INTERGENERATIONAL OBESITY PROFILING IN MALAYSIA AND EXPLORATION OF MOTHER-CHILD OBESITY DETERMINANTS AMONG MALAY LOW SOCIOECONOMIC INDIVIDUALS: A MIXED METHOD STUDY

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by

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LIST OF ABBREVIATIONS

AOR	Adjusted odds ratio
ASEAN	Association of South East Asian Nations
B40	Bottom 40% of the income distribution in Malaysia
BAZ	Body mass index-for-age
BMI	Body mass index
CI	Confidence interval
DOHaD	Developmental origins of health and disease
EBs	Enumeration Blocks
GDP	Gross Domestic Product
GSHS	Global School-based Student Health Survey
IPH	Institute for Public Health
ID	Identification number
LMICs	Low- and middle-income countries
LQs	Living Quarters
M40	Middle 40% of the income distribution in Malaysia
NCD	Non-communicable diseases
NHMS	National Health and Morbidity Surveys
NWM/NWC	Normal weight mother/normal weight child
NWM/OWC	Normal weight mother/overweight child
NWM/UWC	Normal weight mother/underweight child
OR	Odds ratio
OW/OB	Overweight or obesity
OWM/NWC	Overweight mother/normal weight child
OWM/OWC	Overweight mother/overweight child
OWM/UWC	Overweight mother/underweight child
RM	Ringgit Malaysia
ROC	Receiver Operating Characteristic
SD	Standard deviation
T20	Top 20% of the income distribution in Malaysia
UNICEF	United Nations Children's Fund
US	United States

UWM/NWC	Underweight mother/normal weight child
UWM/OWC	Underweight mother/overweight child
UWM/UWC	Underweight mother/underweight child
VIF	Variance Inflation Factor

PENCIRIAN OBESITI ANTARA GENERASI DI MALAYSIA DAN PENEROKAAN PENENTU OBESITI IBU-ANAK DALAM KALANGAN INDIVIDU MELAYU DARI SOSIOEKONOMI RENDAH: KAJIAN KAEDAH CAMPURAN

ABSTRAK

Berat badan berlebihan atau obesiti (OW/OB) dalam kalangan ibu dan anak telah menjadi kebimbangan kesihatan awam kerana ia boleh membawa kepada OW/OB antara generasi yang berterusan. Selain pewarisan genetik, OW/OB dalam kalangan ibu dan anak juga dipengaruhi oleh faktor peribadi dan persekitaran. Tujuan kajian ini adalah untuk menunjukkan trend prevalens dan faktor yang dikaitkan dengan OW/OB dalam kalangan ibu dan anak. Selain itu, kajian ini juga bertujuan untuk meneroka bagaimana OW/OB antara generasi berlaku dalam isi rumah berpendapatan rendah. Kaedah gabungan reka bentuk konvergen telah digunakan, dengan menggabungkan data kuantitatif daripada Kajian Kesihatan dan Morbiditi Kebangsaan Malaysia dan dapatan daripada kajian kualitatif. Data daripada kajian kuantitatif dan kualitatif dikumpul dan dianalisis secara berasingan dalam satu fasa. Dalam kajian kuantitatif, seorang ibu dan seorang anak berumur antara 5 hingga 17 tahun dikenal pasti dari setiap isi rumah dan mereka dipadankan sebagai pasangan ibu dan anak mereka mengikut kategori indeks jisim badan mereka. Prevalens dan faktor berkaitan pasangan ibu berlebihan berat badan /anak berlebihan berat badan (OWM/OWC) telah dianalisis untuk tahun 2006, 2011, dan 2015. Analisis regresi logistik telah dilakukan untuk menentukan faktor yang dikaitkan dengan OWM/OWC. Dalam kajian kualitatif,

persepsi ibu-ibu tentang bagaimana mereka dan anak-anak mereka menjadi berlebihan berat badan atau obes telah diteroka melalui temubual mendalam. Sebanyak 27 temu bual mendalam telah dijalankan. Pendekatan analisis tematik digunakan untuk menganalisis data kualitatif. Data yang diperoleh daripada kedua-dua kajian telah diintegrasikan melalui pendekatan naratif. Antara tahun 2006 hingga 2015, prevalens OWM/OWC meningkat daripada 15.3% kepada 21.7%. Lebih mengejutkan, prevalens OWM/OWC dalam kumpulan berpendapatan terendah meningkat dua kali ganda daripada 7.9% kepada 17.8% dalam tempoh yang sama. Risiko OWM/OWC meningkat apabila umur ibu meningkat. Dalam kalangan kanak-kanak, umur antara 10 hingga 14 tahun berisiko tinggi untuk menjadi OWM/OWC manakala umur di antara 15 hingga 17 tahun dilindungi daripada OWM/OWC. Risiko OWM/OWC juga meningkat dalam kalangan ibu-ibu yang berpendidikan rendah dan menengah. Sementara itu, etnik Cina, kaum lain-lain, dan tinggal dalam isi rumah yang besar dilindungi daripada OWM/OWC. Dalam kajian kualitatif, 27 wanita Melayu berumur antara 27 hingga 52 tahun telah ditemubual. Empat tema utama muncul daripada temu bual mendalam. Pertama, faktor peribadi boleh mempengaruhi OW/OB antara generasi melalui faktor demografi, kognitif, dan kemahiran. Tema kedua ialah persekitaran sosial perhubungan ibu bapa-anak. Tema ketiga ialah persekitaran fizikal, yang terdiri daripada persekitaran rumah dan binaan. Tema terakhir ialah persekitaran peringkat makro, termasuk harga makanan dan pengaruh media. Kesimpulannya, prevalens OWM/OWC di negara ini semakin meningkat, khususnya dalam isi rumah berpendapatan rendah. Selain faktor peribadi, persekitaran peringkat sosial, fizikal dan makro juga terlibat dalam OW/OB antara generasi.

