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Built Environment Characteristics and its Association between Physical Performance, Falls Risk and Functional Mobility among Malaysian Older Adults

(Ciri-ciri Binaan Persekitaran dan Hubungannya dengan Prestasi Fizikal, Risiko Jatuh dan Kefungsian Mobiliti dalam Warga Emas di Malaysia)

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ABSTRACT

Older adults who walk in their neighbourhood with greater street connectivity are reported to have lower limb physical performance decline. There is limited information regarding the association between built environment characteristics and physical performance in older adults. The aim of this study was to examine the association between built environment characteristics, physical performance, falls risk and functional mobility among older adults. Sixty four (27 men and 37 women) community dwelling older adults aged 60 years and above (mean 67.4 ± 7.1 years) from senior citizen clubs in Kuala Lumpur, Malaysia participated in this cross-sectional study. Built environment characteristics were assessed using an adapted Neighbourhood Environment Walkability Scale (NEWS). Physical performance and falls risk was measured using Short Physical Performance Battery (SPPB) and Profile Physiological Profile Assessment (PPA) respectively. Timed Up and Go (TUG) and gait speed tests were used to assess functional mobility. There was a significant correlation between built environment and physical performance ($r = 0.43$, $p < 0.001$) and functional mobility measured using gait speed test ($r = 0.27$, $p < 0.05$) among older adults. Built environment was identified as a significant determinant of physical performance ($R^2 = 0.19$, $p < 0.001$). Built environment characteristics is an important external factor in preserving physical performance in older adults. Programmes and policies for a more favourable built environment characteristics in the neighbourhoods should be encouraged to promote and maintain physical performance among older adults.

Keywords: Physical performance; falls risk; built environment

ABSTRAK

Warga emas yang berjalan di kawasan kejiranan mereka dengan kesambungan jalan yang lebih baik dilaporkan mengalami penurunan prestasi fizikal yang lebih rendah. Terdapat maklumat yang terhad mengenai hubungan antara ciri-ciri persekitaran yang dibina dan prestasi fizikal pada warga emas. Tujuan kajian ini adalah untuk mengkaji hubungan antara ciri-ciri persekitaran yang dibina, prestasi fizikal, risiko jatuh dan kefungsian mobiliti di kalangan warga emas. Enam puluh empat (27 lelaki dan 37 wanita) warga emas dalam komuniti yang berusia 60 tahun ke atas (min 67.4 ± 7.1 tahun) dari kelab warga emas di Kuala Lumpur, Malaysia mengambil bahagian dalam kajian keratan rentas ini. Ciri-ciri alam sekitar yang dibina dinilai dengan menggunakan Neighbourhood Environment Walkability Scale (NEWS) yang telah diadaptasi. Prestasi fizikal dan risiko jatuh diukur dengan menggunakan Short Physical Performance Battery (SPPB) dan Physiological Profile Assessment (PPA). Ujian Timed Up and Go (TUG) and gait speed digunakan untuk menilai kefungsian mobiliti. Terdapat korelasi yang ketara di antara persekitaran binaan dan prestasi fizikal ($r = 0.43$, $p < 0.001$) dan kefungsian mobiliti yang diukur dengan menggunakan ujian gait speed ($r = 0.27$, $p < 0.05$) di kalangan warga emas. Ciri-ciri persekitaran telah dikenalpasti sebagai penentu prestasi fizikal yang ketara ($R^2 = 0.19$, $p < 0.001$). Ciri-ciri persekitaran yang dibina adalah faktor luaran yang penting dalam mengekalkan prestasi fizikal pada warga emas. Program dan dasar untuk ciri-ciri persekitaran yang lebih baik di kawasan kejiranan harus digalakkan untuk mempromosikan dan mengekalkan prestasi fizikal di kalangan warga emas.

