

INFLUENCE OF PERCEIVED NEIGHBOURHOOD ENVIRONMENT AND HEALTH BEHAVIOURS ON BODY MASS INDEX

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DEDICATION

This thesis is dedicated to those who struggle to maintain a healthy weight.

It's not you. It's the environment.

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ABSTRACT

The obesity phenomenon in Malaysia is becoming increasingly worrying as it is closely linked to deteriorating health consequences. There has in fact been a significant growth in the literature identifying neighbourhood-level environment concerning food and built environment as influential factors of health-related outcomes. However, both of the environmental attributes mentioned have been rarely explored collectively in Malaysia to explain health behaviours and outcomes. Additionally, past studies tended to be based on objectively-measured data while ignoring subjectively-measured ones through self-reported perception of the environment. Self-reported perceptions were found to be as influential as objectively-gathered field data in studies of public health. As such, this study aimed to explain the obesity phenomenon through perceived neighbourhood environmental factors, health behaviours and Body Mass Index (BMI). Participants of the study comprised of 256 adults above the age of 18 years old in the district of Johor Bahru, Johor from 22 higher and 21 lower socioeconomic status neighbourhoods selected using the stratified random sampling technique. Data were collected via a 107 question-item questionnaire administered face-to-face with the assistance of six qualified enumerators. The data were analysed using Statistical Package for Social Sciences version 22.0 (SPSS v.22) and IBM SPSS Amos version 23.0 (AMOS v.23). Confirmatory Factor Analysis was then used to produce the measurement model, while Structural Equation Modelling was used to compute the causal model due to its suitability for quantifying latent variables. Analysis of the data revealed that the causal model linking perceived neighbourhood environment, health behaviours and BMI was a good fit ($\chi^2= 2164.5$, $df= 1356$, $\chi^2/df= 1.596$, $TLI= .903$, $CFI=.914$, $RMSEA=.048$). Both Perceived Neighbourhood Food Environment (PNFE) ($\beta= -.303$, $r^2= .092$) and Perceived Neighbourhood Built Environment (PNBE) ($\beta= -.208$, $r^2= .043$) were found to have significant direct effects on BMI. Consistent with past studies, the former had a higher influence on BMI. As expected, Diet Quality (DQ) ($\beta= -.142$, $r^2= -.142$) and Physical Activity (PA) ($\beta= -.169$, $r^2= -.169$) were significantly associated with BMI as weight is basically the result of energy intake and energy expenditure. Other variables influencing BMI includes monthly household income, gender and education level. The study also found that full mediation was observed when PNFE and PNBE were tested as mediators between the relationship of DQ and PA to BMI. This suggests that the environmental factors were highly significant as predictors of BMI, warranting further exploration in future studies. Subsequently, a causal model explaining the obesity phenomenon from the aspects of perceived neighbourhood environment and health behaviours was developed. The model exemplifies the intimate implications that urban and regional planning has on public health. This study serves as a basis for inter-sectoral future research by linking more environmental-related variables to public health.

