

# Nursing Interventions on Nutrition and Exercise in the management of Gestational Diabetes: A Literature Review

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Gestational diabetes is a specific type of diabetes that develops during pregnancy in women who previously did not have diabetes, affecting more than 200,000 women every year. It is characterized by high blood sugar levels resulting from insulin resistance, where the body's cells do not respond effectively to insulin. According to 2019 International Diabetes Federation (IDF) Diabetes Atlas estimates, gestational diabetes mellitus affects 13.2% of pregnancies worldwide, representing about 17.1 million births each year causing several severe complications to mother and unborn baby. Therefore, the requirement for more research and investigation has increased to find and understand about nursing interventions on nutrition and exercise during prevention and management of Gestational Diabetes Mellitus.

The aim of this thesis is to study, analyse and provide understanding about nursing intervention on nutrition and exercise while managing gestational diabetes mellitus. This thesis will be useful for nursing students, nurses, and patients as well. Literature review was used as research method to get essential information for the gestational diabetes. The articles were derived from trustful sources like, EBSCOhost, ScienceDirect, ProQuest Central, SAGE Premier and Laurea Finna. The search term used while searching data was "Nursing Interventions" and "Nutrition and Exercise" and "Gestational diabetes mellitus".

Twelve most relevant research were selected for analysis where full-text English articles less than 10 years old with peer reviewed were criteria of selection. After analysing the collected studies through inductive thematic approach, the authors have concluded that, nursing interventions on nutrition and exercise are vital while managing pregnancy related diabetes to minimize the catastrophic outcomes for both the mother and foetus. However, Further study is recommended due to lack of specific guidelines about nutrition and exercise for patients with gestational diabetes mellitus based on their individual needs.

Keywords: Exercise, Gestational diabetes, Lifestyle, Nursing Intervention, Nutrition, Prevention.

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### 1 Introduction

During pregnancy a mother's body takes care of two lives, the mother's body and the infant growing inside her womb (Moore 2018). In the process, the mother's body goes through significant hormonal changes where the skin, the muscles, and the organs must expand to make room for the developing infant (Wisner 2021). Not all the changes have positive outcomes that are beneficial as gestational diabetes mellitus is a type of diabetes that develops during pregnancy when the body is unable to produce enough insulin to regulate the increased levels of glucose in the blood that occur during pregnancy where it mainly goes away after birth but sometimes continue as type 2 diabetes (Sobrevia 2013, 3). According to the International Diabetes Federation (2020), Pregnancy-related hyperglycemia affected 20 million live births or 16% of all births, where approximately 84% were due to gestational diabetes. In other words, gestational diabetes affected 1 in every 6th childbirth in 2019.

Age, obesity, smoking habit, family history with type 2 diabetes, previous diagnosis of gestational diabetes and sedentary lifestyle are some common reasons for developing gestational diabetes where the incidence might rise at fast rate in near future. The prevalence of gestational diabetes mellitus effects both the mother and fetus. In one hand, the mother may face adverse outcome like polyhydramnios, pre-eclampsia, prolonged and obstructed labor, caesarean section, uterine atony, postpartum hemorrhage, mortality and the fetus might have to deal with intrauterine death, stillbirth, congenital malformation, birth injuries, neonatal hypoglycemia, and infant respiratory distress syndrome in the other. (Ray 2020, 9-10; Alia et al. 2019; Kim et al. 2020.)

After the mother is diagnosed with gestational diabetes mellitus, managing it involves a comprehensive approach to ensure the well-being of both the mother and the developing baby in her womb where the primary aim is to maintain the stable blood sugar level through several approaches where the dietary modifications, regular physical activity, and if needed, pharmacological intervention is also applied (Radenkovic 2022, 29). Following a balanced diet that emphasizes complex carbohydrates, lean proteins, and healthy fats can help regulate blood sugar spikes while portion control and spacing out meals and snacks evenly throughout the day can prevent extreme fluctuations (Ray 2020, 36). Engaging in regular, moderate exercise, as advised by healthcare professionals, enhances insulin sensitivity, and supports overall health and monitoring blood sugar levels at home and attending prenatal appointments allow healthcare providers to adjust the management plan as needed (Lin, Yang, Zhang & Wei 2020). In cases where lifestyle modifications are insufficient, medication or insulin therapy might be recommended where collaborating with healthcare experts, including doctors and registered dietitians is mandatory (Rasmussen et al. 2020).

