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Identifying Fall Risk Factors Influencing Malaysian Older Adults Prior to Engaging in Healthy Lifestyle Activities

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Abstract
Background: Participation in recreational physical activity is identified as one of the crucial factors that promotes maintenance of healthy lifestyle among older adults. However, risk of falling is a serious limiting factor to engage in physical activities among people over 65 years of age. Hence, the purpose of this study is to identify factors contributing to fall risk among Malaysian older adults. Method: A total of 212 participants were recruited from designated zones in peninsular Malaysia. Each participant was subjected to a balancing protocol for assessment of overall stability index, and a fall risk documentation form was administered to acquire selected socio-demographic variables. Logistic regression analysis was performed to determine variables that contribute to fall risk. Results: Study identified four variables that contributed to risks of falling among Malaysian older adults: (i) medical condition [OR=10.63; p=0.014], (ii) mobility limitation [OR=5.94; p=0.019], (iii) participants' age [OR=1.36; p=0.001], and (iv) sensory deficit [OR=0.27; p=0.011]. Conclusion: It is recommended that any planning of recreational activities for Malaysian geriatric population must consider these four variables to ensure their safe participation. Future studies should investigate other social and environmental factors that might also contribute to fall risks among the older adults in Malaysia.
Keywords: Biodex, Fall Risk, Mobility Limitations, Older Adults, Overall Stability Index

Introduction

Malaysia is evolving into an ageing nation. Based on the Malaysian 2010-2040 population projection statistics, Malaysia has an estimated population of 28.6 million in 2010, 32.4 million in 2018 and this figure is expected to rise sharply to 41.5 million in 2040. From 5% of 65 years and older population in 2010, the percentage rose to 6.5% in 2018, and estimated to be up to 14.5% by the year 2040. World Health Organization (WHO) categorizes a country as an ageing nation when her percentage of senior citizens above 65 years old reaches 7.2%. Indication of Malaysia attaining this status within these forthcoming years is evident. This present situation necessitates prioritization of promoting a healthy lifestyle among the older adults in order to maintain life quality and productivity within this population segment.

Participation in physical activity has been found to reduce the risk and dear of falls among Malaysian elderly. In recent years, community-based healthy lifestyle programmes for the general public have been developed and promoted through national-level campaigns, most notably the government-sponsored FitMalaysia series (during years 2015-2018) targeting the suburban and rural areas in promoting physical fitness and active living trends. The likes of these programmes offered sound healthy lifestyle concepts and were subjected to open participation though not specifically tailored to older adults. They were typically marketed directly to the public without formal referrals from healthcare providers, hence did not serve the older adult segment with the most to benefit from participation. In view of the impending ageing nation status, this circumstance must change and it requires only minimal shift in mindset to ensure programmes with similar concepts reach the mentioned targeted population. Such shift involves consideration of fall risks and inclusion of fall intervention activities within the events to ensure better and safer participation among participants over 65 years of age.

Falls among older adults are common occurrences, with a recent study found that majority of the Malaysian elderly residing in nursing home are taking at least one fall risk increasing drugs or orthostatic drug (Lee et al., 2020). Annually, it is estimated a quarter of those 65 years of age or older will experience fall (Jeon, Gu & Yim, 2017). These falls usually result in debilitating, most likely fatal, injuries and affect the individual's psychosocial status. Among older adults, falls are the leading reason for injury-induced fatality. Even when falls do not require medical attention, the experience most likely result in fear of falling, which can be psychologically disabling and lead to future falls through physical deconditioning (Howland et al., 2018).

Definition of fall constitutes unintentionally coming to rest, trips or stumble to the ground or other surface lower than the body or a part of it (Sherrington & Henshke, 2013). Therefore, fall is technically not part of an ageing process. However, fall has become an endemic crisis among older adults, thereby posing major issues for the healthcare industry (Schnock et al., 2019) and government organizations that have connections with this community (e.g., Tinetti et al., 1988; Reinoso et al., 2018). A fall is always accompanied by a traumatic physical experience that leads to other catastrophic health-related consequences. It has been documented that older adults who have experienced fall incidents, have high probabilities to fall again within a period six months (Yoo et al., 2019).