ABSTRAK

Fenomena obesiti di Malaysia menjadi semakin membimbangkan kerana ia berkait rapat dengan kesihatan. Terdapat hubungan yang signifikan dalam kajian lepas yang mengenal pasti persekitaran tahap kejuruan, terutamanya persekitaran makanan dan alam sekitar sebagai faktor penting yang mempengaruhi kesihatan. Walau bagaimanapun, kedua-dua faktor tersebut jarang dikaji secara kolektif di Malaysia dalam menjelaskan tabiat kesihatan. Di samping itu, kajian lepas cenderung menggunakan data yang dikumpul secara objektif dan mengabaikan persoalan subjektif melalui persepsi persendirian terhadap persekitaran. Persepsi persendirian di dapati mempunyai pengaruh yang standing dengan data yang dikumpul secara objektif dalam kajian kesihatan awam. Oleh itu, kajian ini bertujuan untuk menjelaskan fenomena obesiti melalui persepsi persekitaran kejuruan, tabiat kesihatan dan Indeks Jisim Badan (BMI). Peserta kajian terdiri daripada 256 orang dewasa berumur 18 tahun ke atas di daerah Johor Bahru, Johor dari 22 kawasan kejuruan bersosioekonomi tinggi dan 21 kawasan kejuruan bersosioekonomi rendah yang dipilih berdasarkan teknik persampelan rawak berstrata. Data dikumpul melalui 107 soalan soal selidik yang diberi secara bersemuka dengan bantuan enam orang pembanci berkelayakan. Data dianalisis dengan menggunakan Pakej Statistik untuk Sains Sosial versi 22.0 (SPSS v.22) dan IBM SPSS Amos versi 23.0 (AMOS v.23). Analisis Faktor Pengesahan kemudiannya digunakan untuk menghasilkan model pengukuran, manakala Model Persamaan Struktur digunakan untuk menghasilkan model penyebab kerana kesesuaiannya untuk mengkuantifikasi pemboleh ubah terpendam. Analisis data menunjukkan bahawa model penyebab berkaitan persepsi persekitaran kejuruan, tabiat kesihatan dan BMI adalah baik ($\chi^2 = 2164.5$, $df = 1356$, $\chi^2 / df = 1.596$, $TLI = .903$, $CFI = .914$, $RMSEA = .048$). Kedua-dua Persepsi Persekitaran Makanan Kejuruan (PNFE) ($\beta = -.303$, $r^2 = .092$) serta Persepsi Persekitaran Alam Bina Kejuruan (PNBE) ($\beta = -.208$, $r^2 = .043$) di dapati mempunyai kesan langsung yang signifikan terhadap BMI. Selaras dengan dapatan kajian lepas, PNFE mempunyai pengaruh yang lebih tinggi terhadap BMI. Seperti yang dijangkakan, Kualiti Pemakanan (DQ) ($\beta = -.142$, $r^2 = -.142$) dan Aktiviti Fizikal (PA) ($\beta = -.169$, $r^2 = -.169$) di dapati berkait rapat dengan BMI kerana berat badan seseorang pada dasarnya merupakan hasil daripada pengambilan dan pengeluaran tenaga. Pemboleh ubah lain yang mempengaruhi BMI termasuk pendapatan isi rumah bulanan, jantina dan tahap pendidikan. Kajian ini juga mendapati bahawa pengantara penuh telah di dapati apabila PNFE and PNBE diuji sebagai pengantara kepada hubungan DQ dan PA kepada BMI. Ini menunjukkan bahawa faktor persekitaran sangat penting dalam mempengaruhi BMI, menjamin kajian selanjutnya pada masa akan datang. Seterusnya, model penyebab yang menjelaskan fenomena obesiti dari aspek persekitaran kejuruan dan tabiat kesihatan telah dibangunkan. Model ini membuktikan hubungan rapat antara perancangan bandar dan kesihatan awam. Kajian ini berfungsi sebagai asas penyelidikan pada masa akan datang dalam pelbagai bidang dengan menghubungkan pemboleh ubah yang berkaitan dengan persekitaran terhadap kesihatan awam.

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LIST OF ACRONYMS

AGFI	-	Adjusted Goodness-of-Fit Index
AMOS	-	Analysis of Moment Structures
ANOVA	-	Analysis of Variance
AVE	-	Average Variance Extracted
BMI	-	Body Mass Index
CA	-	Component Analysis
CFA	-	Confirmatory Factor Analysis
CFI	-	Comparative Fit Index
CI	-	Confidence Interval
CLF	-	Common Latent Factor
CMB	-	Common Method Bias
CPTED	-	Crime Prevention Through Environmental Design
CR	-	Composite Reliability
DQ	-	Diet quality
DQI-FFQ	-	Diet Quality Index – Food Frequency Questionnaire
FFQ	-	Food Frequency Questionnaire
GFI	-	Goodness-of-Fit Index
GIS	-	Geographical Information System
GoF	-	Goodness-of-Fit
GPAQ	-	Global Physical Activity Questionnaire
HEI	-	Healthy Eating Index
HIA	-	Health Impact Assessment
JPPH	-	Valuation and Property Services Department of Malaysia
KM	-	Key Message
KR	-	Key Recommendation
MANS	-	Malaysian Adult Nutrition Survey
MD	-	Mahalanobis Distance
MDG	-	Malaysian Dietary Guidelines
MFP	-	Malaysian Food Pyramid