INTERGENERATIONAL OBESITY PROFILING IN MALAYSIA AND EXPLORATION OF MOTHER-CHILD OBESITY DETERMINANTS AMONG MALAY LOW SOCIOECONOMIC INDIVIDUALS: A MIXED METHOD STUDY

ABSTRACT

Maternal and child overweight or obesity (OW/OB) has become a public health concern because it can lead to a continuous intergenerational OW/OB. Besides genetic inheritance, OW/OB among mothers and children are also influenced by personal and environmental factors. This study aimed to describe the prevalence trends and factors associated with OW/OB among mothers and their children. Moreover, this study also seeks to explore how intergenerational OW/OB occurs in low-income households. A convergent mixed methods design was applied, combining quantitative data obtained from the Malaysian National Health and Morbidity Survey and the findings from the qualitative study. The quantitative and qualitative studies data were collected and analysed independently in a single phase. In the quantitative study, a mother and a child aged between 5 to 17 years were identified from every household, and they were matched as mother-child pairs according to their body mass index categories. The prevalence and associated factors of overweight mother/overweight child pairs (OWM/OWC) were analysed for the years 2006, 2011, and 2015. Multiple logistic regressions analysis was performed to determine the factors associated with OWM/OWC. In the qualitative study, maternal perception of how they and their children become overweight or obese was explored through in-depth interviews. A total of 27 in-depth interviews were carried out. A thematic analysis approach was

used to analyse the qualitative data. Data obtained from both studies were integrated through a narrative approach. Between the years 2006 to 2015, the prevalence of OWM/OWC increased from 15.3% to 21.7%. Surprisingly, the prevalence of OWM/OWC in the lowest income group doubled from 7.9% to 17.8% over the same period. The risk of OWM/OWC increased as maternal age increased. Among children, aged between 10 to 14 years had a higher risk of OWM/OWC, while aged between 15 to 17 years were protective against OWM/OWC. The risk of OWM/OWC also elevated among mothers with primary and secondary education levels. Meanwhile, being Chinese, Other ethnicity, and large household size were protective against OWM/OWC. In qualitative study, 27 Malay women aged between 27 to 52 years were interviewed. Four major themes emerged from in-depth interviews. First, personal factors can influence intergenerational OW/OB through demographic, cognitions, and skills. The second theme was the social environment of parent-child relationships. The third theme was the physical environment, which comprises the home and built environments. The final theme was the macro-level environment, including food price and media influence. In conclusion, the prevalence of OWM/OWC in this country is on the rise, particularly in low-income households. Besides personal factors, the social, physical and macro-level environments are also involved in intergenerational OW/OB.

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Intergenerational overweight or obesity (OW/OB) has become the most worrying public health threat globally. A growing body of literature shows that children with OW/OB were significantly associated with their mothers' OW/OB status, indicating there is an intergenerational OW/OB between mothers and their children (Soskolne *et al.*, 2018; Armoon and Karimy, 2019; Heslehurst *et al.*, 2019; Xu *et al.*, 2019; Brand *et al.*, 2021). Also, OW/OB among adults begins in early life and follows an intergenerational cycle (Keane *et al.*, 2012; Muhlhausler *et al.*, 2013; Haire-Joshu and Tabak, 2016; Portha *et al.*, 2019).

According to the fetal origins hypothesis, Barker (1990) proposed that the intrauterine environment may "program" the foetus to have specific metabolic characteristics and develop diseases during adulthood. Barker continued to prove this hypothesis which concentrated on the association between fetal nutrition and birth weight with mortality from cardiovascular disease (Barker *et al.*, 1993; Barker, 1995). The findings of these studies emphasized the role of poor maternal nutrition during the gestational period, which could result in infants with low birth weight and increase the risk of cardiovascular disease in later life.

Barker's hypothesis set the foundation for a new theory of disease development, the Developmental Origins of Health and Disease (DOHaD) hypothesis. This theory posits that adult chronic disease development was influenced by early-life exposure to environmental factors during pre-conception, prenatal, or early postnatal periods (Gluckman *et al.*, 2016). Even though early studies related to the DOHaD

hypothesis were based on undernutrition and disease development in adulthood, the current research interests employed this hypothesis as a foundation in the studies of the obesity epidemic globally (Benyshek, 2013; Cheng *et al.*, 2016; Lahti-Pulkkinen *et al.*, 2018).

Archer (2015) proposed the maternal resources hypothesis, which suggested that the epidemic of childhood OW/OB is not only due to the over-consumption of food but also resulted from the non-genetic evolutionary process of the mother over the past century, such as a reduction in physical activity and improved nutrition. The non-genetic evolutionary process causes maternal energy resources (such as adiposity and body mass) to increase while energy expenditure and metabolic control (such as insulin sensitivity) decrease. Consequently, an infant born to a mother with OW/OB may also suffer from impaired metabolic function, which is also related to childhood OW/OB (Archer, 2015; Archer *et al.*, 2018).

The factors contributing to intergenerational OW/OB are not limited to early life exposure to environmental factors but also involve exposure to family and social environments in later years (Yang *et al.*, 2015; Dolton and Xiao, 2017; Partap *et al.*, 2017). These findings agreed with the ecological system theory by Bronfenbrenner (1977, 1979). According to this theory, human development occurs through the interaction between a person with his environment. The ecological system theory was used to develop a socio-ecological model, which described that individuals' changes are determined by the individual factors, such as age and gender, and environmental factors, which include social factors, physical and macro-level. The socio-ecological model has been used to understand the multifaceted factors involved in OW/OB

(Davison and Birch, 2001; Institute of Medicine, 2005; Willows *et al.*, 2012; Verstraeten *et al.*, 2014; Barr-Anderson *et al.*, 2018; Timmermans *et al.*, 2020).

Researchers have also applied social cognitive theory to determine the factors linked to obesity-related behaviours (Torkan *et al.*, 2018; Benajiba *et al.*, 2020; Sebastian *et al.*, 2021; Xu, 2021). This theory, introduced by Bandura (1986), proposes that human behaviours are influenced by the bidirectional interaction between personal, environmental, and behavioural factors. The application of social cognitive theory in research can help in understanding why and how a person and the environment can change an individual's health-related behaviours (Glanz *et al.*, 2008).

