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ORIGINAL ARTICLE

The linkage of perceived neighbourhood environmental safety with travel-time and leisure-time physical activity in adults

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ABSTRACT

BACKGROUND

Having the highest obesity prevalence and physical inactivity among its South East Asian counterparts, it is important for Malaysia to understand the factors contributing to this epidemic. Because low neighbourhood safety is linked to physical inactivity, the objective of this study was to explore perceived neighbourhood safety from traffic and crime with its effects on adults' travel- and leisure-time physical activities.

METHODS

This cross-sectional study was conducted on 256 adults. Six items on a 4-point Likert scale from the Neighbourhood Environment Walkability Scale (NEWS) and WHO's GPAQ questionnaires to record weekly minutes of physical activity were used to measure the variables. Forty-three neighbourhoods from Johor Bahru district were categorised into higher and lower socio-economic status by median housing price per square feet. Structural equation modelling (SEM) was used to analyse the data.

RESULTS

Among 256 adults, males were found to be more physically active than females. SEM showed that for every 1 unit increase in neighbourhood socioeconomic status, males' perceived neighbourhood environmental safety increases by 0.23 unit (p=0.006); however, this does not explain their physical activities. For the females, regardless of neighbourhood socioeconomic status, every 1 unit increase in perceived neighbourhood environmental safety from traffic and crime encourages physical activity to increase by 0.47 unit (p=0.006), especially for leisure purposes. Both genders perceived that street lighting at night and pedestrian visibility are important safety features of the neighbourhood environment.

CONCLUSION

The study outcomes facilitate understanding of causal factors of physical activity through perceived neighbourhood environmental safety, especially among females.

Keywords: Neighbourhood environment safety, neighbourhood socioeconomic status, physical activity, gender, adult

INTRODUCTION

According to the World Health Organization (WHO), physical inactivity can be detected when a person's total metabolic equivalent of task-minutes per week (MET-minutes/week) for physical activity is less than 600 METs.[1] Physical inactivity is closely linked to increased obesity prevalence and higher risk of contracting non-communicable diseases [2] as evidently demonstrated by Malaysia over the past two decades.[3] The association between neighbourhood environments and physical activity has long been established,[4] especially in other countries,[5] where both self-reported and objectively measured environmental characteristics showed consistent results in influencing physical activity.[6,7]

On many occasions, perceived neighbourhood safety from crime [8-10] and from traffic [8,9,11,12] have been significantly linked to influencing physical activity among adults, especially walking. However, there are also studies which have reported differing results,[13,14] making the aforementioned relationship inconclusive. Additionally, there has been a rise in evidence showing that inhabitants of lower neighbourhood socioeconomic status often have lower physical activity levels, especially for leisure purposes as exemplified by Sasaki et al.[15] The latter study concluded that neighbourhood characteristics are associated with physical activity, and this relationship can be influenced by the socioeconomic status of a neighbourhood. This conclusion is supported by Sallis et al.,[16] who imply that neighbourhood socioeconomic status is a potential predictor of neighbourhood safety, and this in return dictates health behaviours such as physical activity.

Furthermore, gender difference also plays an important role when estimating perceived neighbourhood environments and physical activity.[17,18] This situation is more pronounced among females, whereby when this cohort for example has low perceived safety from crime, it reportedly has lower physical health than has another with higher perceived safety.[19] Evidence from Malaysia highlights that moderate to vigorous physical activities, especially for leisure time purposes, can be significantly associated with the gender of a person.[3] The latter study and one other study also done in Malaysia consistently found that males were more physically active than females, putting the latter at higher health-related risks.[20]

As stressed by Cai et al.,[3] the constructs of physical activity in developing countries such as Malaysia are still indistinct, partly due to the fact that nearly all studies linking aforementioned variables were conducted outside of the South East Asian region. Hence, there is a need to estimate such relationship especially in Malaysia, as it is one of the top countries with over 60% of physically inactive inhabitants compared to the rest of the world.[3] Understanding whether or not the perceived neighbourhood safety (traffic and crime) under different neighbourhood socioeconomic status (NSES) is a predictor of male and female physical activity within the Malaysian setting is important as it provides valuable insight to the estimation based on a culturally, environmentally and socially different setting than that of western countries.

