elderly women aged 60 years and above (63.9 (4.1) years). Another study in Portugal found that moderate intensity multi-component exercise programme (8-month intervention) was beneficial in improving blood lipid profile and antioxidant capacity in older women aged 60 years and above (68.52 (5.09) years) (Carvalho et al., 2010) and a study by Vincent and Braith (2002) on resistance exercise (REX) effect on elderly men and women (68.4 (6.0) years) found positive association between REX and bone turnover.

Although health benefits of physical activity are well-documented, population levels of PA particularly among older adults were still found to be low (Agency for Healthcare Research and Quality and the Centers for Disease Control, 2002, Hallal et al., 2003, Mummery et al., 2007, Ferreira et al., 2010, Poh et al., 2010, Hansen et al.,

2012). Therefore, increasing physical activity and decreasing sedentary behaviours are important targets of public health promotion. In Malaysia in particular, limited information exist describing the level of physical activity in older adults (Guthold et al., 2008, Poh et.al., 2010). Malaysia is a multiethnic population comprising the Malays (50.7%), which make up the majority of Malaysian population, followed by Chinese (23.1%), Indian (6.9%) and other Bumiputera (11%) (indigenous people) as the major groups within the total population of 28 million (Institute for Public Health, 2008). According to the 2011 National Health and Morbidity Survey (NMHS), the Malays had the highest prevalence of Type 2 Diabetes Mellitus at 58.9% (Feisul and Azmi, 2013) and had the worse glycaemic and cardiometabolic controls compared to other ethnicities (Lee et al., 2011). According to physical activity assessment studies on Malaysian adults, the Malays also had the lowest prevalence of meeting the physical activity recommendations compared to other ethnic groups (Poh et.al., 2010). These evidences warranted further studies on the lifestyle of this particular ethnicity.

Despite the existence of numerous reports describing a physically inactive adult population, the findings are still considered to be inconclusive due to the lack of comparable data to draw trends and make comparisons among populations (Carlson et al., 2009). One of the confounding issues is the use of subjective measures such as questionnaires which have limitations in assessing PA levels (Wareham and Rennie, 1998). Some researchers argue that regardless of the use of appropriate validity and reliability tests, subjective measurement of PA is subject to overestimation (Gillison et al., 2006) and susceptible to various other forms of bias (Choi and Pak, 2005, Corder et al., 2009). Although essential in many aspects of epidemiological research, questionnaires have limitations in giving accurate

quantification of PA levels, and they are especially affected by bias derived from cultural differences (Corder and van Sluijs, 2010). Even with proper translation, questions on a self-report questionnaire may be confusing, misinterpreted, or irrelevant in certain populations due to cultural differences. These confounding factors raised the questions on the validity of previous studies that had used self-report methods for physical activity survey.

Previous studies in Malaysia assessing physical activity levels have used questionnaires as the method of assessment (Ismail et al., 2002, Disease Control Division: Malaysia NCD Surveillance, 2006, Guthold et al., 2008, Poh et.al., 2010). Recently, PA objective measurement such as accelerometry have garnered more attention due to its ability in measuring a more accurate activity counts and the intensity of physical activity. It is claimed to be able to overcome the limitations of self-reports and provides data for comparisons across populations. The device is also currently viewed as the minimum standard for PA assessment in epidemiological research (Corder and van Sluijs, 2010). Although the device comes with limitations, for example the inability to detect some movement patterns such as upper body movements during stationary activities or non-ambulatory activity such as cycling, it could eliminate a number of biases stemming from using self-reports method and able to give more accurate data (Corder and van Sluijs, 2010). With this in mind, present study aimed to re-evaluate the findings of previous local studies on the physical activity levels of older adults by using a new technology that could eliminate the biases present in previous methodology and to also measure PA in a more comprehensive manner. The gathering of accurate data of physical activity levels of older adults could give us more insight into their lifestyle and provide evidence for interventions. Moreover, the assessment of physical activity in older

adults is crucial in the road to prevention of diseases, reducing age-related disability and increase the betterment of quality of life. In addition, limited information exist on the physical activity levels of local older adults or their compliance with current physical activity guidelines (Sun et al., 2013).

