SLEEP PATTERN, WEIGHT GAIN STATUS AND BODY COMPOSITION OF WOMEN WITH GESTATIONAL DIABETES MELLITUS (GDM) AND HEALTHY PREGNANCY

By

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CONTENT

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SLEEP PATTERN, WEIGHT GAIN STATUS AND BODY COMPOSITION OF WOMEN WITH GESTATIONAL DIABETES MELLITUS (GDM) AND HEALTHY PREGNANCY

ABSTRACT

Pregnancy is the most important and interesting period in women. During the pregnancy period, there were some physical, psychological and biological changes that experienced by the pregnant women. The objective of this study was to determine the association between sleep pattern and nutritional status (weight gain status and body composition measurement) among pregnant women at HUSM. The validated Pittsburgh Sleep Quality Index Malay Version (PSQI-M) questionnaires were distributed to pregnant women aged 20 to 40 years old within their second to third trimester at Obstetrics and Gynecology Clinic, Antenatal Ward Akik and Baiduri at HUSM. The questionnaire measure seven domains; subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction over the last month. The Global PSQI-M score was summed up from all the seven domains and the score range are between 0 to 21. The respondents with Global PSQI-M score less than or equal to 5 are considered having good sleep quality and respondents with Global PSQI-M score more than 5 are considered having poor sleep quality. Anthropometry indicators include pre-pregnancy weight, pre-pregnancy BMI, weight and height during pregnancy, BMI during pregnancy and body composition measurements. Body composition was measured using body composition analyzer (TANITA SC-330GS) and this instrument gives reading of weight, total fat mass, fat mass percentage, fat-free mass, total body water, body water percentage and BMI based on the bioelectrical impedance analysis technology. A total 99 respondents

completed the study. Sixty respondents were in healthy pregnancy and 39 respondents were GDM during pregnancy. There was no significant association between sleep pattern and weight gain status (p=0.782). However, there was a significant association between sleep pattern and visceral fat rating (p=0.037) and there was a significant correlation between sleep pattern and body fat percentage (p=0.011). Thus, this study showed that visceral fat rating and body fat percentage of pregnant women have a strong link with sleep pattern of them than weight gain status.

POLA TIDUR, KADAR KENAIKAN BERAT BADAN DAN KOMPOSISI BADAN DALAM WANITA MENGANDUNG YANG MENGALAMI KENCING MANIS SEMASA HAMIL (GDM) DAN WANITA HAMIL YANG SIHAT.

ABSTRAK

Hamil adalah perkara yang penting dan menarik dalam kalangan wanita. Semasa hamil, wanita akan mengalami beberapa perubaan fizikal, psikologi dan biologi. Kajian ini bertujuan untuk mengkaji hubungan antara pola tidur dan status pemakanan (kadar kenaikan berat badan dan komposisi badan) dalam kalangan perempuan mengandung di HUSM. Soalan Pittsburgh Sleep Quality Index Malay Version (PSQI-M) yang telah disahkan diagihkan kepada wanita hamil yang berumur diantara 20 hingga 40 tahun semasa usia kandungan mereka adalah trimester kedua hingga trimester ketiga di Obstetrik dan Ginekologi (O&G) Klinik, Wad Akik serta Baiduri di HUSM. Soalan soal selidik PSQI-M itu mempunya tujuh bahagian; kualiti subjektif tidur, kependaman tidur, tempoh tidur, kecekapan tidur biasa, gangguan tidur, penggunaan ubat tidur, dan gangguan pada siang hari sepanjang bulan lepas. Skor Global PSQI-M adalah menambahkan kesemua dari tujuh bahagian tersebut dan julat skor adalah di antara 0-21. Responden yang mendapat skor Global PSQI-M kurang atau sama dengan 5, mereka adalah dianggap mempunyai kualiti tidur yang baik dan manakala responden yang mendapat skor Global PSQI-M melebihi 5, mereka dianggap mempunyai kualiti tidur yang kurang baik. Indikator antropometri termasuk berat sebelum hamil, BMI sebelum hamil, berat dan tinggi semasa hamil, BMI semasa hamil dan komposisi badan semasa hamil. Komposisi badan semasa hamil diukur menggunakan penganalisis komposisi badan (TANITA SC330GS) dan instrumen ini memberikan bacaan berat, jumlah jisim lemak, peratusan jisim lemak, jisim bebas lemak, jumlah air dalam badan, peratusan air dalam badan dan BMI. Seramai 99 orang responden telah berjaya menamatkan kajian.

60 orang responden terdiri daripada perempuan hamil yang sihat dan 39 orang responden terdiri daripada perempuan hamil yang mempunyai penyakit kencing manis semasa mengandung (GDM). Tiada hubungan yang ketara diantara polar tidur dengan kadar kenaikan berat badan (p=0.782). Manakala, terdapat hubungan yang ketara di antara pola tidur dan taraf lemak viseral (p=0.037) dan terdapat hubungan korelasi yang ketara di antara pola tidur dan peratusan lemak badan (p=0.011). Oleh yang demikian, kajian ini menunjukkan taraf lemak viseral dan peratusan lemak badan dalam kalangan wanita hamil terdapat hubungan yang kuat dengan pola tidur mereka berbanding dengan kadar kenaikan berat badan.

