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Perception of Neighbourhood-Level Built Environment in Relation to Youth Physical Activity in Malaysia

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***Abstract*—**Neighbourhood environment walkability on reported physical activity (PA) levels of students of Universiti Sains Malaysia (USM) in Malaysia. Compared with previous generations, today's young people spend less time playing outdoors and have lower participation rates in PA. Research suggests that negative perceptions of neighbourhood walkability may be a potential barrier to adolescents' PA. The sample consisted of 200 USM students (to 24 years old) who live outside of the main campus and engage in PA in sport halls and sport fields of USM. The data were analysed using the t-test, binary logistic regression, and discriminant analysis techniques. The present study found that youth PA was affected by neighbourhood environment walkability factors, including neighbourhood infrastructures, neighbourhood safety (crime), and recreation facilities, as well as street characteristics and neighbourhood design variables such as facades of sidewalks, roadside trees, green spaces, and aesthetics. The finding also illustrated that active students were influenced by street connectivity, neighbourhood infrastructures, recreation facilities, facades of sidewalks, and aesthetics, whereas students in the less active group were affected by access to destinations, neighbourhood safety (crime), and roadside trees and green spaces for their PAs. These results report which factors of built environments have more effect on youth PA and they message to the public to create more awareness about the benefits of PA on youth health.

***Keywords*—**Fear of crime, neighbourhood built environment, physical activities, street characteristics design.

I. Introduction

THE need to increase PA is a public health priority. Given the age-related decline of PA, youth seems to be a critical period of age to target for intervention [1]. However, to promote PA among youth more effectively, it is necessary to identify the factors that may influence their participation. PA is influenced by a complex array of personal attributes and environmental factors [2], and the latter may be related to the built or social environment [3]. Several studies suggested that physical environment variables play an especially important role in PA [4]. Furthermore, the creation of supportive environments has the potential to encourage PA because improving features of the built environment has the capacity to affect a large number of people on a relatively permanent basis [4], [5]. Until recently, the majority of research focused on personal and social environmental factors, with little attention paid to perceptions of the physical or built environment [6]. Despite the recent surge of research on the association between environmental attributes and PA behaviour [7], research in this area is still in its infancy.

The literature has revealed associations between the physical environment and adult's PA [8]-[11], but little is known about the role of the neighbourhood or built environment in the PA behaviour of youth [12]. Knowledge of perceptions of the environment in relation to PA in young people outside of the US or Australia also is limited. As features of the built environment are related to PA among youth [7], [13], changes in built environments could have widespread and long-term effects. For example, recreational PA of youth has been associated with characteristics of PA facilities in the neighbourhood [14]-[16]. Walking and cycling for transportation by youth have been associated with community design and transportation attributes such as distance to destinations, sidewalks, and traffic safety [17]-[19]. Young people are physically active in a variety of specific locations [20] and engage in different types of activities in places such as parks and streets [21]. Studies are beginning to examine environmental correlates of location-specific PAs [20], [22], [23].

PA is affected by built or physical environmental factors such as street connectivity, accessibility to services and destinations, walking and cycling facilities, aesthetic quality, and safety [24]-[27], which improve the neighbourhood walkability reflected the ease of walking to destinations in a neighbourhood [28]. The Neighbourhood Environment Walkability Scale (NEWS) was developed to assess environmental factors hypothesized to influence PA [9]. The NEWS demonstrated good reliability among adults in several countries [5], and the validity of an abbreviated version (NEWS-A) was supported [29]. However, the ability of the NEWS or NEWS-A to explain PA of children and adolescents has been insufficiently studied [30]. A version of the NEWS relevant to youth, which can be completed by adolescents themselves, is needed to further research on the impacts of the built environment on PA among youth. Thus, the first aim of the present study was to examine the measurement properties of a new measure, the NEWS for youth (NEWS-Y), when completed by adolescents. The second aim was to assess relationships between NEWS-Y scales and PAs of youth undertaken in specific places.

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II. Methods

A. Subjects and Setting

Students of USM participated in this study. The potential sample included 232 students encountered in sport halls and sport fields. The questionnaires were distributed and filled out during the PA. A response rate of 86.95% was obtained. Questionnaires were deleted from the analysis if they contained a majority of missing information. After deletions, 200 students' responses (120 female and 80 males) were used in the analysis. The average age was 21 years (SD = 1.6). Informed written consent was obtained from the participants before the subjects entered into the study.