MI	-	Modification Indices
NEWS	-	Neighbourhood Environmental Walkability Scale
NCD	-	Non-communicable Disease
NNP	-	National Nutrition Policy
NSES	-	Neighbourhood Socioeconomic Status
PA	-	Physical activity
PCA	-	Principal Component Analysis
PFA	-	Perceived Food Affordability
PFSA	-	Perceived Food Store Type Availability
PGFA	-	Perceived Geographical Food Store Accessibility
PHFA	-	Perceived Healthy Food Availability
PLMA	-	Perceived Land Use Mix Accessibility
PLMD	-	Perceived Land Use Mix Diversity
PNFE	-	Perceived Neighbourhood Food Environment
PNBE	-	Perceived Neighbourhood Built Environment
PRD	-	Perceived Residential Density
PSA	-	Perceived Surrounding Aesthetics
PSC	-	Perceived Street Connectivity
PSCT	-	Perceived Safety from Traffic and Crime
PWCF	-	Perceived Walking and Cycling Facilities
RM	-	Ringgit Malaysia (Malaysian Ringgit)
RMSEA	-	Root Mean Square Error of Approximation
SD	-	Standard Deviation
SEM	-	Structural Equation Modelling
SPSS	-	IBM Statistical Package for Social Sciences
TLI	-	Tucker-Lewis Index
UTM	-	Universiti Teknologi Malaysia
U. S.	-	United States
VIF	-	Variance Inflation Factor
WHO	-	World Health Organisation

LIST OF SYMBOLS

df	-	Degrees of freedom
χ^2/df	-	Relative Chi-square
χ^2	-	Chi-square
β	-	Standardised Regression Weights
r^2	-	Squared Multiple Correlations
p	-	Probability value
H_0	-	Null Hypothesis
H_1	-	Alternative Hypothesis

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Chapter 1 demonstrates the need for a study which considers neighbourhood level environmental factors and its association with public health outcomes when predicting body mass index (BMI). The current worrying health-related issues in Malaysia such as increasing obesity rate, unhealthy diet quality and low physical activity level are evident through the presentation of several statistical data relevant to the study. Due to its importance, as highlighted by the Ministry of Health Malaysia, environmental variables linking diet-based and health-based outcomes were presented to reveal the seriousness of the said issue. After which, the gap of research is outlined, along with the development of research questions, aim and objectives. Then it is followed by the scope of research and research assumptions. Lastly, the expected contributions, significance of research and also the research design are presented as well.

1.2 Research Background

The severity of the obesity issue is widely recognised as it does not only mean that a person is unable to function properly to carry out daily activities, it also indicates that the person is exposed to higher risks of developing chronic diseases. Although obesity is one of the risk factors prioritized in Malaysia (NSP-NCD, 2010), unfortunately Malaysia still finds itself as the fifth obese country among its Asian counterparts as of year 2013 (OECD 2013). In an effort to understand the epidemic, the Malaysian government has launched the National Health and Morbidity Survey (NHMS) in the year 1996, as a monitoring mechanism to track the trend of Malaysian's health. The results were worrying, as it is evident that there has been a steady increase in the percentage of obese and overweight adults throughout the years since 1996 (26.5%),

year 2006 (43.6%), year 2011 (44.5%) to year 2015 (47.7%). Moreover, result of Malaysian Adults Nutrition Survey 2009 has reported that people living in the Southern part of Malaysia, i.e. Johor, Melaka and Negeri Sembilan, showed significantly higher mean body weight, BMI, prevalent in both categories of being overweight obese compared to other geographical zones in Malaysia.



Figure 1.1 Percentage of adult population with body mass index of greater than 25 in Southeast Asia
 Source: World Health Organization (WHO), 2011

Hence, the Ministry of Health Malaysia put a stance in stressing on continuous health promotion and research to decrease the prevalence of Non-Communicable Diseases (NSP-NCD, 2010) due to obesity. Apart from that, the Malaysian Dietary Guidelines 2010 has come up with 14 Key Messages, in which, Key Message 1, 2 and 3 particularly stresses on keeping a good diet quality (KM1) ‘eat a variety of foods within your recommended intake’; sustaining a healthy body mass index (KM2) ‘maintain a good body weight within a healthy range’; as well as keeping the habit of being active (KM3) ‘be physically active everyday’.