LIST OF ABBREVIATIONS

GDM	Gestational Diabetes Mellitus
O & G	Obstetrics & Gynecology
HUSM	Hospital Universiti Sains Malaysia
T2DM	Type 2 Diabetes Mellitus
DM	Diabetes Mellitus
PSQI-M	Pittsburgh Sleep Quality Index (Malay version)
US	United States
REM	Rapid Eye Movement
RLS	Restless Legs Syndrome
PPH	Postpartum hemorrhage
IOM	Institute of Medicine

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CHAPTER 1: INTRODUCTION

1.1 Background of study

In women life, pregnancy is one of the most important and interesting periods. It is natural phenomenon that pregnant women will discover major physiological, psychological and social changes during pregnancy (Palagini *et al.*, 2014).

Most of the pregnant women will experience sleep disturbance throughout the pregnancy time within the trimester. According to National Sleep Foundation, 2015, it stated 78% of women said their sleep pattern had been change during pregnancy period. They also mentioned that they felt extremely fatigue, especially during the first and third trimester. This could be by the changing in hormone levels which is rising in progesterone levels is partly show that excessive daytime sleepiness. (National Sleep Foundation, 2015). From that, if the women have a sleep deprivation, it may increase hunger, increase opportunity to eat, alter thermoregulation and increase fatigue (Patel & Frank, 2008). All of these will lead to excessive calorie intake and reduced energy expenditure and at the same time will cause insulin resistance and adiposity. Both of this will make the pregnant women to have an increased risk to get Gestational Diabetes Mellitus (GDM) (Patel & Frank, 2008).

Gestational Diabetes Mellitus (GDM) is one of the types of Diabetes Mellitus (DM). Diabetes can complicate pregnancy, but it is not the major complication of pregnancy (Sreekanthan, Belicita, Rajendran & Vijayakumar, 2014). However, DM is defined as a group of metabolic diseases that occurs because of resistance in insulin secretion, insulin action, or both of it that may lead to hyperglycemia (American Diabetes Association, 2014). Meanwhile, GDM is refers to carbohydrate intolerance that first was diagnosed during pregnancy (Ashwal & Hod, 2015). The carbohydrate metabolism in pregnant women plays an important role to supply glucose and amino acid to the fetus and provide to maternal fuel

extra free fatty acids, ketones, and glycerol (Facco, 2013). However, if the GDM become worst among pregnant women, it will lead to adverse effects to both infants and mothers. In addition, GDM is one of the well-known risk factors that will lead to development of Type 2 diabetes mellitus (T2DM) in future (Khan, Ali & Khan, 2013). GDM has a strong association with increasing serious perinatal morbidities and mortalities, maternal morbidities. For example, the child of gestational diabetic mothers are usually big in size (macrosomic baby) and large for gestational age (Khan *et al.,* 2013).

In future, the various factors of the pregnant women that may become diabetic were: early diagnosis of GDM in pregnancy: need insulin treatment during pregnancy; high blood glucose level; preterm delivery; macrosomic babies; and abnormal oral glucose tolerance test (OGTT) after two months of delivery (Khan *et al.,* 2013). GDM is a disorder that can be monitored and effectively controled by decreasing the high risk factors. Thus, appropriate and proper monitoring and management of GDM will result in better health for neonates and maternal consequences (Khan *et al.,* 2013).

1.2 Problem Statement

GDM is not a new problem among pregnant women. Recent data shows that GDM prevalence has increased by 10% to 100% past 20 years (Ferrara, 2007). Surprisingly, there are ethnic differences in the prevalence of GDM. According to American Diabetes Association, 2007, the prevalence of GDM among Asians and Hispanics was greater than African-Americans and non-Hispanic whites. Furthermore, the population of GDM of Asians women in other countries was higher than the population of Asians women with GDM in Asian countries (Ferrara, 2007). The prevalence of GDM was increased in all age-groups from 1991 to 2000 (Figure 1). Based on Figure 2, the Asian women had the highest prevalence among four others race/ethnicity from 1991 to 2000.