Based on a systematic literature review on the neighbourhood built environmental attributes that encourage active mobility among adults,[22] it was noted that the choice of geographic units in measuring people's perceptions toward their surrounding living area is an important determinant of the result outcome. The review found that the use of area demarcation by local administrative boundaries is one of the geographical measurement units used. It is regarded as a feasible unit of measurement for neighbourhood contextual studies because it reduces the mismatch in relational outcomes by being able to differentiate between areas of different socio-economic status.

As such, the present study hypothesised that neighbourhood socioeconomic status influences an individual's perceived neighbourhood environmental safety from traffic and crime, and that subsequently this perception has a direct effect towards physical activity level by gender. Therefore, the objective of this study was to determine the association between neighbourhood environmental safety as perceived by Malaysian adults, and their physical activities for leisure and travelling purposes, categorised based on their neighbourhood socioeconomic status.

METHODS

Research design

This cross-sectional study was performed in the urban areas of Malaysia, where four main conurbations in the country were initially identified, i.e. Kuala Lumpur, Georgetown, Kuantan and Johor Bahru. Through simple random sampling, Johor Bahru was selected as the

study area. Data was then collected between July and October 2022.

Research subjects

Based on the *a-priori* sample calculation,[23,24] with 2 latent variables, 10 manifest variables, effect size of 0.2, statistical power level of 0.8 and probability level of 0.05, a minimum sample size of at least 223 was needed. Six enumerators were engaged to conduct the face-to-face surveys by selecting one subject per house based on the eligibility criteria of being more than 18 years old, not pregnant, not disabled, and have been residing in their places of residence for at least 3 years. From the eligible respondents, the exclusion criteria included having illness that causes one not being able to do physical activity as a normal healthy person. Using simple random sampling, a total of 256 adults living in the Johor Bahru district were selected, who agreed to participate in the study.

First order dependent variables: travel- and leisure-time physical activities

The respondents' physical activities for travel and leisure were gauged through the Global Physical Activity Questionnaire (GPAQ) as recommended by the WHO. For the purpose of the study, the workplace and sedentary behaviour parts of the original questionnaire were excluded. The GPAQ analysis guidelines state that 1 metabolic equivalent of task (MET) is assumed to be used by a resting or sedentary individual, 4 METs is assumed to be used by a moderately active individual, and 8 METs is assumed to be used by a vigorously active individual. As the GPAQ intends to measure an individual's physical activity on a weekly basis, the subject's active day(s) per week and minutes per day is recorded and multiplied by the METs assigned. Thus, 3 categories were introduced i.e. vigorously active (more than 3001 MET-minutes per week), moderately active (601 to 3000 MET-minutes per week) and sedentary (less than 600 MET-minutes per week).

First order independent variables: perceived safety from traffic and crime

Sub-scales for perceived safety from traffic and perceived safety from crime were derived from the Neighbourhood Environment Walkability Scale (NEWS) questionnaire introduced by Saelens et al.[25] The overall questionnaire has been validated in Malaysia [26] and other Asian countries including Hong Kong [27] and India.[28] As the scope of this study was to focus on the perceived safety of the physical-related features in a neighbourhood, some questions which do not conform to the scope were excluded. As such, only 3 questions from perceived traffic safety (traffic condition, traffic speed and air pollution), as well as 3 questions from perceived crime safety (lighting quality at night, pedestrian visibility and social interaction), were retained in this study. Also, a 4-likert scale i.e. strongly agree, agree, disagree and strongly disagree, was used as the answering range. It was noted that the 3 questions on safety from traffic were negatively phrased, hence, data coding was reversed so as to avoid having negative values; while the remaining 3 questions on safety from crime were positively phrased, hence data coding was retained as is.