Living in a shared environment tends to influence children to adopt parental dietary and physical activity behaviour (Costa-Font and Gil, 2013; Dong *et al.*, 2016). Thus, parents and their children with OW/OB are likely to share a similar obesogenic environment through unhealthy dietary or lifestyle behaviour (Schrempft *et al.*, 2016). Parents also become role models for their children (Suhaimi *et al.*, 2017; Coto *et al.*, 2019). Although both parents can affect children's behaviour, mothers have greater influence because they are the closest relationship with their children. They are also mainly responsible for food preparation in families (Tzioumis and Adair, 2014; Paduano *et al.*, 2020).

The risk of intergenerational OW/OB is also influenced by socioeconomic status (Costa-Font and Gil, 2013; Newton *et al.*, 2017; Pavela *et al.*, 2020). However, the association between socioeconomic status and risk of OW/OB differed according to the country's economic development. In high-income countries, OW/OB is more pronounced among low socioeconomic families (Dinsa *et al.*, 2012; Newton *et al.*, 2017). The findings from low- and middle-income countries (LMICs) were

inconsistent (Monteiro *et al.*, 2004; Subramanian *et al.*, 2011; Dinsa *et al.*, 2012). In the past, OW/OB was prevalent among individuals from high socioeconomic status, while individuals from low socioeconomic groups suffered from undernutrition (Sobal and Stunkard, 1989). However, current evidence suggests that OW/OB cannot be regarded as the problem of the rich alone (Samal *et al.*, 2015). Due to the social and economic transition experienced in the LMICs, the trend of OW/OB in the LMICs is shifting from high to low socioeconomic groups (Jones-Smith *et al.*, 2012; Ford *et al.*, 2017).

Globally, more than one-third of the adult population was reported overweight or obese (Chooi *et al.*, 2019). It was projected to be more than half of the worldwide population by 2030 (Finkelstein *et al.*, 2012). It is a worrying issue because adults with OW/OB are at risk of numerous non-communicable diseases (NCD), including cardiovascular disease, diabetes mellitus, cancers, liver and kidney diseases (Al-Goblan *et al.*, 2014; Hall *et al.*, 2014; James *et al.*, 2015; Mitchell *et al.*, 2015; Noureddin and Rinella, 2015). NCD, in turn, contributes to 71% of worldwide mortality (World Health Organization, 2018b).

The epidemic of OW/OB in children worldwide is not exceptional. Among children, the prevalence of OW/OB worldwide was 18% (World Health Organization, 2017). Even though the figure was lower than adults, the rate of prevalence increase among children with OW/OB is much more alarming. In the 1970s, the prevalence of obesity among children and adolescents globally was 0.7% in girls and 0.9% in boys and increased to 5.6% in girls and 7.8% in boys in 2016 (Di Cesare *et al.*, 2019). The NCD Risk Factor Collaboration (2017b) estimated that the prevalence of OW/OB had increased 4 to 5 times in both boys and girls from 1975 to 2016. Like adults, children

with OW/OB are also at risk of developing NCD at a young age (Williams *et al.*, 2015; Farrag *et al.*, 2017) and may persist in becoming obese adults (Simmonds *et al.*, 2016).

In Malaysia, the prevalence of OW/OB among adults and children also showed a worrying trend. In the NHMS 1996, 1 in 5 Malaysian adults were either OW/OB (Lim *et al.*, 2000). However, the recent NHMS 2019 reported that 1 in 2 Malaysian adults was either OW/OB, with the highest prevalence among women (Institute for Public Health, 2020). The latest NHMS 2019 also reported that almost one-third (29.8%) of children aged between 5 to 17 years were OW/OB (Institute for Public Health, 2020). Among 14 countries in the Southeast Asia region, Malaysia was ranked first in the prevalence of OW/OB (58.2%), followed by Thailand (41.0%) and Singapore (37.3%) (World Health Organization, 2011).

Considering the prevalence of OW/OB was higher among women, and the prevalence of children with OW/OB is increasing faster, it is crucial to provide evidence involving maternal and children with OW/OB to inform prevention policy for intergenerational OW/OB. Understanding how intergenerational OW/OB occurs in socially disadvantaged groups is also essential. Therefore, this study was conducted to address three research questions:

1) What is the prevalence of OW/OB among mother-child pairs in Malaysia?

2) What are the factors associated with OW/OB among mother-child pairs?

3) How does intergenerational OW/OB play a role in low socioeconomic households?

1.2 Statement of the problem

Intergenerational OW/OB is a continuous process of passing down adiposity from one generation to the next, either through genetic inheritance or by sharing the same obesogenic environment as the child grows up (Dolton and Xiao, 2017). In the cycle of intergenerational OW/OB, mothers who are overweight or obese have an increased risk of giving birth to an offspring with high birth weight (Yu *et al.*, 2013) or preterm birth (Ju *et al.*, 2018). An infant with a higher birth weight can remain overweight or obese until adulthood and develop NCD (Black *et al.*, 2013; Cai *et al.*, 2019). On the other hand, being born preterm is also associated with childhood OW/OB (Pringle *et al.*, 2019). If the overweight or obese child is a female, she tends to become an overweight or obese adult woman (Gillman, 2016). Since the cycle of intergenerational OW/OB can continue to the next generation, there is a need to address this problem by investigating its determinants quantitatively and qualitatively.

OW/OB has brought an enormous financial burden to the nation (Tan *et al.*, 2020; Boachie *et al.*, 2022; D'Errico *et al.*, 2022). Likewise, a tremendous amount of health expenditure is needed to treat overweight- or obesity-related diseases such as chronic heart diseases, kidney diseases, and cancers (Hong *et al.*, 2019; Hoque *et al.*, 2020). The economic burden of OW/OB does not merely inflict on the country but also on families and individuals. For instance, Solmi and Morris (2018) reported that mothers with OW/OB had to spend a higher delivery cost than normal-weight mothers. A previous study also revealed that overweight or obese mothers have a higher health care expenditure for their children over the first 18 years of life compared to normal weight mothers (Kuhle *et al.*, 2019). Hence, intergenerational OW/OB is necessary to intervene because it can decrease the financial burden on the country and the family, especially low-income families.