1.2 Problem statement

Subjective measurements have been proven to have a lot of limitations in assessing PA levels in older adults (Wareham and Rennie, 1998). Subjective measurement of PA were proven to be subjected to overestimation (Gillison et al., 2006) and susceptible to various other forms of bias, namely recall bias, impaired cognitive ability and reduced information processing speed commonly suffered by older adults (Rikli, 2000, Choi and Pak, 2005, Corder et al., 2009). Even with proper translation, PA questions on a self-report questionnaire may be confusing, misinterpreted, or irrelevant in certain populations due to cultural differences (Corder and van Sluijs, 2010). In addition, previous studies studying the associations of self-rated heath and metabolic indicators to physical activity levels had used self-report methods to assess the physical activity levels (Bize et al., 2007, Burholt and Nash, 2011). Thus, a new objective method of assessment such as accelerometer with reduced biases is needed obtain a more accurate data and to measure PA in a more comprehensive manner. Moreover, the device is highly dependent of the compliancy of participants to ensure the most accurate measure of their physical activity (Gemmill et al., 2011). Therefore, a study on the compliancy level and issues with using the device on the Malay elderly was warranted to determine the feasibility of using the new method in future studies.

1.3 Objectives of study

1) To measure the PA levels of Malay older adults using triaxial accelerometers.
2) To determine the status of health-related quality of life, metabolic syndrome factors and physical capability of Malay older adults and their associations to objectively measured physical activity.
3) To determine the feasibility of using accelerometer on Malay older adults.

1.3.1 Research questions

1) What is the current physical activity level of Malay older adults?
2) Do Malay older adults meet the recommendations and guidelines of physical activity by the American College of Sports Medicine and American Heart Association?
3) Are there any associations between health related quality of life, metabolic syndrome factors and physical capability and the objectively measured physical activity in the Malay elderly?
4) Were the Malay elderly compliant in wearing the accelerometers as instructed?

1.4 Significance of the study

The focus of this study was on physical activity and utilizing the latest technology (triaxial accelerometer) to assess physical activity levels and pattern of the elderly to overcome the limitations of self-reports. The current study had approached the objective assessment method by using triaxial motion sensor and employing series of tests on self-rated health, metabolic syndrome factors and physical capability in order to study the association with objectively measured physical activity levels. Data on associations allowed a better understanding on the influences of physical activity levels on different dimensions of health.

To our knowledge, there have yet to be any published data measuring the physical activity levels of Malay older population using triaxial accelerometer. A device that could measure multiaxes of movements gave a significant advantage to obtain an accurate measurement of their physical activity levels. Accuracy of physical activity assessment is important in order to prescribe an exercise prescription that is realistic and suitable to their physical capacity. The assessment and establishment of a community based study population of older adults will provide a comprehensive database that will allow the investigation of a wide range of age-related issues, including physical and health parameters. The findings will ultimately increase our understanding of the current lifestyle of the aging population and give further information to formulate specific interventions for successful aging.

1.5 Study terminology

Objective measurement	- unbiased measurement/analysis and not impacted by beliefs or philosophy of something.
Accelerometer	- a device that measures proper accelerations. Accelerometers can provide an objective measures of frequency, intensity and duration of physical activity. Accelerometer registers acceleration in units called counts.
Triaxial accelerometer	- is a three axes or multiaxis accelerometer that can detect magnitude and direction of the proper acceleration (or g-force), as a vector magnitude (VM). Triaxial accelerometer is able to record motion in 3 axes (anteroposterior (AP), mediolateral (ML), and vertical (VT))
Uniaxial accelerometer	- is a single axis accelerometer that is able to record motion in vertical axis (VT) only.
Physical activity	- any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level
Sedentary behavior	- any waking activity characterized by an energy expenditure ≤ 1.5 metabolic equivalents and a sitting or reclining posture
Bout	- a period of time spent in a particular way
Epoch	- a user defined sampling interval
Vector magnitude	- is a composite vector of the 3 axes (AP, ML, VT)
Activity counts per day	- total activity counts (in counts per minute) accumulated divided over valid days