Questionnaire reliability was achieved when Cronbach's alpha values for the questions were adequate (0.612 – 0.875) and when none of the items had a communalities issue by having a value of more than 0.30. The Kaiser-Meyer-Olkin (KMO) value was 0.851, while the Bartlett's Test of Sphericity significance value of 0.000 indicates that the output from this data set is meaningful, with 1 factor extracted accounting for 60.613% of total variance explained. As such, the 6 items which were loaded together under the same factor are named 'perceived neighbourhood environmental safety' from here onwards.

Second order dependent variable: neighbourhood socioeconomic status

Subjects were sampled from 43 urban neighbourhoods in the district of Johor Bahru, Johor, Malaysia; 21 lower neighbourhood socioeconomic status and 22 higher neighbourhood socioeconomic status areas stratified by median housing price per square feet. Neighbourhood socioeconomic status was derived by asking subjects to report the name of the street they were living in and the neighbourhood name. This information was then cross checked on the *www.brickz.com.my* website [29] for respective median property values based on the latest transactions as reported by the Valuation and Property Services Department of Malaysia. In November 2022, the median housing price per square feet in Johor Bahru was Ringgit Malaysia (RM) 342. Hence, neighbourhoods with median housing price per square feet above RM342 were categorised as higher NSES, while those that were below that price were categorised as lower NSES. These 43 neighbourhoods have a good mix of

housing types including bungalow, semi-detached, terrace, townhouse, apartment, and condominium.

Statistical analysis

Descriptive statistics and exploratory factor analysis (EFA) were calculated by using the Statistical Package for Social Science (SPSS) for Windows, version 22.0. Assumptions were checked for the data set whereby there were no missing cases, no multicollinearity and no homoscedasticity issues found, except that the variable of 'race' was non-linear. As such, the 'race' variable was eliminated from further analysis. There were 12 outliers detected, but because there was no justification for their removal, these cases were retained. Next, confirmatory factor analysis (CFA) was conducted to establish construct validity of latent variables (perceived neighbourhood environmental safety factor) and respective manifest variables.

Then the predictor variable i.e. neighbourhood socioeconomic status, the outcome variable i.e. physical activity, as well as the confounding variables i.e. sociodemographic characteristics, were added into the model at the Structural Equation Modelling (SEM) stage. The direct effects between the variables were tested for the groups of male and female gender. Both CFA and SEM were conducted using IBM SPSS AMOS (AMOS) version 23.0, with Maximum Likelihood Estimator using a 95% confidence interval. The model fit indices referred to were χ^2 (CMIN), degrees of freedom (df), relative χ^2 (CMIN/df), comparative fit index (CFI), Tucker-Lewis Index (TLI) and root mean square error of approximation (RMSEA). Values indicating a good model fit are that CMIN/df should not be more than 5; CFI should be closer to 1; TLI should be closer to 1 and RMSEA should not be more than 0.08.

RESULTS

Sample characteristics

The study has a total of 256 subjects (Table 1). The mean age of the subjects was 34 ± 12.6 years, most subjects were male (n=151, 59%), of Malay ethnicity (n=128, 50%), had highest education at tertiary level (n=128, 50%) and had monthly household income of RM5001-RM7000 (n=77, 30%). Overall, there was more participation from subjects living in lower NSES (n=177, 69%) than from those in higher NSES (n=79, 31%). The mean MET-minutes per week of subjects' physical activity was 93 ± 428 for travel and 464 ± 944 for leisure, which can be categorised as being sedentary or inactive.

Indicators of perceived neighbourhood environmental safety

Individual CFA of perceived neighbourhood environmental safety is shown in Table 2. All 6 items of perceived neighbourhood environmental safety were established as valid indicators for the factor. For the first 3 questions on safety from traffic, the majority of subjects agreed to the statements of 'there is so much traffic along the street I live on that it makes it difficult or unpleasant to walk in my neighbourhood' (n=74, 29%) and 'when walking in my neighbourhood, there are a lot of exhaust fumes' (n=69, 27%). However, about 82 respondents (32%) disagreed that most drivers exceed the posted speed limits while driving in their neighbourhoods. On the other hand, for safety from crime, most subjects unanimously agreed that the streets in their neighbourhoods are well lit at night (n=87, 34%), walkers and bikers on their neighbourhood streets can be easily seen by people in their homes (n=82, 32%), as well as they see and speak to other people when they are walking in their neighbourhoods (n=79, 31%).