Falls are affected by multifaceted connection of multiple risk factors, such as extrinsic and intrinsic factors. Extrinsic factors refer to causes more external in nature such as environmental hazards that increase the risk of falling during daily living activities. Built environment was found to be associated with fall risk among the elderly (Devinder et al., 2018). Older adults who live alone or independently within a community are more exposed to these factors (Florence et al., 2018). On the other hand, intrinsic factors involve age or disease-related changes which occurred among older adults. Notable intrinsic factors contributing to the increment of risk of falling include limitation to perform activities of daily living (Rajalingham et al., 2021; Heesch et al., 2008), medical condition or chronic illness (Thibaud et al., 2012), previous fall history, fear of falling and cognitive impairment (Qader et al, 2013). Declining engagement in physical and recreational activities due to aging was also found to increase the risk of falling (Peeters et al., 2010).

Due to the diverse conditions which imposes risks of falling among the older adult population, efforts to minimize fall incidences should be prioritized. The initiation stage involves the need to identify factors influencing the risk of falling and determining level of fall

risks among older adults. Available information regarding fall risks are generous and insightful, however most of current findings regarding fall risk factors reflected lifestyle norms from regions that dominated the fall risk literature. Logically, these factors are dependable on differences based on cultures, environment and specific knowledge with regards to the fall phenomenon (e.g., Gale et al., 2016; Worapanwisit et al., 2018). Hence accounting for fall risk factors specifically within the context of Malaysian socio-demographic setting is a relevant research endeavour. As recent as Firth et. al (2019) stated that even older adults without a fall history would still possess 21% risk of falling when undergoing the normal daily life routines. This statement provide the necessary foundation to emphasize the importance of determining risk factors associated to falling as majority older people and communities in Malaysia are not aware of living variables contributing to level of fall risk or fail to recognize the risk factors. Following valid identification of the fall risk factors for Malaysian older adults, subsequent initiatives may focus toward community-based fall intervention programmes, either as independent programmes or special activities incorporated within larger related events. Further, such efforts must then need to be well disseminated and engage substantial portion of the local older adult community in order to achieve population-level impact.

The present study represented a pioneering effort in terms of establishing a reference database for fall risk factors affecting Malaysian older adults. The purpose was to identify specific predictor variables that influence levels of fall risks among adults aged 65 years and above, regardless of gender. In this report, we focus on the results involving intrinsic factors only.

Method

Participants and Research Design

A total of 212 participants aged 65 years old and above were recruited for this study. They were randomly selected based on availability and the clustering of areas within Klang Valley Peninsular Malaysia into four zones, which were labelled as the north, south, east and west zones. Zoning and mapping of selected areas were created with the assistance of the Geographical Information System (GIS) ArcGIS Version 9.3. Designated areas were randomly selected according to the algorithm. Each zones were further divided into rural, suburban and urban areas. Recruited participants were divided into three age cohorts, which included 65-74 years old (young-old), 75-84 years old (mid-old) and 85 years old and older (oldest old). Participants recruitment process adhered to the inclusion and exclusion criteria put forth and approved by the institutional ethical committee of Universiti Teknologi MARA.

This study employed an ex post facto design to determine fall risk factors and level of fall risks among older adults based on their OSI, and in accordance to their specific demographic profiles. These profiles include gender, three main ethnicity, residency, living arrangements, educational attainment, socioeconomic status, and current marital status. Details were acquired via a fall risk documentation form. The form consisted of Section A for Fall Screening Test results (OSI), Section B for socio-demographic details and Section C for intrinsic and extrinsic living factors.

Instrumentation and Measurement

Participants OSI were assessed with the aid of Biodex Balance System. OSI is a reliable indicator to represent level of fall risk among the older adults as this method of assessment quantifies the participants' ability to maintain balance through an actual physical testing protocol. The Biodex Balance System consists of a circular platform with diameter measuring

21.5 inches (approximately 55 cm). This platform can be subjected to a series of perturbation along the anterior-posterior and medial-lateral axes almost simultaneously. Further, this platform can tilt to the angle up to 20^0 from horizontal in all directions (or 360^0 range of motion). For data collection purposes, this system was interfaced to the Biodex Software 2.09 and Firmware 1.33. Three separate measurements can be determined, which are anterior-posterior stability index, medial-lateral stability index and OSI. The OSI is the most functional measure to demonstrate participants' ability to maintain balance on top of the platform, shown through a coloured touch screen display. Test-retest reliability method was conducted to determine the reliability of this system (r = .798). High OSI scores reflect poor balance, hence higher risk of falling for the related participant. For the present study, only OSI data were reported.