Kata kunci: Prestasi fizikal; risiko jatuh; ciri-ciri persekitaran yang dibina

INTRODUCTION

Adults aged over 60 years and above are increasing globally (World Health Organisation 2012). This number is expected to increase up to 21%, totaling to two billion by year 2050 (World Health Organisation 2012). Similarly, Malaysia will attain ageing nation status by year 2035 (United Nation 2013). Older adults experience various changes associated with aging, including decline in physical performance (Leyk et al. 2010) and increase in falls-induced injuries (Kannus et al. 2005). We have demonstrated physical performance status among Malaysian older adults in our earlier study (Won et al. 2014) and are almost similar to other studies (Miyamoto et al. 2008; Balasubramanian 2014). Malaysian older adults have a low to moderate falls risk (Singh et al. 2015).

Locality, including both living and working has an impact on physical and psychological health of older adults (Srinivasan, O'Fallon & Dearry 2003). Built environment, defined as a land usage patterns such as arrangement of buildings, roadways, trails and parks, and transportation investments (Frank, Kavage & Devlin 2012), are essential not only for people with disabilities but also for older adults (Mohammad & Abbas 2012; Rahim, Amirah & Samad 2010). Favourable neighbourhoods not only assist older adults to continue to live in their own homes but also encourage active participation and socialisation (Mohammad & Abbas 2012). Community-dwelling older adults who lived in deprived neighbourhoods, for example with limited accessibility to fulfill their daily routines were found to be associated with poor mobility and reduced gait speed (Lang et al. 2008; Glass & Balfour 2003). Furthermore, built environment modifications were expected to be more effective in terms of its long term impact on majority of the people (Sallis et al. 2012) rather than targeting individual risk factors which are costly and less effective.

The relationship between built environment, physical function, psychological health, walking behaviour and weight status has been examined (Balfour & Kaplan 2002; Saelens et al. 2003). Evidence showed that unfavorable neighbourhood designs are related to obesity, decrease physical activity, poor lower limb function and falls in older adults (Michael et al. 2011; Chippendale, Otr & Boltz 2014). However, there is lack of information on association between built environment, physical performance, falls risk and functional mobility among older adults. Thus, the aim of the present study was to examine the association between built environment, physical performance, falls risk and functional mobility among older adults.

METHODS

This cross-sectional study was performed at 2 senior citizen clubs in Kuala Lumpur, Peninsular Malaysia. Older adults aged 60 years and above were recruited through flyers distributed at these clubs. An information sheet was provided to eligible participants and verbal information regarding the whole study was given. An informed written consent was obtained from all participants. This study was approved by the Medical and Research Ethics Committee of Universiti Kebangsaan Malaysia. Optimal ratio of 10 participants to each independent variable was deemed sufficient for the purpose of this study.

In order to be included, potential participants must be 60 years and above, live in the community, and ambulate independently with or without an assistive device. Participants with known cognitive impairment, mild depression with Geriatric Depression Scale (GDS) score more than 5, and consumed prescribed drugs, that could potentially affect physical function and balance, such as corticosteroids, antipsychotic or antidepressants, were excluded. In addition, older adults with impaired physical function caused by recent fractures, severe arthritis, lower extremity or joint replacements, neurological diseases, musculoskeletal disorders, cardiac problems, or Parkinson disease, were excluded. Participants' demographic data were recorded as active if they met the 150 minutes of physical activity per week.

A translated version Neighbourhood Environment Walkability Scale (NEWS) (Pin and Scherer 2015) was used to assess built environment characteristics that was translated back-to-back from English to Malay language. The reliability of the self-administered Malay version questionnaire as calculated using Cronbach's alpha and was found to be 0.95. The 4 main components of the questionnaire were home and neighbourhood environment, accessibility in community and neighbourhood satisfaction. The scoring was calculated and higher the score better the satisfaction and accessibility.

