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The Effectiveness of a Health Education Intervention on Self-Efficacy for Adherence to  
Healthy Behaviors among Women with Gestational Diabetes

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of  
Philosophy in Nursing

by

Iman Hamdoon Al Hashmi

2017

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## ABSTRACT OF THE DISSERTATION

The Effectiveness of a Health Education Intervention on Self-Efficacy for Adherence to  
Healthy Behaviors among Women with Gestational Diabetes

by

Iman Hamdoon Al Hashmi

Doctor of Philosophy in Nursing

University of California, Los Angeles, 2017

Professor, Felicia S Hodge, Chair

The treatment of gestational diabetes mellitus (GDM) is currently undergoing assessment and revisions to improve pregnancy outcomes of GDM women. Previous studies focused on finding new strategies to decrease the incidence of GDM complications, however, there is insufficient evidence supporting strategies that enhance adherence to healthy lifestyle behaviors among women with GDM.

The purpose of this pre-test and post-test comparative experimental study (control vs. intervention) is to evaluate the effectiveness of a health education intervention on improving gestational diabetes women's self-efficacy for adherence to healthy behaviors and ability for adherence to healthy behaviors. This study was conducted at Sultan Qaboos University Hospital between October 2016 and January 2017, among Omani women with GDM. Standard prenatal care was received by the control group, the intervention group received an additional health education session and a biweekly text messages for 4 weeks. Different self-

efficacy enhancing strategies (e.g., motivational messages, role modeling, goal setting, and mastery experiences) were used to encourage women to maintain the recommended healthy behaviors.

Total of ninety GDM women completed both the pre-test and post-test. At baseline, no significant variances between study groups in relation to self-efficacy for adherence to healthy behaviors ( $t=1.14, p=.62$ ) and adherence to healthy behaviors ( $t=-.80, p=.23$ ) were found. At post-test, the intervention group reported significant improvement in the self-efficacy score ( $M=9.89, SD=19.58$ ) in comparison to the control group ( $M=-1.84, SD=17.58$ );  $t(88)=-2.99, p<.001$ ). The improvement in self-efficacy for adherence to healthy behaviors was not a significant predictor for the improvement in adherence to healthy behaviors ( $B=.01, SE=.01, p=.08$ ), controlling for the group. However, it was found that the improvement in self-efficacy for adherence to healthy behaviors partially mediates the relationship between the group assignment and the improvement in adherence to healthy behaviors. While physical limitations was the primary barrier for adherence to healthy behaviors, participants' concern of GDM-related complications was the top motivator for adherence to healthy behaviors.

The findings from this study demonstrate that the health education intervention significantly improved gestational diabetes women's self-efficacy for adherence to healthy behaviors and their ability for adherence to healthy behaviors. Improved adherence to healthy behaviors should reflect in decreased incidence of GDM-related complications. Future examination of the data is planned that will study its effect on improving pregnancy outcomes of Omani pregnant women with gestational diabetes. Upcoming research should focus on preventing incidence of gestational diabetes through lifestyle modification interventions that incorporates self-efficacy as motivational strategy to improve adherence to healthy behaviors.

The dissertation of Iman Hamdoon Al Hashmi is approved.

Sarah Choi

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## Dedication

I dedicate this work to the love of my life, Mr. Mahmood Al Abri, my little man Ahmed Al Abri, my heavenly parents, Mr. Hamdoon Al Hashmi and Mrs. Fatma Al Rawahi and my brothers and sisters.

## Acknowledgment

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Third, I owe a special thanks to my employer Sultan Qaboos University for honoring me with a full scholarship to pursue my PhD degree. My appreciation also goes to the College of Nursing at Sultan Qaboos University in Oman for the Dean's fund that I received to cover expenses of my research.

Fourth, I contribute my success in doctorate study in particular and my practical life in general, for my heavenly parents and my dearest husband. To my mother, my father, my brothers and my sisters, thank you for your love and for encouraging me to keep up and achieve my dreams. I hope you are proud of my achievement and I wish you all a successful life and a bright future. Lastly, but not the least, I must admit the patience and understanding of my beloved husband for the long time I spent sitting in front of my laptop to complete this dissertation. I am deeply thankful for your love and your persistent support to achieve my dreams. I love you with my heart and soul and I am feeling grateful for having you in my life! I believe on your abilities and I wish you a very luck, courage and strength to complete your master degree successfully. I hope you and my parents know that you are a big motive for succeeding in my doctorate journey.

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1. Seshan, V., Al Khasawneh, E., Al Hashmi, I. (2015). Risk factors of urinary incontinence in women: A literature review. *International Journal of Urological Nursing*.

## **Poster Presentations:**

1. The effectiveness of a health education intervention on self-efficacy for adherence to healthy behaviors among women with gestational diabetes, 4<sup>th</sup> World Congress on Midwifery and Women’s Health, July/ 20-22/ 2017, Melbourne, Australia, Accepted.
2. Concept analysis of self-efficacy, Annual UCLA Nursing Research Days, May/9-10/2017, Los Angeles, USA.
3. The effectiveness of calcium supplementation on reducing risk of hypertensive disorders during pregnancy- A review based on evidence, 1<sup>st</sup> International Conference on Advances in Obstetrics and Gynecology, December /3-6/2013, Muscat, Oman.

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## LIST OF ABBREVIATIONS

GDM	Gestational Diabetes Mellitus
Type 2 DM	Type 2 Diabetes Mellitus
HBM	Health Belief Model
ACOG	American College of Obstetricians and Gynecologists American Diabetes
CDC	Centers for Disease Control and Prevention Type 2 Diabetes
HEI	Health Education Intervention
SMBG	Self-Monitoring of Blood Glucose
OGTT	Oral Glucose Tolerance Test
ADA	American Diabetes Association
IADPSG	International Association of the Diabetes and Pregnancy Study Groups
HAPO	Hyperglycemia and Adverse Pregnancy Outcome
NDDG	National Diabetes Data Group
GCT	Glucose Challenge Test
BMI	Body Mass Index
ACOG	American College of Obstetricians and Gynecologists
HF	High Fiber
LGI	Low-glycemic Index
CS	Caesarean Section
LGA	Large for Gestational Age
WHO	World Health Organization
PI	Principal investigator
UCLA	University of California, Los Angeles
IRB	Institutional Review Board

RCT	Randomized Controlled Trial
SQUH	Sultan Qaboos University Hospital
SDSCA	Diabetes Self-Care Activities Measure
DMSES	Diabetes Management Self-Efficacy Scales
SPSS	Statistical Package for the Social Sciences
PCOS	Polycystic Ovarian Syndrome
OB&GYN	Obstetrics and Gynecology
CVI	Content Validity Index

## CHAPTER I

Gestational diabetes mellitus (GDM) is the leading metabolic problem during pregnancy that shares the same pathophysiology and disease process of type 2 diabetes (Asemi, Samimi, Tabassi, & Esmailzadeh, 2014; Barakat, Youssef, & Al-Lawati, 2010). Worldwide, the prevalence of GDM is increasing, particularly among specific ethnic groups (Nayak et al., 2013; Turki, 2012). In the country of Oman, approximately three percent of Omani pregnant women developed gestational diabetes in 2004 (Barakat et al., 2010). This rate increased to 12.2 percent in 2013 (Al Farsi, Ahuja, & Ali, 2014). Recent studies reported that GDM complicates between 2.7 to 27 percent of all pregnancies based on the population composition and the diagnostic criteria used (Baker & Haeri, 2012; Nayak et al., 2013; Turki, 2012; Shang & Lin, 2014).

Gestational diabetes has been associated with numerous adverse effects influencing the maternal and neonatal health status both at short and long term (Brakat et al., 2010; Sajani, Rahman, & Karim, 2014; Shiraam, Rani, Sathiyasekaran, & Mahadevan, 2013). These adverse effects create an overload on the health-care system budget for prenatal care, intranatal care, baby care, and the prolonged postpartum recovery (Danyliv et al., 2015).

The treatment of choice for GDM includes pharmacological and non-pharmacological interventions. Since individual treatment plans for GDM are highly dependent on the women's active role on controlling her blood glucose level, non-pharmacological interventions are recommended as first line treatments. Non-pharmacological interventions involve self-care through lifestyle modifications (diet and exercise) and self-monitoring of blood glucose level (SMBG) (Holanda et al., 2012). However, women whose blood glucose levels remain high after non-pharmacological intervention often are treated with insulin injections on a daily basis.

Although adhering to a healthy lifestyle is widely recommended for management of GDM, the frequency of GDM complications continue to increase (Odar, Wandabwa, & Kiondo, 2004; Shiraam et al., 2013). Therefore, the treatment of GDM is experiencing significant changes in an attempt to improve pregnancy outcomes of women with GDM. Previous studies focused on finding new interventions such as refashioned dietary advices, individualized education, and dietary supplements to decrease the incidence of GDM complications (Asemi, et al., 2014; Barakat, Pelaez, Lopez, Lucia, & Ruiz, 2013; Bo, 2014; Cao, 2012; Yang, 2014). Numerous studies support the effectiveness of healthy lifestyle behaviors such as diet, exercise and weight gain control in reducing GDM-related adverse outcomes, such as macrosomia, large for gestational age and caesarean delivery (Bo, 2014; Cao, 2012;). However, there is insufficient evidence supporting strategies that enhance adherence to healthy lifestyle behaviors among women with GDM. Researchers agree that treatment of GDM is highly dependent on the active participation of women in maintaining normal blood glucose levels (Carolan, Steel, & Margetts, 2010). Additionally, many studies included self-efficacy as a motivational strategy in the diabetes treatment plan to increase adoption of healthy behaviors such as weight loss, dietary modifications and exercises (Wen, Shepherd, & Parchman, 2004; Bas, & Donmez, 2009). Evidence suggests that higher perception of self-efficacy is linked to increased adherence to healthy behaviors (Chen, & Lin, 2010).

The purpose of this study is to evaluate the effectiveness of a health education intervention (HEI) on improving GDM women's self-efficacy, and adherence to healthy behaviors in a population of Omani women with GDM. The experimental design utilized a pre- and post-test testing of an intervention administered to two groups of women with GDM (control vs. intervention). It is hypothesized that providing a comprehensive HEI to women with GDM

will enhance their self-efficacy for adherence to healthy behaviors and thus increase their adherence to healthy behaviors (specifically healthy diet, exercise and self-monitoring of blood glucose [SMBG]).

## **BACKGROUND AND SIGNIFICANCE**

### **Prevalence of Gestational Diabetes Mellitus**

Gestational diabetes is the most common metabolic problem that occurs during pregnancy (Lindsay et al., 2015). GDM complicates between 2.7 to 27 percent of all pregnancies based on the population composition and the diagnostic criteria used (Baker & Haeri, 2012; Nayak et al., 2013; Shang & Lin, 2014; Turki, 2012). Globally, GDM prevalence is growing, and this growth is particularly true in ethnic groups. The highest incidence of GDM (27%) is reported in India (Nayak et al., 2013). The Canadian Diabetes Association (2008) reported a lower percentage of GDM in Canada; a rate ranging between 8 and 18 percent. In the United States (U.S.), approximately 14 percent (200,000 cases) of pregnancies develop GDM annually (Poomalar, 2015). In China, the percentage of GDM has increased from 2.3 percent in 1999 to 8.1 percent in 2012, nearly a threefold increase (Leng et al., 2015). On the other hand, at 2.7 percent, the lowest GDM percentage is in the country of Saudi Arabia (Turki, 2012).

### **Pathophysiology and Risk Factors of Gestational Diabetes Mellitus**

Gestational diabetes mellitus (GDM) is defined as glucose intolerance with onset or first recognition during pregnancy, and generally reverts to normal in the postpartum period (Carlson, Steel, & Margetts, 2010). Gestational diabetes has the same physiological process as type 2 diabetes, and is characterized by insulin resistance. During pregnancy, specifically the second and third trimesters, insulin resistance occurs as a result of the insulin desensitizing effects of the placental hormones and maternal adipose tissues to meet increased glucose demand for fetal

growth and development (Buchanan & Xiang, 2005). It is thought that the placental hormones and the maternal adipose tissues inhibit insulin function that transfers the blood glucose into the cells, leading to the accumulation of high blood glucose level in the bloodstream (Buchanan & Xiang, 2005). In normal pregnancy, the beta pancreatic cells compensate for the insulin resistance by increasing insulin production. However, in abnormal cases, the pancreatic beta cells are not able to compensate for the insulin resistance (Buchanan & Xiang, 2005). As a result, a state of hyperglycemia or elevated blood glucose level will occur, and this is called gestational diabetes.

Risk factors associated with increased risk of developing gestational diabetes among pregnant women include modifiable and non-modifiable risk factors (Carlon et al., 2010). Advanced maternal age ( $\geq 25$  years) and family history of diabetes mellitus are the most common reported non-modifiable risk factors for GDM (Nayak et al., 2013; Sajani et al., 2014; Saxena et al., 2011). Other non-modifiable risk factors include increased parity, nonwhite ethnicity, and polycystic ovarian syndrome. Modifiable risk factors include obesity (BMI  $\geq 30$  kg/m<sup>2</sup>), previous history of GDM, or a history of having a macrosomic baby (birth weight  $> 4,000$  g) (Han, Crowther, Middleton, & Heatley, 2013). Obesity has been reported in several studies as the most common modifiable risk factor for GDM (Baker & Haeri, 2012; Carlon et al., 2010; Roy, Morin, Cousineau, & Rey, 2012; Saxena et al., 2011). Given this information, it is imperative to recognize that the growing rate of maternal obesity worldwide is linked to the increasing incidence of GDM and its related complications (Artal et al., 2007). Studies have documented that obesity could be managed effectively through the adherence to healthy lifestyle behaviors, such as maintaining a healthy diet, exercising, and losing weight (Artal et al., 2007; Turki, 2010), therefore, attention to maternal obesity and steps to reduce obesity is encouraged.

## Screening and Diagnosis of Gestational Diabetes Mellitus

Screening for GDM among pregnant women uses universal screening methods or selective screening. Worldwide, there is a debate among experts regarding which approach is best to use. A concern has arisen that selective screening, which is performed on high-risk pregnant women, might lead to missing up to 30 percent of the GDM cases (American Diabetes Association [ADA], 2015). Therefore, the ADA (2015) recommends using selective screening only for populations where the prevalence of GM is less than 3 percent. Pregnant women at a higher risk of GDM may be screened for undiagnosed GDM at the first antenatal visit, however, GDM screening and diagnosis typically occur between the 24th and 28th week of gestation using a one-step or two-step approach.

In the one-step approach, the diagnostic test of GDM requires a 75 g oral glucose tolerance test (OGTT) administered between 24 and 28 weeks of gestation on pregnant women who were not diagnosed with overt diabetes previously. In these cases, the GDM diagnosis is considered if the women met at least one of the cutoff values set by the International Association of the Diabetes and Pregnancy Study Groups (IADPSG) criteria (fasting  $\geq 92$  mg/dl, 1 h  $\geq 180$  mg/dl, 2 h  $\geq 153$  mg/dl) (ADA, 2015). Using the one-step approach was expected to significantly increase the diagnosis of GDM from 5 percent to 15 percent because of the reliance on one abnormal value (ADA, 2015). The Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study, a multinational cohort study with approximately 25,000 enrolled pregnant women, informed that there is no threshold for the occurrence of GDM-related complications among women with GDM (ADA, 2015). Based on this finding, this study proposed new diagnostic criteria for GDM called IADPSG.

The most recent recommendation from the ADA is to follow the two-step approach for GDM screening. Experts from ADA supported this recommendation due to the lack of the evidence supporting the benefit of the one-step approach. In addition, there is the potential for over diagnosing pregnant women with GDM, leading to the possibility of increased medical interventions and costs (ADA, 2015). In the two-step approach, a non-fasting 1h, 50 g glucose challenge test (GCT) is performed initially followed by fasting 3h, 100 g OGTT if the results of the first step are abnormal ( $> 140$  mg/dl). Using the National Diabetes Data Group (NDDG) criteria, a GDM diagnosis is then made if at least two values from the following four readings exceeded the cutoff values of fasting=105 mg/dl, 1h=190 mg/dl, 2h=165 mg/dl, 3h=145 mg/dl (Poomalar, 2015). Table in Appendix A illustrates diagnostic criteria for GDM that are available worldwide.

### **Management of Gestational Diabetes Mellitus**

The primary goal of GDM management is to maintain glycemic control in order to have healthy pregnancy outcomes. Based on the fifth international workshop conference of the ADA about GDM, the recommended glycemic targets using the maternal capillary blood glucose concentration are preprandial  $\leq 96$  mg/dl, 1h postprandial  $\leq 140$  mg/dl, and 2 h postprandial  $\leq 120$  mg/dl (Poomalar, 2015). Most often, the treatment of GDM focuses on nutritional counseling by a registered dietician with the aim to maintain the recommended glycemic targets, gain adequate weight, prevent ketosis, and contribute to healthy pregnancy outcomes. Dietary advice is based on a woman's body mass index (BMI) and caloric needs during pregnancy (American College of Obstetricians and Gynecologists [ACOG], 2013). Generally, the recommended dietary advice given to women is carbohydrates restriction (33%–40 %) from the total caloric intake of 1,900–2,400 kcal/day, with the remaining calories being distributed

between fat (40%) and protein (20%) sources. In some cases, however, pharmacological interventions, such as oral hypoglycemic or insulin prescription are added later to the treatment plan if the initial treatment plan unsuccessfully maintained blood glucose levels within normal ranges (ACOG, 2013).

### **Adverse Effects of Gestational Diabetes Mellitus**

Elevated blood glucose levels presented in GDM women have various maternal and neonatal adverse effects observed at short and long-term periods. In the short-term period, GDM women are at increased risk of necessitating a caesarean delivery, developing preeclampsia, and having pregnancy-induced hypertension. Moreover, they are at greater risk of developing type 2 diabetes mellitus in the future (Brakat et al., 2010; Shiraam et al., 2013; Turki, 2010).

Gestational diabetes has also been associated with infant adverse effects such as macrosomia (birth weight > 4 kg), shoulder dystocia, bone fracture, birth trauma, nerve palsy, hypoglycemia, neonatal jaundice, and respiratory distress syndrome (Shiraam et al., 2013; Turki, 2010). Over time, these infants are more likely to develop obesity and type 1 diabetes mellitus during their childhood (Shiraam et al., 2013; Turki, 2010). Furthermore, a recent study completed by Danyliv et al. (2015) reported that the care provided to GDM women is associated with an extra cost of approximately \$864.38 for each pregnancy as well as an extra cost of \$719.44 post pregnancy. Over time, these additional costs will create an overload on the health-care budget for the care provided for GDM mothers and their newborns during the prenatal, intranatal, and postpartum period.

