UNIVERSITI PUTRA MALAYSIA

CONTRIBUTION OF MATERNAL FACTORS TOWARDS BIRTH WEIGHT OF FULL-TERM INFANTS IN SELECTED GOVERNMENT HEALTH CLINICS IN KUALA LUMPUR AND SELANGOR, MALAYSIA

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By

MULIANA BINTI EDI

Thesis submitted to School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chair : Chin Yit Siew, PhD
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Birth weight is one of the indicators of suboptimal prenatal growth, which strongly linked to cardio-metabolic condition including central obesity, diabetes mellitus (Type 1 and Type 2), hypertension and heart disease. Foetal adaptation to a poor environment of early life linked with maternal physiological and metabolic changes, which influences the health and illness possibility in later life of infants. Hence, the present study aimed to determine the contribution of maternal factors towards birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor, Malaysia.

In overall, 472 pregnant mothers (29.2±4.2 years) participated in this cross-sectional study. They were interviewed for their socio-demographic characteristics, medical history, obstetrical history, emotional state and dietary intake during their third trimester and eventually followed-up until parturition, to acquire birth outcomes when infants at three-month old. Medical record books of the pregnant mothers also were utilised to cross-check the information obtained. A majority of pregnant mothers were Malay (90.9%), attained tertiary educational level (82.0%), working (68.6%), and earned monthly household income within RM2300 to RM5599 (52.8%), and had a mean household size of 3.9±2.0. About half of the pregnant mothers (52.0%) were disease-free before and during pregnancy. Almost half of pregnant mothers were malnourished before pregnancy (Underweight: 9.7%, Overweight: 25.8%, Obesity: 10.9%). There were one in three pregnant mothers gained either insufficient (32.6%) or excessive weight (28.0%) during pregnancy. The present study found more than half of the pregnant mothers experienced multiple pregnancies (65.0%) and had at least one child (57.4%). Almost all of the pregnant mothers (99.2%) were non-smokers, but 40.5% and 26.2% of them were exposed to smoke in their living house and workplace, respectively. Most of the pregnant mothers started their antenatal care visit during first trimester of pregnancy (71.4%), attended an average of 10.8±3.0 times visit and 16.1% of them were at risk of depression during the pregnancy. Most of the pregnant mothers achieved the recommended intakes of nutrients, except for vitamin A, niacin, folate, calcium, and iron. There was about

9.1% of infants being delivered with birth weight of less than 2.5kg, with a mean weight at birth of 3.0±0.4 kg.

Based on the multiple logistic regression analysis, pregnant mothers who attained tertiary educational level (OR=2.881), with hypertension during pregnancy (OR=11.814), and energy intake more than recommended nutrient intakes (RNI) (OR=1.022), had higher risk of delivering low birth weight infants, while high gravidity (OR=0.798) and calcium intake more than RNI (OR=0.691) reduced the risk of delivering low birth weight infants, which explained 38.5% of the variances in birth weight of infants (χ^2=196.789, $p<0.001$). Hence, women who plan for pregnancy should make sure they have adequate knowledge before pregnancy, maintain healthy blood pressure and have optimal energy and calcium intake as recommended in RNI during pregnancy to deliver a healthy infant.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
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SUMBANGAN FAKTOR MATERNAL TERHADAP BERAT KELAHIRAN BAYI CUKUP BULAN DI KLINIK KESIHATAN TERPILIH DI KUALA LUMPUR DAN SELANGOR, MALAYSIA

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Berat kelahiran merupakan salah satu indikator pertumbuhan prenatal yang sub-optimal, yang berkait rapat secara kuat dengan keadaan kardio-metabolik termasuklah obesiti berpusat, diabetes (Jenis 1 dan Jenis 2), tekanan darah tinggi dan penyakit jantung. Penyesuaian janin terhadap persekitaran yang kurang memuaskan pada awal kehidupan berkait dengan perubahan fisiologi dan metabolik ibu, yang mempengaruhi kebarangkalian untuk mendapat penyakit dalam kehidupan bayi pada masa akan datang. Oleh itu, kajian ini bertujuan untuk menentukan faktor maternal yang menyumbang kepada berat kelahiran bayi cukup bulan di klinik kesihatan terpilih di Kuaa Lumpur dan Selangor, Malaysia.