An unhealthy diet (processed foods rich in simple carbohydrates) and lack of physical activity is directly associated with the development of gestational diabetes mellitus where dietary change and exercise before and during pregnancy are first-line treatment method to prevent and manage the complications where the appropriate nursing interventions are crucial (Lambert, Munoz, Gil & Roman 2023; do Nascimento, Borges, Figueiroa, Alves, & Alves 2019). Therefore, this thesis intends to study the usefulness of nursing interventions on nutrition and exercise in the management of gestational diabetes mellitus. After analyzing the collected articles, the authors have found nursing interventions on nutrition and exercise as crucial steps while managing gestational diabetes mellitus. The authors also recommended further detailed and specific studies on nutrition and exercise to manage gestational diabetes mellitus, as no guidelines about the amount of nutrition and exercise on individual-based criteria like age, weight, height, and lifestyle were found. In the writing process artificial intelligence ChatGPT was used to get a basic understanding and flow of writing in a few sections, and QuillBot was used to rephrase sentences.

#### 2 Theoretical background

The theoretical background is a critical component of the thesis, as it serves to establish the scholarly context for the research project and demonstrates that the study is grounded in relevant literature and theories (Theoretical Framework - University of Southern California 2023). In this section of this thesis, the concept of gestational diabetes mellitus, its symptoms, screening & diagnosis, risk factors, and complications that can occur including treatment options are described. The theoretical knowledge of nutrition and exercise are mentioned accordingly in further part of this section followed by nursing interventions.

# 2.1 Gestational Diabetes Mellitus

Gestational diabetes mellitus is one of the most prevalent medical issues of pregnancy, and if left untreated, it can have catastrophic health consequences for both the mother and the upcoming child (Modzelewski, Stefanowicz-Rutkowska, Matuszewski & Bandurska-Stankiewicz 2022). Gestational diabetes develops due to the failure of compensatory mechanism when there is lack of pancreatic beta cells affecting 1-2% of all pregnancies (Sobrevia 2013, 3). Insulin-resistance is the condition when the effectiveness of the insulin produced by the pancreas begins to weaken due to increase in pregnancy hormones, body fat, and carbohydrate-rich diet (The Finnish Diabetes Association 2023; Moore 2018, 2). Gestational diabetes is diagnosed if the fasting plasma glucose is  $\geq$  5.1 mmol/L, 1 h  $\geq$  10 mmol/L, or 2 h  $\geq$ 8.5 mmol/L during a 75 g oral glucose tolerance test according to IADPSG/WHO criteria that is first diagnosed during pregnancy (Modzelewski et al. 2022).

Insulin insufficiency and insulin resistance are the reasons behind developing gestational diabetes also known as carbohydrate intolerance, is diagnosed during pregnancy (Moore 2018, 2). According to the latest data from the International Diabetes Federation (IDF), gestational diabetes affects almost 14.0% (95% confidence interval: 13.97-14.04%) of pregnancies worldwide, representing approximately 20 million births annually (Modzelewski et al. 2022). According to The Finnish Diabetes Association (2023), approximately one in five expectant mothers is diagnosed with gestational diabetes. In most cases, no signs or symptoms are experienced by pregnant women except few pregnant women can feel increased thirst, fatigue, and dry mouth that are signs of gestational diabetes (Riverside 2022).

#### 2.1.1 Screening and Diagnosis

The gestational diabetes screening test is used to identify if pregnant women are at a higher or lower risk of developing it based on a certain glucose threshold approved by a related organization based on locality, and the definitive diagnostic test will continue subsequently for those who surpass the screening test threshold to confirm the existence or non-existence of gestational diabetes (Bhavadharini, Uma, Saravanan & Mohan 2016). Different associations, the American Diabetes Association (ADA), the International Association of Diabetes in Pregnancy Study Group (IADPSG), and the American College of Obstetricians and Gynecologists (ACOG) have forwarded different criteria for screening and diagnosis (Moore 2018, 45). The screening of gestational diabetes is crucial to identify and interrupt the development of glucose intolerance in the mother and baby in her womb (Moore 2018, 46). Nowadays, screening is done between 24 and 28 weeks of pregnancy in all pregnant women without previously diagnosed diabetes (Modzelewski et al. 2022).