Testing Protocol

Firstly, Elderly Cognitive Assessment Questionnaire (ECAQ; Kua & Ko, 1992) was administered in order to exclude participants who were potentially cognitive-impaired, as this condition may influence their ability to recall. ECAQ measures elements of cognitive functions related to memory and orientation information. An ECAQ score of above 7 is classified as normal and recruitment of study participants was based on this score. SECA Bodymeter 206 and SECA weight scale 881 were utilized to record participants' height and weight.

As a safety precaution during testing sessions, participants were required to wear a full body harness before positioning themselves on the Biodex platform. This body harness was an added external feature to the testing setup, and was not an original package included in the Biodex system. Participants underwent the testing sessions barefooted, with minor adjustments to the footing position done individually to ensure participants relaxed feel and comfort when mounted on the platform. Foot position coordinates were recorded in accordance to the platform grid to ensure OSI data obtained from each participants were consistent throughout the testing sessions. Participants were given verbal instructions not to move their feet positions until the end of the balance assessment procedure. Throughout this procedure, participants were told to fixate their visual focus towards the Biodex screen in front of them.

A one-minute trial was provided to each participant for the purpose of adaptation and familiarization to the platform perturbation. This was followed by the fall risk testing procedure immediately after the one minute trial duration was completed. This process negated any learning effects that might be acquired from the trial process. Use of handrails to assist initial balance was allowed during the one-minute trial, but not during the actual testing. The testing period consisted of three trials for balance measurement, with a 20-second duration for each trial. A 10-second rest interval was administered between each of these three trials. During testing, participants adopted a bilateral stance with feet shoulder-width apart crossing the midline of the platform, with eyes opened throughout the testing. The assessment procedure started from level 12 (static level) to level six (moderate dynamic level), with stability level reduced automatically at every 3.33 seconds.

Fall risk screening via the Biodex balance system comprised a multiaxial platform connected to a screen which was located in front of the participant. Participants task were simply to maintain their balance on the platform when subjected to various forms of mild to moderate perturbation of the platform. They were in position to observe the degree of displacement of the tilting platform with the aid of a moving cursor on the screen. Upon completion of screening, participants were interviewed based on the required details relating

to fall risk factors. Overall, completion of the whole screening and interview session took within 15 to 20 minutes.

Analyses Procedures

The Biodex system automatically calculate the precise index as to whether participants displayed high or low risk index. Each participant's index was compared to the normative values provided within the system. These were normative norms, and serve as a cutoff point to distinguish the high fall risk individual from the low fall risk ones. OSI values were recoded as high risk and low risk from the actual numerical data with the aid of a statistical software (SPSS version 16).

Logistic regression analysis using force entry method was perform to assess the impact of nine independent (predictor) variables that potentially contributed to high risk of falling. These predictor variables were medical condition, medication, sensory, fall history, mental status, involvement in physical activities, mobility limitation, activity of daily living (ADL) difficulties and age. Differences between socio-demographic variables of interest were subjected to one-way analysis of variance, with the necessary post hoc procedures (i.e. Tukey test) where applicable. Significance level for all analyses was predetermined at $\alpha = 0.05$.

Results

Table 1 summarized the physical characteristics and socio-demographic profiles of participants. All participants (mean age 76.6 $\pm$ 7.89) that met the inclusion criteria were divided into three age groups during the recruitment process.

Table 1: Participants' socio-demographic profile

		AGE GROUP		
		65-74 years (n)	75-84 years (n)	>85 years (n)
Zones	North	11	9	12
	South	11	11	20
	East	13	7	12
	West	44	44	18
Ethnicity	Malay	36	28	42
	Chinese	33	36	13
	Indian	10	7	7
Residency	Rural	26	23	20
	Suburban	21	30	22
	Urban	32	18	20
Living arrangements	Nursing home	31	33	23
	Live with others	29	17	24
	Living alone	19	21	15
Education level	Never attended school	16	22	18
	Primary level	16	25	16
	Secondary level	43	20	27
	Tertiary level	4	4	1
Present marital status	Single	4	1	2
	Married	43	34	39
	Widow/widower	30	35	17
	Divorcee	2	1	4
OSI	Low risk	42	9	0
	High risk	37	62	62

Table 2 illustrates the pertinence of each of the predictor variables to the following equation model:

$$*P(Y) = \frac{1}{1 + e^{-(b0+b1+b2+b3\ldots)}}$$

** Probability high risk of falling = (involved three or more predictor variables)*

Table 2: Logistic regression determining influential predictor variables based on level of fall risk