Neighbourhood socioeconomic status, perceived neighbourhood environmental safety and physical activity by gender

The structural equation modelling of the neighbourhood socioeconomic status, perceived neighbourhood environmental safety and physical activity by gender was drawn using the validated construct established during CFA. Upon inserting age, income and highest education level as controls in the model, none of these sociodemographic variables were significant. As such, these variables were excluded from the final model. Later, the achievement of structural model fitness adequacy was established (χ^2=79.621, df=66, χ^2/df=1.206, TLI=0.976, CFI=0.983, RMSEA=0.029). At 95% confidence interval level, the significant direct effects are presented in bold lines, while the nonsignificant direct effects are presented in dotted lines.

Table 1. Distribution of socio-demographic characteristics, neighbourhood socio-economic status and physical activity by gender (n=256)

Age (years)	Proportion distribution by gender		
	Overall	**Male (*n*= 151, 59%)**	**Female (*n*=105, 41%)**
	34 ±12.6	**33 ±12.0**	**35 ±13.4**
Race, n			
Malay	128	84	44
Chinese	82	40	42
Indian	41	25	16
Others	5	2	3
Education, n			
Primary	49	38	12
Secondary	79	51	26
Tertiary	128	62	67
Household Income, n			
≤RM3000	25	17	11
RM3001-RM5000	54	41	13
RM5001-RM7000	77	48	27
RM7001-RM10000	54	24	29
≥RM10001	46	21	25
Neighbourhood socioeconomic status, n			
Lower	177	109	67
Higher	79	42	38
Physical Activity, mean MET-minutes /week			
Leisure	464 ± 944	552 ± 428	333 ± 638
Travel	93 ± 428	113± 525	62 ± 212

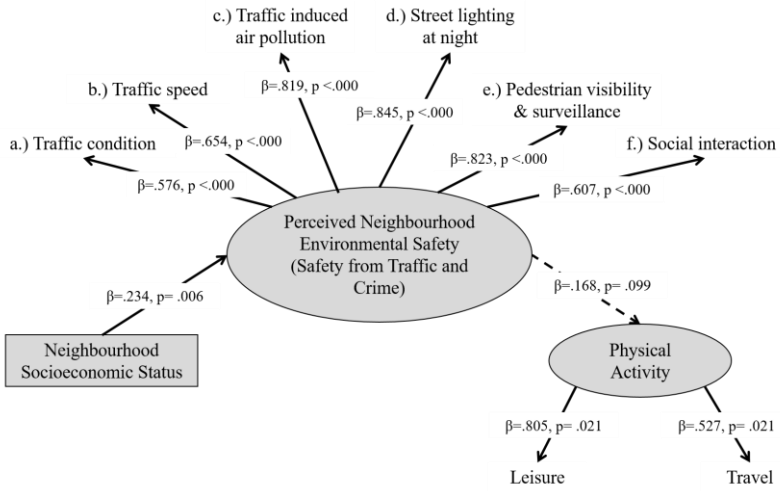
Data presented as n, except for age and physical activity (Mean ± SD)

Table 2. Confirmatory factor analysis of latent variables for perceived safety

Latent variable	Factor loading		
	β	**Estimate**	**p value**
Perceived neighbourhood environmental safety			
There is so much traffic along the street I live on that it makes it difficult or unpleasant to walk in my neighbourhood	0.523	0.625	<0.000
Most drivers exceed the posted speed limits while driving in my neighbourhood	0.664	0.772	<0.000
When walking in my neighbourhood, there are a lot of exhaust fumes (such as from cars, buses)	0.767	0.941	<0.000
My neighbourhood streets are well lit at night	0.837	0.988	<0.000
Walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes	0.820	1.000	<0.000
I see and speak to other people when I am walking in my neighbourhood	0.663	0.785	<0.000