## STATEMENT OF THE PROBLEM

### Gestational Diabetes Mellitus in Oman

According to Brakat et al. (2010), three percent of Omani pregnant women experienced GDM complications in 2004. More recently, Al Farsi, Ahuja, and Ali (2014) published a prospective study that measured the prevalence of GDM among 120 Omani pregnant women in the city of Sohar. The results demonstrated that 12.2 percent of Omani pregnant women developed GDM. The average age of the GDM women ranged from 18 to 44 years (Al Farsi et al., 2014). The majority of women completed a secondary education (46%) or obtained a diploma (22.5%). The results indicated that 85.8 percent of the study participants had a family history of type 2 diabetes, and 53.3 percent had a prior history of GDM. Furthermore, the Al Farsi (2014) study showed that 85 percent of the subjects reported that they were aware of GDM complications. However, when further analyzing reported GDM experiences and awareness of GDM complications, the study found that 92.2 percent of the subjects with a prior history of GDM were aware of GDM complications, while only 76.8 percent who had GDM for the first time were aware of its complications. One possible explanation for this finding is that during the disease process, the mothers with GDM had a chance to learn more about GDM, therefore, their GDM awareness level increased over time as compared to newly diagnosed women with GDM. The Al Farsi study (2014) showed that only 45.8 percent of Omani pregnant women with GDM were interested in controlling their weight by diet, 6.7 percent were interested in weight control with exercise, and only 13.3 percent were interested in using both diet and exercise to control their weight. It is important to understand that GDM treatment is highly dependent upon the active participation of the women. Maintaining the glycemic target is essential in order to have healthy pregnancy outcomes. GDM management will not be achieved successfully, and the

prevalence of GDM-related complications will continue to increase, if the GDM woman indicates a lack of interest in following the recommended GDM treatment regimen. Although the Al Farsi study (2014) was conducted in a small city in Oman and the results are not generalizable, the findings are informative and may be instrumental in guiding future studies.

### **STUDY AIMS**

This study was designed to evaluate the effectiveness of a health education intervention based on the health belief model administered to Omani women with GDM. The study sought to increase women's self-efficacy to adhere to healthy behaviors (e.g. healthy diet, exercise and weight control) thus improving adherence to healthy behaviors. A clinical trial utilizing an experimental design was implemented that gathered pre- and post-test measures which were compared to two groups of GDM women (control vs. intervention).

The specific aims of the study are to:

1. Measure the difference in self-efficacy pre and post health education among intervention and control group.
2. Investigate the impact of improved self-efficacy on improvement in adherence to healthy behaviors.
3. Determine the relationship between improvement in adherence to healthy behaviors and women's demographic variables.
4. Determine the barriers and cue to action to adhere to healthy behaviors.

We hypothesized that providing a comprehensive health education intervention for GDM pregnant women will promote self-efficacy for adherence to healthy behaviors, and increases adherence to healthy behaviors.

## **SUMMARY**

This experimental study sought to improve self-efficacy, and adherence to healthy behaviors by developing and testing a comprehensive GDM health education intervention for Omani pregnant women with gestational diabetes. The study was conducted in Oman among pregnant women with GDM aged 19 - 43 years. The effectiveness of a health education intervention that incorporates aspects of GDM knowledge and self-efficacy provided much needed information on the acceptance and adherence to healthy behaviors in areas of diet, exercise and weight control. This study has implications for improving pregnancy outcomes for maternal and neonatal complications over time.

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## **CHAPTER II**

### **CONCEPTUAL FRAMEWORK**

#### **Health Belief Model (HBM)**

The Health Belief Model (HBM) is a middle-range theory proposed in the 1950s by a group of social psychologists as a means to examine the factors that hinder individual engagement in preventative health behaviors, such as tuberculosis screening and polio vaccination (Rosenstock, Strecher, & Becker, 1988). Eventually, this model expanded to address individual responses to the existing health problems and possible treatment interventions (Davidhizar, 1983). Nowadays, the HBM is one of the most widely used theoretical frameworks in health promotion and disease prevention programs. In nursing research studies, the HBM model was used to explain and predict active participation in numerous healthy practices, such as exercise (Fallon, Wilcox, & Ainsworth, 2005; Schwarzer et al., 2007), diet (Hamuleh, Vahed, & Piri, 2010; Schwarzer et al., 2007), condom use (Hiltabiddle, 1994), oral health (Solhi, Zadeh, Seraji, & Zadeh, 2010), compliance with asthma regimen (Becker et al., 1987), and adherence to interventions (Jones, Smith, & Llewellyn, 2014). Relative to women's health problems, the HBM has been used to address breast cancer and cervical cancer screening (Tanner-Smith & Brown, 2010). The application of the HBM, however, among women with GDM is not well documented.

#### **Theoretical Assumption of the Health Belief Model**

The main focus of the HBM model is the subjective belief of the individual rather than the individual's experience (Thomas, 1995). The model posits one's beliefs may serve as motivators that enhance readiness or as barriers that hamper readiness to undertake the healthy behaviors (Thomas, 1995). The HBM is grounded on the belief that (a) the individual adheres to

healthy behaviors to prevent disease basically if he believes that he is vulnerable to a particular disease, (b) believes that the disease has serious complications, (c) believes that the disease is preventable, (d) believes the effectiveness of taking behavior to avoid disease, and (e) believes on his/her abilities to successfully implement the recommended behavior (Thomas, 1995).

### **Concepts of the Health Belief Model**

The HBM is ordered into three groups: (1) individual perceptions, (2) modifying behaviors, and (3) likelihood of taking action to illustrate the impact of the model concepts in the individual's readiness to actively engage in healthy behaviors (Rosenstock et al., 1988). Figure in Appendix B illustrates the visual relationship between the concepts of the HBM. There are six concepts that are recognized in the HBM as strong and influential factors that determine the individual's decision whether to adhere to the healthy behaviors (Rosenstock et al., 1988). These concepts include: perceived susceptibility to disease, perceived severity of disease, perceived benefits of health behavior, perceived barriers to health behaviors, cues to action, and the newly added concept, self-efficacy (Rosenstock et al., 1988). *Perceived susceptibility* is one's belief that he/she is at higher risk to develop a particular disease, which stimulates engagement in healthy behaviors to prevent the disease. *Perceived severity* is one's belief of the serious complications related to having the disease or leaving it not treated. *Perceived benefit* is one's belief in the efficacy of undertaking the recommended health behaviors to avoid disease. *Perceived barriers* are one's belief about the obstacles related to implementing the recommended behavior (Hiltabiddle, 1994). *Cues to action* refer to the triggers that stimulate or assist the individual in the decision-making process about whether to adhere to the health behavior. The cues to action triggers can be internal triggers like physiologic factors or external triggers like the knowledge received from the health-care providers (Hamuleh, Vahed, & Piri, 2010). This

asserts the essential role that the health education interventions may play in motivating individuals to engage in health-related behaviors. *Self-efficacy* is the individual's belief in his ability to effectively perform the recommended behavior (Hiltabiddle, 1994).

The HBM suggests that there are modifying factors, which indirectly affect the main six concepts of HBM. *Modifying factors* refer to the individual's characteristics, including demographic variables, structural variables, and psychosocial variables that influence the individual's perceptions of health-related behaviors. Demographic variables involve gender, age, ethnicity, race, economic status, and educational level. Structural variables include knowledge about the particular disease and earlier contact with that disease. Psychosocial variables include the type of personality, social class, and pressure from the reference group (Rosenstock et al., 1988). These personal characteristics mediate the relationship between the concepts of the HBM and the probability of taking the behavior. For example, GDM women who have a higher level of knowledge about gestational diabetes will have a higher perceived vulnerability to GDM, and this will significantly impact the adoption of healthy behaviors.

### **Application of the Health Belief Model to Guide the Study**

To meet study aims, the HBM was selected as an appropriate theory to guide the study on hand about the effectiveness of a health education intervention on enhancing GDM women's self-efficacy, and adherence to the recommended healthy behaviors among Omani pregnant women with GDM. Its theoretical base directed the development of a health education intervention designed to increase GDM women's self-efficacy for adherence to healthy behaviors, appreciate the effectiveness of healthy lifestyle behaviors in decreasing GDM complications, and increase self-care measurements undertaking by GDM women in order to

prevent GDM-related complications. Improved self-care measures are translated into improvement in adherence to the recommended healthy behaviors (e.g., weight management, diet, and exercise) and self-monitoring of blood glucose (SMBG) levels. In applying the HBM in the study, it was asserted that women with GDM with a higher degree of perceived threat (perceived susceptibility plus perceived severity), higher degree of self-efficacy, higher degree of perceived benefit of preventative behavior, and lower degree of perceived barriers are more likely to adhere to healthy behaviors, keeping in mind that the perceived benefit of health behavior should outweigh the perceived barriers to that behavior. The barriers that hamper women's adherence to healthy behaviors were recognized to provide the essential support for the women with GDM to overcome such barriers. Moreover, different self-efficacy enhancing strategies (e.g., motivational messages, role modeling, goal setting, and mastery experiences) were reinforced in the educational sessions to motivate GDM women to adhere to the healthy lifestyle behaviors.

## **CONCEPT ANALYSIS OF SELF-EFFICACY**

### **Defining Self-Efficacy**

In the Longman Dictionary of Contemporary English online (n.d.), efficacy is defined as “the ability of something to produce the right result”. The Oxford Dictionaries (n.d.) yields almost a similar definition for efficacy, which is “the ability to produce a desired or intended result”. However, self-efficacy is not defined in these two dictionaries. The history of self-efficacy begins in 1977 with Bandura's social cognitive theory. Self-efficacy is considered one of the core concepts of the Social Cognitive Theory (Cheraghi, Hassani, Yaghmaei, & Alavi-Majed, 2009). Bandura defines self-efficacy as “beliefs one holds in one's capabilities to

organize and execute the courses of actions required to produce given attainments” (Montigny & Lacharite, 2004). In this respect, the definitions of efficacy offered by the above dictionaries are the closest match between definitions of efficacy and Bandura’s definition of self-efficacy. Self-efficacy is a situation specific that deals with the judgment that one has the ability to produce a desired outcome. In Bandura’s work (1977, 1986) self-efficacy is described in terms of efficacy expectations and outcome expectations. Efficacy expectations suggest the belief that one can achieve specific behavior. Unlike the efficacy expectations, the outcome expectations deal with the potential consequences that certain behaviors are likely to produce (Maibach & Murphy, 1995).

### **Significance of Self-Efficacy**

According to Bandura, the sense of self-efficacy has a great impact on how people think, feel, behave, and motivate themselves to accomplish certain behaviors (Maibach & Murphy, 1995). Thus a high sense of self-efficacy enhances person’s cognitive process and performance in a variety of situations, this involving setting personal goals and quality of decision-making. For example, the greater the level of perceived self-efficacy the person has, the greater the goal challenges the person sets for himself and, therefore, the greater the level of commitment to achieve the goals. Successful goal achievement in turn increases the perceived level of self-efficacy and motivates the person to pursue more complicated goals. In contrast, repetitive goal failures decrease a person’s perceived self-efficacy and consequently lead to avoidance of certain behaviors in which they felt challenged (Robb, 2012). In terms of feeling, a low sense of self-efficacy is linked with developing stress, anxiety, helplessness, and depression. Also, those individuals have low self-esteem, and they become more pessimistic about their achievements and personal growth and development. In terms of behaviors, self-efficacy has a strong

influence on people's choice of certain behaviors. The level of self-efficacy influences level of motivation the person has, so self-efficacy can increase motivation or hamper it. Beliefs of self-efficacy determine an individual's motivation level, which reflects how much effort the individual will exert in an endeavor and how long he will persevere in the face of obstacles (Bandura, 1982).

### **Related Concepts to Self-Efficacy**

Related concepts are terms that demonstrate a relationship to the concept of interest, but have different attributes. The literature review indicates that self-esteem, self-confidence, locus of control and generalized self-efficacy are the most common concepts related to self-efficacy (Maibach, & Murphy, 1995). Unlike self-efficacy, self-esteem refers to individual feeling of self-worthiness or self-value. Self-efficacy is concerned about one's perception of ability to attain a specific goal rather than the general perspective of what an individual thinks about oneself. Obviously, the two concepts have distinct attributes. The other related concept is self-confidence, which refers to the individual's perception of being competent to attain expectations of a particular role. It is related to an individual's belief that he knows how to do a particular activity and can make it happen. Self-confidence is learned over time, and it develops through frequent reinforcement of positive behaviors. On the contrary, self-efficacy is concerned with the judgments of what a person is able to do with certain skills rather than the skills one has. In addition, self-efficacy is connected to a particular situation in a specific field, which cannot generally be sensed (Zulkosky, 2009). For example, a patient may feel competent to walk 15 minutes per day but not certain about walking 1 hour per day. For this reason, this person demonstrates a high level of self-efficacy when walking 15 minutes per day but a lower level of self-efficacy when walking 1 hour per day. It is evident that the self-esteem and self-confidence

are concepts related to the personal characteristics, and they have a constant influence on the person's behavior. In contrast, self-efficacy has a temporary influence on the individual behaviors that is only related to a specific situation or specific task and not generally sensed (Zulkosky, 2009). Locus of control is also one of the terms that have been confused with the meaning of self-efficacy. Locus of control deals with the individual's perception about controlling the situation affecting him or her. Locus of control is more concerned about perceived association between action and the outcome while self-efficacy is concerned whether one is able to perform the desired behavior. The final related term is generalized self-efficacy, which refers to the belief in abilities across all behavioral domains. However, it is clear that it is different from self-efficacy, which deals about behavior specific to situations (Maibach & Murphy, 1995).

### **Attributes of Self-Efficacy**

Concept attributes are defined as the consistently recurring characteristics of the concept of interest that helps to clarify it further and distinguish it from other concepts. These attributes are the one that make the concept unique from others. The literature review revealed that the defining characteristics of individuals who have high level of self-efficacy are (a) having a strong personal belief to master certain activity, (b) having perceived capability or confidence to perform the required behavior for goal achievement; and (c) having sustained efforts and ability to cope successfully with stress or environmental stimuli. Accordingly, the major underlying attributes of self-efficacy involve confidence, skills or perceived capability, outcome and persistence (Montigny & Lacharite, 2004).

## **Antecedents of Self-Efficacy**

Antecedents are the factors that take place before the incidence of the concept and influence its occurrence (Robb, 2012). Bandura identified the major sources of information for self-efficacy that are: vicarious experience, enactive attainment, verbal persuasion and physiological state (Bandura, 1982). Vicarious experience or modeling refers to the visual experience of a person when he/she sees others are successfully performing similar behaviors. As a result, this experience encourages the person about his ability to perform the same behavior successfully. Enactive attainment or mastery is based on the experience the person has, and it is considered the most influential source of self-efficacy information. It is attained by successful demonstration of the required behavior in many occasions. Verbal persuasion is a verbal reinforcement that is given by other to encourage one of his specific capabilities to achieve the desired behavior. However, this source of information is not as effective as enactive attainment or vicarious experience to increase the level of self-efficacy. The last source of self-efficacy information is the physiological state. This information includes that which occur as a result of a stressful situation such as fatigue, fear, pain and shortness of breath. Individuals with high arousal during a stressful event tend to have low self-efficacy to perform certain behaviors. Therefore, the identified self-efficacy antecedents are relevant knowledge, personal real experience, role modeling and a person's emotional status. So, in order to gain the perception of self-efficacy, the individual has to observe someone else performing the behavior successfully, perform the desired behavior or skill successfully, and get positive feedback after completing the task. All of these sources of information must occur before one's sense self-efficacy.

## **Consequences of Self-Efficacy**

Consequences are outcomes that follow concept occurrence (Robb, 2012). The consequences of self-efficacy are reliant on one's perceptions of the event, behavior desired, and judgment of his abilities of performing the required behavior. As a result, after the development of the self-efficacy, one of the following may happen. First, an individual with high levels of self-efficacy decides to perform the behavior because he believes his abilities to accomplish the desired goal. This is enhanced by imagining successful outcomes rather than thinking about negative outcomes. Second, an individual with low self-efficacy decides not to perform the behavior because he thinks he cannot attain the goal. Or, perhaps the individual performs the required behavior after positive verbal encouragement. For example, someone convinces the individual that he can succeed in achieving the desired goal (Robb, 2012).

## **Use of Self-Efficacy among GDM Women**

To date, the role of self-efficacy is not well documented in GDM in relation to lifestyle modifications. However, the reviewed literatures revealed that the concept self-efficacy has received mounting recognition as a strong predictor of health promoting behaviors. Numerous research studies used self-efficacy for diabetes prevention and management plans, including dietary modification, weight loss, and physical activity. The majority of these studies reported that participants who had a higher level of self-efficacy were able to lose more weight compared to those who had low self-efficacy (Chen et al., 2010). In examining the role of self-efficacy on exercise behaviors, Neupert et al., (2009) reported that higher self-efficacy is predictive of engaging in and maintaining regular exercises among older adults. Also, the concept of self-efficacy gained adequate attention in research studies in relation to controlling diabetes. It was reported that both efficacy expectations and outcome expectations were linked to a healthy

lifestyle plan, and it was found that the efficacy expectations is a determinant for following such a plan. Since it is well known that GDM is one type of diabetes, the above findings implicated that self-efficacy can be incorporated into health education programs to enhance lifestyle modification among women with GDM and subsequently, may decrease incidence of GDM-related complications.

### **Implications of Self-Efficacy in Nursing Practice**

Self-efficacy has many implications for nursing practice. In nursing practice, self-efficacy can be a key to encourage patients for learning health promotion and disease prevention behaviors. Learning a new behavior is facilitated mostly by a combination of different strategies such as observing a role model, practicing the skill until confidence is gained and by getting positive feedback. For example, to enhance a patient's adherence for insulin injection, the nurse should first demonstrate for the patient insulin administration VIA step-by-step instruction. This demonstration serves as a mean to increase patient confidence in his ability to perform insulin injection for himself. Then after demonstration, the patient should repeatedly practice until he masters the skill and gains the confidence. The successful administration of insulin injection will enhance patient's self-efficacy (Robb, 2012).