Steps per day	- total step counts accumulated divided over valid days
Bouts of ≥10 mins MVPA	- number of bouts of 10-sustained minutes of at least moderate level of physical activity
Non-wear time	- at least 90 continuous minutes of 0 activity counts without interruptions.
Time in sedentary	- counts less than VM 200 activity counts per minute
Time in light intensity	- time spent in counts between VM 200 to 2689 counts per minute
Time in moderate intensity	- time spent in counts between VM 2690 to 6166 counts per minute
Time in vigorous intensity	- time spent in counts between VM 6167 to 9642 counts per minute
Time in very vigorous intensity	- time spent in counts more than VM 9642 counts per minute
Semi-rural	- areas adjacent to suburbs or town
Extended family	- a kinship group consisting of a family nucleus and various relatives, as grandparents, usually living in one household and functioning as a larger unit.

CHAPTER 2

LITERATURE REVIEW

2.1 Aging in Malaysia

Malaysia is approaching to be an aging nation as the world population increases. Based on the projection rate and current trend, the Malaysian populace is expected to reach 35 million by the year 2020, with 3.4 million being senior citizens (Malaysia-today.net, 2011). The terms 'senior citizens', 'elderly' and 'aging population' have been used interchangeably when describing older adults. However, the United Nations World Assembly on Aging held in Vienna 1982, had used '60 years and over' as the age cut-off to refer to the elderly people (Rashid and Hamid, 2007). Hence, since then, Malaysian policy makers have adopted this demarcation as cut-points when defining the elderly (Mat and Taha, 2003, Rashid and Hamid, 2007).

Over the years, the number of aging population in Malaysia has been steadily increased :- 5.2% in 1970, 5.7% in 1990, 6.3% in the year 2000, and the percentage is expected to be increased to 9.8% of the population in the year 2020 (Mafauzy, 2000). Malaysia is expected to reach the status of an aging nation by 2030 when 15% of the population are those aged 60 and above (Malaysia-today.net, 2011). According to the last Population and Housing Census of Malaysia in 2010, the proportion of the population of Malaysia below the age of 15 years has decreased to 27.6% compared with 33.3% in 2000, indicating a decline in fertility rate (Figure 2.1) (Population And Housing Census, 2010). In contrast, the proportion of population aged 65 years and over was found to increase to 5.1% as compared with 3.9% in 2000, indicating a decline in mortality rate (Figure 2.1) (Population And Housing Census, 2010). These

trends are similar with the transition of age structure towards aging population seen in other countries (World Population Ageing, 2013).