B. Measures

PA assessment- PA items assessed included frequency of walking to/from USM, engaging in PA in the street, walking to a park, walking to shops, and doing PA in a park at least once per week. The items relating to walking to a park and being active in a park had acceptable test–retest reliability for students (all intraclass correlation coefficients were > 0.40) [20]. Total PA was measured with two self-reported items, and these results were used to determine whether participants met moderate-to-vigorous PA guidelines (60 min of activity five days per week) [31]. Respondents reported "on how many days were you physically active for a total of at least 60 min per day?" Number of days was reported for "the past seven days" and during a "typical or usual week". A scale was created by taking the mean of the two items. The two-item scale performed better than either item separately on test–retest reliability (intraclass correlation coefficient = 0.77) and validation against accelerometer data ($r = 0.40$, $p < 0.001$). The two-item scale also demonstrated reasonable sensitivity and specificity [32]. Youth were classified as meeting PA guidelines if the mean score indicated they were active for at least 60 min per day, five or more days per week.

Environmental assessment- Participants completed the new NEWS-Y and survey items assessing PA in various locations. To create the NEWS-Y, the abbreviated NEWS [29] was adapted for youth. Simplifications in wording were made to the NEWS-A scales to make items easier to understand for the youth version (e.g., the types of residences people live in were simplified). Some items pertaining especially to youth were added. For the current study, the NEWS-Y was summarized into the seven subscales from the original NEWS [9]. An additional scale that was not part of the original NEWS was developed that covered facades of sidewalk, roadside trees and green spaces and aesthetic.

C. Hypothesis Development

This study included 10 independent variables (access to destinations, street connectivity, neighbourhood infrastructures, neighbourhood safety (traffic and crime), walking/cycling facilities, recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics), one mediating variable (fear of crime), and one dependent variable (PA), and the research framework is shown in Fig. 1. The set of independent variables in Fig. 1 is partially supported by [9]. The purpose of this cross-sectional study was to examine associations between perceptions of neighbourhood walkability and how those notions affect students' PA. Accordingly, this study tested the following hypotheses: ***H1***. Access to destinations leads to reduced PA of students. ***H2***. Street connectivity leads to reduced PA of students. ***H3***. Neighbourhood infrastructures lead to reduced PA of students. ***H4***. Neighbourhood safety (traffic) leads to reduced PA of students. ***H5***. Neighbourhood safety (crime) leads to reduced PA of students. ***H6***. Walking/cycling facilities leads to reduced PA of students. ***H7***. Recreation facilities lead to reduced PA of students. ***H8***. Facades of sidewalks lead to reduced PA of students. ***H9***. Roadside trees and green spaces lead to reduced PA of students. ***H10***. Aesthetics lead to reduced PA of students.

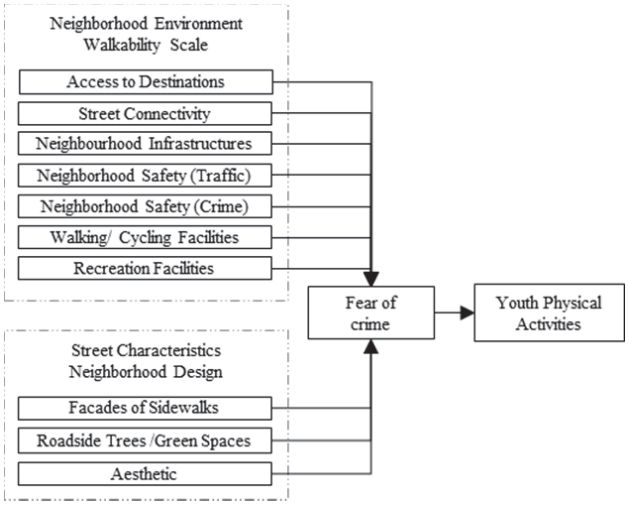

Fig. 1 Conceptual research framework

D. Data Analysis

Statistical analysis was carried out using the SPSS 12.0 program. The Chi-square (v2) test was used to identify differences in perceived environmental variables between active and non-active groups. Bivariate associations between variables were identified using Spearman correlation. The independent association of perceived environmental variables with PA as the dependent variable was examined using logistic regression analysis. The variables entered in the final model were those that exhibited a p-value < 0.05 in the correlation.