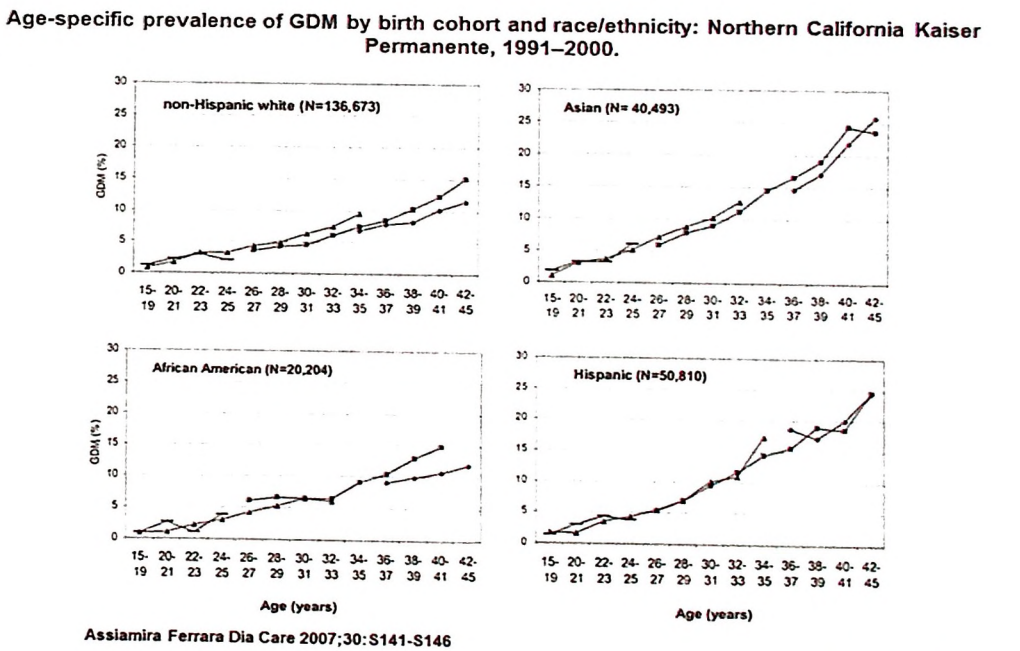

Figure 1.2 (a): Age-specific prevalence of GDM by birth cohort and race/ethnicity: Northern California Kaiser Permanente, 1991, 2000.

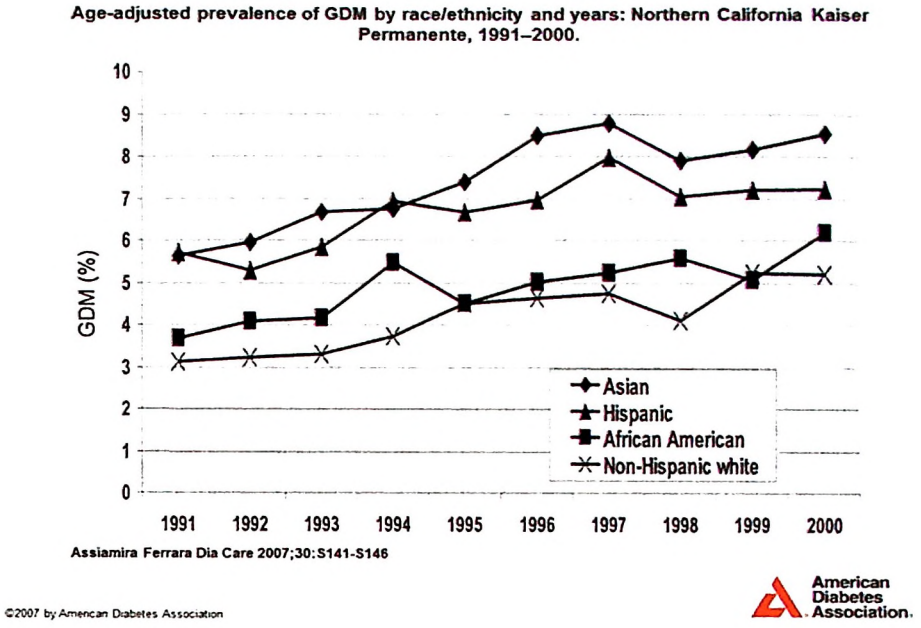

Figure 1.2 (b): Age-adjusted prevalence of GDM by race/ethnicity and years: Northern California Kaiser Permanente, 1991-2000.

In addition, in United States (US), the incidence of GDM was reported as 14% of all pregnancies and the rate were constantly increasing in multi-ethnic populations (Khan *et al.*, 2013). A study from Universiti Kebangsaan Malaysia, Department of Obstetrics and Gynecology, it showed that 76.3% of women were GDM on diet control, 19.8% were GDM on insulin and 4% were pre-existing DM (Nirmala *et al.*, 2013).

1.3 Objectives

1.3.1 General Objective

1) To determine the sleep pattern and weight gain of women with Gestational Diabetes Mellitus (GDM) and healthy pregnancy.

1.3.2 Specific Objective(s)

i. To determine the sleep pattern of pregnant women

ii. To compare the sleep pattern of GDM and healthy pregnant women

iii. To determine the weight gain status of pregnant women with GDM and healthy pregnancy

iv. To determine the body composition of pregnant women with GDM and healthy pregnancy

v. To determine the association between sleep pattern and weight gain status of GDM and healthy pregnant women

vi. To determine the association between body composition and sleep pattern of GDM and healthy pregnant women

1.4 Hypothesis

Hypothesis 1

Null Hypothesis (H_0)

There is no association between sleep pattern and weight gain status of GDM and healthy pregnant women.

Alternative Hypothesis (H_A)

There is an association between sleep pattern and weight gain status of GDM and healthy pregnant women.

Hypothesis 2

Null Hypothesis (H_0)

There is no association between sleep pattern and body composition between GDM and healthy pregnant women.