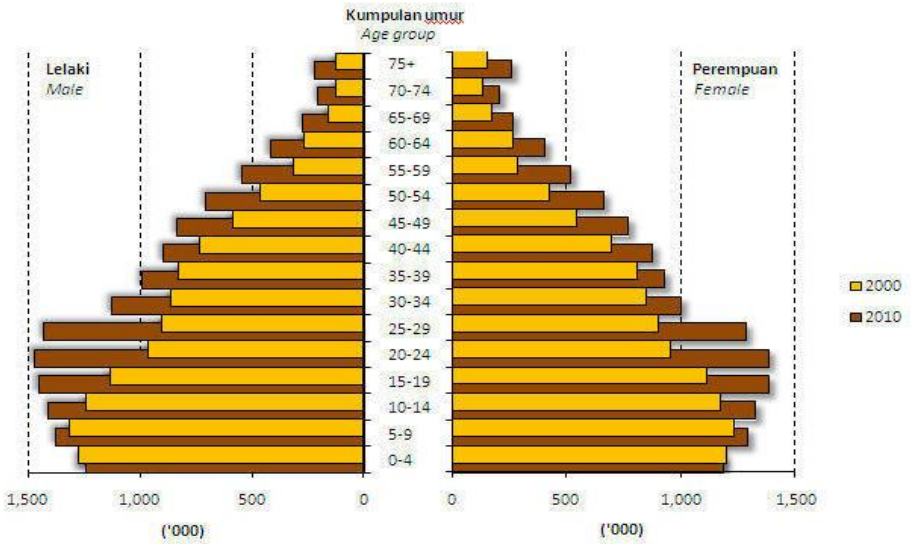

Figure 2.1 The Malaysian population by age group and sex in 2000, and 2010. Source: Population and Housing Census, Malaysia 2010**.**

In addition to the increased number of the population, the sex distribution is also disproportionate as women tend to outlive men. It is expected that by the year 2020, the population life's expectancy will increase to 74.2 years for men and 79.1 years for women, compared with 72.6 and 77.5 years, respectively, in 2010 (Malaysia-today.net, 2011). Moreover, demographic shift is also expected to occur due to urbanization. With the advancement in the economy, the percentage of the population in the urban area has increased from 34.2% in 1980 to 50.7% in 1991 (Population And Housing Census, 2010) and the percentage has increased drastically in ten years from the year 2000 from 62% to 71% in 2010 (Figure 2.2).

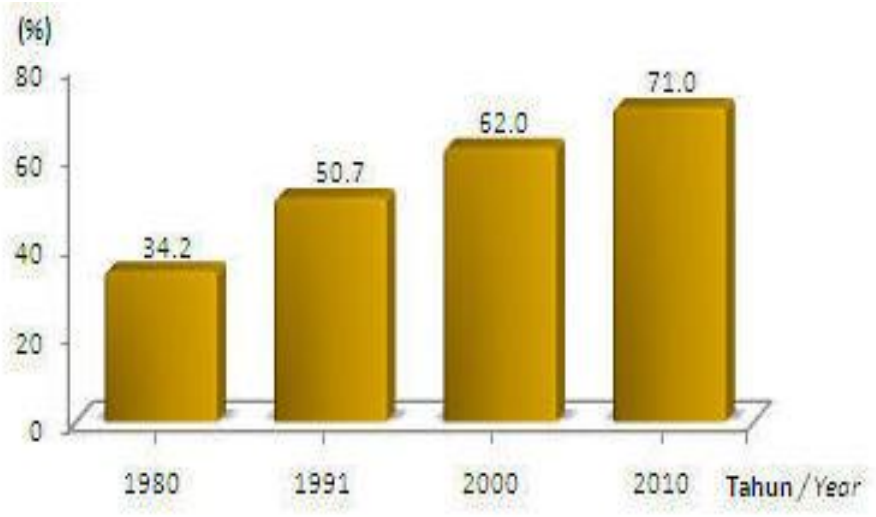

Figure 2.2 Level of urbanization in Malaysia in 1980, 1991, 2000 and 2010.
Source: Population and Housing Census, Malaysia 2010**.**

Due to the shift in demographic, the pattern is likely to affect the distribution of health care resources (Mafauzy, 2000). With the increase in retirement age from 58 to 60 years old, it is important to increase the health span of the population and reduce the onset of old age disability. Based on the trend, it is apparent that the nation needs to prepare in advance for an eventuality of an aging nation, especially in developing policies and programs beneficial for the aged, preparing proper infrastructure and healthcare for the senior citizens and providing adequate medical facilities.

2.2 Problems and challenges associated with aging population in Malaysia

Although the increase of life expectancy is a proof of a successful milestone in mankind, it also comes with great challenges and raises issues that need to be tackled early. For example, the growing population is expected to cause strain in many developing countries such as Malaysia where the country could face with tremendous difficulties in providing healthcare facilities and rehabilitation services especially for the poor (Jitapunkul et al., 2003, Cho et al., 2004, Gavazzi et al., 2004). The stress load is expected to be greater on the healthcare system as aging is directly associated with increased prevalence of ill health. With the social changes such as migration, urbanization, changes in family structure, lack of relative care taker and increase in life expectancy, the number of older adults that would need institutionalizations is expected to increase (Mafauzy, 2000).