### **Assumptions**

The main assumption in this study is that health promotion of healthy behaviors is the key to improve the quality of health and to eliminate the burden of diseases experienced by underserved populations. For example, women with GDM at high risk for having caesarian delivery, pregnancy induced hypertension and developing type 2 diabetes in the future (Brakat et al., 2010; Shiraam et al., 2013; Turki, 2010). So, encouraging those women to adhere to healthy behaviors during pregnancy has a great impact on improving pregnancy outcomes and improving

their quality of life as well (Artal et al., 2007). The second assumption is that optimizing people's health status is a fundamental nursing role; therefore, nurses are obligated by profession to promote health status for all citizens, specifically underserved populations such as women who often live in environments that lack caring and supportive advocates. Part of the health advocacy method to health promotion, nurses should assess the health risk factors on each individual and determine the obstacles that hinder the individual ability to get involved in health-promotion activities. Finally, self-efficacy is the key predictor of behavior change that should have adequate attention on any health education programs (Chen et al., 2010; Neupert et al., 2009).

### **Conclusion**

In conclusion, it was illustrated in the above discussion how self-efficacy is an imperative concept to acquire as it has significant influences on people's thinking, feeling, motivation and performance. Literature review revealed that self-efficacy has been used widely and consistently as a model to examine health-promoting interventions in different areas such as physical activity, weight loss, dietary modification, and compliance with prescribed medications. This concept plays a vital role in developing advanced nursing practice since promotion of healthy lifestyle and risk reduction is the major role of advanced practice nurses. In nursing practice, examining the concept of self-efficacy will assist nurses to identify its key attributes and, therefore, enable them in decision-making during nursing caring. Also, it was recognized that the concept analysis process is an essential part of the generation of nursing knowledge. By defining and extensively analyzing the concept of self-efficacy, nursing researchers will add valuable knowledge to the nursing discipline. Additionally, concept analysis of self-efficacy will provide a theoretical foundation for future studies about significant approaches that enhance self-efficacy.

In diabetes research studies, self-efficacy has been identified as a crucial indicator of successful adherence to healthy behaviors and diabetes control. However, the role of self-efficacy in enhancing lifestyle modifications among gestational diabetes pregnant women is not well documented. Despite the fact that a great deal of work has been done to maximally decrease the prevalence rate, little is done in nursing research to assess the effectiveness of high self-efficacy in enhancing self-care activities and adherence to healthy behaviors among GDM women. In gestational diabetes, self-care is a crucial point in the management plan in order to decrease maternal and neonatal complications. Relevant knowledge and coping strategies are not adequate for GDM women to enhance adherence to healthy lifestyle: rather, they need a perceived outcome expectation, positive reinforcement, high level of confidence, and determination to attain the desired goal. Accordingly, future nursing researchers should be focused on interventions that enhance perceived self-efficacy among GDM women. Also, there is a need to develop a tool that reflect all of the identified attributes of self-efficacy and match it specifically for pregnant women with gestational diabetes. Evidence showed that role modeling and positive reinforcement by healthcare providers increases patients' self-efficacy effectively. Although other antecedents of self-efficacy, including personal experience, relevant knowledge, and family support can shed significant light on these interventions: however, they have not been tested empirically and they need to be documented by future research.

## **REVIEW OF THE LITERATURE**

A search of the literature was performed in February 2015 using the PubMed, CINAHL and electronic databases. The following criteria were included in searching research studies: published in peer-reviewed journals during the last 10 years (2005 to 2015), written in English language, involved human female subjects in the reproductive age, and had the primary aim of assessing different strategies or interventions in decreasing incidence of GDM-related complications (at least one complication of interest) among GDM pregnant women. Systematic reviews and articles that included male subjects or animals were excluded. The keywords used in the search process included educational strategies, improved pregnancy outcomes, treatment, pregnancy, GDM, gestational diabetes, lifestyle, diet, exercise, maternal outcomes, and fetal and neonatal outcomes.

### **Literature Review Results**

The literature search identified 14 studies that met the inclusion criteria and were considered for this review. The article selection process is illustrated in the Figure in Appendix C. In the reviewed articles, the intervention group received a combination of various strategies or only one strategy that was compared to the control group (received routine antenatal care or placebo). Of the 14 studies reviewed, seven experimental studies reported effects of particular dietary advice (Asemi, Samimi, Tabassi, & Esmilazdeh, 2014; Castilla et al., 2013; Crowther et al., 2005; Landon et al., 2009; Louie et al., 2011; Perera et al., 2009; Sugiyama, 2014), one trial described the impact of regular exercises (Barakat, Pelaez, Lopez, Lucia, & Ruiz, 2013), and four studies evaluated combination of different lifestyle modifications (Artal, Catanzaro, Gavard, Mostello, & Friganza, 2007; Bo, 2014; Cao et al., 2012; Yang et al., 2014). Moreover, one study examined supplementation of vitamin D (Asemi, Karamali, & Esmailzadeh, 2014), and one

study evaluated supplementation of probiotics (Lindsay et al., 2015). Insulin treatment was considered in most of these studies if the glycemic target was not achieved after using these strategies. Detailed information pertaining to the study aim, sample, and setting, method, and results of all of the reviewed studies are described in Table 2. Assessment of risk of bias was performed in each study by considering eight domains. These domains included randomization, double-blinded, powered sample size, appropriate statistical analysis, adequate intervention period, managed violation in assumptions of statistical tests, controlled for confounding factors and co-intervention. Each domain was assigned one point, where a total score of  $\geq 5$  indicate low-moderate risk of bias and a total score of  $< 5$  indicate moderate-high risk of bias.

### **Effectiveness of Dietary Advice**

Seven experimental studies evaluated the effectiveness of various dietary advices on improving maternal and neonatal outcomes of GDM women that were considered for this review. Dietary advices employed in these studies include low-sodium diet, low-to-moderate carbohydrates diet, low-glycemic index diet, and high-fiber diet (Asemi, et al., 2014; Landon et al., 2009; Louie et al., 2011; Perera et al., 2009).

Altogether, five dietary advice studies showed a statistically significant effect on decreasing incidence of at least one of the GDM-related complications (Asemi, et al., 2014; Crowther et al., 2005; Landon et al., 2009; Perera et al., 2009; Sugiyama et al., 2014). In a recent randomized controlled trial (RCT) by Asemi, Samimi, Tabassi, and Esmilazdeh (2014), the results revealed that consumption of low-sodium diet for four weeks significantly lowered risk of a caesarean section (CS), macrosomia rate, and need for insulin treatment. Low-sodium diet included fruits, vegetables, whole grains, low-fat dairy products, reduced amounts of saturated fats, and a total of 2,400 mg/day sodium. Similarly, Landon et al. (2009) conducted a

single-blinded RCT study and found that combination of dietary counseling, nutrition therapy, and self-monitoring of blood glucose (SMBG) had a significant effect on reducing risk of preeclampsia rate, CS delivery, macrosomia rate, and large for gestational age (LGA). Furthermore, the intervention group had a significant lower weight gain in comparison to the control group ( $p < .001$ ) (Landon et al., 2009). Unfortunately, specific dietary recommendations were not reported in this study. A quasi-experiment with historical control study conducted by Perera et al. (2009) found that the risk of having a baby with low birth weight (birth weight  $< 2,500$  g) was significantly lower among GDM women who received medical nutrition intervention than GDM women in the control group. Medical nutrition therapy in this study consisted of moderate carbohydrate intake (40%–45%), SMBG, and individual nutrition counseling. Compliance rates were acceptable, and 73.1 percent of the intervention participants were adherent to the recommended dietary advice. A double-blinded RCT by Crowther et al. (2005) reported that GDM women who received individualized dietary advice and instructions about SMBG had a significant reduction in the incidence of serious perinatal adverse effects ( $p=.01$ ) as compared to those women who received routine prenatal care. Serious perinatal adverse effects included neonatal death, shoulder dystocia, bone fracture, and nerve palsy. Finally, Sugiyama et al. (2014) reported evidence of a significant lower rate of LGA and lower maternal weight gain in a retrospective study that tested, diet therapy alone or with combination of SMBG and insulin( if needed) in comparison to the control group that received routine antenatal care. A multiple logistic regression analysis revealed that both the pre-pregnancy BMI and weight gain during pregnancy were independently correlated with the incidence of LGA (Sugiyama et al., 2014).

It is of interest that two dietary-based studies were unsuccessful in improving any of the maternal and neonatal outcomes of GDM women (Castilla et al., 2013; Louie et al., 2011). Castilla et al. (2013) conducted a study in Spain that resulted in no statistical difference between the low-carbohydrate group and the control diet group in terms of the maternal and neonatal outcomes. Similarly, Louie et al. (2011) reported no statistical difference between the low-glycemic index diet (LGI) group and the high-fiber diet (HF) group in relation to the incidence of macrosomia, caesarean delivery, blood glucose level, hemoglobin A1c, and need for insulin therapy.

Basis of the data reviewed above, the evidence regarding the most suitable dietary advices for GDM women to improve their pregnancy outcomes remains unclear. Dietary advices were diverse the results were inconsistent across studies, and the diversity of population composition and the heterogeneity of the subjects' inclusion criteria among these studies make it difficult to draw a definite conclusion. Additionally, there is inconsistency in the diagnostic criteria employed for GDM diagnosis across these studies, in which pregnant women with various degrees of hyperglycemia have been included. Two of the studies used ADA criteria for GDM diagnosis (Asemi, et al., 2014; Perera et al., 2009), one used the 2006 National Diabetes and Pregnancy Clinical Guidelines (Castilla et al., 2013), one used World Health Organization (WHO) diagnostic criteria (Crowther et al., 2005), one used Australian Diabetes in Pregnancy Society criteria (Louie et al., 2011), one used the Society of Obstetrics and Gynecology criteria, and one did not have clear information about diagnostic criteria used for GDM diagnosis. In addition, women's adherence to suggested dietary advice may have a considerable impact on the effectiveness of specific dietary behaviors. Only one study reported women's compliance to the recommended dietary advice resulting in improved findings (Perera et al., 2009). In contrast,

Perera et al. (2009) employed a mixed population of women with GDM and women with type 2 diabetes, but compliance to the dietary advices among the subgroup of women with GDM was not reported, making it difficult to evaluate adherence. Furthermore, women's interest to specific dietary advice and readiness to change their dietary behaviors were not considered in the two unsuccessful studies, which may have biased the final outcomes. Changing dietary behaviors may be challenging especially during a short period of time during pregnancy. Therefore, it is essential to support and encourage GDM women during the new intervention to enhance adherence and to overcome barriers.

The quality of the above evidence and the risk of bias varied across these studies. Two out of the five trials that reported a significant effect on improving pregnancy outcomes had a low-to-moderate risk of bias (Asemi, et al., 2014; Crowther et al., 2005), and three had moderate-to-high risk of bias (Landon et al., 2009; Perera et al., 2009; Sugiyama et al., 2014). In relation to the studies that were not successful in improving pregnancy outcomes in GDM women, one had low-to-moderate risk of bias (Castilla et al., 2013) and the other one had moderate-to-high risk of bias (Louie et al., 2011). Numerous factors may have contributed to increased risk of bias among these studies, such as the study design, length of the study, and the statistical analysis used. Because of the nature of the study design, two of the studies were not double-blinded, and they lacked random assignment of the subjects to the treatment, which limits the validity of the final outcomes (Perera et al., 2009; Sugiyama et al., 2014). All of the five studies that reported some improvement in the pregnancy outcomes had a short intervention period that contributed to underestimation of the true results (Asemi, et al., 2014; Crowther et al., 2005; Landon et al., 2009; Perera et al., 2009; Sugiyama et al., 2014). Also, all of the five studies that reported significant effect included women who are receiving insulin treatment,

except in one study (Asemi et al., 2014). Taking into the account that insulin has a hypoglycemic effect, it might work as a co-intervention that overestimates the true results. However, both of the two trials that had a negative impact on improving pregnancy outcomes included women on insulin treatment, and this minimizes the risk of insulin as a confounding factor. Furthermore, all of the studies, except the study by Crowther et al. (2005), did not control for the influence of the subjects' demographic characteristics in the statistical analysis, which may work as a confounding factor and therefore increases bias on the final estimates resulted from the analysis. Finally, only two studies clearly stated that normality of distribution had been checked, and both reported significant improvement in the pregnancy outcomes (Asemi et al., 2014; Landon et al., 2009).

### **Effectiveness of Exercise Advice**

One double-blinded RCT study's objective was to evaluate the effectiveness of regular exercise in reducing the risk of GDM-related complications in GDM women (Barakat et al., 2013). The study found that a moderate-intensity resistance and aerobic exercises (3 days/week, 25–30 min/session) had a considerable impact on reducing macrosomia rate, decreasing percentage of caesarean delivery and on restricting weight gain. More than 95 percent of the subjects were adherent to the training sessions, thus explaining the significant results. However, this study had a moderate-to-high risk of bias. One of the potential biases is found in the group's allocation was not blinded to the project staff, thus increasing the likelihood of information bias. Another possible source of bias was no clear information about checking for normal distribution of the continuous variables. Also, it was not clear if the assumptions of the statistical tests used for data analysis were checked and if violations were corrected. Uncorrected violations may lead to incorrect interpretation of the final results. Overall, the studies reviewed above suggest that

moderate exercises (3 days/week, 25–30 min/session) have a promising positive effect on reducing GDM-related complications.

### **Effectiveness of Dietary and Exercise**

There were four randomized controlled trials discovered in the literature search that examined the efficacy of mixed strategies, such as diet, exercise and SMBG on improving the maternal and neonatal outcomes of GDM women (Artal et al., 2007; Bo, 2014; Cao et al., 2012; Yang et al., 2014). Generally, all of the four studies showed a beneficial effect on limiting the incidence of at least one of the GDM-related complications. The majority of the subjects in the four studies were Caucasian and Asian. In a non-double-blinded RCT study, Bo (2014) found that the exercise intervention applied either alone or in combination with the behavioral intervention had a significant effect in reducing incidence of caesarean section, HbA1c, postprandial glucose, and large for gestational age in comparison to the diet intervention and behavioral intervention. Behavioral advice provided to study participants included oral and written advice to assist the participant with healthy dietary choices. Cao et al. (2012) demonstrated that intensive treatment regimen had a significant impact on reducing frequency of premature delivery, neonatal admission to neonatal intensive unit, and average birth weight. Comparably, Yang et al. (2014) found that lifestyle interventions had a significant impact on reducing macrosomia rate, LGA, and infant Apgar at one minute less than seven. Surprisingly Yang et al. (2014) study showed that lifestyle interventions lead to a significant increase in the risk for preeclampsia. Taking into the account that women who received lifestyle modifications (diet and exercise) in this study had a significant higher rate of achieving target physical activity in the past month (30 min/time,  $\geq 7$  times/week) than the diet group, this brings to our attention the risk that combines overdoing physical activities during pregnancy. Furthermore, the results

of the Artal et al. (2007) study showed that the exercise intervention limited weight gain among obese GDM women, but it did not have any significant difference in relation to the gestational age at delivery, need for caesarean delivery, and infant birth weight. One possible explanation is that Artal et al. (2007) considered subjects' preference in the assignment to the exercise group, and this may explain the significant limited weight gain among the exercise group. On the other hand, there are several factors that could contribute to non-significant findings in Artal's study. One factor is having too many missing data for the infant birth weight, gestational age at delivery, and delivery method in both groups, which may lead to bias in the estimates resulting from the analysis. However, it was found that the subjects who experienced weight gain were at higher risk for having macrosomic babies in comparison to those subjects who had weight loss or no weight change (Artal et al., 2007).

Overall, it is important to note that the above findings are based on limited data, generated from RCT studies that had moderate-to-high risk of bias, and caution should be considered when interpreting the results. The above studies varied in their population composition and diagnostic criteria used for GDM diagnosis. Also, because of the nature of the pregnancy, none of these studies had an adequate intervention period which increases underestimation of the results. Except for the study completed by Artal et al. (2007), all three studies have a risk for co-intervention from insulin treatment affecting the validity of the results. All of the four studies, except the study by Cao et al. (2012), share the risk of information bias because of not blinding outcome assessors, and this increases risk of reporting positive results. Furthermore, only the study by Bo (2014) controlled for the subjects' age, baseline metabolic activity, and pre-pregnancy body mass index in the data analysis, and this increased confidence on the final estimates resulting from the analysis.

In light of the above limitations, the data appear to be consistent in reporting low macrosomia rate, low for large for gestational age, and low caesarean delivery experiences among GDM women who received lifestyle modifications compared to women who received routine antenatal care. For example, Cao et al. (2012) used WHO criteria for GDM diagnosis and his findings were consistent with Yang et al. (2014) who used the IADPSG criteria. In conclusion, the evidence support the efficacy of dietary advices combined with moderate exercises and SMBG in decreasing the incidence of GDM-related complications.

### **Effectiveness of Dietary Supplements**

Studies that examined dietary supplements have found some impact in recommended areas of GDM outcomes. The evidence found in one double-blinded RCT study indicates that consumption of vitamin D supplement had a significant impact on reducing incidence of polyhydramnios, neonatal jaundice, and newborn admission among GDM women compared to the placebo supplement (Karamali, Asemi, & Esmailzadeh, 2014). This study was a response to the accumulating evidence regarding the association between abnormal glucose levels and vitamin D deficiency (Karamali et al., 2014). In general, this study had a low to moderate risk of bias. One of the potential biases introduced in this study is the risk for confounding factors because of the fact that women in the control group may get vitamin D from other sources, such as sun exposure and fortified food with vitamin D. However, there was no significant difference between vitamin D group and placebo group in relation to vitamin D intake. The serum 25-hydroxvitamin D level was significantly higher among vitamin D group, indicating the low risk of confounding factors on the final results. Overall, it appears that supplementation of GDM women with vitamin D has a promising effect on reducing GDM-related adverse effects.

A newly emerging evidence surrounds the potential metabolic effect of probiotics supplementation. A recent double-blinded placebo-controlled RCT revealed that the probiotic supplementation did not have a significant effect on improving the maternal metabolic values or improving the pregnancy outcomes of GDM women (Lindsay et al., 2015). One possible explanation for the non-significant findings could be due to the high dropout rate (18%) after starting the treatment, which may cause underestimation of the true results.

### **Gestational Diabetes in Oman**

Relative to the incidence of GDM-related complications experienced by Omani women with GDM, only one study was found whose objective was to evaluate the adverse effects of gestational diabetes among Omani pregnant women with GDM. This retrospective study, among 510 Omani pregnant women, found that 26 percent of the Omani women with GD were at higher risk of a caesarean delivery compared to non-GDM healthy pregnant women (Barakat et al., 2010). The findings revealed that Omani women with GDM complications were three times more likely to give birth to a macrosomic baby (birth weight > 4 kg). In addition, 22.07 percent of infants born to GDM mothers were at higher risk of having Apgar score < 7 at one minute compared to only 10.20 percent of infants born to healthy mothers. Furthermore, the study showed that these infants were at increased risk for admission to the intensive care unit because of birth asphyxia and respiratory distress. Again, the results of this study have limited generalizability because the study was conducted in a small city in Oman. Furthermore, this study has a risk for selection and information bias because the source of the data was derived primarily from medical records.