Alternative Hypothesis (H_A)

There is an association between sleep pattern and body composition between GDM and healthy pregnant women.

1.5 Significance of Study

There are many risk factors that associated with GDM and may affect to neonates and maternal health consequences, it is important to know the sleep pattern status among pregnant women as there are not many local studies investigating sleep pattern and weight gain.

1.6 Conceptual Framework

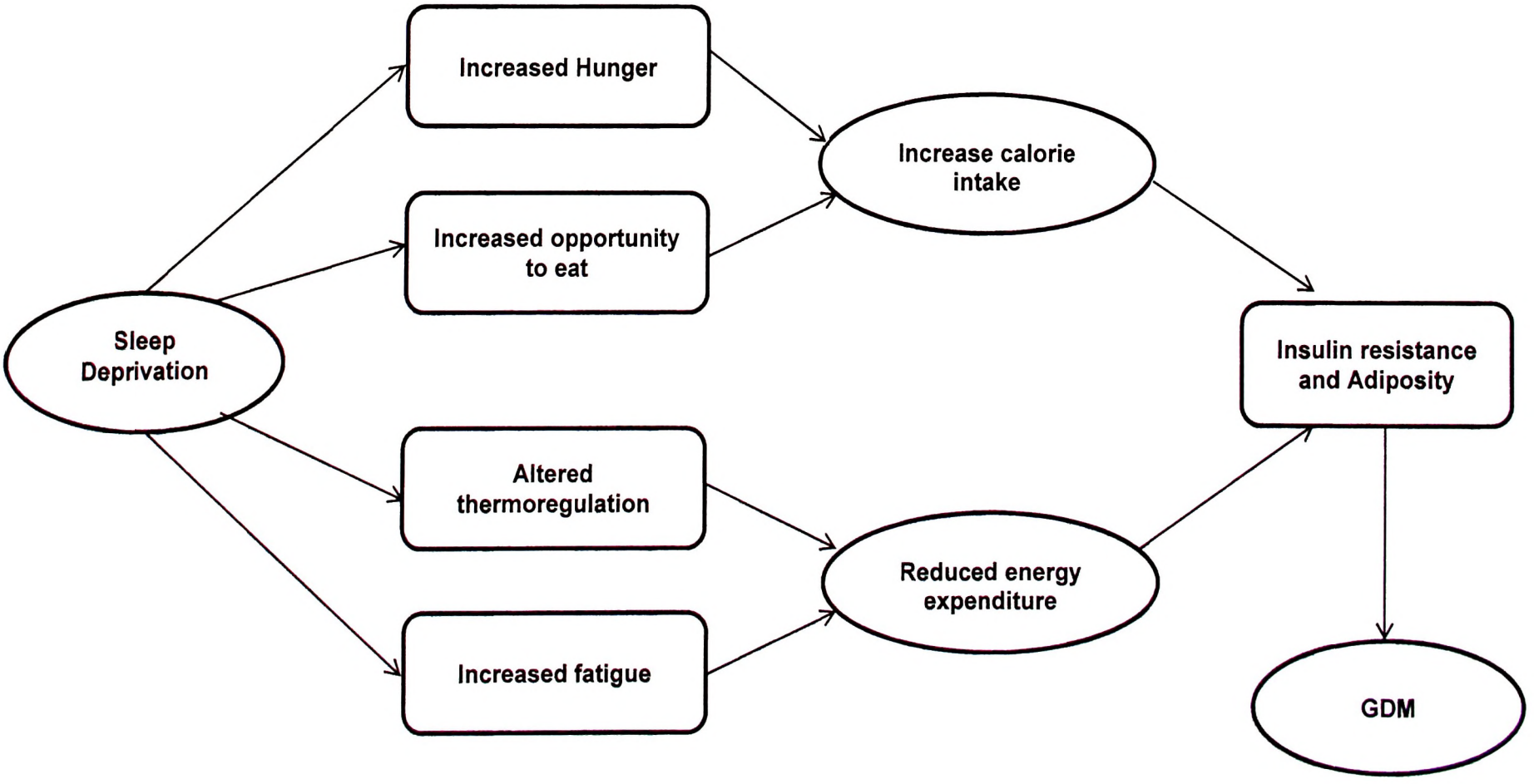

Figure 1.6: Conceptual Framework

Modified from (Patel & Frank, 2008)

CHAPTER 2: LITERATURE REVIEW

2.1 Pregnancy and sleep

2.1.1 Sleep

Sleep is very important in our daily life because it affects our daily functioning and our physical and mental health in many ways (American Sleep Association, 2007). Plus, sleep also is one of the basic and inevitable human daily activities which affect individual life quality and health of individuals with physiological, psychological and social dimensions (Taskiran, 2010). According to Taskiran, 2010, sleep is defined as "the state of the organism, in which environmental interaction is reversible, partially and periodically lost and can be revoked by various external stimuli". During sleeping, our brain is very active at that time.

We usually pass through five stages during sleep: stage 1, 2, 3, 4 and REM (rapid eye movement). Each individual usually were spend almost 50 percent of total sleep time in stage 2 sleep, about 20 percent in REM sleep, and the remaining 30 percent in the other stages. Meanwhile, infants usually spend about half of their sleep time in REM stages of sleep (American Sleep Association, 2007).