The screening of gestational diabetes is mainly done by two different methods known as onestep testing and two-step testing depending on area and organization (Moore 2018, 50; Coustan, Dyer & Metzger 2021). Screening through the one-step method, the patient must be fasting where 75g oral glucose load is given after measuring fasting blood glucose level. After that, the blood glucose level is checked at 1 and 2 hours and gestational diabetes is diagnosed if the values exceed the recommended cutoffs. (Moore 2018, 51; WHO 2013; Coustan et al. 2021.) According to WHO 2013, Gestational diabetes mellitus is diagnosed if the fasting plasma glucose is between 5.1-6.9 mmol/l (92-125 mg/dl), 1-hour plasma glucose is greater than 10.0 mmol/l (180 mg/dl) followed by 75g oral glucose load, and 2-hour plasma glucose lies between 8.5-11.0 mmol/l (153-199 mg/dl) following 75g oral glucose load. The International Federation of Gynecology and Obstetrics, IADPSG, and the International Diabetes Federation have also adopted the 1-step approach for use in societies, and many countries worldwide follow the guidelines of these organizations (Coustan et al. 2021).

The two-step testing method does not require fasting for screening. During this method, 50g of oral glucose load is given to pregnant women and a glucose tolerance test is carried out after 1 hour. If the result exceeds the threshold value, the patient needs to perform 3h test. In this second phase, 100g of oral glucose load is given in the fasting state as the second diagnostic step and blood sugar are measured at 1, 2 and 3 h. The recommended cutoff value for 1h test is 7.2-7.8 mmol/l (130-140 mg/dl). In the 3h test, the 1 h threshold value is 10-10.6 mmol/l (180-190 mg/dl), 2 h threshold value is 8.6-9.2 mmol/l (155-165 mg/dl) followed by 3 h where the cutoff limit is 7.8 mmol/l (140 mg/dl). Any two abnormal values are diagnosed as gestational diabetes. (Moore 2018, 51-55; Coustan et al. 2021.) This approach is commonly used in the United States through the recommendation of the American College of Obstetricians and Gynecologists (Coustan et al. 2021).

#### 2.1.2 Risk Factors

The underlying root causes of gestational diabetes mellitus are crucial to dig out at an early stage for effective diagnosis, prevention, and management (Amiri, Faramarzi, Bakhtiari & Omidvar 2018; Liu, Zhao, Gao & Wang 2019). One significant risk factor for gestational diabetes is a previous diagnosis of it, and the risk of reoccurrence increases by six times (Alia et al. 2019; Modzelewski et al. 2022). According to a study, mothers with a history of gestational diabetes are seven times more likely to develop type 2 diabetes mellitus later in life than those without a history of gestational diabetes (Liu et al. 2019).

In addition to a previous diagnosis of gestational diabetes, other risk factors include advanced maternal age (>25), increased BMI, parity, family history of Type 2 diabetes, ethnicity, genetics, Polycystic Ovary Syndrome (PCOS), dietary habits, and no physical activity (Amiri et al. 2018). Pregnant women with a body mass index (BMI) >30 or a rise of pregnancy weight over 110% are most likely to develop gestational diabetes (Alia et al. 2019, 2). Obese and extremely obese women before pregnancy had a 4 to 8 times greater chance of developing gestational diabetes than healthy women (Kim, Sharma, & Callaghan 2015). Obesity raises blood pressure, increases insulin resistance, and produces hypertriglyceridemia (high triglycerides in the blood) increases the likelihood of developing gestational diabetes mellitus (Yen et al. 2019). A recent study also shows that the rate occurring gestational diabetes in pregnancies is double in women who are previously treated for polycystic ovary syndrome (PCOS) (Modzelewski et al. 2022).