## Summary of the Reviewed Literature

Gestational diabetes is a worldwide metabolic problem that has negative maternal and neonatal effects, primarily observed at short term periods. With a significant advancement in medical care, the incidence of GDM complications is no longer acceptable. In light of the literature reviewed, various interventions have been used to evaluate their effectiveness in relation to improved maternal and neonatal outcomes among GDM women. A wide range of nutritional therapy has been employed across the reviewed studies, including low-sodium diet, low-to-moderate carbohydrate diet, high-fiber diet, and low-glycemic index diet. The findings suggest that the best specific dietary advice to improve pregnancy outcomes of GDM women remains inconclusive. However, the findings imply that low-sodium diet and moderate carbohydrate diet combined with self-monitoring of blood glucose level four times/day has a promising effect in improving pregnancy outcomes of GDM women. It has been noticed that limited adherence to the recommended dietary advices is one of the major problems in prenatal diet-based intervention studies aimed to prevent GDM-related complications. This provides an explanation why other healthy dietary advices did not have significant positive effect on the pregnancy outcomes of GDM mothers. Study results indicated as well that moderate-intensity exercises (3 days/week, 25–30 min/session) were more beneficial in reducing the frequency of certain GDM-related complications than the application of certain dietary advice alone. Yet, the safety of practicing daily exercises more than 30 minutes/day among GDM pregnant women should be subjected to further evaluation. However, studies were consistent in finding significant improvement in the maternal and neonatal outcomes when the diet is combined with moderate exercises, SMBG, and individualized health education.

There is promising new evidence regarding the effectiveness of vitamin D supplementation on improving pregnancy outcomes experienced by GDM women. The reviewed studies suggest that higher adherence to the recommended healthy lifestyle modifications was linked to a reduction in weight gain, and consequently, low weight gain was associated with decreased GDM complications. On this basis, these findings support the contention that obesity is the only modifiable risk factor for GDM complications, and this can be addressed successfully by adherence to healthy lifestyle behaviors.

Although the majority of the reviewed articles were randomized controlled trials with powered sample size and appropriate statistical analysis, most of these studies had methodological issues, such as risk for confounding factors, risk for information bias, and risk for contamination, which may affect the interpretation of the final results. In addition, there is a lack of the sample diversity, with majority of these studies targeting White women. None of the reviewed studies had a representative sample of Arab women with gestational diabetes, particularly Omani women. Furthermore, none of the reviewed literature reported a theoretical foundation.

### **Gaps in Literature**

Overall, the studies reviewed in this research indicate that well-designed double-blinded RCT studies are highly valuable to evaluate the safety of moderate-intensity exercises among pregnant women with GDM. Further trials are needed to explore the type, intensity, and duration of the exercises that result in improved pregnancy outcomes of GDM women. Also, high-quality RCT studies need to be conducted in a larger sample size and with GDM women who range in ethnicities while using a consistent diagnostic criterion for GDM to further evaluate the effectiveness of different diet regimens on reducing GDM-related complications. In addition, the

effectiveness of probiotic and vitamin D supplementation on pregnancy outcomes of GDM women need to be further studied.

Recent studies among GDM women have focused on identifying the best intervention to improve pregnancy outcomes, however, few studies have investigated the perceived self-efficacy in relation to the adherence to healthy behaviors among pregnant women with gestational diabetes. Perceived self-efficacy has been identified as a strong predictor of healthy behaviors, such as weight loss, dietary modification, and physical activity among diabetic patients (Chen & Lin, 2010; Lee et al., 2011). In addition, it has been recognized that the treatment plan for gestational diabetes is primarily dependent on the active role of pregnant women with GDM to adhere to the recommended healthy lifestyle behaviors. Women's active role entails further understanding about risk factors and complications of GDM in order to increase appreciation of the seriousness of the problem. Also, adherence to the healthy behaviors is highly dependent on the women's belief about the effectiveness of these behaviors in decreasing the adverse effect of gestational diabetes. Lack of belief in the usefulness of the recommended healthy behavior on reducing risk is suggested to have an association with poor compliant to the management plan, which subsequently may lead to poor pregnancy outcomes. Therefore, a high-quality RCT study is recommended to evaluate the effectiveness of improved self-efficacy to adhere to healthy behaviors in reducing GDM-related complications among pregnant women with gestational diabetes, as little is known about the factors that enhance adherence to healthy behaviors among pregnant women with GDM. Also, barriers that prevent women with GDM to adhere to healthy lifestyle behaviors are not well documented requiring further investigation.

Barakat et al. (2010) and Al Farsi et al. (2014) report a high prevalence of type 2 diabetes and a history of gestational diabetes among the Omani population. The evidence suggests that the prevalence of GDM and its associated complications is not well studied among Omani pregnant women. No study was found with the aim to examine any of the known interventions for GDM treatment among Omani pregnant women with gestational diabetes. Furthermore, there is no evidence exists that examines the barriers that prevent Omani GDM women from adherence to healthy lifestyle behaviors, and no evidence exists as well that investigates the strategies that enhance adoption of healthy behaviors among Omani GDM women.

### **Conclusion**

Although our body of knowledge is growing in the field of GDM management, the incidence rate of GDM-related complications continues to increase most likely because of unhealthy lifestyle behaviors. Current studies on the management of GDM have focused on new interventions that improve pregnancy outcomes, however, there is a lack of evidence about the strategies that enhance adherence to healthy lifestyle behaviors. Based on the reviewed evidences regarding the effectiveness of healthy lifestyle behaviors on reducing frequency of GDM complications, the focus of the upcoming research studies should be directed to identifying the factors that enhance and encourage adherence to healthy behaviors, such as increased self-efficacy to healthy behaviors. Therefore, this study sought to evaluate the effectiveness of a health education intervention on increasing perceived self-efficacy to adhere to healthy behaviors and the ability for adherence to healthy behaviors among Omani women with GDM.

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## **CHAPTER III**

### **METHODOLOGY**

#### **Research Design**

The current study was designed to be an experimental study among Omani pregnant women with gestational diabetes. A pre- and post-test design was planned, with two groups of gestational diabetes mellitus (GDM) women (control vs. intervention) in order to test the efficacy of a health education intervention (HEI) on increasing women's self-efficacy and ability to adhere to healthy behaviors (e.g. healthy diet, exercise and self-monitoring of blood glucose [SMBG]) (Appendix D).

#### **Research Goal**

The goal of this study is to improve adherence of GDM women to the recommended healthy behaviors by enhancing their self-efficacy and understanding the barriers that prevents and factors that motivate adherence. Subsequently, this is expected to help in improving pregnancy outcomes of GDM women and their infants.

#### **Research Questions**

This design was developed to answer the following research questions:

1. Is there any difference in the self-efficacy score among subjects who received the health education intervention as compared to that of subjects in the control group?
2. Does improvement in self-efficacy predict improvement in adherence to healthy behaviors, controlling for the group?
3. Is there any relationship between women's demographic variables (e.g. age, education level, monthly income, pre-pregnancy weight, income, parity, family history of type 2 diabetes/GDM, previous history of GDM) and improvement in adherence to healthy behaviors, controlling for the group?

4. What are the barriers that prevent GDM Omani women from adhering to healthy behaviors?
5. What are the factors that motivate GDM Omani women to adhere to healthy behaviors?

### **Research Aims**

The specific aims of the study are to:

1. Measure the difference in self-efficacy pre and post health education among intervention and control group.
2. Investigate the impact of improved self-efficacy on improvement in adherence to healthy behaviors, controlling for the group.
3. Determine the relationship between improvement in adherence to healthy behaviors and women's demographic variables, controlling for the group.
4. Determine the barriers and cues to action to adhere to healthy behaviors.

It was hypothesized that providing a comprehensive health education intervention based on self-efficacy enhancing strategies for GDM pregnant women will promote self-efficacy, and increases adherence to healthy behaviors.

### **Sample**

The study sample was Omani pregnant women diagnosed with gestational diabetes. The inclusion criteria for the participants were Omani women, 18 years or older, with a single pregnancy, less than 34 weeks of gestation, diagnosed with gestational diabetes, attending the study setting during the study timeframe, and able to speak, read and write in the Arabic language. Gestational diabetes pregnant women with multiple gestations, type 1 or type 2 diabetes, chronic medical problems that prevent them from doing exercises, mental illness, and have pregnancy complications that require bed rest were excluded from the study. The exclusion

criteria were specifically identified to control for the possible external variables such as confounding factors and co-intervention that may introduce bias in the final outcome of this study. Since no studies were found similar to the proposed study needed to obtain a good estimate of the effect size, the study will follow Cohen's recommendation on effect size, as well as take into consideration physical and financial constraints, to estimate the appropriate number of subjects required for the given study (Appendix E). Assuming power of 80 percent, with alpha level 0.05, one tailed and medium effect size 0.6 for differences between independent two-population means; a total of 70 subjects are required to be included to answer hypothesis one. We expected an attrition of about 20 percent so the final estimate for overall sample is 90 pregnant women with GDM, 45 in each group (intervention and control). Random sampling was conducted using a computerized random number generator. A medium size effect (0.6) was selected as the most appropriate effect size for the primary hypothesis of the given study. Choosing a small effect size requires a total of 620 subjects that is not feasible in terms of time, money and efforts. A condition such as gestational diabetes that is temporary, not chronic, and with the given inclusion and exclusion criteria make it more difficult to recruit such a large sample within the limited time period. Furthermore; it is believed that having a medium effect size for the outcome in aim one will still be adequate to detect moderate effects for the other study aims. Consideration that the required sample size to answer hypothesis two using multiple linear regression would be only 68 subjects with a medium effect size compared to 70 subjects required with the medium effect size for the primary hypothesis. This further justifies the appropriateness of the selected sample size for the proposed study. Therefore, the final effect size of this study lies between medium and small effect size.

## **Setting**

The setting for this study was the Antenatal Clinic at Sultan Qaboos University Hospital (SQUH). The Antenatal Clinic at SQUH runs daily from 7:30 am to 3:30 pm. An average of three women with GDM were expected to visit this clinic daily. SQUH is located in the capital city, Muscat, of the Sultanate of Oman. Muscat City is the largest city in Oman, and the estimated total number of population in 2016 was 4, 654, 471 including Omani and non-Omani citizens. SQUH is one of the leading hospitals in Oman that provides tertiary care, clinical training and health research. Patients attending this hospital consist predominately of Omani citizens from various regions of Sultanate of Oman, thus this hospital was an ideal setting for the study as its patients represent Omani women with gestational diabetes. The standard prenatal care for women with GDM at the Antenatal Clinic include routine antenatal visits, monthly blood sugar profiles, fasting blood sugar test every visit, glucose monitoring at home, and one to one individualized education visit with a diabetic dietician.

## **Study Procedures**

Prior to initiation of study procedures, protection of human subjects approval of the study was obtained from the Institutional Review Board (IRB) at the University of California, Los Angeles and the Research Committee at SQUH. The recruitment process was coordinated with the hospital head nurse, staff nurses and physicians of the antenatal OPD after they have been provided an orientation to the study purpose and the eligibility criteria of participation. A daily list of the total number of Omani women diagnosed with gestational diabetes and attending the study setting during the study period was generated on a daily basis. Each woman in the list was assigned a number starting from zero until the last number in the list. Using a random number generator, the required sample was selected from the list on a daily basis. Later, the principal investigator (PI) approached the potential participants during their antenatal appointment to

invite them to participate in the study. Once the potential participants signed the consent form, the PI reviewed their medical records for the purpose of confirming study eligibility.

### **Study Intervention**

Once recruited women agreed to participate in the study, the PI obtained informed consent, baseline demographics and pre-test from all of the subjects. Study participants attending the study setting for antenatal care on Sunday, Tuesday, and Thursday were assigned to be in the intervention group while the study participants attending the study setting on Monday and Wednesday for antenatal care were assigned to be in the intervention group. The participants in the control group received standard antenatal care. In addition to the standard prenatal care; the intervention group received one-to-one health education intervention through an educational video prepared by the PI for the purpose of this study. The educational video was displayed in a private room in the antenatal clinic at SQUH and under the supervision of the PI for about 20 minutes. In addition, a pamphlet that has the same content of the educational session was provided for all of the participants in the intervention group. During the education session, the participants had the chance to ask questions and to discuss their concerns. Different self-efficacy enhancing strategies (e.g., motivational messages, role modeling, goal setting, and mastery experiences) were used to encourage women to maintain the recommended healthy behaviors. The health education content included the following main points: 1) general information about gestational diabetes such as definition, etiology, risk factors and treatment of GDM, 2) focus on maternal and neonatal complications related to GDM, 3) importance of healthy lifestyle behaviors such as weight management, healthy diet, exercises and self-monitoring of blood glucose (SMBG) level to prevent GDM complications, and 4) measurement to prevent type 2 diabetes post-partum. Demonstration of the recommended exercises and

SMBG was displayed in the video and then practiced during the education session. The cultural sensitivity aspects and the practicality of the recommended exercises for mothers with a newborn were considered when preparing the health education contents. As cultural beliefs and religious practices exerts great impact on the ability of Omani women to engage in exercises, indoor exercises such as walking, swimming and safe dancing were recommended for this group of women to increase their physical activity.

All of the participants in the intervention group were provided with a glucose meter and a chart to record their blood glucose levels four times/day during the study period. To enhance adherence to the recommended healthy lifestyle behaviors, all participants were asked to write measurable goals. In addition, they received short biweekly text messages to reinforce information given in the educational sessions. For example, dear mom: physical activity can help you reach your blood glucose targets. Being physically active will also help lower your chances of having type 2 diabetes and its problems in the future. Besides, exercising helps you control weight gain, reduces your stress and prepare for labor and delivery.

To reinforce the educational session provided, a booster session that has the same content of the health education video was delivered to the intervention group via cell phone between 32-35 weeks of gestation. The educational session for the intervention group started immediately after the enrollment in the study. Pre-test questionnaires of Diabetes Self-Care Activities Measure (SDSCA) and Diabetes Management Self-Efficacy Scales (DMSES) were administered to the participants in both groups before the start of the educational session. Post-test questionnaires of SDSCA and DMSES were re-administered to the participants after four weeks from filling the pre-test questionnaires. At the end of the study, all of the participants involved in this study received a thank you text message as an appreciation for the participation time they

spent during the study.

### **Protection of Human Subjects**

Once the eligibility criteria were met, the PI met with each participant to provide an overview on the study purpose, and the approximate time to fill the questionnaires. Each participant was informed that they are a volunteer in the study, they can ask questions they like, and that they have the right to not answer any question. Participants were told that they have the right to withdraw from the study at any point of time. Written informed consent was obtained from all of the participants before the start of the study. No threat or harm took place in this study other than the daily threat that the individual may have in daily life. Participants were subject to a minimum risk of anxiety or fear from developing GDM complications. However, the study intervention was designed to help those women to control their blood glucose level in order to prevent GDM complications. Participants' privacy was maintained by allocating code numbers for each participant and the PI was the only person who had access to the master list. All of the participant's information and the collected data were locked in a secure cabinet in a locked room, each separately. The collected data will be destroyed after a minimum of six years from the start of the study. Data entered in a SPSS program will have limited access by the PI only.

### **Instruments**

Two instruments were used for data collection after obtaining required approval from the author of each instrument. These instruments included revised version of Summary of Diabetes Self-Care Activities Measure (SDSCA) and revised version of Diabetes Management Self-Efficacy Scales (DMSES). The approval to use these instruments was obtained from the developer of the tools. The reliability of both of the instruments was examined following three

steps that are back translation, testing content validity, pilot testing to determining scale's internal consistency and stability over time. In the first phase, two professional bilingual translators were employed to translate the DMSES and SDSCA scales from English into Arabic independently. Then, the two translated versions were compared and analyzed by two Arabic researchers until they had a consensus that the Arabic version best reflects the language and concepts of the English version. As a result, the final Arabic version was produced. In the second step, the translated Arabic version of DMSES and SDSCA was submitted to a panel of five experts to test the content validity of the Arabic version of the DMSES and SDSCA. The panel of experts included two diabetes nurses, one diabetologists, and two lecturers in nursing. Panel members were asked to rate each item on a four-point scale (4 = very relevant, 3 = relevant with some adjustment to phrasing, 2 = only relevant if phrasing is profoundly adjusted and 1 = not relevant). The panel experts were also asked to provide comments on individual items about the clarity, accuracy and cultural relevance of the translation. As a result, the final version of the Arabic DMSES and SDSCA was produced. In the third step, the final version of the Arabic DMSES and SDSCA was pilot tested in five pregnant women with gestational diabetes from the antenatal clinic at Sultan Qaboos University Hospital in Oman. The selected participants were representatives of the target population of this study and they were not included in the study. The five participants completed the instrument twice (at baseline and after 2-4 weeks) during the waiting time for their antenatal appointment. The retest was administered after two to four weeks from the initial test to decrease probability of recall bias. Besides, participants were asked to provide their comments and suggestions about the clarity and comprehension of each item on the scale. The readability of the instruments was considered for 8<sup>th</sup> grade reading level.

### **Summary of Diabetes Self-Care Activities Measure (SDSCA)**

SDSCA is a tool used to measure the frequency of self-care behaviors undertaken by type 2 diabetes patients over the past seven days. This 11-item tool evaluates five domains of diabetes specific management including diet, exercise, glucose monitoring, foot care and smoking. Response categories in SDSCA range from 0-7 days a week. Using the average mean of items, the total score in this tool lies between 0-35, with higher score suggesting higher engagement in healthy behaviors. Taking into account study purpose, nature of gestational diabetes, and Omani culture, subscales of smoking and foot care were excluded from measurement. Also, minor changes were made in the items by substituting the word diabetes with gestational diabetes. The internal reliability of the original tool has been well established with high inter-item correlation (mean = 0.47) and moderate test-retest correlation (mean = 0.40) (Toobert, Hampson & Glasgow, 2000).

### **Diabetes Management Self-Efficacy Scales (DMSES)**

DMSES is a tool designed to measure perceived self-efficacy (self-ability) to adhere to healthy behaviors related to management of type 2 diabetes. The original tool is a 5-point scale with 20 items divided to 4 subscales including nutrition specific and weight, nutrition general and medical treatment, exercise and blood glucose. The total score in this tool lies between 0-100, with higher score indicating higher perceived self-efficacy for healthy behaviors (Bijl, Poelgeest-Eeltink, Shortidge-Baggett, 1999). However, the revised version of DMSES includes 20 items with an 11-point scale (Sturt, Hearnshaw & Wakelin, 2010). The DMSES is a reliable tool with Cronbach's alpha 0.81 and test-retest reliability 0.79.