Apart from the physical and social changes that come with aging, there is also the debilitating effect that comes with chronic diseases. Elderly with chronic diseases requires long term care and the health care system in this country is primarily oriented towards short term care and hospitalization (Mafauzy, 2000). Although Malaysia has comprehensive medical and health care services, it was mainly geared towards the general population and lacks the appropriate programs for the aged. Furthermore, older population is directly associated with age-related disability. Age-related disability can hamper the quality of life and increase the need for home services, hospitalisation, institutionalisation and also increased risk of premature death. In addition, multiple drug regimes due to the treatments of their poor health are also reducing the quality of life of the elderly and incidence of drug reaction is also more prevalent in the elderly with the increase of drug usage (Routledge et al., 2004).

2.3 Prevention is the best solution

With the saying 'Prevention is better than cure', prevention is the best measure to ensure that the added years to life are not spent in poor health, chronic medical conditions, disability or age-related diseases such as dementia. With this in mind, a preventive-based solution or 'prevention model' that is concentrated on hindering the onset of diseases before the manifestations of symptoms or life-threatening conditions is needed (Marvasti and Stafford, 2012). Prevention model incorporates all efforts to anticipate the genesis of disease and prevent its progression into clinical sign (Marvasti and Stafford, 2012). One of the best prevention models is practicing a healthy lifestyle. With the current emphasis in prevention models, healthcare providers worldwide are focusing more on the preventive medicine approach rather than curative (Loeppke et al., 2010). By employing the prevention model, the disease-free lifespan can be increased by preventing further progression of disease, making it ideal to address chronic condition that takes years to develop and manifest with ultimately fatal ends (Marvasti and Stafford, 2012). Prevention model is perfect in molding a healthy elderly population by instilling a healthy lifestyle in their early life, minimizing the occurrence of diseases and inabilities in the later years and maintain the independence in their daily lives. Maintaining good well-being by leading a healthy lifestyle, practicing healthy diet and exercise and avoiding sedentarism would lead to a healthy elderly. Healthy elderly would require fewer doctor visit and fewer medications, which would result in increased quality of life. Primary interventions such as health education and counseling are desirable to be provided at all opportunities and awareness on early intervention treatment to prevent age-related disability must be raised for early practice (Marvasti and Stafford, 2012). Prevention model is slowly taking its footing in the health care system worldwide

(Marvasti and Stafford, 2012). The topic was even highlighted in a health care reform debate in the United States, emphasizing its need versus the acute care model (Marvasti and Stafford, 2012). With the aging population, there was a shift in the burden of diseases toward chronic conditions. The prevalence of chronic diseases is increasing in developing countries, surpassing the prevalence of acute infectious diseases (Marvasti and Stafford, 2012). Such epidemiological evolution requires more attention on public health and prevention. Prevention strategies such as lifestyle modification are now encouraged to be taught in medical schools to decrease the focus of technical knowledge and profit-based system of medical technology that is becoming a barrier to disease prevention (Marvasti and Stafford, 2012). By taking a more personal approach and concentrated on sustainable functional health will help to draw attention to current structure of healthcare allow for standardization of prevention strategies. Although primary preventions such as health education and counseling is the best type of prevention, secondary prevention which concerns with reducing the progression of disease once it occurs and preventing complication and deterioration is also helpful in impeding disease manifestation (Marvasti and Stafford, 2012). Although lifestyle modification is difficult, the employment of prevention model in the health care system would benefit the future population in the long run.

2.4 Aging and physical inactivity

Aging is a lifelong, developmental, and complex process that reflects the cumulative impact of decades of lifestyle and behaviors that consequently affect function and health outcomes later in life (Sheets, 2012). As the body ages, it will go through changes that indicate deterioration and it is one's own responsibility to make

sure that the changes are not accelerated in any way due to poor choice of diet or unhealthy lifestyle.