Participants were assessed for physical performance using Short Physical Performance Battery (SPPB) using the standard protocol that included timed measure of 8-metre walk at usual pace, standing balance (side by side, semi tandem and tandem stands) and repeated timed five times of chair stand tests (Guralnik et al. 1994). The scoring ranged from 0 (worst performance) to 12 (best performance) (Guralnik et al. 1994). The intra-class correlation coefficients for SPPB measures were shown to be high (0.89; 95% CI: 0.83, 0.93). (Freire et al. 2012)

Physiological profile approach (PPA) (Lord, Menz, and Tiedemann 2003) shorter version was used to assess falls risk. It consists of balance, hand reaction time, knee extensor strength, knee proprioception, and vision tests. Balance was measured using a body sway meter. For hand reaction time, participants pressed a switch in response to light and the reaction was recorded in milliseconds. Dominant knee extensor muscle strength was assessed in high sitting using a spring gauge. A large protector was used to measure knee proprioception. For this test, participants were requested to place their lower limbs parallel on either side of the protector with eyes closed and placement errors were recorded in degrees. Visual acuity was measured using Melbourne Edge contrast sensitivity test. Higher scores indicate greater falls risk (Whitney, Lord & Close 2005). Reported intra-class correlation coefficients for PPA ranged from 0.50 to 0.70 with 75% accuracy in predicting fallers among community dwelling older adults (Lord, Menz & Tiedemann 2003).

Functional mobility was assessed using timed up and go (TUG) and 10 meters gait speed tests (Podsiadlo and Richardson 1991). Both the Timed up and Go and gait speed tests were performed in a standard manner. During the TUG test, participants rose from a 46cm high chair, walked forward at their normal pace for three metres, turned 180°, return back to the chair and sat down (Whitney, Lord & Close 2005). The mean of 2 TUG sessions was taken and recorded in seconds (Bohannon 2006). As for the gait speed test, participants were required to walk for 10 metres at their preferred speed (Shubert et al. 2006). Time was measured for the intermediate 6 metres in order to allow acceleration and deceleration period (Tiedemann et al. 2008). Participants were allowed to perform this test with the use of their walking aid if present. Two trials were conducted and the average was recorded in metres/second (m/s) (Shubert et al. 2006).

A rest period was provided in between all tests and whenever required. Each test was performed by the same trained final year physiotherapy undergraduate. Statistic Package for Social Science (SPSS Inc. Chicago, USA) version 19.0 was used to analyse the data. Pearson correlation coefficient was used to determine the correlation between the variables. In order to further examine independent association of variables with built environment total score, stepwise multiple regression analysis was applied. The data was stated as statistically significant at $p < 0.05$.

RESULTS

The demographic characteristics of the participants are as depicted in Table 1. Majority of the participants were aged 60-70 years (70.3%), leading an active lifestyle (84.4%), had no falls history (95.3%), had at least 1 medical illness (79.7%) and were taking 1 to 3 medications (67.2%). PPA mean score for this population (1.0 ± 0.7), indicated low risk of falls. Women performed better in TUG (8.6 ± 1.0 seconds) and gait speed (1.3 ± 0.3 seconds) tests, while men had higher scores in SPPB and lower risk of falls. Among the parameters, only SPPB was found to be significantly different ($p < 0.05$) between genders.