	B	S.E.	Wald	*df*	*p*	OR	95% C.I for OR	
							Lower	Upper
Medical condition	2.364	0.961	6.051	1	.014*	10.634	1.617	69.950
Medication	- 0.496	0.518	0.914	1	.339	0.609	0.221	1.682
Sensory 0.741	- 1.314	0.517	6.455	1	.011*	0.269	0.098	
Fall history	- 0.382	1.001	0.146	1	.703	0.682	0.096	4.856
Mental status	- 1.161	0.801	2.100	1	.147	0.313	0.065	1.506
Physical activity 2.942	- 0.146	0.625	0.054	1	.816	0.865	0.254	
Mobility limitation	1.781	0.758	5.525	1	.019*	5.936	1.344	26.208
ADL difficulties 4.997	0.605	0.512	1.393	1	.238	1.831	0.671	
Age	0.310	0.053	34.036	1	.001*	1.363	1.228	1.512
Constant	-20.886		3.521	35.180	1	.001	0.000	

*significant at p < .05

Four predictors were found to contribute significantly to the risk of falling among participants. These variables were medical condition, sensory deficit, mobility limitation and age. Medical condition appeared to be the strongest predictor to classify an individual into a high fall risk category with reported odds ratio (OR) of 10.63 [95% of CI = 1.617 - 69.950; p = .014]. This result indicates that participants with several types of medical condition are over 10 times more likely to be subjected to high level of fall risks, as compared to older adults with a good health record. Mobility limitation is the second influential predictor for high risk of falling [OR = 5.94; 95% of CI = 1.344 – 26.208; p = .019]. Here, mobility limitation refers to participants who require assistive device (for example, a walking frame) for their daily movement chores. Despite the more profound visual outlook for potential falls, mobility limitation statistically indicated almost half the probability of being subjected to high risk of falling as compared to participants with medical condition. For age, it reported an OR of 1.36 [95% of CI = 1.228 – 1.512; p = .001] which indicates that the natural process of aging will

result in higher risk of falling with advancing age among participants. The last significant predictor that contributed to the fall risk model was sensory deficit [OR = 0.27; 95% of CI = 0.098 – 0.741; p = .011]. This finding implies that for participants who are able to circumvent their sensory problems, regardless the forms of interventions, they will less likely be reported to have a high level of fall risk. In sum, the higher the odds ratio, the higher will the probability be for the predictor variables to contribute to risk of falling.

Table 3 summarized the results of all main comparisons involving the selected socio-demographic variables based on participants OSI. One way ANOVA was applied across all comparisons, including for gender factor despite involving only two comparison groups. The rationale for this decision was for consistency in the choice of using F statistic, and to take advantage of the robustness of this statistic against violations to the assumption of normality.

Analyses yielded significant differences for comparisons involving biological factors, which are gender [F (1, 210) = 17.89; p <.05] and ethnicity [F (2, 209) = 4.33; p < .05]. On the social front, residency factor comparing OSI of participants residing in urban, suburban and rural areas [F (2, 209) = 7.57; p < .05] and current marital status of participants [F (3, 208) = 3.53; p < .05] also yielded statistical significance in terms of fall risks. However, fall risks among Malaysian older adults due to the factors relating to personal and environmental aspects will be elaborated in a different report.

Table 3: One Way ANOVA for comparison of OSI across selected socio-demographic variables

		df	*F*	*p*	
Gender	Between groups		1	17.89	.001*
	Within groups	210			
	Total	211			
Ethnicity	Between groups		2	4.33	.014*
	Within groups	209			
	Total	211			
Residency	Between groups		2	7.57	.006*
	Within groups	209			
	Total	211			
Living arrangements	Between groups		2	2.32	.101
	Within groups	209			
	Total	211			
Educational attainment	Between groups		3	0.38	.766
	Within groups	208			
	Total	211			
Present marital status	Between groups		3	3.53	.049*
	Within groups	208			
	Total	211			

*significant at p < .05

Discussion

Engagement in healthy and active lifestyle programmes is crucial towards ensuring decent life quality of older adult population in ageing nations. Foremost priority to such programme involvement for this population segment must be their safety during participation. Here, considerations for risk of falling during programme participation ought to be the major concern for organizers of such events. The intent of this study was to determine the reliable predictor variables that could be the major contributor to the risk of falling among Malaysian older adults. These predictors need to be factored in during the planning of the aforementioned programmes, namely sports for the masses and recreation.