Model fit= chi-square indexes CMIN: 16.103, df: 8, CMIN/df: 2.013, TLI: 0.979, CFI: 989, RMSEA: 0.063
Path Coefficients= β: Standardised Regression Weight, p value: significance at 95% confidence interval, CMIN: χ^2, df: degrees of freedom, CMIN/df: relative χ^2, TLI: Tucker-Lewis index, CFI: comparative fit index, RMSEA: root mean squared error associated

Under the perceived neighbourhood environmental safety factor, the indicators most influenced by neighbourhood socioeconomic status were 'my neighbourhood streets are well lit at night' (β=0.845, p<0.000), followed by 'walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes' (β=0.823, p<0.000), and 'when walking in my neighbourhood, there are a lot of exhaust fumes' (β=0.819, p<0.000). In other words, males tend to perceive that neighbourhoods of higher socioeconomic status have better street lighting at night, better pedestrian surveillance from home and lower air pollution from traffic.

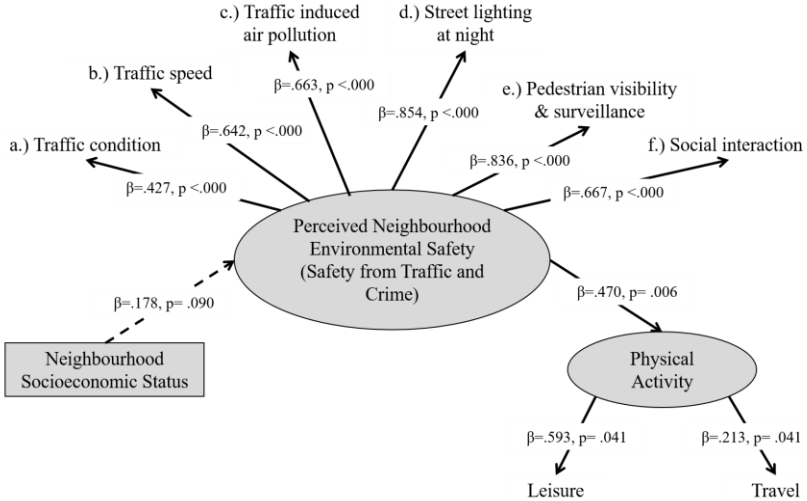


Path Coefficients: β= Standardised Regression Weight, r²= Squared Multiple Regression; Model fit: CMIN=79.621, df=66, CMIN/df=1.206, TLI=0.976, CFI=0.983, RMSEA=0.029

Figure 1. Structural equation modelling of neighbourhood socioeconomic status, perceived neighbourhood environmental safety and physical activity among males

For the female cohort (Figure 2), it is evident that their perceptions toward neighbourhood environmental safety do not differ by neighbourhood socioeconomic status, in other words, the relationship is nonsignificant (β=0.178, p=0.090). The perceived neighbourhood environmental safety however, was found to be positively associated with physical activity (β=0.470, p=0.006) among females. In other words, for every 1 unit increase in perceived neighbourhood environmental safety, the physical activity among females increases by 0.47 unit (47%). This relationship was moderately positive and was more pronounced for leisure time physical activity (β=0.593, p=0.041) compared to travel time physical activity (β=0.213, p=0.041). The most influential indicators of

eived neighbourhood environmental safety towards female physical activity were 'my neighbourhood streets are well lit at night' (β=0.854, p=0<000), 'walkers and bikers on the streets in my neighbourhood can be easily seen by people in their homes' (β=0.836, p<0.000), and 'I see and speak to other people when I am walking in my neighbourhood' (β=0.667, p<0.000).