Moreover, women belonging to ethnic minority groups, particularly Hispanic and Asian women, have been reported to have a higher risk of gestational diabetes than non-Hispanic white women (Hedderson, Darbinian & Ferrara 2014). The Asia-Pacific region is known for the largest number of individuals with gestational diabetes as Asians are more prone to abdominal obesity with high insulin resistance compared to Western countries (Amiri et al. 2018). Poor eating habits are also one important factor that triggers the occurrence of gestational diabetes. The study has also found that smoking before pregnancy is associated with an increased risk of developing gestational diabetes that requires insulin therapy (Kim et al. 2020).

# 2.1.3 Complications

Gestational diabetes carries both short-term and long-term complications for the mother and fetus, and it might lead towards severe maternal and fetal morbidity and mortality if the case is left undiagnosed, unmonitored, and untreated (Ray 2020, 3). Regarding fetus complications, the increased risk of macrosomia defined as a birth weight greater than or

equal to 400g, shoulder dystocia, birth injuries as well as neonatal hypoglycemia and hypo bilirubinemia, stillbirth, apnea, and bradycardia are possible to occur. It also acts as a catalyst to increase genetic risk for the development of obesity, endocrine morbidity, cardiovascular morbidity and diabetes or metabolic syndrome in childhood. (Alia et al. 2019, 4; Sheiner 2020; Zhuang, Lv, Liang, Chen, Zhang & Sun 2020.)

In the context of the mother, gestational diabetes-related pregnancy has a high possibility of developing a risk of gestational hypertension, pre-eclampsia, cesarean section, postpartum hemorrhage, amniotic fluid pollution and premature rupture of membranes (Sheiner 2020; Zhuang et al. 2020). Increased risk of developing type 2 diabetes mellitus, cardiovascular disease, malignancies, ophthalmic disease, and renal disease are some long-term effects of gestational diabetes (Alia et al. 2019, 4; Sheiner 2020). According to Alia et al. (2019, 4), the possibility of developing permanent diabetes (Type 2 diabetes) is 40% in the coming 10 years, and the risk of gestational diabetes in subsequent pregnancies is 35% considering the increasing age and weight of the mother. Alia et al. 2019 also state that, women with a history of gestational diabetes are also more likely to develop cardiovascular risk factors such as hypertension, dyslipidemia, obesity, and metabolic syndrome. Many recent investigations have also discovered a link between gestational diabetes and Stress urine incontinence and mixed urinary incontinence that has increased the incidence of premenopausal overactive bladder (Alia et al. 2019, 4). The short-term and long-term complications for unborn baby and mother are shown in summarized way through the figure below.

Mother	Pregnancy	Labor	Postpartum and beyond
	↑ Pre-eclampsia	<ul> <li>↑ Induction of labor</li> <li>↑ Cesarean section</li> <li>↑ Operative deliveries</li> <li>↑ Labor complications</li> </ul>	↑ Recurrent GDM ↑ Type 2 diabetes
Offspring	Congenital	Neonatal complications	Long-term outcome
	<ul> <li>– CNS</li> <li>– Cardiac</li> <li>Fetal programming</li> <li>– ↑ LGA</li> <li>– ↑ Macrosomia</li> <li>– Increased fat mass</li> </ul>	Prematurity Perinatal asphyxia Respiratory distress Metabolic complications (hypoglycemia and hypocalcemia) Polycythemia and hyperviscosity Low iron stores Hyperbilirubinemia Cardiomyopathy	↑ Obesity ↑ Type 1 diabetes ↑ Type 2 diabetes ↑ Metabolic syndrome

Figure 1. Short- and long-term health consequences of gestational diabetes mellitus for mothers and their fetus (Hopkins & Artal 2013)

#### 2.1.4 Prevention and Treatment

There are several simple steps that can be taken to minimize the risk of developing gestational diabetes (Bevan 2023). Planning and preparation before pregnancy is a great way to prevent the risk of gestational diabetes and it includes factors like having a physical examination, following blood glucose, and adopting good dietary and lifestyle (Wang & Yang 2016). Bevan (2023) also emphasizes on healthy weight as one of the most effective ways to prevent gestational diabetes. Eating a healthy diet and avoiding sugary drinks and foods, regular exercise and an active lifestyle are crucial steps that play an important role in staying away from being a victim of gestational diabetes. Regular monitoring of blood sugar is also beneficial before and during pregnancy to avoid unexpected complications. (Bevan 2023; Alia et al. 2019, 3.)