The independent association of built environment walkability variables with PA as the dependent variable was examined using binary logistic regression analysis, as well as two-group discriminant analysis was conducted using SPSS version 22. Chi-square analysis was used to identify the differences in perceived environmental variables between less active and more active youth groups. Factor analysis and reliability analysis were used to test the data. The questions in the 10 constructs of independent variables (i.e., access to destinations, street connectivity, neighbourhood infrastructures, neighbourhood safety (traffic and crime),

walking/cycling facilities, recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics) were included in the factor analysis to determine whether their subjective measurements in the Likert scale of 1–5 were actually converging to their respective constructs; this included 30 questions associated with the 10 constructs (independents) and 10 questions connected with fear of crime (mediating). Reliability analysis (Cronbach's α) was used to determine whether the measurements of the 10 constructs were consistent. The independent two sample t-test was applied to compare the two groups of respondents (students with fewer activities and with more activities) for the 10 independent variables and the results. The Fisher's procedure was used to make pair-wise comparisons.

E. Power Estimates of the Models

The power of the two different models (binary logistic and discriminant) were compared [33], and Table I provides the basic matrix of the computation. Youden's index was used to identify correctly the sensitivity and specificity of the tests. A higher the value of Youden's index means a better ability to avoid failures. The index is defined as: Youden's index (P) = sensitivity/ (1 – specificity), where sensitivity = tp/ (tp + fn) and specificity = tn/ (fp + tn). Likelihoods are measures that evaluate the classifier's performance to a finer degree with respect to both classes (positive and negative). It treats sensitivity and specificity separately. Let A = classification findings from discriminant analysis and B = classification findings from binary logistic regression analysis. Then,

$$P+= \ sensitivity/(1-specificity)$$

$$P- = \ (1-sensitivity)/specificity$$

Therefore: $P^{+}_{A} > P^{+}_{B}$ and $P^{-}_{A} < P^{-}_{B}$ implies A is superior overall. $P+_{A} < P^{+}_{B}$ and $P^{-}_{A} < P^{-}_{B}$ implies A is superior for confirmation of negative examples. $P^{+}_{A} > P^{+}_{B}$ and $P^{-}_{A} > P^{-}_{B}$ implies A is superior for confirmation of positive examples. $P^{+}_{A} < P^{+}_{B}$ and $P^{-}_{A} > P^{-}_{B}$ implies A is inferior overall.

Discriminant power (DP) is another measure given by:

$$DP \ = \ (\sqrt{3}/\pi) \ (log \ X \ + \ log \ Y)$$

where X = sensitivity/(1-sensitivity), Y = specificity/(1-specificity). The DP summarizes sensitivity and specificity to evaluate how well an algorithm distinguishes between positive and negative. The discrimination is poor if DP < 1, limited if DP < 2, fair if DP < 3, and good in other cases.

III. Results

A. T-Test Analysis

Cronbach's α values > 0.95 for the four constructs indicated that the data were consistent. Of the 200 students, 90 (45%) reported less PA, and the remaining 110 (55%) stated that they engage in PA at least three times per week. Of the respondents, 125 (62.5%) reported not being very fearful, whereas 75 (37.5.5%) reported feeling fear of crime. The independent two sample t-test was applied to compare these two groups of respondents for the 10 independent variables (Table II). The respondents who participated in less PA gave higher scores for concerns about access to destinations, neighbourhood safety (crime), and roadside trees and green spaces, whereas students with higher active levels worried about street connectivity, neighbourhood infrastructures, recreation facilities, facades of sidewalks, and aesthetics. Statistically significant ($p < 0.05$) results supported hypotheses H1, H2, H3, H5, H7, H8, H9, and H10 but not H4 and H6.

TABLE I
BASIC MATRIX FOR COMPARISON COMPUTATION

Class/Recognized	as positive	as negative
Positive	tp	fn
Negative	fp	tn

B. Binary Logistic Analysis

The binary logistic regression is used when the dependent variable is dichotomous and the independent variables are of any type. In this study, the dependent variable had two measurements (i.e., student respondents who were more active (1) and those respondents who were less active (0)). The model was first applied without the mediating variable (fear of crime), but it subsequently was added to the model. In the first case, the binary logistic analysis with the 10 independent revealed that the Nagelkerke R2 value was 0.198 ($p < 0.05$), and the overall correct classification was 84%. However, the Wald Chi-square statistic showed that the neighbourhood infrastructures, neighbourhood safety (crime), recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics were statistically significant (Table III). With the introduction of fear of crime as a mediator, the Nagelkerke R2 value increased slightly to 0.217, and the overall correct classification increased to 86%. Thus, fear of crime was significant as a mediating variable and could be included in the framework.