Previous studies have demonstrated a positive association between parental body mass index (BMI) and children's BMI, with a stronger association observed for maternal BMI than paternal BMI (Devakumar *et al.*, 2016; Dolton and Xiao, 2017; Xu *et al.*, 2019). The prevalence of OW/OB among mothers and their children showed an increasing trend across many countries (Black *et al.*, 2013; Poston *et al.*, 2016; NCD Risk Factor Collaboration, 2017b). Mothers and children with OW/OB can lead a continuous intergenerational OW/OB (Gillman, 2016). Besides the individual level, the studies on OW/OB among mother and child can be conducted at a mother-child pair level (Cauich-Viñas *et al.*, 2019). However, the majority of the literature on mother-child pairs concentrated on the coexistence of overweight mothers with an underweight child in a household, which is also known as a dual form of malnutrition (Wong *et al.*, 2015; El-Kishawi *et al.*, 2016; Gubert *et al.*, 2017; Das *et al.*, 2019; Masibo *et al.*, 2020). There is still limited information available from the literature on the prevalence of coexistence between an overweight mother with an overweight child in a household (Bralić *et al.*, 2005; Pawloski *et al.*, 2012; Watts *et al.*, 2014; Muthuri *et al.*, 2016; Choy *et al.*, 2017; Partap *et al.*, 2017; Cauich-Viñas *et al.*, 2019).

Even though the national prevalence of OW/OB among adults and children has been reported previously (Lim *et al.*, 2000; Institute for Public Health, 2008b, 2011b, 2015b), there has been no such information on the coexistence of mother and child with OW/OB in a household. A large-scale study in Malaysia setting on parent-child pairs was conducted by Partap *et al.* (2017). The study's findings revealed that children with OW/OB living with an obese father or an obese mother were 14.2% and 13.8%, respectively. However, the study by Partap *et al.* (2017) did not involve the whole Malaysian population.

Apart from Cauich-Viñas *et al.* (2019), there is a lack of research to determine the factors associated with OW/OB among mother-child pairs. Cauich-Viñas *et al.* (2019) suggested that household size and parental education level were significantly associated with OW/OB in mother-child pairs. The associated factors of OW/OB among adults and children in Malaysia have been documented in many studies (Ghee, 2016; Chan *et al.*, 2017; Ullah *et al.*, 2018; Mohd Nor *et al.*, 2020; Shahrir *et al.*, 2021). However, studies investigating the factors associated with the coexistence of OW/OB among mothers and children in this country are still scarce.

The association between low socioeconomic status and the risk of OW/OB among women was reported in innumerable studies conducted in high-income countries (Newton *et al.*, 2017). In the LMICs, previous studies disclosed that the trend of OW/OB is moving from high to low socioeconomic status (Jones-Smith *et al.*, 2012; Ford *et al.*, 2017). The findings using NHMS data for 1996, 2006, and 2011 indicated that the burden of OW/OB among women in Malaysia becomes concentrated among socioeconomically disadvantaged groups (Mariapun *et al.*, 2018). However, the association of socioeconomic status with the risk of OW/OB among both mother and child is unknown.

A few studies have been conducted in low socioeconomic households to explore mothers' and children's perceptions and experiences of how they become overweight or obese (Kalinowski *et al.*, 2012; Pescud and Pettigrew, 2014; Anderson *et al.*, 2015; Tester *et al.*, 2016; Beck *et al.*, 2019). However, all of these studies were conducted in high-income countries. Both studies by Kalinowski *et al.* (2012) and Pescud and Pettigrew (2014) were related to parental feeding practice on childhood OW/OB in socioeconomically disadvantaged groups. Meanwhile, Tester *et al.* (2016)

have explored children's eating behaviour in low socioeconomic households, leading to OW/OB. The studies by Anderson *et al.* (2015) and Beck *et al.* (2019) concerned the barriers to healthy eating among mothers and children from low socioeconomic households.

The determinants of OW/OB are multifactorial and involve individual, household, social, and environmental factors. A few published studies described the associated factors of OW/OB in Malaysian settings (Ghee, 2016; Mohamad Nor *et al.*, 2018; Ullah *et al.*, 2018; Mohd Nor *et al.*, 2020). However, most OW/OB studies in Malaysia were quantitative, with only a small number of qualitative studies (Chang *et al.*, 2009; Abdul Aziz *et al.*, 2016; Mohammadi *et al.*, 2021; Yunus *et al.*, 2022).

Malaysia's population is made up of people from various ethnicities. There are three primary ethnic groups in Malaysia: Malay, Chinese, and Indian (Department of Information, 2016). In national population surveys, Indian was found to be overweight or obese than Malay and Chinese (Institute for Public Health, 2008b, 2011b, 2015b). However, the prevalence of OW/OB among Malay spiked rapidly (Ghee, 2016). In other studies, Malay adults had the highest likelihood of becoming OW/OB, followed by Indian adults (Zakaria *et al.*, 2019; Nordin *et al.*, 2020). Similar to adults, the risk of OW/OB was also greater among Malay children (Cheong *et al.*, 2019; Mahaletchumy *et al.*, 2019). Hence, there is a need to understand about the risk of overweight and obesity which is higher among Malay, known as the largest ethnic group in this country.

1.3 Significance of the study

The finding of this study can contribute to the body of literature regarding the prevalence of OW/OB mother and child in the same household in Malaysia in terms

of mother-child pairs. Besides providing information on the prevalence of overweight mother-child pairs, this study also presents the BMI profiles of other mother-child pair categories, such as the coexistence of an overweight mother and an underweight child and a normal weight mother living with a normal weight child. Hence, the findings can attract stakeholders' attention and provide updated information for policymakers.