Sleep requirement were various that depend on many factors including age, gender, diet, physical activity, health status and other personal factors (Taskiran, 2010). According to National Sleep Foundation, 2015, the new recommendation includes: newborns (0 – 3 months) the sleep range was 14 – 17 hours each day, infants (4 – 11 months) the sleep range were 12 – 15 hours per day, for toddlers (1 – 2 years old) the sleep range were 11 – 14 hours per day. Meanwhile, for preschoolers and school age children (3 – 5 years, 6 – 13 years), the sleep range were between 10 – 13 hours and 9 – 11 hours per day respectively. Next, for teenagers and younger adults, the sleep range were between 8 – 10 hours and 7-9 hours per

day respectively. In adults, the sleep range was 7 – 9 hours and for older adults, the sleep range was between 7 – 8 hours per day.

However, during pregnancy, it had been shown that quality and quantity of sleep among pregnant women has been change (Palagini *et al.*, 2014). The most common sleep problems during pregnancy are sleep restriction, short sleep duration, poor sleep quality, sleep disordered breathing and parasomnias (Palagini *et al.*, 2014). Globally, women tend to have greater risk for sleep disorders than men (Facco, 2013).

2.1.2 Sleep disturbance and pregnancy

Sleep disturbances are frequently occur during pregnancy period (Mindell, Cook & Nikolovski, 2015). Normally, pregnant women will experience short sleep duration within their pregnancy period. There are several symptoms that lead to short sleep duration; insomnia (difficulty falling asleep, waking up too early and feeling not refreshed), restless legs syndrome (RLS) (unpleasant feelings in the legs), sleep apnea (breathing is repeatedly interrupted during sleep) and frequent nighttime urination (National Sleep Foundation, 2015).

Sleep disturbance are associated with pregnancy complications is biologically plausible (Facco, 2013). There are two possibilities; first, sleep disorders are prevalent in early pregnancy and secondly is sleep disturbance is associated with autonomic dysfunction, inflammation, oxidative stress, metabolic dysregulation, endothelial dysfunction and inflammation (Facco, 2013).

One study had documented pregnancy, as well as a trimester-specific that changes in sleep pattern among pregnant women. Usually, during the first trimester, it is common for the pregnant women to increase daytime sleepiness as well as total sleep time (Keffee & St-Onge, 2013). This may due to rising hormones levels. During the second trimester, less time is spent on stage 3 and 4 of sleep and there is a significant decrease in REM sleep (Keffee *et al.,* 2013). Compression of the bladder will increase the uterine size and experience more frequent urination among mothers (Keffee *et al.,* 2013). Mothers will frequently nighttime awakenings and their sleep duration and sleep quality may deteriorate. Backache and itching are most complaints by the mothers during their third trimester. Plus, physical changes that may cause the discomfort to the mothers can impair the ability to fall asleep and maintain the sleep (Keffee *et al.,* 2013).

One survey of 650 pregnant women reported that during their end of pregnancy, they experienced significantly less total hours of sleep from 8.1 hours to 7.5 hours and increased Global Pittsburgh Sleep Quality Index (PSQI) score (18% to 61%). Most of them experienced pain, discomfort, and frequent urination that lead to sleep difficulties and at once increased perceived poor sleep quality (Mindell *et al.,* 2015). In another survey that recruited 189 pregnant women reported that the respondents also have significantly decrease in sleep duration with increased snoring from 11% to 16%, and also increased the symptoms of RLS from 18% to 31% and having poor sleep quality (39% to 54%) (Mindell *et al.,* 2015).

Chronic partial sleep deprivation may lead to reduced physical activity that caused by feelings of fatigue. Plus, it also may lead to neurohormonal effects that will lead to increase in calorie intake (Patel & Frank, 2008). Both of this will cause obesity which characterized on increase in insulin resistance as well as adiposity. As we know, obesity is one of the risk factor that may cause GDM to pregnant women. In addition, previous research stated that, long sleep durations also may lead to increasing weight. So that, both short sleep duration and long sleep duration resulting in U-shaped curved between sleep duration and weight gain (Patel & Frank, 2008).