It has been reported by various studies that the aging process is significantly affected by physical inactivity (Cherkas et al., 2008, Pedersen, 2009, Evans, 2010, Booth et al., 2011). Cherkas et al. (2008) found that lack of physical activity negatively affect the length of leukocyte telomere which is ostensibly a biological indicator of human aging. A review article by Evans (2010) stated that reduced physical activity may contribute to age-related sarcopenia, which is the loss of muscle mass and Booth et al. (2011), concluded that physical inactivity plays a significant role in shortening average life expectancy by accelerating secondary aging (i.e increase the rate of reduction of bone mineral density and maximal oxygen consumption). In addition, lack of physical activity is also found to be one of the risk factors for certain chronic diseases, including cardiovascular diseases, obesity, diabetes, and osteoporosis (CDC, 2005).

Despite known consequences of inactivity, the world aging population continue to be sedentary (Agency for Healthcare Research and Quality and the Centers for Disease Control, 2002, Hallal et al., 2003, Mummery et al., 2007, Ferreira et al., 2010, Poh et al., 2010, Hansen et al., 2012). A study conducted in Brazil reported that 50.1% of the elderly were found to lead a sedentary lifestyle (Hallal et al., 2003). In another study carried out by a Brazil national survey VIGITEL, only 12.7% of the elderly reported to have leisure-time physical activity, and 56.5% were classified as physically inactive (Ferreira et al., 2010). Data from the Centers for Disease Control and Prevention (CDC) in the United States indicated that about 28% to 34% of adults aged 65 to 74 and 35% to 44% of adults ages 75 or older were inactive and reported to have no leisure-time physical activity. Inactivity was

also found to be more common in older people compared to middle-aged men and women (Agency for Healthcare Research and Quality and the Centers for Disease Control, 2002). A study in New Zealand reported that 18.3% out of 1894 adults age 60 years and over were found to be physically inactive, females were more inactive than males and the physical activity levels decreases as age increases (Mummery et al., 2007). An epidemiological study in Norway using objectively measured physical activity assessment reported that 62% of the study population age 20-85 years old spent their time awake being sedentary, only 20% of the study population met the current physical activity recommendations and only 22.7% accumulated ≥ 10,000 steps per day (Hansen et al., 2012). In Malaysia, a study by Poh et al. (2010), for Malaysian Adults Nutrition Survey (MANS) found that only one-third of 6926 Malaysian adults reported having ever exercise and only 14% had adequate exercise. In addition, the studied population also reported to spend majority of their time (more than 70% of the day) in sedentary (i.e sleeping or lying down). More men (16%) were also found to have higher level of physical activity compared to women (10%) and more women were categorized as sedentary (43%) compared to men (37%). Although the aging proportion of the percentage is not known, the finding is still alarming. Physical inactivity and its associated health problems have put a lot of pressure on the public healthcare system. A sedentary population is at risk for many chronic illnesses and conditions including cardiovascular disease, diabetes, stroke, obesity, colon cancer, Alzheimer's and osteoporosis. If the sedentary habit continues, it could significantly dampers the progress that has been made in reducing medical problems associated with chronic diseases (U.S. Department of Health and Human Services Office of the Assistant Secretary for Planning and Evaluation, 2002).

2.5 Benefits of physical activity in aging

Physical activity is defined as "any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level" (Caspersen et al., 1985, US Department of Health and Human Services, 2008). According to this definition, when a person is living and moving in such a way that energy is spent above the basal level, they are considered as physically active. However, the gaining of health benefits depends on the sufficiency of physical activitiy accumulated. Thus, researchers have been working to gain more understanding on the concept of quantifiable physical activity and to determine the amount and types of physical activity that can yield optimum health benefits.

Physical activity is usually rated according to four essential benchmarks: (1) the type of the activity - which determined by the main physiological systems that are involved during the activity, for example, aerobic or cardio respiratory system or musculoskeletal system (2) the degree of intensity required in comparison to resting states, (3) the duration of the activity, and (4) the frequency of the activity (Gauvin, 2003). Physical activities can also be characterized by location, social or environmental setting in which they occur such as leisure time activity, transportation, occupational activity, sports, home and household activity, and personal care.