Secara keseluruhannya, 472 orang ibu hamil (29.2$\pm$4.2 tahun) telah menyertai kajian keratan rentas ini. Mereka telah ditemuramah mengenai ciri-ciri sosio-demografik, sejarah penyakit, sejarah obstetrik, keadaan emosi, lawatan penjagaan antenatal dan pengambilan makanan pada trimester ketiga kehamilan, dan telah diikuti sehingga melahirkan bayi untuk mendapatkan keputusan kelahiran bayi sewaktu bayi berusia tiga bulan. Buku rekod kehamilan ibu hamil digunakan untuk menyemak informasi yang diperolehi. Majoriti ibu hamil berbangsa Melayu (90.9%), mempunyai peringkat pendidikan yang tinggi (82.0%), bekerja (68.6%), berpendapatan bulanan diantara RM2300 hingga RM5599 (52.8%), dan mempunyai purata isi rumah 3.9$\pm$2.0. Kira-kira separuh daripada ibu hamil tidak mempunyai sebarang penyakit sebelum dan semasa hamil. Hampir separuh daripada ibu hamil mengalami masalah malnutrisi sebelum mengandung (Kurang berat badan: 9.7%, Berlebihan berat badan: 25.8%, Obesiti: 10.9%). Tedapat satu daripada tiga ibu hamil meningkatkan berat badan secara tidak cukup (32.6%) atau meningkatkan berat badan secara berlebihan (28.0%) semasa hamil Kajian ini menemui lebih daripada separuh ibu hamil mempunyai pengalaman hamil (65.0%) dan mempunyai sekurang-kurangnya seorang anak (57.4%). Hampir kesemua ibu hamil tidak merokok (99.2%), namun 40.5% dan 26.2% daripada mereka terdedah kepada asap rokok di rumah ataupun tempat kerja. Kebanyakkan ibu hamil memulakan

penjagaan antenatal semasa trimester pertama kehamilan (71.4%), menghadiri lawatan penjagaan antenatal dengan purata 10.8$\pm$3.0 kali dan 16.1% daripada mereka berisiko mengalami masalah kemurungan semasa hamil. Kebanyakkan ibu hamil mencapai jumlah nutrien yang disarankan kecuali untuk vitamin A, niasin, folat, kalsium dan zat besi. Terdapat 9.1% bayi yang dilahirkan dengan berat kelahiran kurang daripada 2.5kg dengan purata berat kelahiran 3.0$\pm$0.4 kg.

Berdasarkan analisis regresi logistik berganda, ibu hamil yang mempunyai pendidikan peringkat tertiari (OR=2.881), mempunyai tekanan darah tinggi semasa kehamilan (OR=11.814), dan pengambilan tenaga melebihi pengambilan nutrient yang disarankan (RNI) (OR=1.022) berisiko tinggi untuk melahirkan bayi kurang berat kelahiran, manakala graviditi yang tinggi (OR=0.798) dan pengambilan kalsium melebihi RNI (OR=0.691) mengurangkan risiko untuk melahirkan bayi kurang berat kelahiran, yang menjelaskan 38.5% variasi dalam berat kelahiran bayi (χ^2=196.789, $p<0.001$). Oleh itu, wanita yang merancang untuk hamil perlulah memastikan diri mereka mempunyai pengetahuan yang mencukupi sebelum hamil, mengekalkan tekanan darah yang sihat dan mengambil tenaga dan kalsium yang optimal seperti yang disarankan di dalam RNI semasa mengandung untuk melahirkan bayi yang sihat.

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LIST OF ABBREVIATIONS

ANC	Antenatal care
AOR	Adjusted odds ratio
AIDS	Acquired immune deficiency syndrome
BMI	Body mass index
BMR	Basal metabolic rate
COR	Crude Odds Ratio
DBP	Diastolic blood pressure
DM	Diabetes mellitus
EPDS	Edinburgh Postnatal Depression Scale
ELBW	Extremely low birth weight
FFQ	Food frequency questionnaire
GATs	Global Adult Tobacco Survey
GDM	Gestational diabetes mellitus
GWG	Gestational weight gain
HBW	High birth weight
IOM	Institute of Medicine
IPH	Institute of Public Health
IQ	Intelligence quotient
IUGR	Intrauterine growth restriction
LBW	Low birth weight
LGA	Large gestational age
MCH	Mother and Child Health
MICOS	Mother and Infant Cohort Study
MLR	Multi logistic regression
NBW	Normal birth weight
NCD	Non-communicable disease
NHMS	National Health and Morbidity Survey
NOC	National Occupation Classification
PTD	Preterm delivery
PTH	Parathyroid hormone
RNI	Recommended nutrient intake
SBP	Systolic blood pressure
SES	Socio-economic status
SGA	Small gestational age
SHS	Second-hand smoke
SLR	Simple logistic regression
UNICEF	United Nations Children's Fund
VLBW	Very low birth weight
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The World Health Organization (WHO) (2004) described birth weight as the weight taken once an infant is born. Live birth infants should ideally be weighed directly after being delivered before any occurrence of postnatal weight loss (WHO, 2012). The WHO (2004) classified birth weight into extremely low birth weight (ELBW) (birth weight <1.0kg), very low birth weight (VLBW) (birth weight <1.5kg), low birth weight (LBW) (birth weight <2.5kg), normal birth weight (NBW) (birth weight in between 2.5kg – 4.0kg), and high birth weight (HBW) (birth weight >4.0kg). In most of the epidemiological studies, ELBW and VLBW were considered as LBW since LBW is referring to infants who were born with less than 2.5kg, while HBW with less than 4.0kg was considered as NBW (Kaur et al., 2019; Latiffah & Hanazchi, 2010; Boo et al., 2008). The birth weight of the infants is one of the parameters that is directly associated with nutritional status and well-being of the mother and infant themselves. There are various biochemical, physiological, psychological changes that evolved during pregnancy, and the adaptation of these changes are strongly influenced by nutrition and health status of the pregnant mothers (Soma-Pillay, Nelson-Piercy, Tolppane, & Mebazaa, 2016). Besides, birth weight is vital determinant associated with survival, development and growth of the infants (Mudhaliar et al., 2017).