Recognising the importance of the issue, there were non-clinical studies that were carried out in the Malaysian context with regards to diet-based and health-based outcomes. Those studies use the predictors of demographic factor (Fagerli and Wandel, 1999; Anuar Zaini *et al.*, 2005; Kee *et al.*, 2008; Azmi *et al.*, 2009; Norhasmah *et al.*, 2010; Hamid Jan *et al.*, 2011; Wan Nazaimoon *et al.*, 2011; Asma’ *et al.*, 2011; Cheong *et al.*, 2013), socio-economic factor (Zalilah *et al.*, 2000;

Norhasmah *et al.*, 2010), food and dietary factor (Yong *et al.*, 2009, Norhasmah *et al.*, 2010; Mohamad *et al.*, 2010; Hamid Jan *et al.*, 2011; Chua *et al.*, 2012; Poh *et al.*, 2012; Narimah *et al.*, 2012; Zainal Badari *et al.*, 2012; Ooi *et al.*, 2015; Nurliyana *et al.*, 2015; Fokeena *et al.*, 2016), knowledge factor (Poh *et al.*, 2012; Pang 2003; Pang *et al.*, 2003), psychosocial factor (Yong *et al.*, 2009; Lee *et al.*, 2012; Zalina *et al.*, 2012; Suzana *et al.*, 2013; Rezali *et al.*, 2015), built environmental factor (Hayati Adilin *et al.*, 2015) and physical activity factor (Zalina *et al.*, 2012; Poh *et al.*, 2010).

This shows that non-clinical research linking individual-level predictors in explaining obesity in Malaysia is on the rise. However, Epidemiology and Disease Control Division of the Ministry of Health Malaysia released a statement in 2017 stating that researchers and intervention programs established in Malaysia oftentimes face the problems of lacking inter-sectoral efforts and negligence of contextual facets. This problem is apparent, of all the related past research done in Malaysia, there is limited study done on predicting BMI and other health behaviours through neighbourhood level attributes such as the physical environment pertaining to the issue.

In recent years, linkages of the physical environment and public health has become more apparent and heavily researched in foreign countries. Every built environment, especially neighbourhood level planning is unique to its population and geographical location. The environment, whether within the context of a community, home, workplace or school, has been claimed to have contributions towards the obesity epidemic (Glanz *et al.*, 2005; Poh *et al.*, 2012; Vereecken *et al.*, 2004; Curtis *et al.*, 2011; Gross and Solomon, 2000). As a result, the composition of a neighbourhood level built environmental planning more often has induced implicit influence on the inhabitants' health, which can be explained through their behaviours of food consumption (energy intake) and physical activity (energy expenditure). Additionally, the neighbourhood socioeconomic status has also been found to have influence towards the characteristics of the built environment.

By definition, food or nutrition environment in its simplest form refers to the context where food activities happen, i.e. food purchase and consumption (Glanz *et*

al., 2005). On the other hand, built environment walkability refers to the degree to which an environment stimulates physical activities (Kent and Thompson, 2014). Hence ideally, a neighbourhood environment should have a healthy nutrition environment to encourage consumption of healthy foods, and a high environment walkability to encourage higher physical activity level. The combination of these two features is expected to produce healthy population. However, with an increasing rate of obesity in Malaysia especially in urban areas, it is imperative to identify the causes of this epidemic.

Often times, Malaysian food-related public health system focuses on researching vulnerable groups, such as adolescent, children, pregnant women and older adults, as well as those who are already contracted with diseases such as patients with diabetes and heart diseases. The wider range of the population who are “in between” (not sick nor extremely healthy) are under-studied. According to Rose (1992), profiles of the population should be applied when writing up new policies that are suitable for the ailment of that particular population. As such, understanding the profile of the population delivers more effective policies in producing preventative measures.

In line with the current issues highlighted, combined with government’s policies and recommendations, the study is expected to provide an insight to the occurrence of the obesity phenomenon by studying the influence of neighbourhood environmental factors toward health behaviours and health outcome.

1.3 Problem Statement

From the research background, it is understood that the increase in obese and overweight population needs to be addressed. Thus, the predictors of a person being obese and overweight should be understood first. Obesity and overweight are likely to occur when a person’s energy consumption is more than his or her energy expenditure, in other words, energy imbalance (Romieu *et al.*, 2017). Energy consumption in its simplest form is the amount of our food intake, while energy expenditure is the energy

used either to resume our normal daily activities and the energy used during physical exercises. These can be measured through daily caloric intake and calories burnt throughout the day, either when resting or doing vigorous workouts, or the combination of both. In order to be categorised as having a normal or healthy BMI, a person would have to be eating as much calories as he or she is burning. In other words, if a person is trying to lose weight, he or she should be consuming less energy than he or she is expending energy.