From various research on exercise and physical activity, it was found that the practice is immensely beneficial to the process of aging (Vincent and Braith, 2002, Latham et al., 2004, Angevaren et al., 2008, Taaffe et al., 2008, Yates et al., 2008, Laubach et al., 2009, Carvalho et al., 2010, Etgen et al., 2010, Peterson et al., 2010, Ryan, 2010). In many aging studies, increased physical activity had been proven to

have positive effect on cardiovascular health (Laubach et al., 2009), obesity (Ryan, 2010), body composition (Peterson et al., 2010), blood lipid profile and antioxidant capacity (Carvalho et al., 2010), bone turnover (Vincent and Braith, 2002), cognitive function (Angevaren et al., 2008, Muscari et al., 2010, Etgen et al., 2010), dementia (Taaffe et al., 2008), functional capacity and decreased risk of age-related disability (Latham et al., 2004, Yates et al., 2008). All these benefits have rendered physical activity to be the primary prescription for prevention of chronic diseases and illnesses in older adults.

Due to overwhelming evidence on the benefits of physical activity, creating awareness and increasing promotion of the practice is very important. This is even more critical due to the fact that chronic illnesses were reported to be the most prevalent in older Malaysians age 60 and above, according to the Third National Health and Morbidity Survey in 2006 (NHMS III, 2008, Amal et al., 2011). This report was supported by findings from Ramli and Taher (2008) and Ong et al. (2010), where it was found that Malaysian older adults were commonly affected by chronic illnesses such as hypertension, type 2 diabetes, cardiovascular disease, and stroke. In addition, a study by Rampal et al. (2007), also found that the prevalence of obesity among Malaysian elderly was high at 8.8% in males and 13.2% in females. The pattern of orthopaedic diseases (Hamid, 1997) and functional impairment (Loh et al., 2005) were also found to be increasing in Malaysian aging population.

2.6 Recommendations and guidelines of physical activity by American College of Sports Medicine (ACSM) and American Heart Association (AHA) for older adults

In an effort to tackle the problem of sedentarism and promoting physical activity, American College of Sports Medicine (ACSM), in conjunction with American Heart Association (AHA) had published physical activity and public health recommendations for older adults in 2007 (Nelson et al., 2007). The recommendation basically detailed the frequency, intensity and duration of exercise and physical activity appropriate for older adults to gain health benefits (30 minutes per day, 5 days per week of moderate intensity physical activity or 20 minutes per day, 3 days per week of vigorous intensity physical activity). In 1998, ACSM has also published a Position Stand "Exercise and Physical Activity for Older Adults" (Mazzeo et al., 1998) and later, an updated version in 2009 to promote physical activity in older adults (Chodzko-Zajko et al., 2009). The new version had basically detailed a comprehensive review on the latest evidence regarding the benefits of exercise and physical activity in aging.

2.7 Assessment of physical activity in older adults

Physical activity can be assessed by a variety of techniques such as activity questionnaires (Pereira et al., 1997), activity diaries (Bouchard et al., 1983, Kalkwarf et al., 1989), motion sensors (Tryon and Williams, 1996), heart rate monitoring (Barreira et al., 2009), doubly labeled water (Starling et al., 1999), direct (Schoeller et al., 1986) and indirect calorimetry (Westerterp, 1999) and direct observations (Pate, 1993, McKenzie, 2002). Problems with cost, logistics and burdens of researchers and participants, generally limit the use of objective and criterion method

in physical activity assessments (Butte et al., 2012). Currently, subjective method is the most frequently used method in assessing physical activity at population level due to the practicality and feasibility (Prince et al., 2008).