Once gestational diabetes is diagnosed, the treatment is compulsory and aims to prevent fetal, maternal, and neonatal complications. The woman with gestational diabetes can still improve the pregnancy outcome if the fasting blood sugar are less than 95mg/dl (5,3mmol/l), 1-h postprandial blood sugar <140 mg/dl (7.8 mmol/L), and 2-h postprandial blood sugar <120 mg/dl as recommended by both the American College of Obstetricians and Gynecologists (ACOG) and American Diabetes Association. (Ray 2020, 35.) The very first intervention in treating gestational diabetes starts with diet modification that can be general nutrition therapy or medical nutrition therapy (MNT), physical activity, education and self-monitoring of blood sugar level to maintain normoglycemia and prevent ketosis of the mother and adequate nutrition for fetus where high intake of fruit, green leafy vegetables, poultry, fish, and whole grain is recommended (Alia et al. 2019, 3; Sobrevia 2013, 35). Active lifestyle and physical exercise are also known as part of treatment for gestational diabetes as they improve blood glucose (Ray 2020, 36).

Medication and insulin therapy are the next options if the metabolic target cannot be achieved through nutrition therapy and lifestyle change where oral antidiabetic agents like Glibenclamide (Glyburide) and Metformin are commonly used to decrease insulin resistance and improve insulin secretion (Sobrevia 2013, 9; Ray 2020, 36-37; Alia et al. 2019, 3). Insulin therapy is recommended as a gold standard first-line treatment after diagnosis, and it poses the advantage of non-crossing of the placenta. It is administered based on the timing of the existence of high blood sugar as if the hyperglycemia appears in both fasting and 2h after the meal, a mixed dose of long-acting and short-acting insulin is suggested with common starting dose of 0.7-1 unit/kg of body weight. If the elevated blood sugar occurs only at certain times, the insulin dose is prescribed based on that. For example, the elevated blood sugar level after a meal is treated by short-acting insulin before the meal. (Ray 2020, 37; Alia et al. 2019, 3; Sobrevia 2013, 10.)

#### 2.2 Nutrition

The onset and development of gestational diabetes during pregnancy carries the risk of clinical outcomes for both mother and baby inside her womb and can be influenced by nutritional compounds like carbohydrates (CHO), fiber, protein, and fatty acid as they support to regulate glycemic index and glycemic response where consuming proper nutrition perhaps be a crucial aid in the prevention and management of gestational diabetes mellitus (Ray 2020, 172). According to WHO (2023), nutrition is an important aspect of our health and development, and it has direct effect on maternal health, stronger immune systems, safer pregnancy, and delivery with low risk of noncommunicable illnesses such as diabetes and cardiovascular disease. Nutrition is the cornerstone of human health and well-being, encompassing the intricate relationship between the foods we consume and the functioning of our bodies. It provides the essential nutrients, energy, and building blocks needed for growth, maintenance, and the optimal performance of bodily functions. A balanced and diverse diet, rich in vitamins, minerals, proteins, carbohydrates, and fats, supports physical and mental health and emotional vitality. Nutritional choices have far-reaching effects on our overall health, from immune system strength to disease prevention, making it a fundamental pillar in our journey toward a long and vibrant life. (WHO 2023; Rasmussen et al. 2020.)

Carbohydrates are the most valuable macronutrient for woman with gestational diabetes because glucose is the primary source of energy for the placenta and foetus and play a crucial role in the dietary management of gestational diabetes (Rasmussen et al. 2020, 4). According to the guidelines of IOM, 46-65 Energy per cent (E%) from carbohydrates and a minimum of 175 g of carbohydrate daily is required to ensure appropriate foetal growth and cerebral development and function. Complex carbohydrates found in whole grains, fruits, vegetables, and legumes are preferable, as they release glucose into the bloodstream more gradually, helping to prevent sharp spikes in blood sugar, and the consumption of added sugar must be kept minimal. The Nordic countries follow the guidelines for carbohydrate intake as 45-60E%. (Rasmussen et al. 2020; Moreno-Castilla, Mauricio & Hernandez 2016; Mahajan, Donovan, Vallee & Yamamoto 2019; Mustad, Huynh, Lopez-Pedrosa, Campoy & Rudea 2020.)