TABLE 1. Demographic data of participants

Parameters	Total (n = 64)	Men (n = 27)	Women (n = 37)	*p* value
Age [years; n (%)]				
60-70	45 (70.3)	19 (70.4)	26 (70.3)	0.65 [a]
71-80	14 (21.9)	5 (18.5)	9 (24.3)	
>80	5 (7.8)	3 (11.1)	2 (5.4)	
Lifestyle [n (%)]				
Active	54 (84.4)	22 (81.5)	32 (86.5)	0.73 [b]
Sedentary	10 (15.6)	5 (18.5)	5 (13.5)	
Falls History [n (%)]				
Yes	3 (4.7)	1 (3.7)	2 (5.4)	1.00 [b]
No	61 (95.3)	26 (96.3)	35 (94.6)	
Medical Illnesses [n (%)]				
Yes	51 (79.7)	21 (77.8)	30 (81.1)	0.75 [b]
No	13 (20.3)	6 (22.2)	7 (18.9)	
No. of Medication [n (%)]				
0	21 (32.8)	8 (29.6)	13 (35.1)	0.64 [b]
1-3	43 (67.2)	19 (70.4)	24 (64.9)	
TUG [seconds; mean (SD)]	8.7(1.0)	8.8(1.0)	8.6(1.0)	0.51 [c]
Gait Speed[seconds per metre; mean (SD)]	1.4(0.33)	1.4(0.4)	1.3(0.3)	0.23 [c]
SPPB [score; mean (SD)]	11.3(0.6)	11.6(0.6)	11.2(0.6)	0.01 [c]
PPA [score]	1.0(0.7)	0.8(0.6)	1.2(0.8)	0.06 [c]

Abbreviation: SD = Standard deviation; [a]Anova [b]Chi Square [c]Independent t-test

The correlation results between four parts of built environment questionnaire and its total score, with SPPB, PPA, TUG and Gait Speed are as shown in Table 2. There was a moderate positive correlation between SPPB and built environment total score ($r = 0.43$, $p < 0.05$) indicating better built environment characteristics that are related with a higher physical performance. Besides, total score of SPPB was correlated positively with components in the built environment questionnaire including accessibility in community ($r = 0.45$, $p < 0.001$) and neighborhood satisfaction ($r = 0.26$, $p < 0.05$). This suggested that probably, better accessibility in the community and higher neighborhood satisfaction was correlated with higher status of physical performance.

Meanwhile, functional mobility as examined using gait speed was also significantly correlated with built environment total score ($r = 0.27$, $p < 0.05$). This fair association may indicate that built environment with a more favorable characteristics are associated with better functional mobility. Gait speed had a significant correlation with accessibility in community component in the built environment questionnaire ($r = 0.37, p < 0.05$). Participants who had better accessibility in the community seem to have better functional mobility. Each component of built environment was negatively correlated with PPA score, implying that better scores in built environment were associated with lower risk of falls. However, risk of falls was not correlated with built environment, in this study.

TABLE 2. Correlation between four parts of built environment questionnaire and its total score with physical performances (SPPB), risk of falls (PPA) and functional mobility (TUG and Gait Speed)

Potential correlates	SPPB		PPA		TUG		Gait Speed	
	r	p	r	p	r	p	r	p
Built Environment characteristics								
Home Environment	0.08	0.51	-0.08	0.54	0.07	0.60	0.06	0.67
Community Environment	0.08	0.54	-0.05	0.70	-0.03	0.82	0.03	0.84
Accessibility in Community	0.45**	0.01	-0.13	0.33	-0.23	0.07	0.37**	0.01
Neighbourhood Satisfaction	0.26*	0.04	-0.08	0.52	-0.02	0.88	0.12	0.37
Built Environment Total Score	0.43**	0.01	-0.20	0.12	-0.14	0.26	0.27*	0.03

Abbreviation**:** SPPB-Short Physical Performance Battery, PPA- Physiological Profile Approach TUG-Timed Up and Go Test
** Correlation is significant at the 0.01 level (2-tailed)
* Correlation is significant at the 0.05 level (2-tailed)

Further, stepwise multiple regression analysis was conducted to determine relationship of physical performance (SPPB) and built environment characteristics (Table 3). Built environment explained 19% of the variance, $F (1, 62) = 14.12$, $p < 0.01$ in physical performance.

TABLE 3. Factors associated with physical performance (SPPB) in stepwise multiple linear regression

	Factor	β	*P* value	R^2
Physical Performance (SPPB)	Built environment Total Score	0.43	<0.001**	0.19

** Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

To the best of our knowledge, this is the first study regarding the association between a few objective physical performance measurements, falls risk and built environment. The results of our study showed that built environment was one of the important factors related to physical performance among older adults. Built environment total score appeared to be the most robust determinant of physical performance as it is a composite score of all the sub characteristics of built environment.