This study also investigated the factors associated with intergenerational OW/OB among mother-child pairs. Since OW/OB is a complex and multifactorial health problem, the convergent mixed methods approach applied in this study can help understand the multiple factors contributing to intergenerational OW/OB by converging and comparing quantitative and qualitative data. When using different data types, the results of both approaches can complement each other. The fundamental data on overweight mother-child pairs obtained from this study can inspire numerous research ideas, especially in epidemiology and intervention research. Additionally, this study's findings can also encourage researchers and healthcare practitioners to plan intervention programmes for mothers and their children with OW/OB at the national level in the future.

Apart from that, this study also provides the voices of overweight and obese mothers from low socioeconomic households about the life struggles that cause them to be exposed to the threat of OW/OB. Hence, this information can help understand the hidden factor contributing to intergenerational OW/OB, especially in low-income households. It also can facilitate in designing of suitable intervention strategies for individuals in socially disadvantaged groups.

1.4 Research objectives

1.4.1 General objective

To investigate the prevalence and factors associated with OW/OB among mother-child pairs and to explore how the transmission of intergenerational OW/OB occurs among mothers and children in lower socioeconomic groups in Malaysia.

1.4.2 Specific objectives

i. To describe the prevalence of different BMI categories for mother-child pairs in Malaysia from 2006 to 2015

ii. To describe the prevalence of OW/OB among mother-child pairs in Malaysia by socioeconomic status from 2006 to 2015

iii. To determine the factors associated with OW/OB among mother-child pairs in Malaysia for the years 2006, 2011, and 2015

iv. To determine the factors associated with OW/OB among mother-child pairs from low socioeconomic households for the years 2006, 2011 and 2015

v. To explore the determinants of intergenerational OW/OB among mother-child pairs in Malay low socioeconomic households

1.5 Study hypotheses

Hypothesis 1

H_0: There is no association between demographic factors and OW/OB mother-child pairs

H_a: There is an association between demographic factors and OW/OB mother-child pairs

Hypothesis 2

H_0: There is no association between demographic factors and OW/OB mother-child pairs from low socioeconomic household

H_a: There is an association between demographic factors and OW/OB mother-child pairs from low socioeconomic household

1.6 Theoretical framework

Generally, OW/OB occurs when energy intake exceeds energy expenditure. Energy intake is related to the energy or calories consumed when eating or drinking beverages, while energy expenditure involves physical activity. However, the aetiology of OW/OB is multifactorial and complex.

In the epidemiological studies of OW/OB, many researchers employed a socio-ecological model to understand multiple factors beyond the individual factors that can influence the risk of OW/OB (Willows *et al.*, 2012; Verstraeten *et al.*, 2014; Ohri-Vachaspati *et al.*, 2015; Quick *et al.*, 2017; Barr-Anderson *et al.*, 2018; Lappan *et al.*, 2019; Mahmudiono *et al.*, 2019; Timmermans *et al.*, 2020). Figure 1.1 shows the example of a socio-ecological model of OW/OB, adapted from Story *et al.* (2008), which illustrates the multiple influences on what people eat.

According to this socio-ecological model, OW/OB is determined by individual factors, social, physical, and macro-level environments. The individual factors contributing to OW/OB include demographics, cognitions, skills, behaviours, and biological factors. The social environment surrounds personal factors, including

interactions with family members, friends, and peers. Meanwhile, the physical environment comprises numerous settings such as homes, supermarkets, and food outlets. The individual factors, social and physical, are placed within macro-level environments. At the highest level of the environmental factors, the macro-level environment involves social norms, food marketing, media exposure, land use, and transportation.