LBW (less than 2500g) is known as a public health concern worldwide. According to WHO (2014), there were about 19.3 million and 7 million infants born with LBW in developing and developed countries, respectively, in the year 2000. There are 22.0% of infants were born with LBW in Bangladesh as reported by The United Nations International Children's Emergency Fund (UNICEF), followed by 28.0% in India, 18.0% in Nepal, 32.0% in Pakistan, 17.0% in Sri Lanka, and 22.0% in the Maldives, respectively (UNICEF, 2015). In other words, there is still a high prevalence of infants delivered with LBW in most developing countries than those in developed countries. Meanwhile, in Malaysia, the prevalence of LBW published in the National Health and Morbidity Survey (NHMS) 2016 was 9.6% (Institute for Public Health (IPH), 2016). Although the prevalence of LBW in Malaysia is less than 10.0%, LBW is still the leading cause of death among infants worldwide. WHO (2017a) reported that there were 46.0% of infant's deaths in 2016, and majority of these deaths (75.0%) were caused by LBW. Hence, LBW is a critical health issue that contributes to increase the mortality rate among infants.

LBW was found to be the main factor of adverse outcomes in infants and is associated with both morbidity and mortality of infants (WHO, 2014; Negrato & Gomes, 2013). A pregnant mother who delivers an infant with LBW would bring significant adverse impacts upon herself and her infant. An infant delivered with LBW is more likely to be a sickly infant, has congenital abnormalities, lower intelligence quotient (IQ), cognitive disabilities, under-achieve at school, malnourished, at higher possibility of getting infectious and non-communicable diseases (NCD), poor health status during their

infancy and later childhood, as well as in future adult life as compared to infants with NBW (Kinge, 2017; Triebwasser et al., 2016; Kingston, Heaman, Brownell, & Ekuma, 2015; Valla, Wentzel-Larsen, Hofoss, & Slinning, 2015; Spracklen et al., 2014; Negrato & Gomes, 2013; Pascoe, et al., 2013; Hermann, Dallas, Haskell, & Roghair, 2012; WHO, 2012; Risnes et al., 2011). Besides, LBW infants have a lower quality of life as they suffer from continuous health problems (Baumann, Bartmann, & Wolke, 2016; Dinesen, & Greisen, 2001). The Division of Health Promotion and Disease Prevention reported that parents would be affected as they may have difficulties to take care of their infant due to sleep deprivation, exhaustion, and cost for medication in United Sate (Institute of Medicine (IOM), 1985).

LBW contributes to various kind of acute and chronic health problems to mothers and their infant. Therefore, it is essential to determine factors influencing LBW in order to lessen the incidence of diseases and the financial burden of an individual. Almost all of the observed risks factors leading to LBW can be grouped into before pregnancy and during pregnancy. Early life, which referred as "the window of opportunity", is a critical period, in which pregnant mother who exposed to poor environment and lifestyle would affect the growth and development of infants in their womb (Barker, 1990). In addition, a study conducted by Soma-Pillay et al. (2016) have shown that there are rapid development and growth of the foetus in third-trimester pregnancy compared to first or second-trimester as the demand of nutrients is tremendously increased and various kinds of complication experienced by pregnant mother during this trimester.