This finding is consistent with a similar previous study conducted in four urban areas of United States (Michael et al. 2011). Street connectivity in residential environment was associated with slower decline in lower limb physical performance measured using chair-stand test among older adults (Michael et al. 2011). Older adults in this previous study reported walking as part of their daily routine or as an exercise (Michael et al. 2011).

In a study comparing rural and suburban African-American older adults, those who lived in neighborhoods with poor conditions had higher risk of having lower-body functional limitation (Schootman et al. 2006). This suggests that neighbourhood environment with a more favourable condition, which may be characterised by concentrated housing density, grid like street patterns, shorter block lengths and land with integration of commercial and residential use may be an encouraging factor for promoting physical activity especially walking among older adults (Michael et al. 2011; Schootman et al. 2006). Favourable characteristics of neighbourhood environment may include the aspects of home and community environment, accessibility in community and neighbourhood satisfaction which consequently increase physical performance (Saelens and Handy 2010).

Physical performance among older adults in our present study was significantly associated with components in the built environment, namely accessibility in community. These results were consistent with a previous study reporting perceptions of residents favoring proximity to recreational facilities as encouraging walking activity in neighbourhood (Li et al. 2005). Similarly, older adults who lived in a neighborhood with more walking destinations such as retail areas, service facilities and entertainments were more physically active (Rantakokko et al. 2012; Wang and Lee 2010; King et al. 2005). Providing a safe neighborhood with convenient access to recreational and public facilities, may promote older adults to take part in leisure-time physical activity (Cerin et al. 2013).

Physical performances among older adults were also demonstrated to be related to neighborhood satisfaction in our study. These results generally agree with those in another study showing that perceived neighborhood satisfaction was associated with time spent engaged in physical activity among older adults (Rantakokko et al. 2012). Perceived multiple problems in their neighborhood were associated with decreased lower limb function, in relation to spending less time in walking among older adults (Balfour and Kaplan 2002; Nagel et al. 2008). Perceived problems in the neighborhood include heavy traffic, poorly lit environment, and excessive noise that can affect health and motivation of older adults (Balfour and Kaplan 2002).

No significant correlation between built environments with the risk of falls among older adults was demonstrated in the present study. The probable explanation for these results may be due to the fact that only five percent of the participants had reported to experience a fall. Moreover, most of the older adults were leading an active lifestyle, which is among the robust protective factor of falls. However, literature suggests that lower falls risk is related to more favourable built environment characteristics, such as having ramps at intersections, painting indicating curbs and well-lit places (Chippendale, Otr & Boltz 2014). Causes of falls are multifactorial, but one of the most common factors is environmental related, followed by balance impairments, muscle weakness and dizziness (Rubenstein 2006). It is also noteworthy that the frequency of outdoor falls was higher compared to indoor falls which was associated with higher leisure-time physical activity (Li et al. 2006). Thus, a safe and conducive environment for increasing physical activity is vital in promoting physical health status of older adults.

One of the limitations in our study is that the participants recruited were only from urban areas where types of residential are either multi-storey or terrace housings. Older adults who lived in rural areas may perceive their neighborhood environment differently. The result of physical performance and risk of falls among older adults in rural areas may also be different. Thus, the results of the study may not be applicable to all community-dwelling older adults. Secondly, reliance on the self-reported built environment questionnaire to assess the built environment characteristics may not have given an overall true picture of the environment. Further studies should consider both subjective and objective measurements of built environment characteristics.

CONCLUSION

Findings of our study suggested that physical performance, functional mobility and built environment among older adults are inter-related. Higher overall built environment score was shown to be a significant factor for higher physical performance. Therefore, it is one of the important factors that should be considered in health promotion programs to prevent further deterioration of physical function in older adults. Development of programs and policies that can change neighborhood built environment towards being more conducive for boosting physical function in older adults is justified.

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