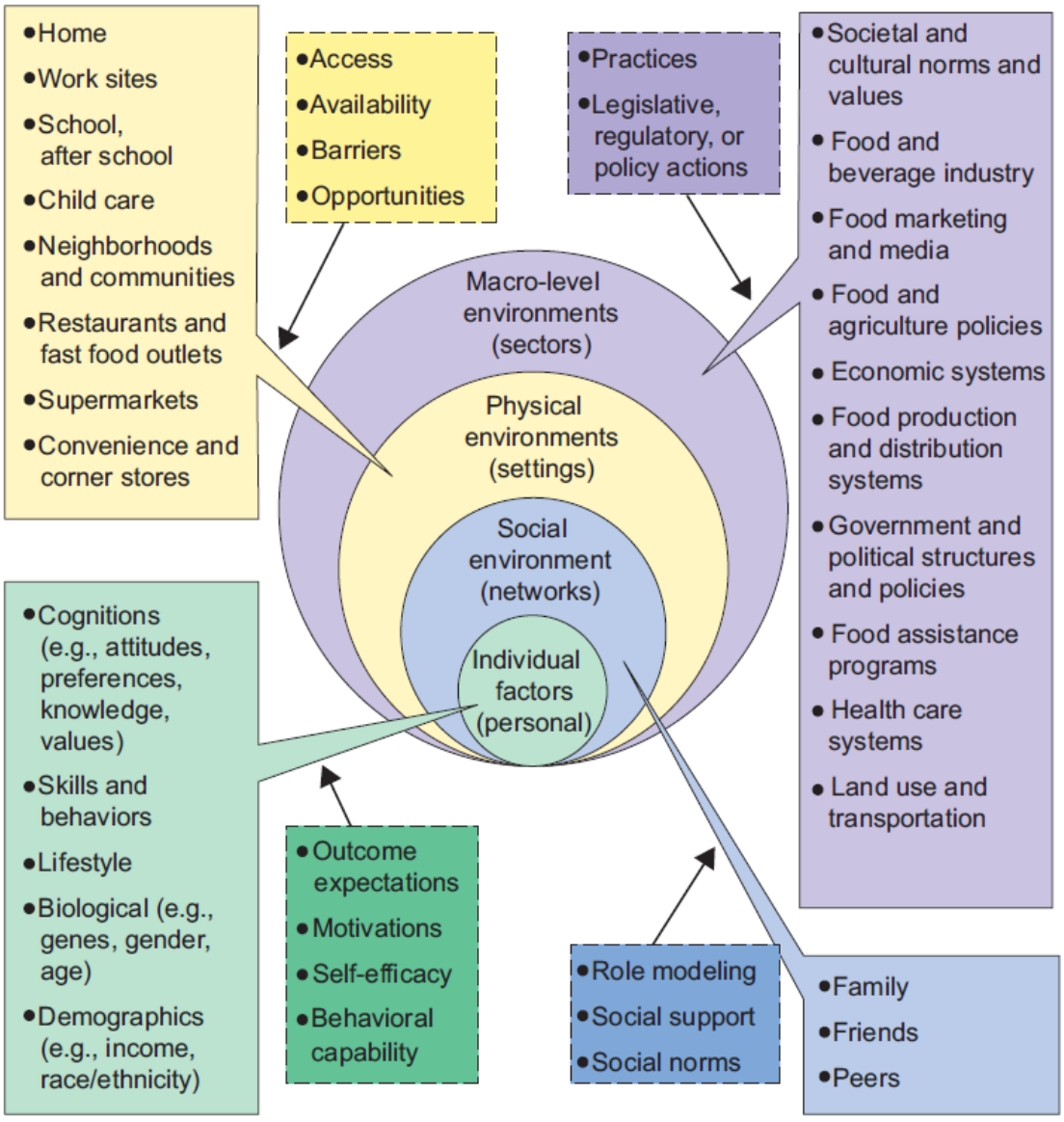


Figure 1.1 A socio-ecological model of overweight or obesity

Source: Adapted from Story *et al.* (2008) ecological framework illustrating the multiple influences on what people eat.

Besides the socio-ecological model, researchers also have applied social cognitive theory to determine dietary behaviour and physical activity, which is related to OW/OB (Dlugonski and Motl, 2016; Torkan *et al.*, 2018; Sondari *et al.*, 2019; Yiga *et al.*, 2020; Balhareth *et al.*, 2021; Seabi *et al.*, 2021). This theory also has been used in various intervention programmes on OW/OB (Alulis and Grabowski, 2017; Joseph *et al.*, 2017; Lau *et al.*, 2018; Naami *et al.*, 2020).

The social cognitive theory was proposed by Bandura (1986). This theory postulates that individual behaviour results from an interaction between personal, behavioural, and environmental influences (Glanz *et al.*, 2008). It focuses on the triadic reciprocal determinism concept, which emphasizes a bidirectional relationship between personal, behavioural and environmental factors (Bandura, 1989). Figure 1.2 present the social cognitive theory, adapted from Bandura (1989), which illustrates the concept of triadic reciprocal determinism.