C. Discriminant Analysis

The discriminant analysis was applied to explore simultaneously the differences between the two groups of the dependent variable, namely students who were more or less active. As for the binary logistic regression model, discriminant analysis with and without the mediating variable of fear of crime was conducted. The mediating variable can be analysed in discriminant analysis as described in Table IV. The Wilks' Lambda scores for the discriminant function were between 0.84 and 0.98 for the 10 independent variables and were found to be statistically significant. Roadside trees and green spaces and recreation facilities had the smallest values, which means that they contributed more to the discriminant function. Overall, the Wilks' Lambda for the model was 0.86 ($p < 0.01$).

D. Comparison between Binary Logistic Analysis and Discriminant Analysis

The results of discriminant analysis and binary logistic regression analysis did not coincide. Therefore, Youden's

index, DP, and likelihoods were tested to identify which analysis fit the models better.

The Youden's index values for the binary logistic regression analysis and the discriminant analysis were 0.48 and 0.53, respectively. Therefore, the discriminant analysis had greater power. For the likelihood calculations, A = results from the discriminant analysis and B = results from the binary logistic regression analysis. The calculations produced the following results: $P^{+}_{A} = 3.6$, $P^{-}_{A} = 0.36$ and $P^{+}_{B} = 5.2$ and $P^{-}_{B} = 0.4$. Therefore, $P^{+}_{A} < P^{+}_{B}$ and $P^{-}_{A} < P^{-}_{B}$ implies that the discriminant analysis was superior for confirmation of negative examples. This means that discriminant analysis was superior for the respondents whose children were less active. In contrast, the binary logistic regression analysis was superior for classifying the respondents whose children were more active. Furthermore, the DP for discriminant analysis was 1.84, whereas it was 1.97 for the binary logistic analysis. This result means that both analyses fell into the limited category. Tables V and VI show the new classification results and the summary of the model power comparisons, and they suggest that the discriminant model was marginally superior to the binary logistic regression model. However, it should be noted that a higher accuracy does not guarantee an overall better performance of an algorithm. The performance of the model is based on a combination of measures to give a balanced evaluation.

IV. Discussion and Conclusions

This study investigated the effects of perceptions of neighbourhood walkability on PA among young people in Malaysia. Research in this area is lacking, thus this study was undertaken to fill the gap in the literature. More than 55% of the student respondents reported high PA levels. The research objective of this study was to examine the factors that influence this level of PA. The independent two sample t-test revealed that students who were more active gave high scores to independent and mediator variables such as street connectivity, neighbourhood infrastructures, recreation facilities, facades of sidewalks, and aesthetics, and the scores were highly statistically significant. In addition, two multivariate statistical techniques (discriminant analysis and binary logistic regression analysis) were applied to identify factors that might contribute to the reduction in PA. These methods were applied to check the validity of the t-test and also to derive predictive inferences. Discriminant analysis showed that students were concerned about access to destinations, neighbourhood infrastructures, neighbourhood safety (crime), recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics, whereas the binary logistic analysis showed that students were concerned about neighbourhood infrastructures, neighbourhood safety (crime), recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics.

These results indicate that concern about road traffic had no influence on the degree of youth PA, although this factor was important in the studies reported by [34] and [26]. However, concern about neighbourhood safety (crime) affected PA, which is in agreement with results of the study reported by [35]. Students' concerns about recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics were the main factors influencing young people's PA in this study.

The mediating variable, fear of crime, was also tested using both statistical methods and was found to be significant. This is consistent with the opinions of [36] and [37]. The two statistical methods were then evaluated for their model power by using Youden's Index, likelihoods, and discriminant power. The discriminant model was slightly superior to the binary logistic regression model. Recreation facilities, facades of sidewalks, roadside trees and green spaces, and aesthetics were found to be statistically significant in both analyses and should be emphasized when devising ways to achieve increased levels of PA among youth. The other factors, such as neighbourhood safety (traffic), street connectivity, and walking/cycling facilities were not highly significant because of their low importance as perceived by the respondents.