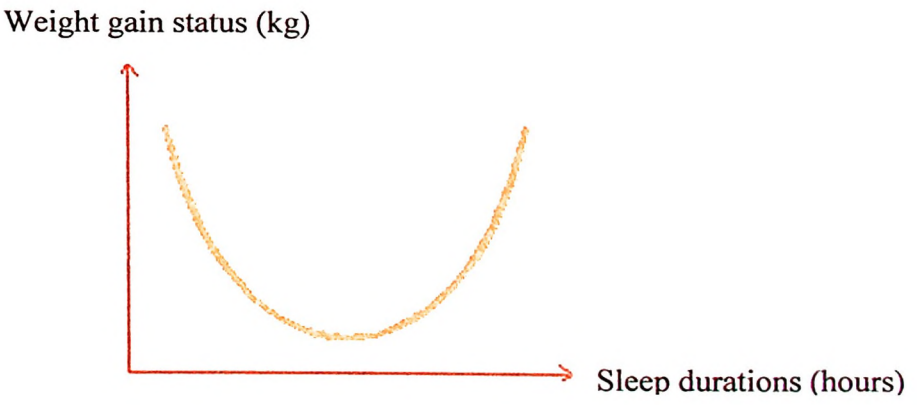

Figure 2.1.2: Relationship between weight gain status and sleep durations

There are some tips to do when people are having sleep disturbance; such as setting a schedule (go to bed at a set time), exercise (daily exercise often helps people sleep), avoid caffeine, nicotine and alcohol, relax before bed, sleep until sunlight, don't lie in bed awake and control rooms temperature (American Sleep Association, 2007). By minimizing the sleep problems, and increase the quality of sleep during pregnancy period, it will help to both neonates and maternal to have healthy pregnancy period (Taskiran, 2010).

2.2 Gestational Diabetes Mellitus (GDM)

Gestational Diabetes Mellitus (GDM) can be defined as glucose intolerance during pregnancy (gestation) (Mumtaz, 2000). Not only give bad effect to mothers, GDM also associated with adverse effects to fetus, neonate, child and adult offspring of the diabetic mother (Ashwal & Moshe, 2015). In addition, GDM can make the pregnant women have some health consequences like increased rate of operative and caesarean delivery, hypertensive disorders and also at high risk of developing type 2 diabetes mellitus (T2DM), as well as obesity, cardiovascular morbidities and can have GDM in future pregnancy (Ashwal & Moshe, 2015). Plus, mothers also may face some implications like increased the rate of cesarean delivery, postpartum hemorrhage (PPH), birth trauma and shoulder dystocia (Ashwal & Mosje, 2015).

GDM is due to insulin resistance and increased the insulin production during pregnancy (Pieczynska & Grajeta, 2015). During the early stages of pregnancy, the maternal blood sugar is lower due to maternal hormones that promote to release the insulin coupled with increasing the peripheral utilization (Mumtaz, 2000). When the weeks of pregnancy increase, the levels of both cortisol and estrogen hormones are also increase that leads to insulin resistance (Mumtaz, 2000). In this situation, only diet or insulin modifications can be used for treatment of GDM (American Diabetes Association, 2003).

Nowadays, GDM is not a new problem among pregnant women. Recent data shows that GDM prevalence was increased by 10% to 100% for the past 20 years (Ferrara, 2007). In United States, GDM was complicates up to 14% of all pregnancies which is about 200,000 cases that major cause of perinatal morbidity and mortality, and also maternal long term morbidity (Ashwal & Hod, 2015).

In addition, there are ethnic differences in the prevalence of GDM which is the prevalence of GDM among Asians and Hispanics was greater than African-Americans and non-Hispanic whites (American Diabetes Association, 2007). In addition, the population of GDM among Asians women in other nation was higher than the Asians women in Asian country (Ferrara, 2007).

Each of diseases has their own risk factors that contribute to the diseases. For GDM, the uniform clinical features with high risk of GDM likes obesity, history of GDM, glycosuria or strong family history of DM, they should go through glucose testing as soon as possible (American Diabetes Association, 2007). If the result at initial screening is negative to GDM, they need to be tested again between 24th to 28th weeks of pregnancy. Meanwhile, pregnancy women that are average risk of GDM should undergo glucose testing at 24th to 28th weeks of gestation and women with low risk of GDM needed no glucose testing (American Diabetes Association, 2007). Besides that, other common risk factors that can lead to GDM are advanced maternal age, high parity, previous delivery of macrosomic infants, maternal short stature and high blood pressure during pregnancy also may lead to GDM (Ashwal & Hod, 2015).

GDM can be control by several treatments like diet & behavioral adjustments, oral hypoglycemic agents (glyburide and metformin), insulin (insulin starting dose, multiple daily injections and continuous subcutaneous infusion), treatment during delivery and also evaluation of treatment (Ashwal & Hod, 2015).

2.2.1 Sleep disturbance and Gestational Diabetes Mellitus (GDM)

GDM were generally developed during 24 – 28 weeks of gestation and be defined as glucose intolerance during pregnancy (Keeffe *et al.,* 2013). When the risk of GDM was increase among pregnant women, it has been parallel by a significant decrease in sleep duration (Keeffe *et al.,* 2013). Reduced in sleep or sleep disturbance among pregnant women were because of the significant metabolic dysfunction, endocrine dysfunction and can adversely impact of glycemic control (Keeffe *et al.,* 2013).

One study reported that participants with both shorter and longer sleep durations were at a high risk of impaired glucose tolerance and diabetes (Gottlieb *et al.,* 2005). However, a study from Coronary Artery Risk Development in Young Adults (CARDIA) mentioned that there was no association between sleep duration and diabetes risk (Knutson *et al.,* 2011). Furthermore, in another study by Bosy-Westphal *et al* (2008), stated that short sleep duration also may decrease insulin sensitivity compared to longer sleep.