Findings from previous studies revealed that LBW is influenced by early life factors such as maternal disease history, nutritional status, and state of depression during pregnancy (Md Reazul et al., 2016; Wado, Afework, & Hindin, 2014; Fosu, Abdul-Rahaman, & Yekee, 2013; Boo & Cheah, 2012; Grote et al., 2010; Ng et al., 2010;). According to Saaka (2012) and Loy (2011) with her colleagues, maternal nutrition intake throughout the pregnancy is also an important indicator of LBW and premature delivery (PTD). Previous studies revealed that the maternal dietary intake adversely affects foetal growth development, especially in the development of organ systems (Bloomfield, Oliver, & Harding, 2006). In addition, LBW may be associated with various kinds of health and socioeconomic problems (Mengesha, Wuneh, Weldearegawi, & Selvakumar, 2017; Sutan, Mohtar, Mahat, & Tamil, 2014; Victora et al., 2008). Hence, a study is needed to determine the determinants of LBW among infants.

1.2 Problem Statement

The Department of Statistics Malaysia (2016b) reported that approximately half a million mothers were pregnant, and more than five hundred thousand infants delivered every year. The recent NHMS IV conducted in Malaysia reported that more than two hundred thousand infants were delivered in the year 2016 and about 10.0% of them were delivered with less than 2500g during the concordant year (IPH, 2016). Meanwhile, few studies conducted in different locations in Malaysia were reported the fluctuated prevalence of LBW which were in between 6.0% to 21.0% (Kaur et al., 2019; Norhasmah et al., 2015; Nurfazlin et al., 2012; Latiffaf & Hanachi, 2010; Boo et al., 2008). This revealed that the prevalence of LBW still exists and remains high in Malaysia. UNICEFF (2015) reported that most infant and child mortality in Malaysia is mainly caused by LBW. By

identifying risk factors causing LBW would address one of the goals in the Sustainable Development Goals (SDGs) 2015 - to lessen infant and child mortality, as well as to improve maternal health in both undeveloped and developing countries (Assembly, 2015). However, there were only less than ten study done to determine the factors associated with LBW in Malaysia, and these studies was aimed to examine the associations between different maternal factors and LBW in which the consistent findings for each factors could not be establish (Kaur et al., Norhasmah et al., 2015, Norsa'dah & Salinah, 2014; Nurfazlin et al., 2012; Rozlan et al., 2012; Latiffaf & Hanachi, 2010; Boo et al., 2008). Considering the seriousness of this issue, the present study intended to determine the prevalence of LBW and factors associated to it.

Socio-demographic characteristics, including age, ethnicity, educational level, employment status, type of resident, marital status, household size and monthly household income, are factors that play a vital responsible in determining the birth weight of infants. In most settings, pregnant mothers who come from the lowest socio-economic status (SES), which is the poorest, least educated, living in the rural area are at the higher risk of delivering LBW infants. Innumerable studies have reported that being a younger (<24 years old) and older (>35 years old) parent, having lower SES would the risk of deliver infant with LBW in Iran (Md Reazul et al., 2016), China (Fan at al., 2015), United States (Young & Declercq, 2010), Brazil (Coutinho, Cecatti, Surita, de Souza, & de Morais, 2009). For instance, Md Reazul et al (2016) and Bhaskar et al. (2015) reported that parents with higher income were more likely to have infants with HBW, whereas studies conducted by Yadav, Chaudhary, and Shrestha (2011) and Kaur et al. (2019) found no significant association between socio-demographic characteristics and LBW. Nevertheless, more studies are required to examine the associations of socio-demographic characteristics with birth weight due to inconsistent relationship between these two variables. There is limited study to examine the association between them conducted in Malaysia.

In addition, the presence of diseases such as anaemia, diabetes mellitus (DM) Type I and Type II and hypertension during pregnancy among pregnant mothers are documented to be associated with lower birth weight. In a case-control study conducted by Bhaskar et al. (2015) in Nepal found that pregnant mothers with medical illness had 2.5 times increase the risk to deliver an infant with LBW compared to pregnant mothers without any medical illness (OR= 2.49, 95% CI: 1.46-4.25). Meanwhile, studies have indicated that pregnant mothers with less haemoglobin concentration and high blood pressure would reduce the birth weight of infants (Bhaskar et al., 2015; Kumari, Guduri, & Venkateswarulu, 2015; Ali, 2012; Steer, Little, Kold-Jensen, Chapple, & Elliott; 2004). There was a local study had been conducted to examine the association between maternal medical history and birth weight (Latiffah & Hanachi, 2010). However, the findings of study conducted by Latiffah and Hanachi (2010) could not be used to reflect the current situation of the Malaysian population. Thus, there is a need to re-examine the association of maternal medical history with birth weight in order to retain the consistent relationship between the variables.