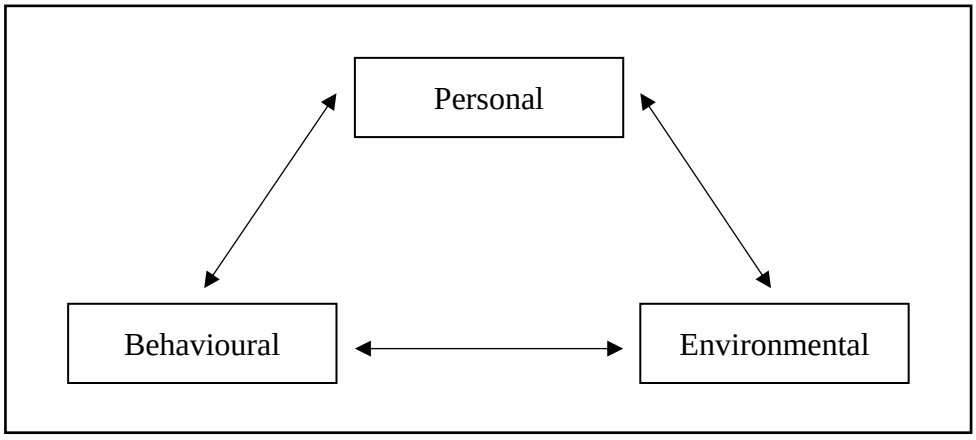


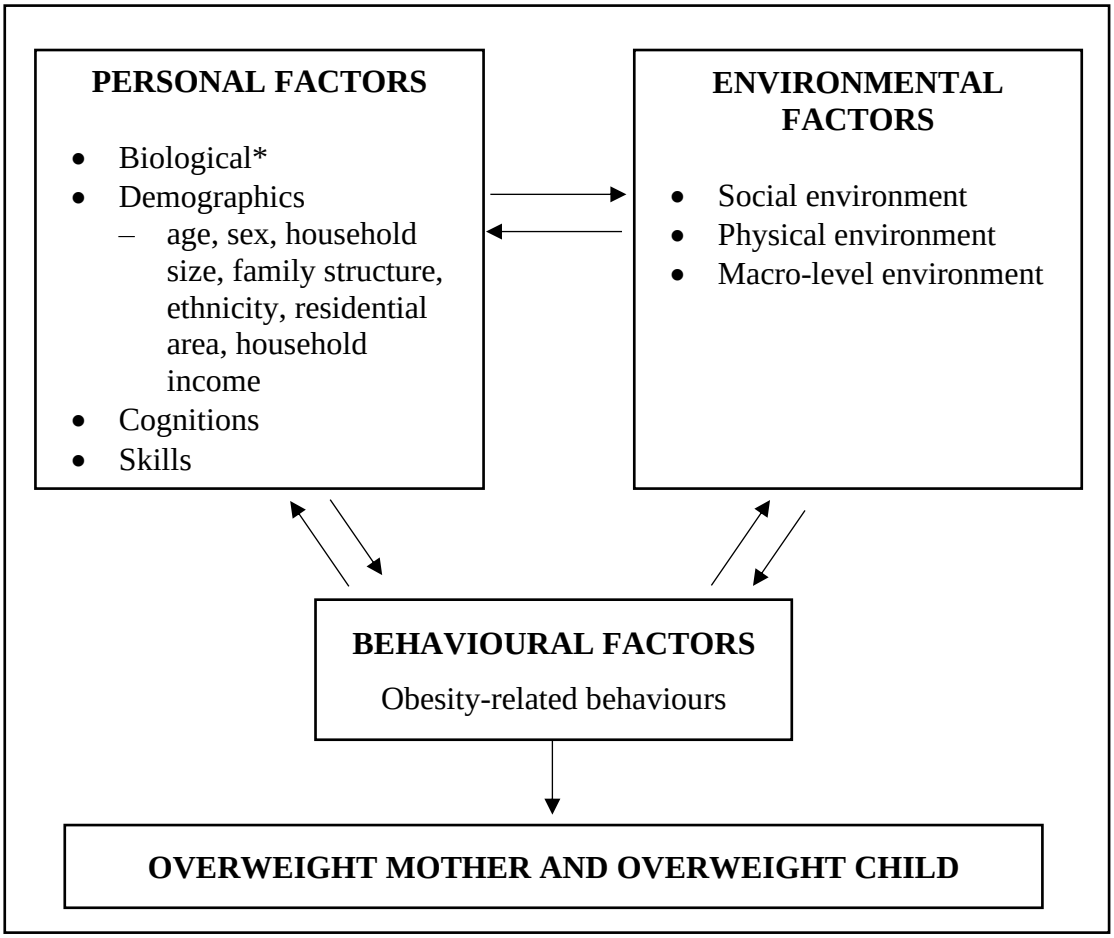
Figure 1.2 Social cognitive theory

Source: Adapted from Bandura's (1989) social cognitive theory portraying the triadic reciprocal determinism concept

The socio-ecological model and social cognitive theory are relevant in understanding the factors related to intergenerational OW/OB beyond personal factors. The social cognitive theory can describe possible interactions between individual factors, behaviours, and environments. These factors can be integrated with the socio-ecological model, which proposes that individual factors are situated within social, physical and macro-level environments. Therefore, the socio-ecological model and social cognitive theory were chosen as the theoretical framework to guide this study.

1.7 Conceptual framework

The conceptual framework of this study (Figure 1.3) was grounded on the socio-ecological model (Story *et al.*, 2008) and social cognitive theory (Bandura, 1986) for understanding the determinants of intergenerational OW/OB among mother and child. Consistent with the socio-ecological model and social cognitive theory, this framework proposed that the mothers' and children's demographics, cognition, skills, and biological can shape the obesogenic behaviours of the mothers and their children, such as unhealthy dietary behaviour and physical inactivity. By contrast, behavioural factors of the mothers and their children also can determine personal factors. This framework also hypothesized that environmental factors, including social, physical, and micro-level environments, could shape both personal factors and obesity-related behaviours of mothers and their children. Conversely, mothers' and children's personal and behavioural factors can influence the social, physical, and macro-level environments.



* Biological factors are not being studied

Figure 1.3 Conceptual framework of this study

In the personal factors, the association of the demographic characteristics and the risk of being OW/OB among mothers and their children were assessed in the quantitative study. However, the biological factors were not studied, especially genetic factors. Since the demographic factors alone are insufficient to explain the complex aetiology of intergenerational OW/OB, the other personal, behavioural, and environmental factors were explored in the qualitative study.

1.8 Operational definition

i. Overweight or obesity (OW/OB)

Overweight refers to an adult's BMI between 25.0 to 29.9 kg/m² (World Health Organization, 1998b) or children aged between 5 to 19 years with BMI-for-age above +1 SD (de Onis and Lobstein, 2010). Adults with BMI ≥30 kg/m² and children with BMI-for-age over +2 SD are categorized as 'obesity' (World Health Organization, 1998b; de Onis and Lobstein, 2010). In this study, OW/OB refers to the mothers with BMI ≥25 kg/m² and children with BMI-for-age more than +1 SD.

ii. Intergenerational OW/OB

Intergenerational OW/OB is a process of passing down adiposity from one generation to the next, either through genetic inheritance or by sharing the same obesogenic environment (Dolton and Xiao, 2017). This study merely focuses on OW/OB between mothers and their children.

iii. Children

According to the Child Act 2001 (Act 611), the United Nations Children's Fund (UNICEF) (2001) defines a child as an individual aged less than 18 years. The children in this study refer to those aged between 5 to 17 years.

iv. Unhealthy dietary behaviour

Dietary behaviour refers to an individual's behaviour related to food intake (Abdella *et al.*, 2019). In this study, unhealthy dietary behaviour is related to obesity-

related dietary behaviours, such as overconsumption of food, low vegetable and fruit intake, skipping meals, and eating away from home.

v. Physical inactivity

Physical inactivity is the absence of physical activity or exercise (World Health Organization, 2010). In this study, physical inactivity refers to the lack of physical activity or exercise and engagement in sedentary activities such as watching television and using smartphones.

vi. Household income

Household income is the total monthly income earned from work and the money received from others, such as family members, scholarships, pensions, and welfare (Institute for Public Health, 2015a). This study categorised household income into five groups; Quintile 1 to Quintile 5. Quintile 1 indicates the 20% of the study population with the lowest household income, whereas Quintile 5 is the top 20% of the study population with the highest household income.

vii. Low-income households

Low-income households refer to households in the bottom 40% of the income distribution. In Malaysia, the population is categorised into three income groups: The Bottom 40% (B40), Middle 40% (M40), and Top 20% (T20). The categorisation is based on the median household income (Department of Statistics Malaysia, 2021). The values of median household income can rise or fall from year to year based on the gross domestic product (GDP), which is one of the measures of country's economic growth. The B40 household is also the Quintile 1 and 2 household income (Mahdzan

et al., 2019). The Economic Planning Unit (2015) described that the B40 households receive a total household income less than RM 3,860.