TABLE II
Results of the Two Sample Independent T-Test

Independent variables		Consumer practice			
		Less activity a (n1=90)	More activity a (n2=110)	t-statistic	p-value
1. NEWS	1.1. Access to destinations	2.87 ± 0.70	2.63 ± 0.71	2.11	0.036
	1.2. Street connectivity	3.13 ± 0.96	3.54 ± 1.01	2.62	0.009
	1.3. Neighbourhood infrastructures	2.86 ± 1.36	3.31 ± 1.28	2.05	0.040
	1.4. Neighbourhood safety (traffic)	3.14 ± 1.02	3.44 ± 1.09	1.81	0.071
	1.5. Neighbourhood safety (crime)	2.70 ± 0.84	2.03 ± 0.72	5.11	0.000
	1.6. Walking/cycling facilities	3.14 ± 1.02	3.44 ± 1.09	1.81	0.071
	1.7. Recreation facilities	2.86 ± 1.36	3.31 ± 1.28	2.06	0.039
2. Street characteristics Neighbourhood Design	2.1. Facades of sidewalks	2.86 ± 1.36	3.31 ± 1.28	2.05	0.041
	2.2. Roadside trees and green spaces	2.70 ± 0.84	2.03 ± 0.72	5.12	0.000
	2.3. Aesthetics	2.87 ± 1.35	3.31 ± 1.24	2.07	0.043

a: Mean ± SD (standard deviation) on times of PAs per week

Overall, students who were more active gave high scores to independent and mediator variables such as street connectivity, neighbourhood infrastructures, recreation facilities, facades of sidewalks, and aesthetics, whereas students in the less active group were influenced by access to destinations, neighbourhood safety (crime), and roadside trees

and green spaces. The local authorities or media may report these variables affected PAs in their messages to the public to create more awareness about the benefits of PA on youth health and related institutions attend to reform neighbourhood built environments features which affect an increase of PA. Further research is required to tease out associations between real and perceived crime-related safety and PA. Ideally, future studies should include behaviour and crime-specific measures and address the moderating role of the social and built environments.

TABLE III
RESULTS OF BINARY LOGISTIC REGRESSION MODELS

Independent variables		Model 1 Without mediating variable			Model 2 With mediating variable		
		Exp (B)	Wald x2	p-value	Exp (B)	Wald x2	p-value
1. NEWS	1.1. Access to destinations	0.77	1.00	0.31	0.76	1.14	0.27
	1.2. Street connectivity	1.21	1.21	0.27	1.12	0.45	0.49
	1.3. Neighbourhood infrastructures	0.35	15.45	0.00	0.32	15.32	0.02
	1.4. Neighbourhood safety (traffic)	1.21	1.21	0.25	1.13	0.45	0.49
	1.5. Neighbourhood safety (crime)	0.37	15.41	0.00	0.37	15.53	0.00
	1.6. Walking/cycling facilities	1.13	0.82	0.36	1.00	0.00	0.98
	1.7. Recreation facilities	0.37	15.45	0.00	0.34	15.41	0.05
2. Street characteristics Neighbourhood Design	2.1. Facades of sidewalks	0.37	15.44	0.00	0.37	15.57	0.03
	2.2. Roadside trees and green spaces	0.38	15.43	0.00	0.38	15.55	0.00
	2.3. Aesthetics	0.37	15.47	0.00	0.37	15.53	0.00
Mediator	Fear of crime				1.43	2.80	0.04

Dependent variable: Youth PAs (less activity = 100; more activity = 100)

TABLE IV
RESULTS OF DISCRIMINANT ANALYSIS

Independent variables		Model 1 Without mediating variable		Model 2 With mediating variable	
		Wilks' Lambda	p-value	Wilks' Lambda	p-value
1. NEWS	1.1. Access to destinations	0.98	0.04	0.98	0.04
	1.2. Street connectivity	0.98	0.07	0.98	0.07
	1.3. Neighbourhood infrastructures	0.99	0.04	0.99	0.05
	1.4. Neighbourhood safety (traffic)	0.99	0.07	0.99	0.08
	1.5. Neighbourhood safety (crime)	0.87	0.00	0.87	0.00
	1.6. Walking/cycling facilities	0.98	0.07	0.98	0.07
	1.7. Recreation facilities	0.84	0.00	0.84	0.00
	2.1. Facades of sidewalks	0.86	0.00	0.86	0.00
2. Street characteristics Neighbourhood Design	2.2. Roadside trees and green spaces	0.84	0.00	0.84	0.00
	2.3. Aesthetics	0.87	0.00	0.87	0.00
	Fear of crime			0.97	0.01

Dependent variable: Youth PAs (less activity = 148; more activity = 52)

TABLE V
NEW CLASSIFICATION RESULTS

Measure	Discriminant analysis	Binary logistic analysis
Youden's index (P)	0.53	0.48
P+	3.6	5.2
P_	0.36	0.4
DP	1.84	1.97

TABLE VI
MODEL POWER COMPARISON

Model	Youden's index	Likelihoods	Discriminating power
Discriminant	Superior	Superior for negative category	Limited
Binary logistic	Inferior	Superior for positive category	Limited

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