Moreover, LBW is found to be influenced by the maternal obstetrical history. Stimuli during early life such as pre-pregnancy body mass index (BMI), weight gained during pregnancy, number of pregnancies, as well as smoking status during pregnancy were

significantly contributed to LBW (Bhaskar et al., 2015; Coelho et al., 2015; Nurfazlin, Hayati Adilin, Siti Shafura, Ajau Dani, & Khairil Anuar, 2012; Ng et al., 2010). Md Reazul et al. (2016) reported that normal-weight mothers before pregnancy and those who have gained an optimal total gestational weight gain (GWG) during pregnancy would promote the birth weight of infants in Bangladesh. On the other hand, mothers with a high number of pregnancies, children, and had less interval between pregnancies were prone to deliver small birth weight infants (Nazari, Sharifah Zainiyah, Lye, Zalilah, & Heidarzadeh, 2013; Boo & Cheah, 2012). However, there were two local studies that aimed to investigate the association of maternal obstetrical history with LBW (Nazari et al., 2013; Boo & Cheah, 2012). Aside from that, both studies examined different obstetrical history (pre-pregnancy anthropometry measurements vs. parity and gravidity), and the findings were not applicable for generalisation the whole population as the study was conducted in a specific location. In spite of that, the multiple obstetrical histories among pregnant mothers (pre-pregnancy BMI, total GWG, parity, gravidity, smoking status and second-hand smoking (SHS) exposure) are necessary to determine the strongest factor that associated with birth weight.

Maternal enrolment in antenatal care (ANC) visit also plays a role in influencing LBW. A study administered in Nepal by Bhaskar et al. (2015) reported that more LBW infants were born by mothers who started their first ANC visit in the middle and late gestational trimester than mothers who starting their first ANC visit in early trimester of pregnancy. The same study also reported that a higher number of ANC visits among mothers would improve the birth weight. In addition, Md Reazul et al. (2016) suggested that mothers who attended less than four times of ANC visits would reduce birth weight in Bangladesh. On the other hand, Yadav et al. (2011) found no association between maternal enrolment in ANC visit and LBW. Consequently, there is limited published study that have been conducted to explore the association of maternal enrolment in ANC visit with infant's birth weight. Therefore, more study is needed to determine the consistent association between maternal enrolment in ANC visit and birth weight among pregnant mothers especially in Malaysia.

Maternal emotional state in pregnancy was also revealed to be associated with LBW. In a meta-analysis study conducted by Gelaye, Rondon, Araya, and Williams (2016) in low- and moderate-income countries revealed that pregnant mothers with a higher depressive disorder increased the risks of having adverse outcomes that included medical complications during pregnancy, reduce birth weight and PTD as compared with their counterparts. Wado, Afework, and Hindin (2014) in their study among Ethiopian mothers reported that pregnant mothers with antepartum depression had a 1.87-times higher risk of deliver to lower birth weight infants. Most of the published studies were conducted in western countries, while studies that have been conducted in Malaysia were aimed to only examine the prevalence of depression level and its associated factors among Malaysian pregnant mothers (Yusuff, Tang, Binns, & Lee, 2015; Fadzil et al., 2013). Western countries reported that antenatal depression is one of the important factors that may influence foetal growth, development, as well as their birth weight. Hence, there is a need to examine the association between maternal emotional state and birth weight since to understand the underlying mechanism between the variables.

In brief, nutritional status is the balance between food intakes and the normal utilisation of nutrients for growth, reproduction, and health maintenance (Wu, 2010). During pregnancy, there is an increasing demand for nutrients, in which a pregnant mother with

malnutrition might affect the status of nutrition and health among mother and infant (Imdad et al., 2011). Several researches have shown that nutritional intakes in pregnancy would portray a positive correlation with LBW (Bhaskar et al., 2015; Coelho et al., 2015; Loy, Marhazlina, & Hamid Jan, 2013). A prospective follow-up study conducted on 1298 pregnant mothers found a positive correlation between intake of snack and birth weight, after adjustment for socio-demographic characteristics and maternal obstetrical history (Coelho et al., 2015). In Malaysia, Loy et al. (2013) reported that higher fruit consumption by pregnant mothers in pregnancy was positively associated with HBW among infants. However, the contribution of maternal dietary practices during pregnancy on birth weight could not be made due to methodological differences in terms of methods used to assess maternal dietary intakes, and most previous studies tended to focus on single food item rather than macro- and micronutrients. However, to date, there is no published study conducted in Malaysia to examine the association between nutritional intakes (energy and nutrient intakes) and birth weight. It is important to determine the type and amount of nutrients that are important for growth and development of foetus as most of the pregnant mothers need more nutrients to accommodate the demand of growing foetus in their womb. Thus, it is crucial to include the maternal nutritional intakes into the present study to determine the link between nutritional intakes and birth weight among pregnant mothers in Malaysia to further understand the underlying mechanism between the variables.