## **Barriers to Adopt Healthy Behaviors**

Barriers to adhere to healthy behaviors were measured by asking a specific question in relation to healthy eating, active lifestyle and blood glucose monitoring. For example, list top three barriers that prevent you from adhering to the recommended healthy behaviors to manage your GDM?

## **Cues to Action**

Cues to action were evaluated by asking one specific question about factors that motivates participants to adhere to healthy behaviors. For example, list the top three factors that motivate you to adhere to the recommended healthy behaviors to manage your GDM?

## **Demographic Data**

A form capturing demographic characteristic of the participants was developed by the PI in order to obtain baseline data. These data included participants' age, education level, work status, income, pre-pregnancy weight, parity, previous history of GDM, family history of type 2 diabetes/GDM, medical history of polycystic ovarian syndrome, history of baby birth weight more than four kilogram, and gestational age at GDM diagnosis.

## **Data Analysis**

Data were entered into a computer and analyzed using Statistical Package for the Social Sciences (SPSS) software, version 24 (IBM Corp, 2016). Entered data were doubled checked manually in order to maintain data accuracy. Prior to data analysis, frequencies and summary statistics were checked to ensure sufficient data are available for each variable planned in the analysis. Descriptive statistics and graphical summaries were obtained for all key outcome and predictor variables to check for outliers, missing data and the need for transformations or non-parametric methods. Assumptions of each test used for data analysis were checked and amended

appropriately. In particular, to characterize the sample we computed means and standard deviations (continuous measures) and percentages (categorical variables) for all measures at each time point. Baseline demographic, clinical and contextual factors were checked for associations with the primary outcome measures and were considered as potential moderators of treatment effects. The analytical tools were independent t-tests and fitting multiple linear regression models for the outcomes improvement in self-efficacy and improvement in mean of adherence. A model selection technique such as stepwise was utilized to investigate models. Model diagnostics was performed and model fit was assessed using adjusted R-square.

### **Research Aim #1**

Test the effects of the proposed HEI on the improvement of self-efficacy for the adherence to healthy behaviors [change in self-efficacy score at post-test from pre-test] (Primary aim). *Hypothesis 1*: GDM women who received the HEI will report improved self-efficacy for the adherence to healthy behaviors as measured by DMSES, compared to GDM women who did not receive the HEI. Two-population independent t-test (one-sided) was performed to answer hypothesis one.

### **Research Aim #2**

Test the effects of improved self-efficacy [change in self-efficacy score at post-test from pre-test] on the improvement in adherence to healthy behaviors [change in mean of adherence at post-test from pre-test] (Secondary aim). *Hypothesis 2*: GDM women who have higher improvement in self-efficacy will report higher improvement in adherence to healthy behaviors as measured by SDSCA, compared to GDM women who have lower improvement in self-efficacy, controlling for the group. Multiple linear regression model was fit with the

improvement in mean of adherence as the outcome and improvement in self-efficacy score and group assignment as the predictors.

### **Research Aim #3**

Determine the relationship between improvement in adherence to healthy behaviors [change in mean of adherence at post-test from pre-test] and women's demographic variables.

*Hypothesis 3:* Participants' demographic variables are significant predictors of improvement in adherence to healthy behaviors, controlling for the group. Multiple linear regression model was fit with the improvement in mean of adherence as the outcome and group, age, income, education level, pre-pregnancy weight, parity, previous history of GDM, family history of type 2 diabetes/GDM, and gestational age at GDM diagnosis as potential predictors.

### **Research Aim #4**

Determine the barriers and cues to action to adhere to healthy behaviors. This aim was analyzed as descriptive data by identifying similar themes and then categorizes them in groups.

### **Reliability Test**

To test instrument's reliability, internal consistency was determined by calculating Cronbach alpha for each subscale in the SDSCA and the overall Arabic DMSES scale. A Cronbach alpha score of more than .7 is considered satisfactory. Test-retest reliability was assessed using Pearson correlation coefficient with two to four weeks interval between two tests. Content validity was examined by calculating the Content Validity Index (CVI) for each item in the Arabic DMSES scale and Arabic SDSCA scale. The acceptable content validity score should be more than .7.

## **Conclusion**

This chapter provided a description of the methodology that was used to answer the specific aims of this study about the effectiveness of a health education intervention on GDM women's self-efficacy to adhere to healthy behaviors and their actual ability to adhere to those healthy behaviors. Detailed discussion on research design and questions, study sample and setting, study procedures, study intervention, protection of human rights, instruments and data analysis has been provided.

### Chapter III References

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## **CHAPTER IV**

### **RESULTS**

The statistical findings of this pre-test post-test, experimental study will be presented in this chapter. First, the description of the sample characteristics and comparison of study variables between the two groups at baseline is provided. Second, the reliability results of the study instruments are presented. Finally, the findings of the study aims are delineated. As previously stated, the main aim of this study was to evaluate the effectiveness of a health education intervention (HEI) on improving gestational diabetes women's self-efficacy to adhere to healthy behaviors and their actual ability to adhere to those healthy behaviors

#### **Sample Characteristics**

This study was conducted between October 2016 and January 2017 in the Antenatal Out-Patient Clinic at Sultan Qaboos University Hospital. A total of 199 Omani pregnant women with gestational diabetes were screened for eligibility. Out of the 199, a total of 95 met the inclusion criteria and were invited to participate in the study. Five potential participants declined to participate in this study because they were not in a good mood to fill out the study questionnaires. A total of ninety Omani women with gestational diabetes were enrolled (Appendix F). None of the enrolled participants has withdrawn from the study. At study completion, a total of ninety pregnant women were enrolled and completed both the pre-test and post-test (45 participants in control group and 45 participants in intervention group).

Descriptive statistics for the sample characteristics are reported in Table 1. As shown in the table, the age of the entire participants ranged from 19 - 43 years (Mean= 33.5, SD= 5.10). The participants' pre-pregnancy weight and body mass index (BMI) was between 42-155 kg (Mean= 70.9, SD= 17.87) and 17.4 - 60.6 (Mean= 29.0, SD= 7.02), respectively. The Gravida

status of the participants ranged from 1-11 (Mean= 4.0, SD= 2.38) with Para status ranged from 0-7 (Mean= 2.3, SD= 1.82). The majority of the study participants were from the capital city Muscat (50%) and the remaining half were from the interior regions of Oman (50%). All of the women were married (100%). The descriptive data of the education level shows that 33.3 percent of the women were high school graduates, 31.1 percent graduated from college and 13.3 percent had some college study. Only 14.4 percent of the participants had less than a high school education.

The data also shows that 54.4 percent of the participants were working. Of those who were working, 34.7 percent had an administrative type of work, 32.6 percent had a medical profession and 22.4 percent were in the teaching field. The majority of the women had a housemaid at home (56.7%). Table 1 demonstrates as well that 61.1 percent of the women did not have a previous history of gestational diabetes. However, 78.9 percent of the study participants had a family history of type 2 diabetes mellitus. Of those, 45.1 percent reported that their mothers have type 2 diabetes as compared to 35.2 percent of them reported their fathers have it. Moreover, approximately one third (32.2 %) of the participants stated that they have a family history of gestational diabetes. Of those, the majority (68.9%) reported a GDM history in their sisters. Approximately 21.1 percent of the study participants reported a history of ovarian polycystic ovarian syndrome and 2.2 percent reported having a history of a baby birth weight more than four kilograms (>8.8 lbs). Out of the 90 participants, 48.9 percent stated that they are on diet for GDM treatment, 24.4 percent reported they are on diet and exercises and 18.9 percent were on diet and hypoglycemic agents. In addition, 61.1 percent of the women received some health education about gestational diabetes previously. Out of those, 41.8 percent reported that

the dietician provided the health education. Only 5 participants (9.1%) reported they received the health education from a staff nurse.

Table 1

*Sample Demographic Characteristics and Inter-Group Comparison*

Characteristic	Total Sample N=90 M (SD) or N (%)	Control Group N=45 M (SD) or N (%)	Intervention Group N=45 M (SD) or N (%)	$\chi^2$ or $t$	P Value
Age (years) <sup>1</sup>	33.5 (5.10)	33.5 (5.34)	33.6 (4.91)	-0.15	0.23
Pre-Pregnancy Weight <sup>1</sup>	70.9 (17.87)	70.9 (16.38)	70.9 (19.45)	-0.01	0.47
Body Mass Index <sup>1</sup>	29.0 (7.02)	29.1 (6.44)	28.9 (7.61)	0.12	0.45
Gravida <sup>1</sup>	4.0 (2.38)	4.0 (2.19)	4.0 (2.58)	0.04	0.48
Para <sup>1</sup>	2.3 (1.82)	2.5 (1.84)	2.2 (1.79)	0.81	0.20
Weeks of Gestation at GDM Diagnosis <sup>1</sup>	20.1 (7.49)	19.7 (7.8)	20.5 (7.26)	-0.54	0.29
Region <sup>2</sup>				1.6	0.40
Muscat	45 (50.0%)	25 (55.6%)	20 (44.4%)		
Interior Region	45 (50.0%)	20 (44.4%)	25 (55.6%)		
Marital Status <sup>2</sup>					
Married	90 (100%)	45 (100%)	45 (100%)		
Divorced	0 (0%)	0 (0%)	0 (0%)		
Education Level <sup>2</sup>				6.5	0.09
Less than High School	13 (14.4%)	6 (13.3%)	7 (15.6%)		
High School Graduate	30 (33.3%)	18 (40%)	12 (26.7%)		
Some College/ College Graduate	35 (44.4%)	16 (35.6%)	24 (53.3%)		

Graduate Degree	7 (7.8%)	5 (11.1%)	2 (4.4%)		
Work Status <sup>2</sup>					
Working	49 (54.4%)	23 (51.1%)	26 (57.8%)	0.40	0.33
Not Working	41 (45.6)	22 (49.9%)	19 (42.2%)		
Work Type <sup>2</sup>	N = 49			4.94	0.38
Medical Professional	16 (32.6%)	9 (39.1%)	7 (15.6%)		
Teaching Professional	11 (22.4%)	3 (13%)	8 (17.8%)		
Administrative Professional	17 (34.7%)	9 (39.1%)	8 (17.8%)		
Business/Engineering/IT Professional	9 (15.3)	5 (21.7%)	4 (8.9%)		
Housemaid Availability <sup>2</sup>				0.05	0.50
Available	51 (56.7%)	26 (57.8%)	25 (55.6%)		
Not available	39 (43.3%)	19 (42.2%)	20 (44.4%)		
Previous History of GDM <sup>2</sup>				5.66	<0.001
Yes	35 (38.9%)	12 (26.7%)	23 (51.1%)		
No	55 (61.1%)	33 (73.3%)	22 (48.9%)		
Family History of Type 2 DM <sup>2</sup>				1.67	0.15
Yes	71 (78.9%)	33 (73.3%)	38 (84.4%)		
No	19 (21.1%)	12 (26.7%)	7 (15.6%)		
Who is the Member? <sup>2</sup>	N = 71			11.58	0.12
Father	25 (35.2%)				
Mother	32 (45.1%)				
Brother/Sister	5 (7.0%)				
Uncle/Aunty	5 (7.0%)				
Grandfather/Grandmother	4 (5.6%)				
Family History of GDM <sup>2</sup>				0.05	0.50
Yes	29 (32.2%)	14 (31.1%)	15 (33.3%)		
No	61 (67.8%)	31 (68.9%)	30 (66.7%)		

Who is the Member? <sup>2</sup>	N = 29			8.00	0.08
Mother	8 (27.6%)				
Sister/Sisters	20 (68.9%)				
Aunty	2 (6.9%)				
History of PCOS <sup>2</sup>				0.60	0.30
Yes	19 (21.1%)	11 (24.4%)	8 (17.8%)		
No	71 (78.9%)	34 (75.6%)	37 (82.2%)		
History of Baby Birth Weight > 4 Kg <sup>2</sup>				2.05	0.24
Yes	2 (2.2%)	0 (0%)	2 (4.4%)		
No	88 (97.8%)	45 (100%)	43 (95.6%)		
GDM Treatment <sup>2</sup>				0.38	0.47
Diet Only	44 (48.9%)	22 (48.9%)	22 (48.9%)		
Diet and Exercises	22 (24.4%)	12 (26.7%)	10 (22.2%)		
Diet and Hypoglycemic Agents	17 (18.9%)	8 (17.8%)	9 (20%)		
Diet, Exercises and Hypoglycemic Agents	7 (7.8%)	3 (6.7%)	4 (8.9%)		
Received GDM Health Education Before <sup>2</sup>				0.05	0.50
Yes	55 (61.1%)	27 (60%)	28 (62.2%)		
No	35 (38.9%)	18 (40%)	17 (37.8%)		
Provider of GDM Health Education <sup>2</sup>	N = 55			6.31	0.14
OB&GYN Physician	11 (20%)				
Dietician	23 (41.8%)				
Self-Learning	14 (25.5%)				
Nurse	5 (9.1%)				

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*Note.* GDM= Gestational Diabetes Mellitus, DM= Diabetes Mellitus, PCOS= Polycystic Ovarian Syndrome, Kg= Kilogram, OB&GYN= Obstetric and Gynecology, 1= *t* test, 2= Chi square test.

### Baseline Inter-Group Comparison on Study Variables

As shown on Table 1, the results of an independent t-test and Chi square test indicated that there are no significant differences between the control and intervention groups on demographic variables at baseline except in one variable. This includes history of gestational diabetes during previous pregnancies ( $\chi^2 = 5.66, p < .001$ ).

As shown in Table 2, the control group reported a higher total score of self-efficacy (122.9) compared to the intervention group (118.2) at the baseline, although it was not significant ( $t = 1.14, p = .62$ ). The findings of the independent t-test demonstrated that both of the groups at baseline had a comparable mean score ( $t = -.80, p = .23$ ) to engage in diabetes self-care (as measured by SDSCA). In summary, the two groups were homogenous with regard to sample characteristics and main study variables at baseline.

Table 2

#### *Baseline Inter-Group Comparison of Study Variables*

Study Variable	Total Sample N=90 M (SD)	Control Group N=45 M (SD)	Intervention Group N=45 M (SD)	<i>t</i>	P Value
Total Score of DMSES, Baseline	120.6 (19.76)	122.9 (19.92)	118.2 (19.51)	1.14	0.62
Mean of SDSCA, Baseline	3.1 (1.07)	3.1 (1.15)	3.2 (0.98)	-0.80	0.23
Mean Diet Subscale	4.0 (1.28)	3.9 (1.39)	4.0 (1.17)	-0.35	0.78
Mean Physical Activity Subscale	2.1 (2.05)	1.8 (2.01)	2.4 (2.01)	-1.19	0.89
Mean Blood Glucose Testing Subscale	2.5 (2.04)	2.5 (2.15)	2.5 (1.94)	-0.05	0.23

*Note.* SDSCA= Summary Diabetes Self-Care Activity, DMSES= Diabetes Management Self-Efficacy Scale.

## **Reliability of Research Instruments**

The two instruments that measured the study aims were the Diabetes Management Self-Efficacy Scale (DMSES) and the Summary of Diabetes Management Self-Care Activity (SDSCA).

The Diabetes Management Self-Efficacy Scale (DMSES) measured perceived self-efficacy to adhere to healthy behaviors related to management of gestational diabetes (Bijl, Poelgeest-Eeltink, Shortidge-Baggett, 1999). The calculated content validity index (CVI) was between .8 and 1 for items in DMSES, suggesting acceptable reliability. Therefore, the final results of the content validity ended with a modified DMSES version for Omani GDM women. It included a 16 items with 11-point Likert-scale rated from 0 (lowest perceived self-efficacy) to 10 (highest perceived self-efficacy). A total score ranged from 0-160 was calculated from summation of all items with a higher score indicating higher perceived self-efficacy to adhere to the recommended healthy behaviors.

The Summary of Diabetes Self-Care Activity (SDSCA) is an instrument used to measure the frequency of self-care behaviors undertaken by gestational diabetes pregnant women over the past seven days (Toobert, Hampsonm Glasgow, 2000). The calculated content validity index (CVI) was between .8 and 1 for items in the SDSCA, indicating acceptable reliability. Therefore, the end result of the content validity was a modified SDSCA version for Omani GDM women. This was composed of a total of eight items and three subscales, which are the diet subscale (4 items), physical activity subscale (2 items) and the self-monitoring of blood glucose subscale (2 items). Response categories in the SDSCA range from 0-7 days a week. Using the average mean of items, the mean score of the SDSCA lies between 0-7, with a higher mean score suggesting higher engagement in healthy behaviors.

To test the instruments' reliability, internal consistency was determined by calculating Cronbach's alpha for each subscale in the SDSCA and the overall Arabic DMSES scale. The internal consistency of the DMSES was satisfactory with a Cronbach's alpha coefficient .84 (Table 3). In relation to the SDSCA, the diet subscale and the physical activity subscale had an acceptable Cronbach's alpha coefficient  $> .70$ . While the self-monitoring of blood glucose subscale had only a Cronbach's alpha coefficient of .52. However, calculating the internal consistency for the whole scale revealed a more satisfactory Cronbach's alpha coefficient of .76.

Test-retest reliability was assessed as well using Pearson correlation coefficient with a two to four weeks interval between the two tests. Table 4 demonstrates that the DMSES and SDSCA instruments had a strong significant correlation over time with a Pearson correlation coefficient  $> .6$ . Overall, the internal consistency and the test-retest indicated that the study instruments had an acceptable reliability and they are consistent over time.

Table 3

*Reliability of Instruments*

Instrument	# of items	Cronbach's Alpha
Diabetes Management Self-Efficacy Scale	16	0.84
Summary Diabetes Self- Care Activity	8	0.76
Diet	4	0.74
Physical Activity	2	0.92
Self-monitoring of Blood Glucose	2	0.52

Table 4  
*Test-Retest Reliability*

Instrument	Mean	SD	Pearson correlation coefficient	P value
Diabetes Management Self-Efficacy Scale (DMSES)			0.67	0.00
DMSES Score, Test 1	122.96	19.92		
DMSES Score, Test 2	121.11	23.03		
Summary Diabetes Self-Care Activity (SDSCA)			0.77	0.00
SDSCA Mean, Test 1	3.05	1.14		
SDSCA Mean, Test 2	3.50	1.13		

### Findings Related to Research Aims

In the following paragraphs, the findings of the study aims are presented.