2.7.1 Subjective method

Population-based data collection commonly involves subjective measures of physical activity through the utilization of surveys, diaries/logs, questionnaires and interviews. These methods are often utilized because of their ease and practicality, low cost and participant burden as well as general acceptance (Washburn and Richard, 2000, Dishman et al., 2001). Although self-reports are feasible to be used to measure the physical activity levels of the population, they tend to over- or under estimate the amount of physical activity and the extent of sedentarism. The self-report methods are frequently laden with issues of recall and response bias, for example inaccurate memory or self-perceived intensity of activity. In addition, self-report are unable to capture the absolute level of physical activity (Choi and Pak, 2005).

Questionnaire is currently the only method of assessment that is feasible for use in large-scale population-based studies. However, many studies have used age-neutral PA questionnaires, which was designed and validated against younger samples, on older individuals (Taylor et al., 1978, Gentry et al., 1985, Sallis et al., 1985). This practice may not be suitable since the focus of those questionnaires is on sport and recreational activity which has been shown to be infrequent in the daily physical activity of older individuals (Washburn et al., 1990, Yusuf et al., 1996).

Some studies have also suggested that PA questionnaires designed primarily for younger demographic are inaccurate when used with older demographic (Rikli,

2000, Washburn and Richard, 2000). Washburn et al. (1990) had made comparisons of responses from the Centers for Disease Control Behavioral Risk Factor Surveillance System questionnaire (Gentry et al., 1985) with estimations of physical activity from a 3-day activity diary of 123 community dwelling volunteers, age 65 - 91 years. The study found that the general demographic questionnaire underestimated the time spent in physical activity by approximately 2 hours 45 minutes per day. Starling et al. (1999) had also found a small and non-significant association (r=0.21) between physical activity assessed by the age-neutral Minnesota Leisure Time Physical Activity Survey (Taylor et al., 1978) and total energy expenditure over a 10-day period measured by the doubly labeled water technique in older adults.

To date, there are only four physical activity questionnaires that have been developed specifically for the assessment of physical activity in the elderly: (1) the Modified Baecke Questionnaire for Older Adults (Baecke et al., 1982), (2) the Zutphen Physical Activity Questionnaire (Caspersen et al., 1991), (3) the Yale Physical Activity Survey (DiPietro et al., 1993), and (4) the Physical Activity Scale for the Elderly (Washburn et al., 1993).

2.7.1.1 Limitations with using self-report measures/questionnaires to assess physical activity in older adults

Studies demonstrated that although questionnaires are valuables in population-based and epidemiological research, the method has a number of limitations to accurately measure the physical activity levels and are particularly influenced by cultural differences (Corder and van Sluijs, 2010). Even with proper translation, the questions may be misinterpreted, confusing or irrelevant in certain

populations (Corder and van Sluijs, 2010). A systematic review on the association between self-report and direct measurement found only low-to-moderate association and ranged from -0.71 to 0.96 (Prince et al., 2008). The paper also stated that self-report tend to measure physical activity as lower or higher compared to directly measured levels of physical activity.

The self-report methods are also often laden with issues of response and recall biases and the inability to capture accurately the level of physical activity. These biases became more of an issue when older adults are involved. An older adult's responses to questionnaire items or interview questions may be influenced by impaired cognitive capability, variance in temperament or moods and slow information processing speed (Rikli, 2000). Their understanding or interpretation of the various levels of PA may be affected by degree of physical disability rather than its true intensity. For example, what feels like light intensity to some, might be at moderate level to most, due to individual's own physical capability (Rikli, 2000). Study also showed that Light PA is the hardest intensity category to recall or remember accurately (Baranowski, 1988). However, light PA is the most common intensity category in which older adults engaged in (Tudor-Locke and Myers, 2001). This could lead to inaccuracy in the assessment. Questionnaires are also found to be insufficiently sensitive to be used as a proxy for measuring energy expenditure (Bonnefoy et al., 2001) and unable to give accurate data to determine the patterns of activity of older adults throughout the day. This information is important for understanding how significant levels of activity are achieved and how strategies to increase physical activity could be targeted (Davis and Fox, 2007). In order to eliminate or at least minimize this type of bias, objective measurements are perceived