To conclude, most previous researches have determined the associations between maternal factors and birth weight. However, most of these published studies are from the western countries and factors determined in these western countries might be different from factors associated with birth weight among the Malaysian population due to demographics, cultural practices, and geographical locations (Bhaskar et al., 2015; Coelho et al., 2015; Gebremedhin, Ambaw, Admassu, & Berhane, 2015; Fosu, Abdul-Rahaman, & Yekee, 2013; Boo & Cheah, 2012; Grote et al., 2010). In addition, by including multiple maternal factors in the present study, factors that influence and contribute the most towards LBW can be determine. Therefore, to narrow down the existing research gap, the present study was carried out to determine the current prevalence of LBW and its associated risk factors among pregnant mothers and their full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

1.3 Conceptual Framework

All the variables included in the conceptual framework were obtained from previous researches. Several factors that were documented to be associated with birth weight, act as independent variables include socio-demographic characteristics of parents, maternal medical history, obstetrical history, enrolment in ANC visit, emotional state, and nutritional intakes during pregnancy. Meanwhile, the dependent variable is birth weight, which was categorised into low birth weight and normal birth weight based on WHO classification of birth weight (2004). The conceptual framework shown in Figure 1.1.

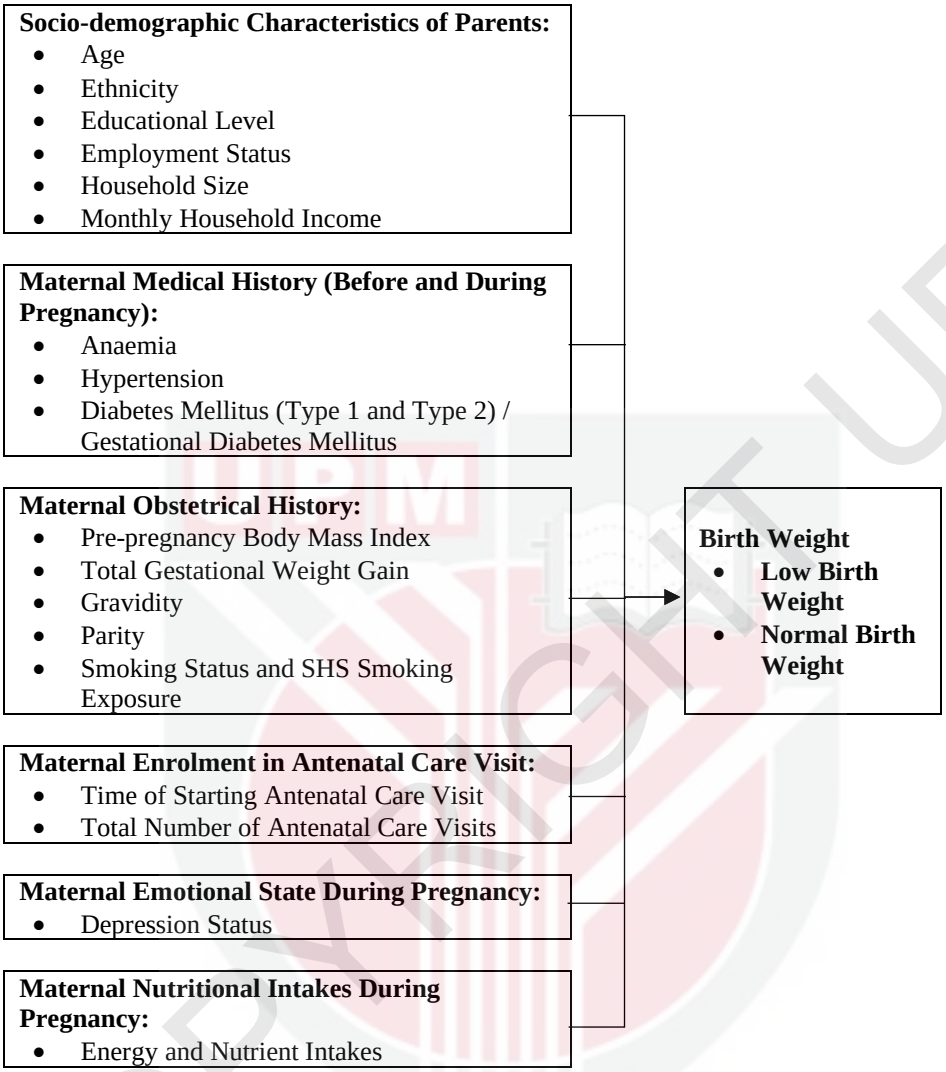

Figure 1.1: The conceptual framework of the study

1.4 Objectives

1.4.1 General Objective

To determine the contribution of maternal factors towards birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