Dietary fibres are from nondigestible carbohydrates and lignin, which the human body does not digest or absorb, and several studies have proved that increasing dietary fibre consumption during pregnancy benefits many women by minimizing excessive weight gain, insulin resistance, and the risk of glucose intolerance (Barber, Kabisch, Pfeiffer & Weickert 2020; Zhang et al. 2022; Sun, Wang, Ma, Miao & Sun 2022). Fibre is an important component of a diabetes-friendly diet. In general, 25 g of dietary fibre is suggested for women by Nordic Nutrition Recommendation (NNR) and the Chinese Dietary Reference Intakes (DRIs) 2013, while the American Diabetes Association recommends a minimum of 28 g of fibre to women with gestational diabetes, same as IOM guidelines for normoglycemic women during pregnancy (Rasmussen et al. 2020; Zhang et al. 2022). Fruits and vegetables, along with whole grains, are excellent sources of dietary fibre where a portion of about 600 g of fruit and vegetables per day with a minimum of 300 g of vegetables, whole grain bread, pasta and rice is preferable (Zhang et al. 2022; Modzelewski et al. 2022).

Protein intake holds significant importance for women with gestational diabetes, contributing to their overall nutritional strategy where protein-rich foods such as lean meats, poultry, fish, eggs, dairy products, legumes, and nuts offer sustained energy and promote satiety, which can assist in managing hunger and preventing excessive fluctuations in blood sugar (Modzelewski et al. 2022). A high protein diet also plays role to support the development of the foetus and maintaining maternal glycaemic control (Trout et al. 2022). The demand for protein is more than the normal period in pregnancy due to its role in the synthesis of maternal, foetal, and placental tissues, and the recommended amount of protein for women with gestational diabetes remains the same as normal pregnancies i.e., 10 - 35E% according to IOM.

Fat consumption plays a significant role in the nutritional approach for women with gestational diabetes, and it's crucial to monitor overall fat intake focused on healthy fats is essential for both maternal and foetal well-being (Wang, Jiang, Yang & Zhang 2015). Unsaturated fats found in sources like avocados, nuts, seeds, and olive oil can provide essential nutrients that promote cardiovascular health, and help slow down the absorption of carbohydrates, contributing to better blood sugar control during pregnancy (Paterson 2019). The IOM suggests keeping the intake of saturated fat as low as possible whereas NNR expresses as the amount of saturated fat must be less than 10E% (Wang et al. 2015; Rasmussen et al. 2020; Radenkovic 2022, 282).

During pregnancy, the requirement for other nutritional compounds like vitamins, minerals, folic acid, D vitamin, calcium and iron also increases (Duarte-Gardea et al. 2018). Due to iron loss during menstruation and low iron reserves, acquiring an adequate quantity of iron through diet is challenging during pregnancy, where the IOM recommends a daily intake of 27 mg, and the Nordic Council of Ministers recommends 40 mg/d from 18 to 20 weeks of pregnancy. (Rasmussen et al. 2020; Moreno-Castilla et al. 2016; Mahajan et al. 2019; Mustad et al. 2020.) The figure below expresses the general sample meal choice for women diagnosed with gestational diabetes published by Terveyskylä 2023.



Figure 2: Gestational diabetes diet (Terveyskylä 2023)

# 2.3 Exercise

Exercise is referenced as a useful tool for managing gestational diabetes mellitus (Allehdan, Basha, Asali & Tayyem 2019; Barakat, Refoyo, Coteron & Franco 2019). Exercise lies within the boundary of physical activity where it is a planned, systematic, and repetitive process of bodily movement done with the aim of enhancing or maintaining physical fitness (Barakat et al. 2019). In other words, exercise is the expenditure of energy and training of the body to improve its function and fitness (Blair & Cooper 2023). According to national and international guidelines, no restrictions are marked in being physically active during the pregnancy period (Davenport et al. 2018). A significant decrease in cramps, lower back pain, oedema, depression, urinary incontinence, the duration of labor, and constipation are some maternal advantages and decreased fat mass, improved stress tolerance, and advanced neurobehavioral maturation are some benefits to the fetus. (Laredo-Aguilera, Gallardo-Bravo, Rabanales-Sotos, Cobo-Cuenca & Carmona-Torres 2020.)