In order to understand why obesity and being overweight occurs, it is crucial to study the factors influencing a person's dietary intake and level of physical activities. Past research focusing on these issues suggests that neighbourhood environmental factors could have major contributions to a person's habitual behaviours, and this includes how a person eats and how he or she expends energy. Thus, it can be said that the neighbourhood food environment correlates with a person's dietary intake, which can be expressed as diet quality. On the other hand, the neighbourhood built environment influences a person's energy expenditure, i.e. level of physical activity. Studies linking health outcomes such as BMI and weight status, usually involves measuring a person's lifestyle activity level from sedentary to active as well as how the neighbourhood environment influences this.

It is interesting that Raja *et al.* (2010) found that, when considering both neighbourhood food environment and built environment together, the study reported that the former has a larger magnitude in predicting a person's BMI and weight status. It is to note that, the study used objectively measured data rather than subjects' self-reported perception. As an example, the nearest distance of food stores by type was computed using Geographical Information System (GIS). Moreover, it only included females in the study. Anyhow, the outcome of the study still sparked curiosity on how different characteristics of different environmental settings can influence health behaviours and BMI. As such, this study explored the usage of self-reported perception to see if the result concurs with that of Raja's.

Food-related health outcome studies in Malaysia were often found to be one of these groups; consumer food environment such as food advertising by Ng *et al.* (2015),

in-store food placement and food labels by Ambak *et al.* (2014); home food environment such as parental style by Chen and Kennedy (2004) and frequency of dining out by Zalilah and Lim (2013); as well as organisational food environment such as school canteen by Moy, Ying and Kassim (2006) and around workplace by Cheong *et al.* (2010).

This denoting an absence of geographical physical environment studies done in Malaysia. Literature review on past studies in Malaysia revealed that limited studies have been done in the area of determining the influence of neighbourhood-level food environment and built environment on a person's diet quality and level of physical activity simultaneously, and ultimately whether these factors affect a person's BMI. Although the issue of obesity and overweight can be explained through a nutrition- and health-based research linking environmental attributes (French *et al.*, 2001c; John and Eyzaguirre, 2002; Popkin *et al.*, 2005; Ball *et al.*, 2006; Sallis and Glanz, 2006), a path exploring the influence of neighbourhood-level food environment and built environment simultaneously is seldom approached in Malaysia (Yong *et al.*, 2009).

It is apparent that the Malaysian government is getting closer in recognizing the food environment and built environment as nutritional and health promotion variables. This is evident as the Malaysian Dietary Guidelines for Children and Adolescents (2013) recommended at least 60 minutes of accumulated moderate intensity physical activity daily, as well as recommending urban designs in a community setting to best be shaped in a way that encourages more physical activities. On the other hand, diet quality is recognised as having correlation towards risky health-related issues in Malaysia and its significance is reflected through the National Nutrition Policy 2005, whereby the staple foods of Malaysia has been incorporated into plans and guidelines to aid in developing healthier eating habits.

As for the measurement methods for the environmental variables, it is noted that self-reported perception of the food environment and built environment is found to be as significant as objectively measured food environment (Freedman and Bell, 2009; Green and Glanz, 2015). It is evident, as this research area has been extensively studied in other countries especially in the U.S., whereby findings have shown that the

perception-based nutrition environment is consistently associated with diet and behavioural outcomes, but is rarely studied in Malaysia. On the other hand, the built environment has also had a fair share of studies done in the local climate, mostly in the form of objective measures through physical mappings in Geographical Information System (GIS) such as those done by Chee Cheong *et al.* (2019) as well as Yi, Samat and Muda (2017), but less were done using self-reported perceptions.

As a conclusion, this study intends to fill this gap by exploring the causal relationships between the perceived neighbourhood environmental variables, i.e. food environment and built environment, with behavioural health outcomes, i.e. diet quality and physical activity level, to a person's BMI. Hereinafter, the word 'environmental factors' and 'neighbourhood environment' denotes both built and food environments, unless specifically or separately stated.

1.4 Research Problem, Purpose and Objectives

Based on the research background and problem statement presented earlier, there is an opportunity to explore the causal relationships of neighbourhood environmental factors, health behaviours and body mass index (BMI). Most of the local studies linking environmental attributes to health tend to skew towards either neighbourhood walkability to predict physical activity level or food environment to predict diet quality. Less were committed to combine both attributes, specifically at the neighbourhood level, which are the basic components that explains energy intake and energy expenditure. By combining both environmental attributes, the health outcome of a population is expected to have a higher prediction ability. Secondly, there is a lack of study done in Malaysia with regards to simultaneously measuring both the neighbourhood food environment and environment walkability in a subjective way, which is through self-reported perceptions, in explaining BMI.