1.4.2 Specific Objectives

i. To assess the socio-demographic characteristics of parents (age, ethnicity, education level, employment status, household size and monthly household income), maternal medical history (anaemia, hypertension, diabetes mellitus (Type 1 and Type 2), gestational diabetes mellitus), obstetrical history (pre-pregnancy BMI, total GWG, gravidity, parity, smoking status and SHS exposure), enrolment in ANC visit (time of starting ANC, total number of ANC visits), emotional state, nutritional intakes during pregnancy among pregnant mothers in selected government health clinics in Kuala Lumpur and Selangor.

ii. To determine the prevalence of LBW of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

iii. To determine the associations of socio-demographic characteristics of parents (age, ethnicity, education level, employment status, household size and monthly household income), maternal medical history (anaemia, hypertension, diabetes mellitus (Type 1 and Type 2), gestational diabetes mellitus), obstetrical history (pre-pregnancy BMI, total GWG, gravidity, parity, smoking status and SHS exposure), enrolment in ANC visit (time of starting ANC, total number of ANC visits), emotional state, nutritional intakes during pregnancy with birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

iv. To determine the contribution of the socio-demographic characteristics of parents (age, ethnicity, education level, employment status, household size and monthly household income), maternal medical history (anaemia, hypertension, diabetes mellitus (Type 1 and Type 2), gestational diabetes mellitus), obstetrical history (pre-pregnancy BMI, total GWG, gravidity, parity, smoking status and SHS exposure), enrolment in ANC visit (time of starting ANC, total number of ANC visits), emotional state, nutritional intakes during pregnancy towards birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

1.5 Hypotheses

i. There are significant associations of socio-demographic characteristics of parents (age, ethnicity, education level, employment status, household size and monthly household income), maternal medical history (anaemia, hypertension, diabetes mellitus (Type 1 and Type 2), gestational diabetes mellitus), obstetrical history (pre-pregnancy BMI, total GWG, gravidity, parity, smoking status and SHS exposure), enrolment in ANC visit (time of starting ANC, total number of ANC visits), emotional state, nutritional intakes during pregnancy with birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

ii. There are significant contributions from socio-demographic characteristics of parents (age, ethnicity, education level, employment status, household size and monthly household income),

maternal medical history (anaemia, hypertension, diabetes mellitus (Type 1 and Type 2), gestational diabetes mellitus), obstetrical history (pre-pregnancy BMI, total GWG, gravidity, parity, smoking status and SHS exposure), enrolment in ANC visit (time of starting ANC, total number of ANC visits), emotional state, nutritional intakes during pregnancy towards birth weight of full-term infants in selected government health clinics in Kuala Lumpur and Selangor.

1.6 Significance of the Study

The present study able to provide information not only on the prevalence of LBW among infants in selected government health clinics in Kuala Lumpur and Selangor, but also able to provide the prevalence of NBW and HBW among infants in study locations. Since there are limited published studies on assessing the current situations of LBW in Kuala Lumpur and Selangor, results of the present study can be used by researchers and healthcare professionals, such as medical doctors, nutritionists and nurses, to recognise the current state of Malaysia in mitigating the prevalence of LBW compared to other developing regions, and initiate new ideas through partnership with other government and non-government agencies to further minimise the incidence of LBW. In addition, the reduction of the prevalence of LBW can lead to a reduction in the prevalence of infant and child mortality rate, as well as reduce malnutrition and diseases in adult life.

LBW is an important factor that influences infant growth, development and their health status during childhood and adult life. Since the problem regarding LBW is still a significant health concern in Malaysia, the present study was conducted and aimed to examine the factors associated with LBW. For instance, the present study included multiple potential factors such as maternal medical history, obstetrical history, enrolment in ANC visit, emotional state and nutrition intakes during pregnancy. Furthermore, the present study able to determine the factors that significantly contribute to birth weight, while narrowing the knowledge gap in this area of interest. Aside from that, the findings from this present study may provide vital information that can be used as a reference to researchers or health professionals specifically nutritionists to understand and manage the factors that contribute the most on birth weight.