CHAPTER 3: MATERIALS AND METHODOLOGY

3.1 Research Design

This research applied comparative cross sectional study design. Through these study design, the comparison between participants that have disease or outcome of interest (cases) with healthy pregnancy participants which do not have any disease or outcomes (controls) was determined.

3.2 Study Location

Data collection was done in three different places in HUSM. The participants were chosen from Obstetrics and Gynecology (O&G) Clinic, 2 Baiduri Ward and 2 Akik Ward. For data collection at O&G Clinic, the time given was on Sunday, Tuesday and Thursday from 8.00am to 12.00pm because the days were specific for antenatal. The remaining days, the data were collected in wards. Average participant for each day was six to seven pregnant women.

3.3 Sample Selection

The participants in this study consists of pregnant women in their late second to third trimester (20 weeks and above). All the participants must meet all the inclusion criteria and exclusion criteria to be eligible for them to join this study.

3.4 Sampling Method

This study's sampling method was convenience sampling method.

3.5 Study Period

The data collection began from early February 2016 until end of April 2016.

3.6 Sample Size

The sample size was calculated by using PS Software. The sample size calculation was performed by using the following inputs:

Power = 80%

Type 1 error probability (α) = 0.05

Standard deviation (σ) = 2.82 (Chaput *et al.*, 2008)

A difference in population means = 1.98

Ratio (m) = 1

Output (n) = 33 participants per group

Drop out compensation of 20% = 7 participants

Sample Size = **40 participants per group**

The sample size population was calculated by using 80% power and the Type I error probability associated with this test of this null hypothesis was 0.05. After considering 20% of dropout rates, the total number of participants for each group was 40 participants. Thus, a total of 80 participants need to be recruited for both pregnant women with GDM and healthy pregnant women.

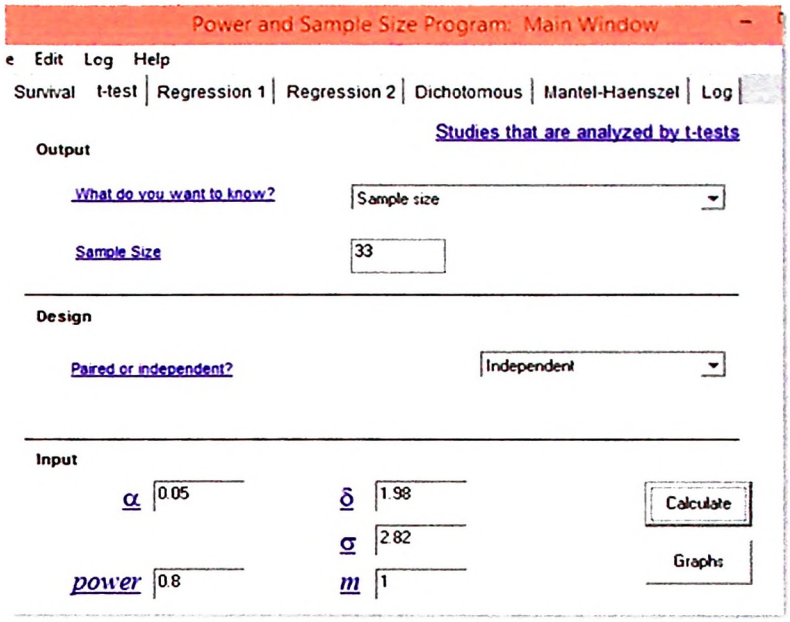

Figure 3.6: A screenshot of sample size calculation from PS software

3.7 Inclusion and Exclusion Criteria

3.7.1 Inclusion Criteria

GDM	Control
i. Malaysian pregnant women	i. Malaysian pregnant women
ii. Pregnant women with GDM	ii. Age between 20 to 40 years old
iii. Age between 20 to 40 years old	iii. The pregnancy was in late second trimester to third trimester (weeks 20 and above
iv. The pregnancy was in late second trimester to third trimester (weeks 20 and above	iv. Singleton pregnancy
v. Singleton pregnancy	

3.7.2 Exclusion Criteria

GDM	Control
i. Pregnant women with pre-existing diabetes mellitus	i. Pregnant women with diabetes mellitus or GDM
ii. High risk pregnancy that determined by O&G specialist	ii. High risk pregnancy that determined by O&G specialist

3.8 Ethical Consideration

3.8.1 Legal Consideration

This study has been obtained authorization from the Human Research Ethics Committee or Jawatankuasa Etika Penyelidikan (Manusia) – JEPeM of Universiti Sains Malaysia, Kampus Kesihatan.

3.8.2 Consent Form (Appendix E)

Consent form is one of the important ethical issues in research based on the principles of autonomy and self-determination. This consent form described the ethical codes and regulations for human subjects for this research. This form needs participants' signatures as a sign that they had read all the principles and agreed to join this study.

3.8.4 Privacy

There is no self-identification needed in the both questionnaires like their name and IC number. Participants might not feel comfortable if their name and IC number are being asked in the questionnaire. Participants were recorded based on their ID number.