Moreover, exercise training improves whole-body insulin-stimulated glucose uptake leading towards progress in insulin sensitivity by increasing fat-free mass, the main location of insulin-dependent glucose clearance (Hopkins & Artal 2013). The research done by Cremona et al. (2018) supports the claims exercise has significant effect in improving capillary blood glucose levels, blood glucose response to OGTT, insulin resistance and gestational weight gain. Exercises maximize the physiological processes that increase insulin sensitivity within skeletal muscle, reducing the load on compensatory cells and maximizing the insulin-sensitive glucose transporters (GLUT4), which boost glycogen synthase activity. Particularly during pregnancy, it improves glucose uptake and provide metabolic advantages because of alterations impacting pathways that control insulin sensitivity, adipokines, and reductionoxidation process as the skeletal muscle is the main source of insulin-stimulated glucose uptake and exercises trigger various metabolic pathways. (Cremona et al. 2018.)

According to the international guidelines and World Health Organization (WHO), pregnant women are recommended to participate in 150 min of physical activity per week or 30 min at least 5 days per week that consist of walking, cycling, swimming, running, or resistance training by avoiding heavy strength training (Paulsen et al. 2023; Allehdan et al. 2019). The Society of Obstetricians and Gynecologists of Canada (SOGC) and Canadian Society of Exercise Physiologists (CSEG) recommend starting with 15 min of continuous aerobic exercise three times a week for women with minimum or no physical activity in past and it can be gradually increased to 30 min at least 4 times a week where the American College of Obstetricians and Gynecologists advice to avoid exercising for more than 45 min due to a risk of increased fetal temperature (Padayachee 2015).

## 2.4 Nursing Interventions

Among the five essential aspects (Assessment, Diagnosis, Planning, Implementation, and Evaluation) of the nursing process, the nursing intervention in the planning phase and in the implementation, phase is the most critical phase that emphasizes the actions a nurse performs to eliminate or reduce the etiology of existing disease and achieve client goals (Berman, Snyder & Frandsen 2016, 227). Werezak (2023) has defined nursing intervention as any actions taken by nurses to promote health, prevent disease, and help patients heal and recover from illness and injury where the actions are evidence-based. Administering medication & treatments, educating patients, adjusting positions, and feeding support are some common examples of nursing interventions (Monteiro 2023). According to Monteiro (2023), reaching patient's health goals, educating patients, safety promotion, and support offerings are some major purposes of nursing intervention. Nursing interventions are targeted and tailored to the individual requirements of each patient, family, or community, with an emphasis on assisting a patient in coping with a chronic disease or managing a complicated health condition. Some nurse interventions, on the other hand, are used to promote healthy lifestyles, avoid injuries, and give information and support to patients and their families, with the overarching objective of nursing interventions being to enhance the health and well-being of all people, groups, and communities. (Werezak 2023.)

Independent nursing interventions, dependent nursing interventions, and interdependent (collaborative) nursing interventions are three different types of nursing interventions that is categorized based on the nurse's level of involvement (Berman et al. 2016, 227). Independent interventions are actions that nurses have the authority to initiate based on their knowledge and expertise where physical treatment, continuing evaluation, emotional support and

comfort, training, counselling, environmental management, and referrals to other health care specialists are some examples (Berman et al. 2016, 227; Nightingale 2022; Simplenursing 2022). Dependent interventions are a set of actions carried out by nurses according to the orders or supervision of licensed health care professionals, where administering IV medicines, serving opioids, and suturing the wounds are some examples (Werezak 2023; Berman et al. 2016, 227). Collaborative or interdependent interventions are a bunch of activities nurse carries out in collaboration with other health team members like doctors, therapists, social workers, dieticians etc. (Berman et al. 2016, 227; Monteiro 2023; RNspeak 2023).