Path Coefficients: β= Standardised Regression Weight, r²= Squared Multiple Regression
Model fit: CMIN= 79.621, df= 66, CMIN/df= 1.206, TLI= 0.976, CFI= 0.983, RMSEA= 0.029

Figure 2. Structural equation modelling of neighbourhood socioeconomic status, perceived neighbourhood environmental safety and physical activity among females

DISCUSSION

Gender differences in association with neighbourhood socioeconomic status, perceived neighbourhood environmental safety and physical activity have not been widely scrutinised in developing countries such as Malaysia, hence, the observed findings in the present study are of interest. This study supports the current Malaysian circumstance that males are more physically active than females. One possible reason for this occurrence, as clarified by Cai et al.[3] is that, for a Muslim predominant country such as Malaysia, females are found to be at a higher risk for physical inactivity than males due to the fact that vigorous physical activity seems inappropriate for females, especially in public areas. This finding is concurrent with the fact that Malaysian females have a higher obesity prevalence than males.[30] It is evident that males are more active in both leisure time and travel time physical activity compared to females. However, as a whole, the mean MET-minutes per week of the respondents' travel- and leisure-time physical activity showed that the average Malaysians are mostly sedentary or inactive. This is similar to the claims of previous studies done in Malaysia.[3,20]

It was found that among both genders, only female physical activity was positively influenced by perceived neighbourhood safety from traffic and crime. The females felt that having well-lit neighbourhood streets especially during night time is most likely to improve their rate of physical activity. It is evident as better street lighting not only reduces the risk of car crashes at night,[31] but strategically placed street lighting also increases the number of pedestrians at night, reduces crime and fear of crime altogether.[32] Next, residential layout plans should implement the principles of Crime Prevention through Environmental Design (CPTED) especially design features which increase neighbour visibility and surveillance as well as decreases traffic speed through traffic calming approaches,[33] so as to increase female perceived neighbourhood environmental safety.

Streetscape features and residential development layout plans are subjected to the approval of governmental agencies, including the town and country planning department. The decision makers in Malaysia, especially planners, should no come to realise the relevance of their work to public health.[34] The result of every development plan has the capability of exuding certain environmental characteristics, which then promotes or restricts community behaviours. This is evidently shown in this study whereby female physical activity can be influenced by perceived neighbourhood environmental safety; the effects of such planning decisions by local authorities on community physical activity are potentially large.

The findings of the study show that clinical study at the individual level should also take into consideration the community-level and neighbourhood-level externalities that have significant impacts on a person's physical activity level. This is crucial as pointed out by the WHO that frequent practice of physical activity is widely known to aid in the prevention and management of non-communicable diseases including but not limited to diabetes, heart diseases, and even certain types of cancers. Also, as males and females often exude differences in terms of disease prevalence, knowing the factors that can encourage or discourage physical activity by gender is important on a multi-disciplinary level.

The study does have its limitations in the sense that it only sampled adults living in urban areas. Studies have shown that children are also vulnerable and susceptible to being overweight and obese. To make matters worse, the habits that they have accumulated during childhood might persist into adulthood. Moreover, there are also indications that the rural inhabitants are facing the obesity epidemic as well. However, the rural cohort is always neglected in body weight-related studies that look into their physical activities. As such, it is highly recommended for future studies to consider children and also the rural dwellers when looking into similar subject matter.

CONCLUSION

Findings of this study shed some light on how health-related behaviours such as physical activity can be influenced by neighbourhood environmental characteristics, wherein this relationship can also change depending on individual level characteristics, especially gender. Health behavioural causal models such as the one presented in this study are helpful in the sense that it aids in shaping ideas and decisions for the development of future physical environmental public health policies. Apart from that, studies such as ours also provide a framework for identification of public health impacts before a development plan is approved in the future.

Conflict of Interest

The authors declare to have no known conflict of interests in the production of this paper.

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Author Contributions

NHHL: study conception, literature review, research design and methodology, data collection, data analysis and manuscript writing. RJ and MRM: study supervision, interpretation of the results and critical revisions of the manuscript content. TBT: manuscript writing and references formatting. NZA, LH and LSH: manuscript amendments, literature review, and writing. All authors have read and approved the final manuscript.

Data Availability Statement

Data is available from the corresponding author upon request.

Declaration of Use of AI in Scientific Writing

Nothing to declare.

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