Globally, falls are common occurrence among the older adult population. Older females exhibit greater tendencies to fall as compared to older males largely due to the greater postural sway evident in aging females (e.g. Heesch, Byles & Brown, 2008; Sherrington & Henske, 2013). The findings of this study further lend support to this statement, via a generous sampling of almost equal sample size between male and female participants (large effect size, 2 = .64). In general, data from the current study confirmed what is present in the literature (for example, e.g., Ashe et al., 2009; Harrison, 2017; Ozturk et al., 2017) with regards to the occurrence of falling mainly due to age and disease factors. The older an adult is, the more susceptible he or she will be to falling. This situation will be further compounded when an individual carry with them three or more long term diseases, most commonly lifestyle-related such as hypertension and diabetes, and physically-deteriorating symptoms such as arthritis and osteoporosis. However in this study through the use of FRDF, we did not seek to identify the exact nature of medical condition or pathological diseases participants might be carrying at the point of recruitment due to the level of confidentiality permitted with respect to the scope of this study.

Sensory deficit contribution to fall incidences among older adults is another well-documented finding supported by the present evidence. Sound posture control for balance and locomotion are influenced by visual, vestibular and somatosensory inputs received simultaneously by the human motor system (e.g., Masud & Morris, 2001; Karsson et al., 2013). As humans aged, the fundamental functions of these three systems deteriorates progressively, notably the visual function which suffers the loss of function rather exponentially as compared to the remaining two sensory modules. This condition leads to decreased posture control abilities, hence more prone to falling as a consequence of reduced modular support for basic balancing (Schnock et al., 2019).

In this study of Malaysian older population with varied living conditions, the potential associations between levels of engagement in future healthy and active lifestyle programes will hinged upon their mobility status. Here, mobility limitation represents the second most influential predictor for fall risks among the participants. Although definition of mobility limitation in this study was restricted to the use of assistive devices by participants, results analysis yielded convincing regards pertaining the influence of mobility status towards fall risk within the Malaysian older adult population. There is valid ground to believe that the results could appear more prevalent should conditions that also constrains movement abilities, such as arthritis, are included under this criterion.

Distinguishing level of fall risks defined by mobility limitations among older adults poses a certain conundrum. The existing literature implies that association between rate of falling and individuals' physical engagement (through performing ADL) may differ by mobility limitations. Physical engagements could either increase or decrease fall risks depending on the functional status of the individual. This may offer a valid explanation to prior findings

reporting U-shaped relation between fall risk and physical activities (Peeters et al., 2010). A rationale for the opposite relationships could be that moderate to highly active older individuals have tendencies to perform beyond their abilities. Individuals with mobility limitations inherently are more aware of their physical capacities constrains. Physical engagements, ADL and specifically exercise-based will most likely be conducted under supervision or guidance due to their limitations. Hence, activity workloads will be proportional to their abilities and this will provide the expected benefits of preventing fall prevention. There is a distinct possibility too, that individuals with mobility limitations may indulge in range of activities that differs from those indulged by individuals without limitations. For example, if the activity has an inherently different risks of injury (e.g., brisk walking had a lower risk than gardening), this may feasibly account for the different associations between activity level and fall risks in the low versus high risk categories defined by mobility limitations (Jefferis et. al., 2015). These are crucial considerations when mobility limitations become among major criteria for reference of fall risk guidelines.

Potential Policy Implication and Conclusion

Healthy lifestyle programmes incorporating mainly physical and recreation-based activities offer diverse range of benefits toward healthy outcomes. It is a worldwide norm that such benefits are encouraged by national health guidelines. Inevitable side effects, unfortunately will include accidents and injuries from falling, with the older adult population at the highest risk for falls. Falls eventually lead to serious health and social consequences on subsequent need towards long term rehabilitation for both fallers and the society. Hence, the major findings of this study recommend that screening for medical condition and level of mobility limitation (of potential participants) become an imperative prerequisite prior to any older adults (65 years old and above) involvements in events based on physical activities and locomotion. In addition, programmes that encourage older adults with medical condition but without mobility limitations, to be physically active, must incorporate fall-prevention strategies to avoid potentially excessive falls. This refers particularly to the more relatively active elderly population. To date, most effective falls prevention programs incorporate general mild to moderate balance-challenging activities. This may be an important aspect of physical activity that is not fully addressed by informal advice and programmes encouraging casual or brisk walking. Finally, greater awareness for prevention of falls in older adults via educational strategies may play a profound role in encouraging individuals to perform within reasonable activity levels. Future interventions could investigate whether lifestyles that encourage active involvement in more physical activities and less sedentary behavior may help reduce the risk of falls in adults who report mobility limitation outdoors.

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