#### Findings of Research Aim #1

**Research Aim #1:** Test the effects of the proposed Health Education Intervention (HEI) on the improvement of self-efficacy for the adherence to healthy behaviors (change in self-efficacy score at post-test from pre-test). *Hypothesis 1:* GDM women who received the HEI will report improved self-efficacy for the adherence to healthy behaviors as measured by the DMSES, compared to GDM women who did not receive the HEI. A two-population independent *t*-test (one-sided) was performed to answer Hypothesis One. Assumptions of independent *t*-test were checked and all of the assumptions have been met (Appendix G). Therefore, an independent *t*-test was performed to answer Aim One. The statistical results of the independent *t*-test show that there was a significant difference in the improvement of self-efficacy for adherence to healthy behaviors between GDM women who received the HEI (M= 9.89, SD= 19.58) and GDM women who did not receive the HEI (M= - 1.84, SD= 17. 58);  $t(88) = -2.99, p < .001$ . In summary, at

five percent level of significance, there is evidence that the self-efficacy improved significantly for the intervention group compared to the control group.

**Findings of Research Aim #2**

**Research Aim #2:** Test the effects of improved self-efficacy (change in self-efficacy score at post-test from pre-test) on improvement of adherence to healthy behaviors (change in mean of adherence at post-test from pre-test). *Hypothesis 2:* GDM women who have higher improvement in self-efficacy will report higher improvement in adherence to healthy behaviors as measured by the SDSCA, compared to GDM women who have lower improvement in self-efficacy, controlling for the group. A multiple linear regression model was fit to predict improvement in adherence to healthy behaviors based on the improvement of self-efficacy and the group assignment. Assumptions of multiple linear regression were checked and no violations were found (Appendix H). The overall model fit was adjusted R-square = .225, meaning that 22.5 percent of the total variation in the improvement in adherence to healthy behaviors was explained by improvement in self-efficacy and group and the overall relationship was significant [ $F(2, 87) = 13.89, p < .001$ ] (Table 5). Using stepwise regression analysis, gave only one model and this included only the group as a significant predictor ( $t = 5.05, p < .001$ ), adjusted R-square = .216 (Table 6).

Table 5

*Multiple Regression Model Results for Aim 2*

	Coefficient	SE	P-Value	Overall Adjusted R <sup>2</sup>
Intercept	0.46	0.14	<0.001	0.225
Group	0.93	0.21	<0.001	
Improvement in Self-Efficacy	0.01	0.01	0.08	

Table 6

*Stepwise Model Results for Aim 2*

	Coefficient	SE	P-Value	Overall Adjusted R <sup>2</sup>
Intercept	0.44	0.14	<0.000	0.216
Group	1.02	0.20	<0.001	

In the next step, mediation analysis was conducted to further investigate for the indirect effect of group assignment on the improvement in adherence to healthy behaviors with improvement in self-efficacy as a mediator (Figure 1). In the first step, simple linear regression model was fit with the improvement in adherence (Y) as the outcome and the group assignment (X) as a predictor. The statistical results of simple linear regression showed that the group assignment significantly predict improvement in adherence to healthy behaviors ( $t= 5.04, p< .001$ ). This implies that there is a significant direct effect between X and Y variables, which could be mediated by a third variable (e.g. M). In the second step, simple linear regression model was fit with the improvement in self-efficacy as the outcome and the group assignment as a predictor. The finding from this test demonstrated that the group assignment is a significant predictor of the improvement in self-efficacy for adherence to healthy behaviors ( $t= 2.99, p< .001$ ). In the third step, multiple linear regression model was fit with the improvement in the level of adherence as the outcome and the group assignment and the improvement in self-efficacy as predictors. The results showed that, controlling for the group assignment; the improvement in self-efficacy for adherence to healthy behaviors is not a significant predictor ( $t= 1.42, p= .16$ ) for the improvement in adherence to healthy behaviors. In the last step, multiple linear regression model was fit with the improvement in adherence to healthy behaviors (Y) as

the outcome, the group assignment (X) as a predictor and the improvement in self-efficacy for adherence to healthy behaviors as a mediator (M). The results showed that there is a non-significant indirect effect of the group assignment on the improvement of adherence to healthy behaviors through improvement in self-efficacy ( $B = .09$ ,  $SE = .07$ , BCa CI [-.01, .28]). The improvement in self-efficacy for adherence to healthy behaviors (M) could account for three percent ( $P_M = .3$ ) of the total effect. The results of step one through step four in mediation analysis indicate that the improvement in self-efficacy for adherence to healthy behaviors (M) partially mediates the relationship between the group assignment (X) and the improvement in adherence to healthy behaviors (Y). Having a partial mediation could be the impact of hidden confounders that were not controlled for throughout the study intervention.

Therefore, considering significant difference found between study groups in relation to the previous history of GDM at the baseline data, the latter variable was included as a covariate in mediation analysis of the regression model. The regression model showed that controlling for previous history of GDM among study participants, there is a non-significant indirect effect of the group assignment on the improvement of adherence to healthy behaviors through improvement in self-efficacy ( $B = .08$ ,  $SE = .07$ , BCa CI [-.02, .26]), although the direct effect was significant ( $B = .94$ ,  $SE = .21$ ,  $p < .001$ ).

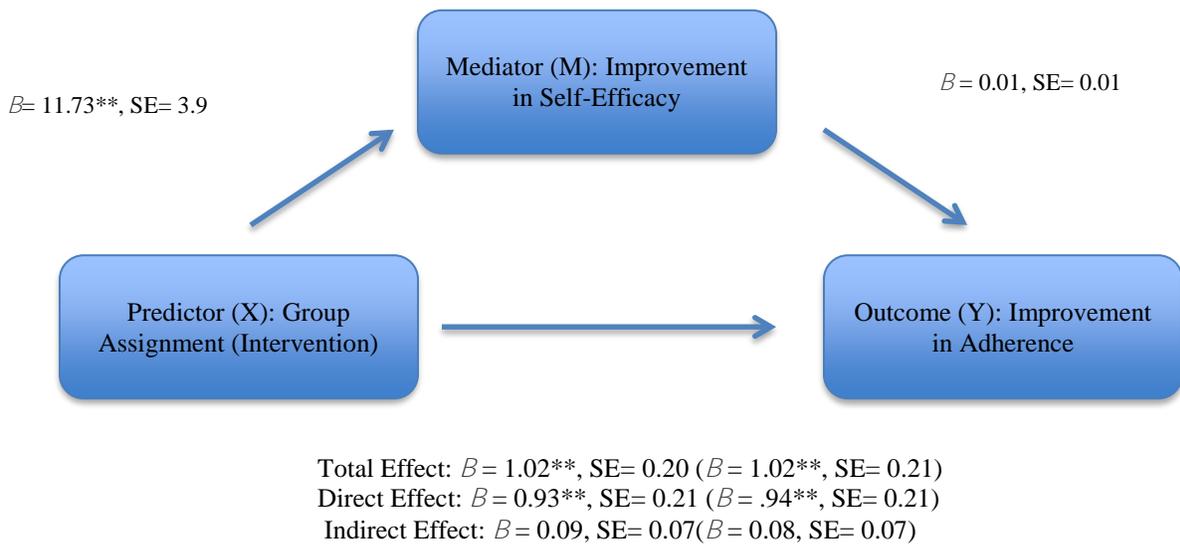


Figure 2. Standardized regression coefficients for the relationship between group assignment and improvement in adherence to healthy behaviors as mediated by improvement in self-efficacy for adherence to healthy behaviors. The standardized coefficient with controlling for previous history of GDM is in parentheses.  $**p < 0.05$ .

The findings of the multiple regression and the medication analysis taken together imply that only group assignment had a unique significant ( $t = 5.04, p < .001$ ) contribution to predict participants' improvement to adherence to healthy behaviors, while the improvement in self-efficacy partially mediates the impact of the group assignment on the improvement in adherence to healthy behaviors. While our hypothesis that improvement in self-efficacy would be significantly associated with improvement in adherence to healthy behaviors was not supported by the data, our finding that the intervention was the only factor associated with improved adherence to healthy behaviors is a great testament to the intervention itself.

### **Findings of Research Aim #3**

**Research Aim #3:** Determine the relationship between improvement in adherence to healthy behaviors (change in mean of adherence at post-test from pre-test) and women's demographic variables. *Hypothesis 3:* Participants' demographic variables are significant predictors of improvement in adherence to healthy behaviors, controlling for the group. A multiple linear regression model was fit with improvement in adherence as the outcome and group, age, education level, income, pre-pregnancy weight, parity, previous history of GDM, family history of type 2 diabetes/GDM, and gestational age at GDM diagnosis as potential predictors. Assumptions of multiple linear regression were checked and no violations were found (Appendix I). The overall model fit was adjusted R-square = .188, meaning that 18.8 percent of the total variation in the improvement in adherence to healthy behaviors was explained by participants' demographic and the overall relationship was significant [ $F(10, 67) = 2.78, p < .001$ ] (Table 7). Using stepwise-regression analysis gave only one model with one predictor, group, which was significant ( $t = 4.9, p < .001$ ), adjusted R-square = .229 (Table 8). In conclusion, we found that none of the demographic factors were predictive of the improvement in adherence to healthy behaviors. The only predictor was the intervention.

**Table 7*****Multiple Regression Model Results for Aim 3***

	Coefficient	SE	P-Value	Overall Adjusted R <sup>2</sup>
Intercept	0.87	1.11	0.22	0.188
Group	0.92	0.22	<0.001	
Age	-0.02	0.024	0.34	
Education Level	-0.18	0.12	0.07	
Monthly Income	-0.04	0.00	0.29	
Previous GDM Diagnosis	0.06	0.25	0.40	
Family History of Type 2 DM	-0.07	0.29	0.40	
Family History of GDM	-0.13	0.25	0.30	
Pre-Pregnancy Weight	0.00	0.01	0.31	
Parity	0.03	0.07	0.33	
Weeks of Gestation at GDM Diagnosis	0.01	0.02	0.22	

**Table 8*****Stepwise Model Results for Aim 3***

	Coefficient	SE	P-Value	Overall Adjusted R <sup>2</sup>
Intercept	0.44	0.14	0.001	0.229
Group	0.99	0.20	<0.001	

## **Findings of Research Aim #4**

**Research Aim #4:** Determine the barriers and cues to action to adhere to healthy behaviors. To obtain the descriptive data, the participants were asked to answer two open-ended questions that were: 1) List the top three barriers that prevent you from adhering to the recommended healthy behaviors to manage your GDM, and 2) List the top three factors that motivate you to adhere to the recommended healthy behaviors to manage your GDM?. The descriptive data was then analyzed by identifying similar themes and was categorized into groups. Later, the frequency and percentages were calculated for each theme.

The top five barriers that were reported frequently by study participants are physical limitations (47.8%), time constraints (40%), availability of healthy food outside home (35%), holidays and social gathering (27.8%), and increased appetite and craving for certain foods (15.5%) (Table 9). The main reasons given for the physical limitations were lack of energy, feeling exhausted from long work hours, and having pregnancy-related musculoskeletal pain (e.g. back pain, feet pain, hip pain and false contractions). Time constraints were primarily due to home and family responsibilities and long work hours. Participants indicated that availability of healthy food is a major barrier, especially when eating outside the home. In addition, having holidays and social gatherings were consistent barriers that prevented participants from following a healthy diet plan. Increased appetite and craving mostly for sweet foods is noted to be one of the common barriers for eating healthy food as well.

Table 9

*Barriers to Adhere to Healthy Behaviors for GDM Management*

Barrier	Total Sample N (%)	Control Group N (%)	Intervention Group N (%)
Time Constraints	36 (40%)	14 (31%)	22 (48.9%)
Availability of Healthy Food	32 (35%)	13 (28.9%)	19 (42.2%)
Increased Appetite and Craving for Certain Foods	14 (15.5%)	7 (15.6%)	7 (15.6%)
Physical Limitations	43 (47.8%)	19 (42.2%)	24 (53.3%)
Influence of Other Family Members	7 (7.8%)	4 (8.9%)	3 (6.7%)
Glucometer Strips	6 (6.7%)	3 (6.7%)	3 (6.7%)
Holidays and Social Gatherings	25 (27.8%)	10 (22.2%)	15 (33.3%)
Knowledge to Choose Healthy Food	2 (2.2%)	2 (4.4%)	-
Written Meal Plan	1 (1.1%)	1 (2.2%)	-
Frustration from Uncontrolled Blood Glucose	2 (2.2%)	-	2 (4.4%)

As shown in Table 10, the participants reported that their concern from the maternal and neonatal GDM-related complications (94.4%), family moral support (52.2%), self-determination for blood sugar control (12.2%), self-determination for weight control (8.9%) and having a written goal plan (6.7%) are the top five factors that motivated them to adhere to the recommended GDM management healthy behaviors. It is noted that the GDM women's concern about their baby's health (46.7%), their concern about their own health during pregnancy (22.2%) and their concern regarding developing type 2 Diabetes Mellitus in the future (15.6%) are the specific motivating factors related to concern about maternal and neonatal GDM-related complications. Also, the majority of the family moral support arose from family members (28.9%) and their husbands (17.8%) specifically. Interestingly, 6.7 percent and 8.9 percent of

the intervention participants indicated that the health advice on the health education video and the text messages received as part of the study intervention motivated them to adhere to the recommended healthy behaviors, respectively.

Table 10

*Motivators to Adhere to Healthy Behaviors for GDM Management*

Motivator	Total Sample N (%)	Control Group N (%)	Intervention Group N (%)
Concern from Maternal and Neonatal GDM-Related Complications	85 (94.4%)	40 (88.9%)	45 (100%)
Concern from GDM-Related Complications in General	18 (20%)	15 (33.3%)	-
Concern about Baby Health	42 (46.7%)	16 (35.6)	24 (53.3%)
Concern about their Health	20 (22.2%)	10 (22.2%)	10 (22.2%)
Concern from High Blood Sugar Readings	3 (3.3%)	3 (6.7%)	-
Concern from Having DM in Future	14 (15.6%)	4 (8.9%)	10 (22.2%)
Concern to use Insulin Injection	3 (3.3%)	2 (4.4%)	1 (2.2)
Family Moral Support to Stay Healthy	47 (52.2%)	23 (51.1)	24 (53%)
Husband Support	16 (17.8%)	5 (11.1%)	11 (24.4%)
Participant's Mother	3 (3.3%)	3 (6.7%)	-
Kids	2 (2.2%)	2 (4.4%)	-
Other Family Members and Friends	26 (28.9%)	13 (28.9%)	13 (28.9%)
Self Determination to Control Blood Sugar	11 (12.2%)	4 (8.9%)	7 (15.6%)
Self-Determination for Weight Control	8 (8.9%)	2 (4.4%)	6 (13.3%)
Feeling Physically Well	2 (2.2%)	2 (4.4%)	-
Feeling Mentally Well	1 (1.1%)	1 (2.2%)	-
Have Written Goal Plan	6 (6.7%)	2 (4.4%)	4 (8.9%)
Physician Health Advice	1 (1.1%)	1 (2.2%)	-
Availability of Healthy Foods	5 (5.6%)	3 (6.7%)	2 (4.4%)
Staying at Home	5 (5.6%)	2 (4.4%)	3 (6.7%)

Availability of Glucometer	2 (2.2%)	2 (4.4%)	-
Availability of Treadmill at Home	1 (1.1%)	1 (2.2%)	-
Routine Antenatal Visits	2 (2.2%)	-	2 (4.4%)
Normal Blood Sugar Readings	5 (5.6%)	-	5 (11.1%)
Text Messages Received	4 (4.4%)	-	4 (8.9%)
Health Advice on Video	3 (3.3%)	-	3 (6.7%)
Time Management	3 (3.3%)	-	3 (6.7%)

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### **Summary**

This chapter presents study findings regarding the effectiveness of a health education intervention based on the HBM on GDM women’s self-efficacy to adhere to healthy behaviors and their actual ability to adhere to those healthy behaviors. A total of ninety Omani women with gestational diabetes have completed both the pre-test and the post-test. Five questions have been answered using the appropriate statistical tests. It was found that, gestational diabetes Mellitus (GDM) women who received the health education intervention (HEI) reported a significant improvement in their score of self-efficacy for the adherence to healthy behaviors as measured by DMSES, compared to GDM women who did not receive the HEI. Also, the data showed that only the group assignment was a significant predictor for improvement in adherence to healthy behaviors. However, the participants’ demographic data and improvement in self-efficacy were not significant predictors for improvement in adherence to healthy practices. The participants reported the primary barriers that prevent them from adhering to the recommended healthy behaviors and these included physical limitations, time constraints, availability of healthy food, holidays and social gatherings and increased appetite and cravings for certain foods. They also identified the common motivators for adherence to healthy behaviors which

included concern about the maternal and neonatal GDM-related complications, family moral support, self-determination for blood sugar control, self-determination for weight control and having a written goal plan.

## CHAPTER V

### DISCUSSION AND CONCLUSION

This two two-group, repeated measures experimental evaluated the effectiveness of a health education intervention (HEI) on improving gestational diabetes women's self-efficacy and adherence to healthy behaviors in a population of Omani women with GDM. It was hypothesized that providing a comprehensive HEI for GDM women will enhance their self-efficacy for, and thus increase their adherence to healthy behaviors (specifically healthy diet, exercise and self-monitoring of blood glucose). This approach was expected to help in improving pregnancy outcomes of GDM women and their infants. Initially, this chapter provides a discussion of the study findings and the resulting conclusions. Secondly, strengths and limitations of this study and its implications in nursing are addressed.

#### Study Findings

##### **The Effectiveness of the Health Education Intervention on GDM Women's Self-Efficacy**

Bandura defines self-efficacy as "beliefs one holds in one's capabilities to organize and execute the courses of actions required to produce given attainments" (Montigny & Lacharite, 2004). The primary aim of this study was to explore the effectiveness of a health education intervention (HEI) based on the health belief model for improving GDM women's self-efficacy for adherence to healthy behaviors. It was hypothesized that providing self-efficacy enhancing HEI for GDM women will improve their self-efficacy for adherence to healthy behaviors.