Thirdly, most studies have shown contrasting results between the environmental attributes, health behaviours and BMI; indicating that different characteristics of environmental settings can influence different health behaviours and

BMI outcome unique to the population being studied. In summary, there is a need to examine and establish a causal model depicting perceived neighbourhood environmental factors, health behaviours and BMI in the context of urban neighbourhoods in Malaysia. Thus, the following research question need to be addressed;

How do perceived neighbourhood environment (perceived neighbourhood food environment and perceived neighbourhood built environment) and health behaviours (diet quality and physical activity) explain body mass index (BMI)?

In order to gauge the answer to the question above, the research purpose was formed as follows;

To introduce a model which explains the effects (direct and indirect) between perceived neighbourhood environment (food and built environment), health behaviours (diet quality and physical activity) and health outcome (BMI).

Subsequently, the research objectives to achieve the research purpose and answer the research question are as follows;

1. To develop a conceptual framework and a conceptual model which reflect the linkage between perceived neighbourhood environmental factors (food environment and built environment), health behaviours (diet quality and physical activity) and health outcome (BMI);
2. To introduce adaptations of reliable survey instruments to record self-reported perception of environmental factors, health behaviours and BMI which suits the target population;
3. To establish construct validity of perceived neighbourhood environment, health behaviours and BMI presented in the form of a measurement model; and
4. To present a causal model which explains BMI outcome within the context of perceived neighbourhood environment and health behaviours.

1.5 Scope of Research

Given the research aim and objectives presented, the scope of study are as follows;

1. This study mainly focuses on neighbourhood-level environmental attributes linking to health behaviours as well as health outcome such as proximity to and diversity of desired destinations. As such, individual-level attributes such as home food environment, nutrition knowledge, exposure to healthy eating and response to product's food marketing were not included;
2. The neighbourhood environmental attributes included in this study were measured specifically based on subject's self-reported perceptions;
3. Only planned neighbourhoods located in urban areas were considered in the study. As such, 'kampong' areas and rural areas were excluded from the study;
4. As mentioned earlier that the Southern part of Malaysia has more population that are overweight and obese, hence the study was carried out in the district of Johor Bahru, Johor; and
5. The study focuses on collecting cross-sectional data from adults above the age of 18 years old.

1.6 Research Design

This study seeks to understand the obesity phenomenon within the scope of neighbourhood environment through a causality study. In other words, it wants to measure the occurrence of the obesity phenomenon when there is a characteristic variation in the neighbourhood environment. The district of Johor Bahru was selected as the study area, wherein 256 adults of 18 years old and above were stratified by neighbourhood socioeconomic status. As this study measure its neighbourhood environment attributes using self-reported perceptions, it is categorised as a subjective measure. In order to quantify those attributes, Structural Equation Modelling (SEM) was adopted to analyse the latent environmental variables.

Firstly, a conceptual framework was produced through a collation of findings from past studies linking perceived neighbourhood environments, specifically food and built environments, health behaviours and BMI. Here, the definition of each attribute used in this study was stated. Then, a conceptual model was drawn based on the framework in order to specify the dependent and independent variables, as well as the hypothesized relationships to be tested.

Due to this study relies on self-reported perception data, the method of face-to-face questionnaire survey was chosen. Hence, validated questionnaires which were deemed as suitable to measure the indicators for each attribute were adapted in this study. The data collected was cross checked with data assumptions as required by SEM. Afterwards Confirmatory Factor Analysis (CFA) was conducted to establish construct validity of those indicators to respective attributes and this was presented in the form of a measurement model.

Consequently, by using the output of the measurement model, a structural model was drawn based on the conceptual model established earlier. After establishing validity of the structural model, the hypothesized relationships were tested. In the end, the causal model produced explains the causal links between variables in a structured and straightforward manner while eliminating insignificant factors, resonating the local context.

1.7 Research Assumptions

Throughout the study duration, one main assumption was made, the housing layout plans in the neighbourhoods of Malaysia, particularly in urban areas, were planned and developed based on the same planning policies and planning guidelines. Thus, it can be safely assumed that all urban neighbourhoods in Malaysia exude similar physical characteristics. Hence, random sampling of any neighbourhoods within the urban area will most likely to yield similar results.