Low-income households in the quantitative study referred to the mother-child pairs from the first and second quintiles of the study population. Meanwhile, in the qualitative study, low-income households refer to those with total household incomes less than RM 3,860. Different definitions for low-income households were used for quantitative and qualitative studies because they were conducted at different timelines. The data for the quantitative study was collected in years 2006, 2011, and 2015, while the qualitative study was conducted in 2018 and 2019. Hence, the values of median household income for the B40 group were different for every consecutive year while the study was conducted.

viii. Education level

In this study, the education level of the mothers was categorized into no education (never attended any school in any of the educational institutions that provide formal education), primary (did not complete primary school or completed standard 6), secondary (completed form 3 or form 5), and tertiary (completed form 6, certificate, diploma degree and above) (International Labour Organization and The Commissioner of Law Revision Malaysia, 1996).

ix. Ethnicity

Ethnicity is the classification based on cultural characteristics (Caprio *et al.*, 2008). This study divided ethnicity into four groups: Malay, Chinese, Indian, and Other ethnicities. The Other ethnicity was comprised of the *Orang Asli* population

from Peninsular Malaysia, and indigenous groups in Sabah and Sarawak, such as Iban, Kadazan, Melanau, Murut, Bidayuh, and others.

x. Household size

Household size refers to the total number of individuals living together in the household (Institute for Public Health, 2015a). This study classified household size into three groups: small (less than five persons), medium (5 to 7 individuals), and large (more than seven individuals) (Mok *et al.*, 2011).

xi. Family structure

Family structure is based on the marriage status of the parents (Senkowski *et al.*, 2019). This study classified family structure into single- (parents reported that they were not married, divorced, widow or widower) and dual-parent families (parents reported that they were married).

xii. Invalid BMI

Invalid BMI refers to the BMI values of adults below 13.0 kg/m^2 or above 54.3 kg/m^2 and children's BMI less than 7.5 kg/m^2 or more than 43.1 kg/m^2 (Liu *et al.*, 2013). In the current study, invalid data of BMI for mothers were less than 13.0 kg/m^2 or more than 54.3 kg/m^2. Among children, BMI values below 7.5 kg/m^2 or greater than 43.1 kg/m^2 indicate invalid BMI.

xiii. Cognition

Cognition is a person’s knowledge and perception of the world (Bennett *et al.*, 2005). In this study, cognition includes the mothers' and their children's preferences and attitudes.

xiv. Social environment

The social environment involves relationships with family members, friends, and others (Glanz and Rimer, 2005; Hanemaayer *et al.*, 2022). In the current study, the social environment explicitly describes the relationship between mothers and their children and the paternal influence on their children.

xv. Feeding practices

Feeding practices are defined as certain behaviours parents adopt to influence their children's food intake (Shloim *et al.*, 2015). In this study, feeding practices refer to the interaction between the mothers and their children, which determine children's dietary intake, such as role modelling, permissiveness, rewarding children's positive behaviours with food, and emotional feeding.

xvi. Physical environment

Physical environment refers to physical settings where people spend their time, such as at home, work, school, parks, and neighbourhoods (Davison and Lawson, 2006). This study only concentrates on home and built environments.

xvii. Built environment

A built environment is defined as human-modified sites such as parks, roads, schools, and food outlets (Srinivasan *et al.*, 2003; Hanemaayer *et al.*, 2022). In this study, the built environment encompasses food outlets and public amenities.

xviii. Macro-level environment

The macro-level environment is the highest level of the environment that indirectly influences people at the population level (Story *et al.*, 2008). The macro-

level environment of this study focuses on food price, media influence, and food marketing.

1.9 Structure of the thesis

This thesis comprises six chapters. The first chapter provides a brief idea and introduction regarding intergenerational OW/OB, which leads to the significance of the study. The problem statement, objectives and hypotheses of this study are mentioned in this chapter. This chapter also presents the theoretical and conceptual frameworks used to guide this study.

Chapter two of this thesis comprises the literature review related to this study. This chapter begins with a brief introduction to OW/OB, followed by reporting the worldwide prevalence of OW/OB among mothers and children. In addition, this chapter also reviews the determinants of OW/OB among mother and child in the context of individual characteristics, household factors and environmental factors. The association of socioeconomic status with OW/OB and the mechanisms of how intergenerational OW/OB occurs among mother and child, particularly in low socioeconomic households, are also discussed in this chapter.

The methodology of this study is described in chapter three. Besides study design, this chapter also explains the measures involved in data collection for both quantitative and qualitative studies, including study population, duration, location, sample size, and criteria of the participants. Furthermore, data analyses employed in quantitative and qualitative studies are described at the end of this chapter.

Chapter four of this thesis presents the results of this study. The results from the quantitative study were first presented and followed by the qualitative study

findings. The quantitative study results demonstrate the characteristics of mother-child pairs, including the prevalence and associated factors of OW/OB mother-child pairs. The associated factors of OW/OB mother-child pairs from low socioeconomic households are also reported. Afterwards, the findings from the qualitative study are reported in themes to understand how intergenerational OW/OB occurs in low socioeconomic households.

Chapter five discusses the findings by combining the results from the merged quantitative and qualitative studies. The strengths and limitations of this study are outlined at the end of this chapter. The final chapter, chapter six, draws a conclusion based on the findings of this study. Recommendations are also suggested for future studies.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter overviews intergenerational OW/OB among mothers and their children. It comprises four main sections. The first section begins with the definition and classification of OW/OB, followed by the prevalence of OW/OB among adults and children. Obesity-related behaviours, which include unhealthy dietary behaviours and physical inactivity, are also addressed in this section. The second section comprises of literature review related to intergenerational OW/OB. Initially, this section describes the prevalence of OW/OB among mother-child pairs. Subsequently, it focuses on the factors influencing OW/OB among mothers and their children.

The following section concentrates on OW/OB in low-income households. It includes the trends and contributing factors of OW/OB among individuals in low-income households. The last section of this chapter describes a few theories related to intergenerational OW/OB, including the developmental origins of health and disease hypothesis, socio-ecological model, and social cognitive theory.

Research articles were sought from electronic databases such as PubMed, Web of Science, Scopus, ProQuest, and Google Scholar. The keywords used in the literature search include overweight, obesity, intergenerational obesity, body mass index, maternal obesity, childhood obesity, mother-child pairs, prevalence, trends, associated factors, determinants, obesogenic, dietary behaviours, physical inactivity, obesity-related behaviours, environmental factors, social environment, physical environment, built environment, macro-level environment, low-income households. These keywords were searched individually and in different combinations.