3.9 Research Tools and Instrument

3.9.1 Structured Questionnaire

The participants were approached first and interview session was started to obtain information like medical history pregnancy (whether they have DM before pregnancy), gestational weeks of pregnancy and age to ensure that they meet inclusion criteria.

3.9.2 Socio-demographic Questionnaire

The socio-demographic questionnaires were divided into four parts (Part A, B, C and D). Part A is a social background that consist questions about their age, marital status, occupation, income, number of household, education level, address and contact number. In Part B, focused on medical history for participants' family members include mother, father and siblings and also participant's spouse. Plus, in this part also were asked questions regarding menarche age, para, gravida and miscarriage history, gestation weeks, last menstrual period, and is it the participants or family members or spouse are smoking or vaping. For Part C, it was about anthropometry measurements like height, weight (before pregnancy, during pregnancy and at age 20), body fat percentage, muscle mass, body water percentage, BMI (before pregnancy and during pregnancy) Most of the information were obtained from the body composition analyzer (TANITA SC-330GS). Meanwhile in Part D, it was more specific on the supplementation. All the questions had been created in Malay version to ensure the participants can well understand all the questions.

3.9.3 Pittsburgh Sleep Quality Index (PSQI) – Malay Version

The sleep pattern of the participants was determined by using the Pittsburgh Sleep Quality Index Malay Version (PSQI-M). It is an effective instrument used to measure the quality and patterns of sleep that differentiates poor from good sleep by measuring seven domains: sleep quality (component 1, subjective sleep quality in the past month), sleep latency (component 2, time from going to bed until falling asleep; scoring of sleep latency), sleep duration (component 3, scoring of sleep duration), habitual sleep efficiency (component 4, proportions of hours spent asleep in bed), sleep disturbance (component 5, scoring of the frequency of items that relate to sleep difficulties; nocturnal or early morning walking, walking to use the toilet, difficulty breathing, loud coughing or snoring, feeling cold, feeling hot, having bad dreams, and pain or other reasons, including fetal movement or breastfeeding), use of sleep medication (component 6, scoring the frequency use), and daytime dysfunction (component 7, scoring frequency of onset and enthusiasm get things done) (Hayase, Shimada & Seki, 2014). It is a validated questionnaire that had been translated into several languages including the Malay language (PSQI-M) (Zalina *et al.*, 2015).

These PSQI-M questionnaires consist of four open-ended questions and five questions that have scoring. For scoring part, the participants then would choose score rank from 0 – 3 scales. Questions 5 to 8 scales, which were '0 = not during the past month', '1 = less than once a week', '2=once or twice a week' and '3 = three or more times a week'. For question 9, the scale were '0 = very good', '1 = fairly good', '2 = fairly bad' and '3 = very bad'. Then, the score was summed up from all the seven domains to get total score of Global PSQI-M and the score range is between 0 – 21. Thus, respondents with total Global PSQI-M score less than or equal to 5 are considered having good sleep quality while respondents with Global PSQI-M score more than 5 are considered having poor sleep quality.

3.9.4 Body Composition Analyzer

The body composition of pregnant women was measured by using body composition analyzer (TANITA SC-330GS). This instrument gives reading of weight, total fat mass, fat mass percentage, fat-free mass, total body water, body water percentage and BMI based on the bioelectrical impedance analysis technology.

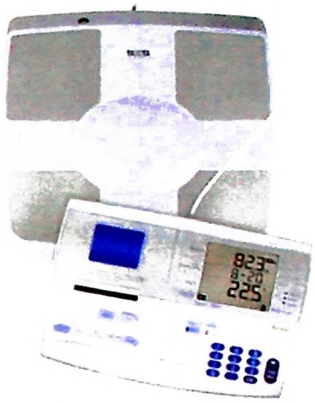

Figure 3.9.4 (a): TANITA Body Composition

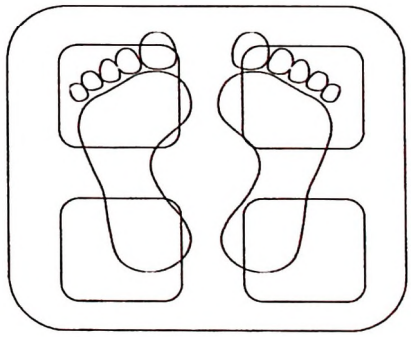

Figure 3.9.4 (b): Correct way to step on TANITA

3.10 Statistical Analysis

All data were compiled, coded and analyzed by using IBM SPSS Statistics Version 22.0 (USA). Descriptive analysis (frequency, mean and standard deviation) were used to determine for numerical variables. To determine the correlation between sleep pattern and weight gain status and between sleep pattern and body composition, Pearson correlation models were used for both hypothesis. In order to determine the association between sleep pattern and weight gain status among pregnant women, Chi-square test model were used. Meanwhile, to determine the association between sleep pattern and body composition status among pregnant women, Chi-square test model also had been used. Plus, to compare the GDM and healthy pregnant women group, Independent t-test were used. At 95% confidence interval was decided to use to accept only 5% of error in rejecting the null hypothesis (H_0). Significant level was set to 0.05 (α=0.05).