In this sample of 90 pregnant women with gestational diabetes, the study intervention showed its greatest impacts in the area of self-efficacy for adherence to healthy behaviors. At baseline, the intervention and control study groups had comparable scores for self-efficacy. However, at post-test the intervention group reported a significant improvement in self-efficacy as compared to the control group, which might be related to the influence of the self-efficacy

factors that were included in the study intervention. With that being said, it is important to note that both the control (60%) and the intervention (62.2%) participants received a health education information about gestational diabetes as part of their prenatal care, contradicting findings of previous studies about the positive relationship between receiving diabetes education and self-efficacy (Bohanny et al., 2013; Rasheed, 2013). Further, it attests that the study intervention that incorporated self-efficacy enhancing strategies in the diabetes health education was efficient in improving participants' self-efficacy for adherence to healthy behaviors. Our study findings fit with previous literatures that document the effectiveness of educational sessions when incorporating self-efficacy enhancing strategies such as motivational messages, role modeling, goal setting, and mastery experiences in increasing participants' self-efficacy (Gaston, Cramp, & Prapavessis, 2012; Neupert, Lachman, & Whitbourne, 2009; O'Dea et al., 2015; Poddar et al., 2010). In contrast, other studies found evidence of fluctuation in self-efficacy over time; intervention improved short-term self-efficacy but was not beneficial at sustaining improvement in self-efficacy at long-term (Mailey & McAuley, 2014; Olson, & McAuley, 2015). Therefore, future studies should test a combination of multiple strategies to sustain long-term improvement in participants' self-efficacy. Also, examining new strategies that improve self-efficacy should be considered in future research.

### **The Predictors of Adherence to Healthy Behaviors among GDM Women**

Self-efficacy has been used as a motivational strategy in the diabetes treatment plan to increase adherence to healthy behaviors such as weight loss, dietary modifications and exercises (Bas & Donmez, 2009; Wen, Shepherd & Parchman, 2004). In the current study, the influence of self-efficacy was tested as a potential predictor of adherence to healthy behaviors among women with gestational diabetes. Our findings indicate that self-efficacy is not a significant

predictor for participants' adherence to healthy behaviors when controlling for the group assignment, as only 0.9 percent of the variances in the adherence to healthy behaviors were explained by self-efficacy. Although there is limited evidence that investigated the relationship between self-efficacy and adherence to healthy behaviors among women with current GDM, this finding is opposite to those of earlier studies conducted among women with a previous history of GDM, participants with type 2 DM and other general populations (Bohanny et al., 2013; King et al., 2010; Kim et al., 2008; Sharoni, & Wu, 2012). However, mediation analysis revealed that the improvement in self-efficacy partially mediates the impact of the group assignment on the improvement in the level of adherence to healthy behaviors and it accounted for three percent of the total effect. With regard to the health belief model, our finding supports the HBM assumption that self-efficacy with other mediators (such as knowledge, socioeconomics and personality), influences the relationship between the individual perception and the likelihood of the adherence to the recommended healthy practices [Appendix A] (Chen, & Lin, 2010). This finding supports that improvement in self-efficacy can not have a complete mediation effect between group assignment and improvement in the adherence to healthy behaviors. There are other mediators that may contribute to the total mediation; not measured in the current study, and therefore they were not included in the mediation analysis.

The influences of participants' characteristics on adherence to healthy behaviors were also tested among study participants. None of the participants' characteristics significantly predicted improvement in adherence to healthy behaviors except for group assignment. Only the group assignment was found to be a significant predictor of improvement in adherence to healthy behaviors. One possible explanation for this finding is that the study participants had a good mean adherence to healthy behaviors score at baseline ( $M= 3.1$ ), suggesting that there is a ceiling

effect in the adherence to healthy behaviors score at baseline regardless of the study health education intervention. This limited further improvement in adherence to healthy behaviors scores. This unexpected finding may be because of prior standard prenatal care in diabetes health education received by the study groups. Therefore, the study findings should be interpreted cautiously because improvement scores in self-efficacy could be a predictor of adherence to healthy behaviors without the ceiling effect (mean of adherence) and without the confounding effect of the diabetes health education received prior to the start of the study (Bohanny et al., 2013; King et al., 2010; Kim et al., 2008; Sharoni, & Wu, 2012).

Another potential explanation is that the intervention period was not adequate in length to demonstrate more influence in participants' adherence development. Overall, it is imperative to consider these issues in future studies on the factors affecting adherence to the recommended healthy behaviors among women with current GDM.

### **The Barriers for Adherence to Healthy Behaviors among GDM Women**

Perceived barriers are one of the main concepts in the HBM that determines the individual's decision whether or not to adhere to the recommended healthy behaviors (Rosenstock et al., 1988). Perceived barrier was defined as one's belief about the obstacles related to implementing the recommended behavior (Hiltabiddle, 1994).

Our study reported that the top barriers for adherence to healthy behaviors were that of physical limitations and time constraints. Approximately 54 percent of the women in the intervention group and 42.2 percent of the control group reported physical limitations due to pregnancy were a barrier for adherence to healthy practices such as physical activities. In addition, 48.9 percent and 31 percent of the women in the intervention and control group, respectively, reported time constraints as a barrier for adherence to healthy behaviors. This

finding is in line with Leppänen et al.'s (2014) study which reported that tiredness, work, and lack of time interfered with physical activity among pregnant women with gestational diabetes. In addition, Saligheh, McNamara, & Rooney (2016) found that fatigue, a lack of motivation and confidence, and substantial time constraints were the top barriers for healthy lifestyle behaviors among postpartum women. However, it is worth noting that 54.4 percent of the study participants are working and 43.3 percent of them do not have a house-maid available to help them in their homes. Juhl et al. (2012) reported that women who are students or who are not working were more likely to adhere to physical activity than women who are working, indicating that working pregnant women are at increased risk of physical inactivity. Leppänen et al. (2014) also found that working part-time is a strong predictor for adherence to physical activities. In their study, Leppänen et al. (2014) elaborated that this could be due to the fact that they have more energy and they have more time to be physically active than working women. From this perspective, providing pregnant women with flexible work hours could encourage them maintaining healthy lifestyle behaviors during the pregnancy period.

This study also found that social gatherings, having holidays and decreased availability of healthy food outside the home, are common barriers to healthy eating. The impact of decreased availability of healthy foods and culture-specific food items along with expected decision-making processes can influence expected behaviors among Omani pregnant women. Although no evidence supports this finding, it is essential to consider the role of culture and environmental factors as determinants for adherence to healthy behaviors. Health prevention interventions should address barriers to healthy behaviors among GDM women such as availability of certain food items due to holidays and celebrations, along with expectations for women's participation. Understating the barriers that hinder GDM women from adhering to the recommended healthy

behaviors, and identifying potential supportive measures, will help care providers deliver the appropriate care and support to overcome the perceived barriers for ultimate health pregnancy outcomes.

### **The Motivating Factors for Adherence to Healthy Behaviors among GDM Women**

In the HBM, cues to action is defined as the triggers that stimulate or assist the individual in the decision-making process in sense of adherence to healthy behaviors (Hamuleh, Vahed, & Piri, 2010). Consistent with previous studies, the participants in this study agreed that their concern for maternal and neonatal GDM-related complications and family moral support was a strong motivator to adhere to the recommended healthy behaviors (Amason et al., 2016; Hansen, Landstad, Hellzen, & Svebak, 2010; Korkiakangas et al., 2011; Leppänen et al., 2014). This finding suggests the importance of the role of perceived risk and supports of significant others on increasing adherence to healthy behaviors. In the current study, 17.8 percent of the women reported that their husband's support was a motivating factor for adherence to healthy behaviors. Similarly, Leppänen et al. (2014) and Saligheh et al. (2016) found that women who had partner support specifically were more likely to adhere to recommended healthy behaviors. In addition, 8.9 percent of the study participants were motivated to adhere to the recommended healthy practices because they reported self-determination for weight management. This finding is similar to those of another two studies (Korkiakangas et al., 2011; Trevorrow, 2016), which indicated that participants' desire for weight control motivated them to adhere to an active lifestyle. Furthermore, it should not be overlooked that women in this study claimed that self-efficacy enhancing strategies used in the study intervention such as having a written goal plan, weekly text messages and health advice on the health education video were motivating factors for adherence to healthy behaviors. Overall, future prevention studies on gestational diabetes

should consider including partner support and new self-efficacy enhancing strategies in the study intervention.

### **Strengths and Limitations of the Study**

The major strengths of this study are the experimental design and the use of the HBM theoretical framework that guided the study intervention. These two characteristics permitted investigation into the unique effectiveness of the study intervention while controlling for extraneous variables among study participants. Thus, it gave greater confidence of the study findings. In addition, using validated questionnaires to measure study variables and no dropouts were additional strengths of this study. Barriers and motivating factors for adherence to healthy behaviors were identified and explored with open-ended questions, providing a clearer picture of the participants' perceived barriers and motivating factors related to their adherence to the recommended healthy behaviors.

In addition to the above-mentioned strengths, several limitations in the study are acknowledged. One potential limitation concerns the composition of the sample. Firstly, as the study participants were Omani pregnant women with GDM, the study findings have limited generalizability to Omani women with GDM. Secondly, a larger sample size would provide a stronger statistical power to measurement scores in the prevent type 2 error and therefore greater confidence in the results. Thirdly, the study intervention's effect on self-efficacy was measured after four weeks from baseline to the intervention. Thus, no long-term effects of the study intervention can be made on self-efficacy for adherence to healthy behaviors.

### **Recommendations for Future Studies**

To address study limitations, future studies should include a more diverse group of pregnant women with gestational diabetes. Also, self-efficacy and adherence to healthy behaviors should be reassessed during the postpartum period to shed light on the long-term effect of the study intervention on self-efficacy for adherence to healthy practices. Future studies should use both subjective and objective measures to assess adherence to healthy behaviors. Furthermore, upcoming studies conducted among pregnant women with gestational diabetes should examine factors affecting both women's self-efficacy for adherence to healthy behaviors and actual adherence to healthy behaviors while considering cultural and environmental factors. Novel research methods such as incorporating partner support in the health education interventions, need to be explored as new strategies to enhance self-efficacy for adherence to healthy behaviors among pregnant women with GDM and subsequently incorporate them with partner support in the health education interventions. Finally, assessing barriers for adherence to healthy behaviors continuously among women with GDM can help to provide the appropriate support to overcome perceived barriers.

### **Conclusion and Implications for Nursing**

Although the field of gestational diabetes mellitus (GDM) management is growing, the incidence rate of GDM-related complications continues to increase, most likely as a result of unhealthy lifestyle behaviors. Recent studies on the management of GDM have focused on new interventions that improve pregnancy outcomes; however, evidence about the strategies that enhance adherence to healthy lifestyle behaviors is lacking. Based on the reviewed evidence regarding the effectiveness of healthy lifestyle behaviors on reducing frequency of GDM

complications, upcoming research studies identify factors that enhance and encourage adherence to healthy behaviors, such as improved self-efficacy for adherence to healthy behaviors.

This study examined the effectiveness of a health education intervention based on the HBM on increasing perceived self-efficacy and actual adherence to the recommended healthy behaviors among Omani women with gestational diabetes. The results of this study have implications for nursing research, nursing practice and policy development. The study added to the nursing body of knowledge the impact of the health education intervention and self-efficacy as essential factors to enhance adherence to healthy behaviors among pregnant women with gestational diabetes. It also provided the foundation for future studies that seek an understanding of barriers and factors that enhance or hinder adherence to healthy behaviors among Arab pregnant women with gestational diabetes.

Study findings have implications for nursing practice, specifically the health care providers of pregnant women with GDM generally and nurses in particular. Nurses, along with other health-care providers of multidisciplinary teams, such as an obstetricians, endocrinologists, and dieticians, should be directly involved in providing the best care to manage GDM cases in order to achieve optimal pregnancy outcomes. Nurses can incorporate self-efficacy enhancing strategies such as goal setting plans, role modeling, mastery experience, and motivational messages on health education intervention that is adapted to the unique needs of pregnant women with gestational diabetes. In addition, exploring barriers to healthy behaviors adherence among women with GDM while providing the required resources and support is one of the nurses' responsibilities for improvement in adherence to healthy practices. Improved adherence to healthy behaviors will impact decreased incidence of gestational diabetes complications associated with physical consequences in women with GDM and their neonates. Study findings

have potential to decrease the financial consequences of GDM-related complications as well as their burden on the health-care system. Improvement in the quality of health care services to pregnant women with gestational diabetes is anticipated.

Nurses who are responsible for the care of women with GDM on different units of care may find benefit in incorporating recommended strategies in their health education interventions. Because women with history of GDM are at increased risk of developing type 2 diabetes mellitus, extending health education sessions to six weeks postpartum and one year postpartum among women with GDM may be helpful in sustaining adherence to the recommended healthy behaviors for prevention of type 2 diabetes.

With regard to the Omani health care system, the study findings have implications for public health and policy advisors; therefore, collaboration between Ministry of Health (MOH), Ministry of Municipality, Oman Infoline TXT and Nursing Schools is warranted. The Ministry of Municipality should play a role on ensuring accessibility to healthy food with calorie labeling in the public arena. Oman Infoline TXT could assist in this effort by sending weekly text messages for all GDM pregnant women in Oman as suggested by the Ministry of Health. In addition, collaborative relationship between Nursing Schools and MOH need to be strengthening in order to raise awareness in the Omani community about the benefit of assuming healthy lifestyle behaviors among pregnant women with GDM. This could be achieved by organizing media campaigns (e.g., television and radio), social media campaigns (e.g., Instagram, Facebook, and App Application) and public campaigns. In Oman, community members should be encouraged to show support for women with GDM in an effort to increase adherence to healthy behaviors. Overall, findings from this study offers a multi-faceted evidence based education program for Omani women with GDM that can be further tested and implemented in the Omani

community to improve these women's adherence to healthy lifestyle and pregnancy outcomes.

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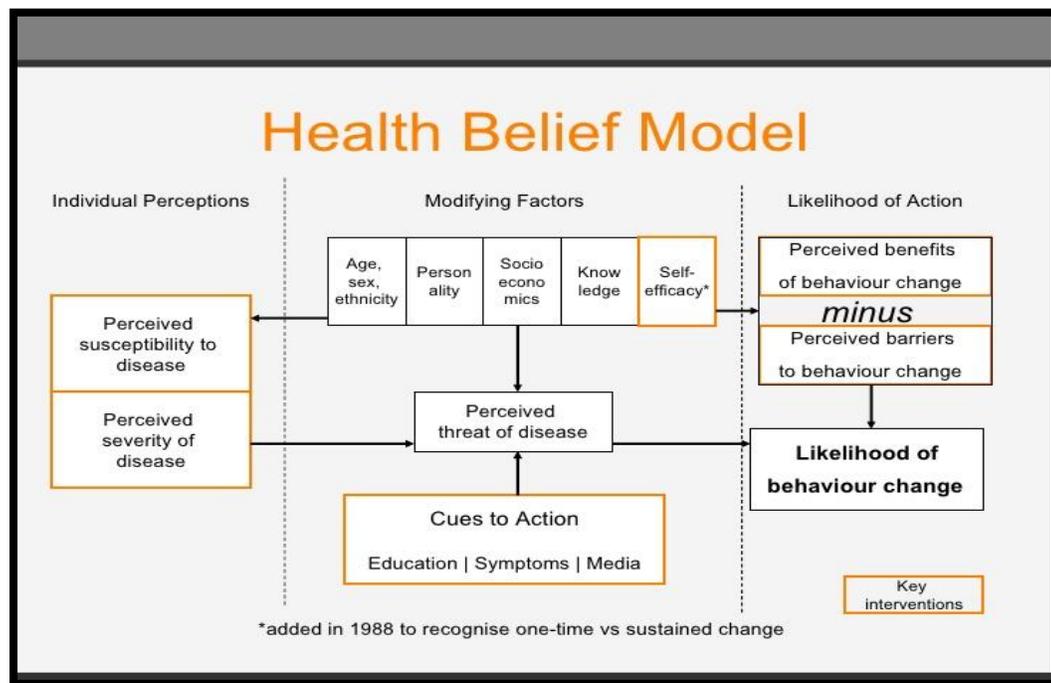
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## Appendix A. Different Diagnostic Criteria for Gestational Diabetes Mellitus

Test	IADPSG (≥ 1 abnormal value)	ADA (≥ 2 abnormal values)	WHO (≥ 1 abnormal value)	NDDG (≥ 2 abnormal values)
Fasting mg/dl	≥ 92	≥ 95	92-125	105
1 h glucose mg/dl	≥ 180	≥ 180	180	190
2 h glucose mg/dl	≥ 153	≥ 155	153-199	165

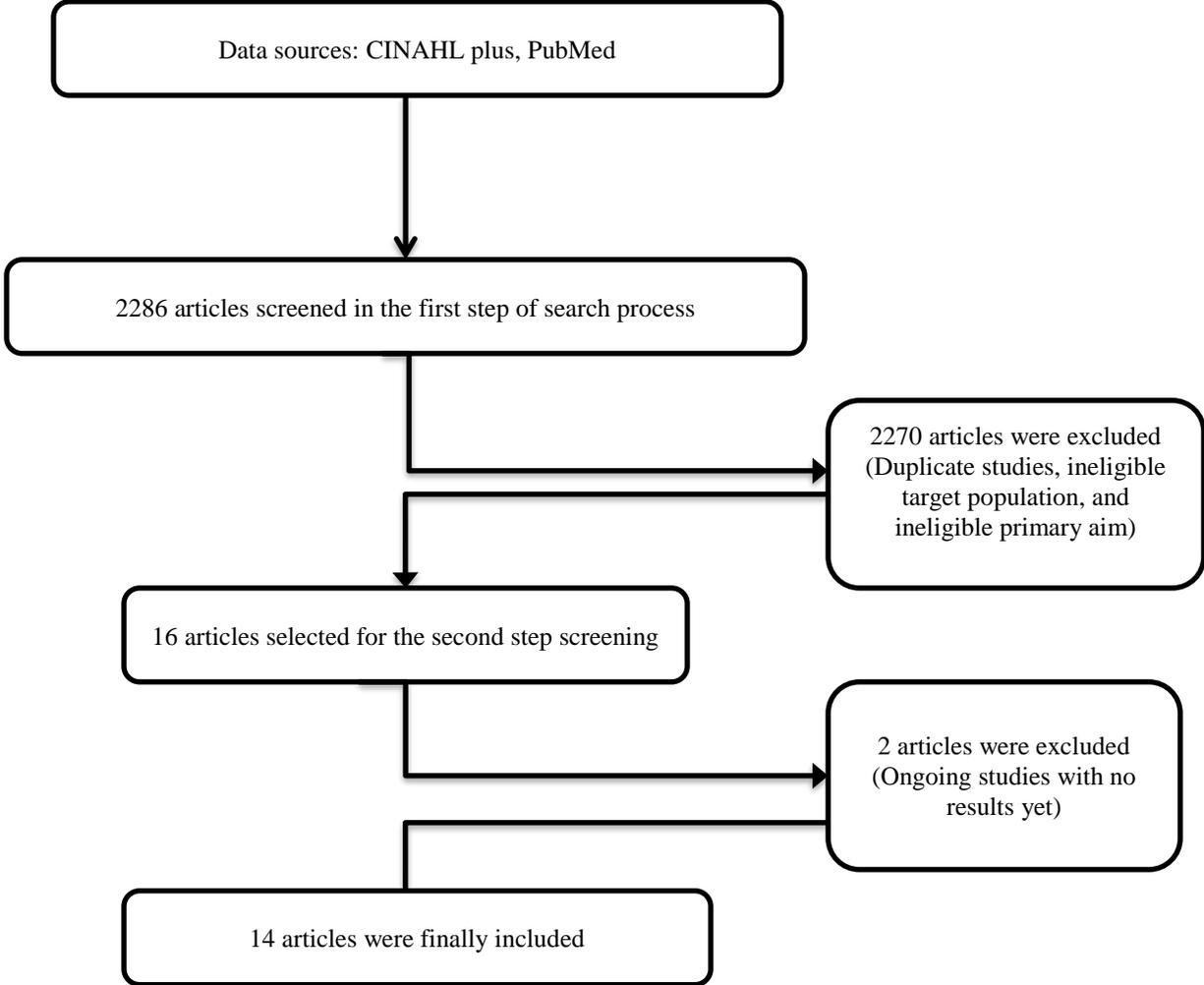
*Note.* IADPSG= International Association of Diabetes and Pregnancy Study Groups, ADA= American Diabetes Association, WHO= World Health Organization, NDDG= National Diabetes Data Group. Data for IADPSG criteria from (American Diabetes Association, 2015), for ADA criteria from (Perera et al., 2009), for WHO criteria from (Crowther et al., 2005), and for NDDG criteria from (Poomalar, 2015).