Based on the reports of World Health Organization, only Wilayah Persekutuan Putrajaya and Johor were steadily ranked top 4, consecutively from year 1998 to year 2000 for prevalence of abdominal obesity. Moreover, the National Health and Morbidity Survey (NHMS 2015) stated that Johor has the third highest diabetes prevalence among its inhabitants. This steady trend of health concerns over the years in Johor as compared to other states in Malaysia indicates a need for health-related studies to be conducted there. As such, taking the district of Johor Bahru as study area, it was assumed that the physical environmental characteristics of neighbourhoods in Johor Bahru is applicable to other planned urban neighbourhoods in Malaysia.

1.8 Significance of the Research

The statistical data which shows the worrying obesity rate of Malaysian population is a clear sign that the issue is worth researching into. Due to the fact that obesity has been linked to high risk of contracting Non-Communicable Diseases (NCDs), this indicates a bleak future for Malaysia as this will have both direct and indirect impact towards the nation including increased health risks and medical expenses, reduced working capabilities and economic output, and declined quality of life, just to name a few. Hence, studying the causal factors contributing to the obesity epidemic is crucial, and one such factor could be the environment in which we live in, particularly the neighbourhood food and built environment.

This study filled in the gap of exploring whether the perceived food and built environment as well as diet quality and physical activity, are significant determinants of BMI among inhabitants of urban neighbourhoods in Johor Bahru. The development and adaptation of a valid and reliable instrument that can be used to collect the data of perceived urban neighbourhood environment, health behaviours and BMI is able to aid in appreciating the current sociodemographic and environment; characteristics of the Malaysian adults. It can also be further modified to suit to the usability of many parties including schools, government authorities and other related organisations.

The measurement model established is significant in highlighting the indicators of the environment that are deemed influential and important, as such provides an idea to related agencies on where improvements can be and should be made. Furthermore, the causal model produced by the study is able to contribute towards health related guidelines, policies and intervention programmes that targets on decreasing BMI of Malaysian adult population through the environment. This is because, it reflects the current trend and scenario of the causal relationship between the determinants of environment, health behaviours and BMI. Finally, the study also cut through barriers between urban planning and nutrition by combining both fields, encouraging more inter-disciplinary research in the future. Therefore, it is not a stretch from the truth to state that this study is significant, both theoretically and practically in encouraging a healthier nation. Moreover, as suggested by Thompson (2007), understanding how the environmental characteristics (specifically within the context of food and built environments in this study) can affect health outcome, is crucial in understanding the obesity phenomenon and also an important step in bridging the partnership gap between planning and health professionals.

1.9 Chapter Outline

There is an accumulative of six chapters in this thesis and the general outline as well as its organizational structure are presented as follows;

Chapter 1: Introduction explains the background of research, problem statement, research question, purpose, objectives, scope, assumptions, expected contributions, significance of research as well as research design in a general manner.

Chapter 2 and 3: Literature Review focuses on presenting information on the study variables including; understanding the concept of food environment and built environment by looking at results of previous studies, as well as the usage of BMI in public health studies. Materials related to the diet quality and physical activity pertinent to the Malaysian context were highlighted, while presenting feasible

measurements methods. In short, this chapter provides reviews and presentation of relevant literature significant to the study.

Chapter 4: Research Methodology demonstrates the rationale for the quantitative research design of the thesis as it includes presenting the theoretical framework, study variables, proposed conceptual model to be tested, sampling design, analytical techniques to achieve the research aim and each objective outlined earlier. This chapter serves as a guideline to the execution phase of the study because it clearly defines the ‘who, what, where, when and how’ of the research.

Chapter 5: Data Collection and Analysis reports the descriptive data and profiling of the targeted population collected through questionnaire survey. The software used were Microsoft Excel, Statistical Package for Social Sciences version 22.0 (SPSS v.22) and IBM SPSS Amos version 23.0 (AMOS v.23), analysed using the techniques outlined in Chapter 4. It ends with highlighting the important findings based on the study output, which will be further elaborated in the following chapter.

Chapter 6: Discussion and Conclusion discusses the results of the study through the establishment of a final causal model which explains the relational link between variables of the perceived neighbourhood environment, health behaviours and BMI of the target population, as well as highlighting the achievement of each research objective. Finally, related recommendations were made accordingly.

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