As the present study would provide information on factors contributing towards birth weight, health professional specifically nutritionists in both government and non-government sectors can focus on the factors that determined in the present study to design and plan policies, as well as develop appropriate health intervention programmes that are able to improve birth weight among infants. The intervention programmes may incorporate the promotion of healthy lifestyle factors during the course before marriage and the importance of optimal nutritional status to reduce the rate of morbidity and mortality among mothers and infants. Additionally, information on factors associated with birth weight can be disseminated through the mass media to increase the knowledge on factors associated with birth weight. As a result, these efforts will lead to better health status among pregnant mothers and their infants, as well as the development of better health care for populations and improve the economic status of Malaysia.

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BIODATA OF STUDENT

Muliana Binti Edi was born on 20th October 1991 (Sunday) in Sarawak General Hospital. She started her primary and secondary educations in her hometown, Kuching, Sarawak; primary school at Sekolah Jenis Kebangsaan (Cina) Chung Hua Bako (1999-2004) and secondary school at Sekolah Menengah Kebangsaan Bako (2005-2009). After completing her secondary education, she attended pre-university in Module I at Labuan Matriculation College. Besides good academic standing with Biasiswa Kecil Persekutuan Scholarship, she was also active in co-curriculum activities. She was the Head of Academic Prefect, a Librarian, an active member of Red Crescent Association, and one of the leaders from Pembimbing Rakan Sebaya (PRS) Club. In the year 2012, she continued her tertiary education in Nutrition and Community Health at Universiti Putra Malaysia and graduated in 2016 with a second-class honour. She also received the Jabatan Perkhidmatan Awam (JPA) Scholarship and dean award during her study period.

She had various experiences in research. She was a part-time enumerator during her fourth year as a bachelor student in Universiti Putra Malaysia for a research project on body image among undergraduate students in the selected universities. She also worked as a research assistant in Department of Nutrition and Dietetics, Universiti Putra Malaysia for a nationwide research project on the evaluation of the rehabilitation program for malnourished children (Program Pemulihan Kanak-Kanak Kekurangan Zat Makanan-PPKZM) who received the food basket in Malaysia. She was in charge of organizing, planning and collecting data for the whole state of Sarawak. She also worked as a part-time nutritionist in various nutrition events, for instance, Malaysia Breakfast Run and Nutrition Month Malaysia (2015, 2018, 2019). Besides, she loves volunteering in health promotion programs with different target populations for the rural and urban community, as well as the healthy and special-needs community.

She has attended various scientific conferences at the national level, such as Nutrition Society Malaysia (NSM) as a poster and oral presenter as well as international level, such as Asian Congress of Nutrition as an oral presenter. She also participated in numerous seminars and workshops. Recently, she participated in iYouLead Training and Workshop in conjunction with the Asian Congress of Nutrition and received a fellowship from Dupont Grant and Nutrition Society of Malaysia to attend the training in Bali, Indonesia. She is also a member of NSM as well as MASO. She is currently pursuing her postgraduate study in Master of Science in Community Nutrition at University Putra Malaysia. With years of experience in the field of nutrition, she is truly passionate in her work and always aspire to share her knowledge with the community.

LIST OF PUBLICATIONS

Woon, F. C., Chin, Y. S., Ismail, I. H., Batterham, M., Latiff, A. H. A., Gan, W. Y., ... & Chan, Y. M. (2019). Vitamin D deficiency during pregnancy and its associated factors among third trimester Malaysian pregnant women. *PloS one*, *14*(6), e0216439.

Muliana, E., Chin, Y. S., Woon, F. C., Geeta, A., & Lim, P. Y. (2021). Inadequate gestational weight gain and exposure to second-hand smoke during pregnancy increase the risk of low birth weight among full term infants. *IJERPH.* (accepted for publication)

LIST OF PROCEEDINGS

Association between socio-demographic background, physical activity level, and nutritional status with academic achievements among adolescents in Kuching, Sarawak. 31st Nutrition Society Malaysia Conference, Kuala Lumpur, Malaysia (2016)- **Poster Presenter**

Associations between socio-demographic characteristics, medical history, obstetrical history and newborn birth weight among mothers in Kuala Lumpur and Selangor. 33rd Nutrition Society Malaysia Conference, Kuala Lumpur, Malaysia (2018)- **Poster Presenter**

Nutrition during pregnancy and its association with birth weight: findings from the Maternal and Infant Cohort Study (MICOS). 34th Nutrition Society Malaysia Conference, Kuala Lumpur, Malaysia (2019)- **Oral Presenter**

Maternal Obstetrical Factors are Associated with Birth Weight: A Health Clinics-Based Prospective Cohort Study in Malaysia. 13th Asian Congress of Nutrition, Bali, Indonesia (2019)- **Oral Presenter**

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