## Appendix B. The Health Belief Model

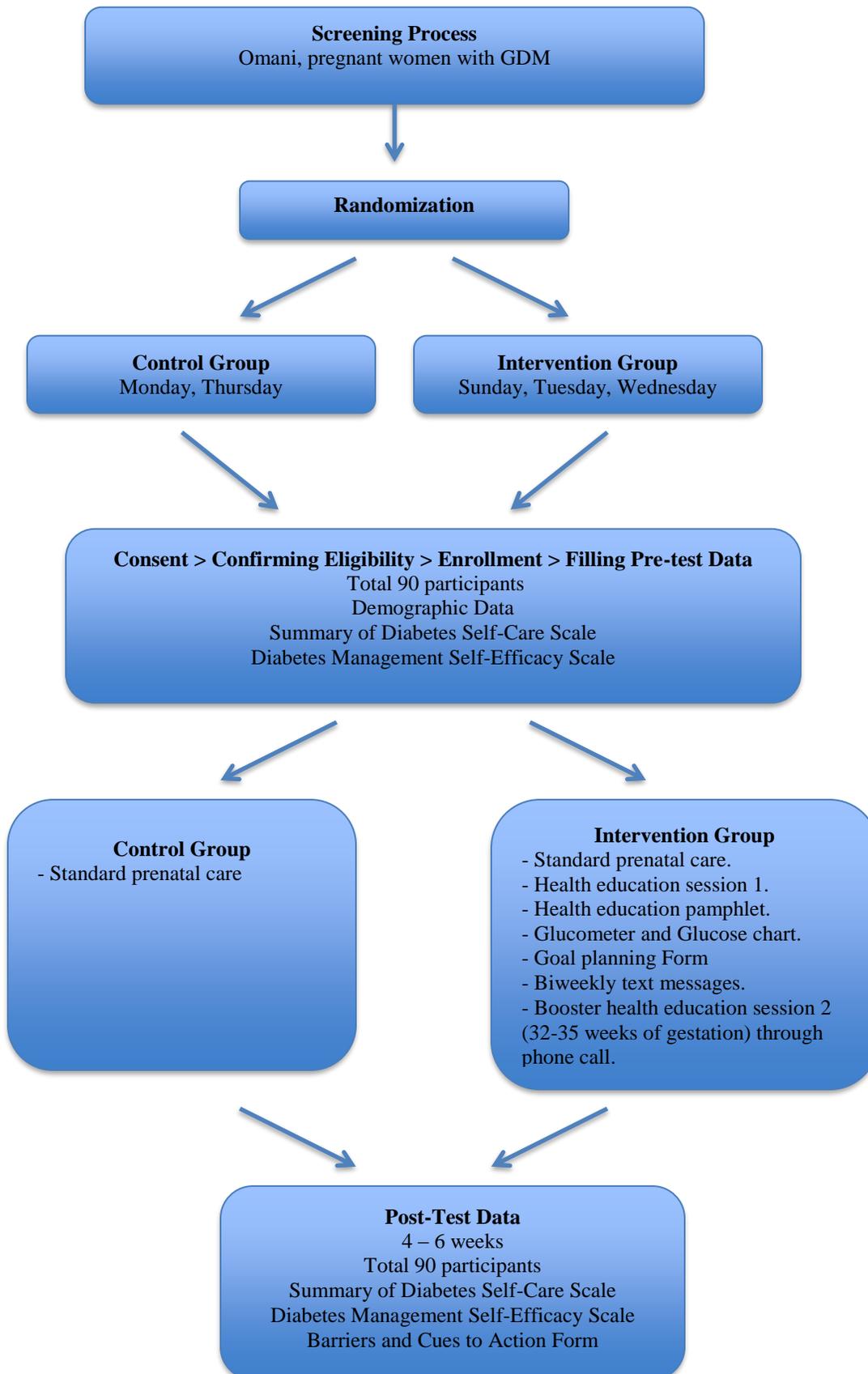


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Appendix C. Article Selection Process



Appendix D. Study Design

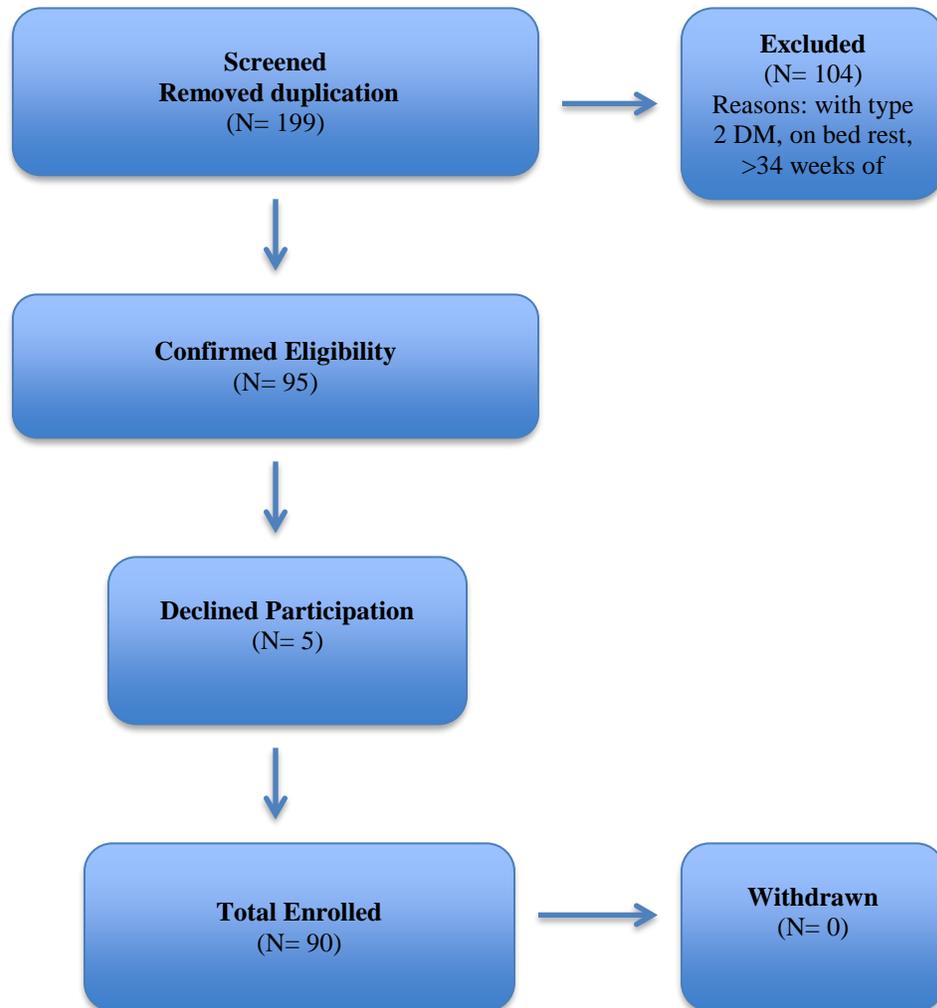


Appendix E. Sample Size Calculations using Power Analysis ( $\alpha=0.05$ , 80% power, one tailed)

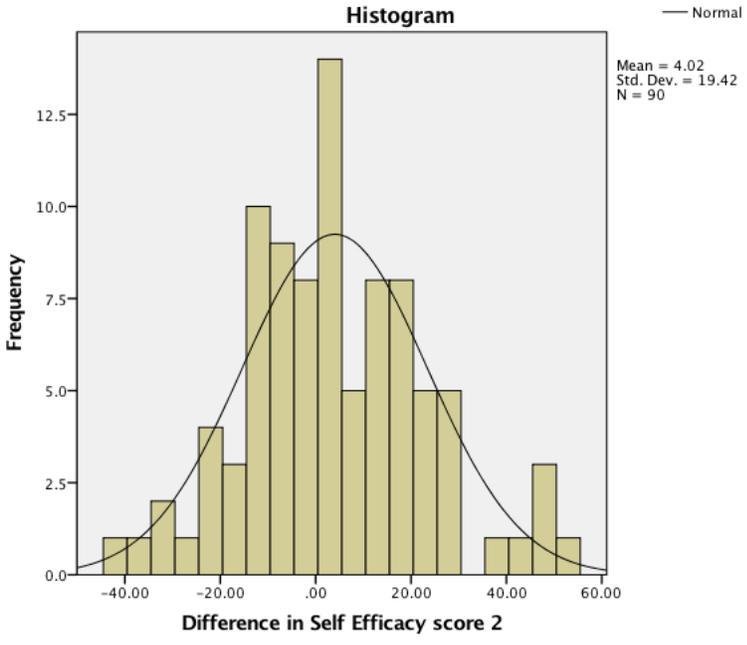
Hypothesis	Outcome Variable	Statistical test	Effect Size	Overall Sample Size
Hypothesis 1: GD women who receive the HEI will report higher self-efficacy for adherence to healthy behaviors as measured by DMSES, compared to GD women who do not receive the HEI.	Self-efficacy score	Independent-t test	M= 0.6	70
Hypothesis 2: GD women who have higher self-efficacy score will report greater adherence to healthy behaviors as measured by SDSCA, compared to GD women who have lower self-efficacy score, controlling for group.	Level of adherence	Multiple linear regression	M = 0.15	68
			L = 0.35	31
Hypothesis 3: Participants' demographic variables are significant predictors of adherence to healthy behaviors.	Level of adherence	Multiple linear regression	M = 0.15	102
			L = 0.35	52

*Note.* M=Medium, L=Large.

## Appendix F. Sample Selection Process

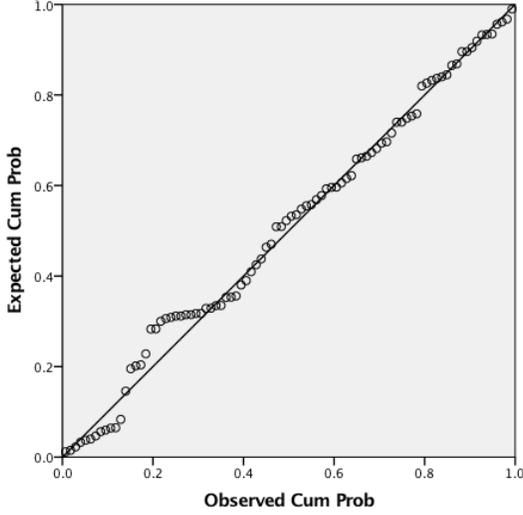
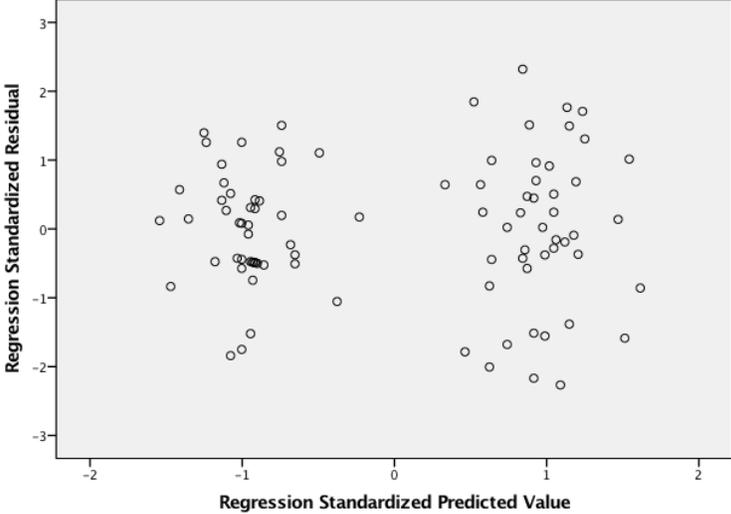


Appendix G. Assumptions of Independent T-test

Assumptions (Aim 1)	Results	Status	Action Taken
Normality	<p>Shapiro-Wilk P-value= 0.31, means normally distributed.</p> <p>Histogram for difference in self-efficacy score shows normal distribution with some outliers.</p> 	Met	Independent t-test
Independence	Two groups, independent from each other.	Met	
Homogenous	Leven's test (t=-2.99, p=0.28), means no variances between two groups.	Met	

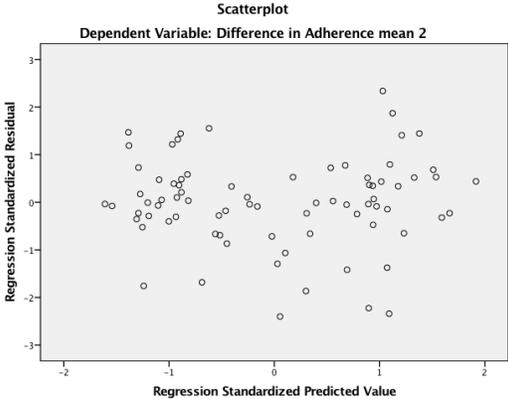
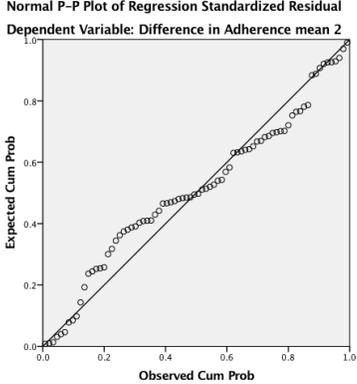
Appendix H. Assumptions of Multiple Linear Regression, Aim 2

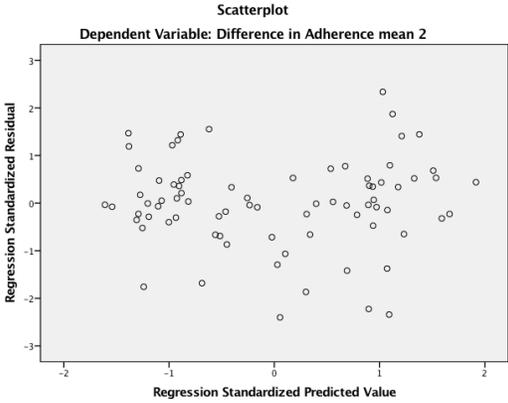
Assumptions (Aim 2)	Results	Status	Action Taken
Linearity	<p>The scatterplot of the residuals against the predicted values of the dependent variable shows that observations are randomly centered around the line of zero standard residual value.</p> <div data-bbox="430 636 1161 1213" data-label="Figure"> <p style="text-align: center;"><b>Scatterplot</b> <b>Dependent Variable: Difference in Adherence mean 2</b></p> <p>The scatterplot displays the relationship between the Regression Standardized Predicted Value (x-axis, ranging from -2 to 2) and the Regression Standardized Residual (y-axis, ranging from -3 to 3). The data points are scattered randomly around the zero line, with no discernible pattern or trend, which supports the assumption of linearity.</p> </div>	Met	Multiple linear regression
Normality of Errors	<p>The P-P Plot shows that the plotted points almost fit in the line, with no serious departures from the line. Also, Mahal. Distance maximum value 8.24, (Critical Value for two predictors= 13.0).</p>	Met	

	<p style="text-align: center;"><b>Normal P-P Plot of Regression Standardized Residual</b>  <b>Dependent Variable: Difference in Adherence mean 2</b></p>  <p style="text-align: center;">Expected Cum Prob</p> <p style="text-align: center;">Observed Cum Prob</p>	
<p>Homoscedasticity of errors</p>	<p>The scatterplot of the residuals against the predicted values of the dependent variable shows there is a rectangle pattern in the points, which doesn't exceed -3 and +3.</p> <p style="text-align: center;"><b>Scatterplot</b>  <b>Dependent Variable: Difference in Adherence mean 2</b></p>  <p style="text-align: center;">Regression Standardized Residual</p> <p style="text-align: center;">Regression Standardized Predicted Value</p>	<p>Met</p>

Independence of errors	Durbin-Watson= 1.9 (>1.5 d >2.5)	Met
Multicollinearity	VIF= 1.1, so (<10) Tolerance= 0.91, so (>0.01)	Met

Appendix I. Assumptions of Multiple Linear Regression, Aim 3

Assumptions (Aim 3)	Results	Status
Linearity	<p>The scatterplot of the residuals against the predicted values of the dependent variable shows that observations are randomly centered around the line of zero standard residual value.</p>  <p style="text-align: center;">Scatterplot Dependent Variable: Difference in Adherence mean 2</p>	Met
Normality of Errors	<p>The P-P Plot shows that the points almost fit in the line. Also, Mahal. Distance maximum value 26.8, (Critical Value for ten predictors= 29.59).</p>  <p style="text-align: center;">Normal P-P Plot of Regression Standardized Residual Dependent Variable: Difference in Adherence mean 2</p>	Met

<p>Homoscedasticity of errors</p>	<p>The scatterplot of the residuals against the predicted values of the dependent variable shows there is a rectangle pattern in the points, which does not exceed -3 and +3.</p> 	<p>Met</p>
<p>Independence of errors</p>	<p>Durbin-Watson= 1.9, (<math>1.5 &gt; d &lt; 2.5</math>)</p>	<p>Met</p>
<p>Multicollinearity</p>	<p>VIF= between (1.1 – 1.9), so (<math>&lt;10</math>) Tolerance= between 0.5 - 0.8, so (<math>&gt;0.01</math>)</p>	<p>Met</p>