While implementing the nursing interventions, the nurse must explain to the client about the intervention implemented, what the patient is expected to do, and the expected outcome. Nursing interventions should be based on scientific knowledge (Evidence-based). The interventions must be adapted according to the patient's individual needs as the client's beliefs, values, age, health status, and environment might affect the success. Patient education, safety, holistic care approach, and respect the privacy and dignity are some backbone of genuine nursing interventions. (Berman et al. 2016, 236-236.) Appropriate assessment of the cause during the diagnosis process is crucial that leads to draw a framework for selecting accurate nursing interventions (RNspeak 2023).

#### 3 Research Approach

A research approach is the broad methodology or plan employed by a researcher or any organization when carrying out a study or investigation (Solanki 2022). The term "research method" refers to a collection of strategies for assembling data to advance with further analysis overlapping the theoretical information that includes phases such as unprejudiced observation, recording, taking notes, interviewing, and more (Bouchrika 2023; Chetty 2016). Several research methodologies can be employed depending on the nature of the research question, the resources at hand, and the objectives of the study (Thattamparambil 2020). During this thesis process, the literature review was used as a research method where every step is being followed according to the guidelines by Coughlan & Cronin 2021 (Doing a literature review in Nursing, Health, and Social Care).

# 3.1 Research Aim, Objective, and Research Question

The Purpose of this thesis is to collect evidence-based knowledge and insight about nursing interventions on nutrition and exercise in the management of gestational diabetes. This thesis will be useful for nursing students, nurses, and patients as well.

The aim of this thesis is to study, analyze and provide understanding about nursing interventions on nutrition and exercise while managing gestational diabetes mellitus.

Research questions are a key component of any research project as they serve as the cornerstone of the entire study provide a clear and focused direction for the research and guide the researcher in every stage of the research process (Ratan, Anand & Ratan 2019). It is important to have research questions clear, concise, specific, and answerable through empirical data and research methods (Ratan et al. 2019). The research question for this thesis is "What kind of nursing interventions on nutrition and exercise are implemented during the management of gestational diabetes?"

#### 3.2 Literature review as a research method

A literature review is an organized evaluation of academic writing on a certain subject that critically examines, assesses, and synthesizes theories, research findings, and methods used by academics and researchers in a field of study (Efron & Ravid 2018, 2). According to Coughlan & Cronin (2021, 2), "A literature review is not an essay where the studies are selected to support a particular opinion, it is the larger process that includes identification of topic, gathering, critically appraising and summarizing." While using the literature review as

a research method, the literature must be collected in a systematic manner to ensure all the relevant information is added (Coughlan & Cronin 2021, 2). There are sets of sequential steps to follow while proceeding with the literature review. Identifying the aim or purpose of the review, searching the literature, identifying the studies, reading, summarizing, analyzing the studies, and presenting the review are some steps where the summary, conclusion and recommendations are also included. (Coughlan & Cronin 2021, 3-4.)

Among the different orientations of literature review, the traditional-narrative review method was applied during this thesis process. Traditional-narrative review is the most common method among students and researchers as it critically summarizes the theories, examines studies, and investigates methods used in existing research (Efron & Ravid 2019, 22). During the research process, the aim and objective was identified first, followed by an appointment with a responsible teacher for data search. The data extraction and analysis were done from the best-matched studies saved for this research purpose.

# 3.3 Database search

Data search refers to the process of searching for and gathering relevant information and high-quality data to support the research objectives, where identifying the data, formulating search strategies to locate relevant sources, evaluating the quality and relevance of sources, and synthesizing the data collected is the process involved (Efron & Ravid 2018, 59). There are three types of data sources. The first one is primary source, that are known as firsthand data which is written by the researcher who conducted the study. The second one is secondary source, that include summaries, discussions, and interpretations of original research presented elsewhere. The third one is tertiary source, provide an overview or summary of information gathered from primary and secondary sources. Encyclopedias, textbooks, bibliographies, handbooks, and manuals are some examples of tertiary sources. (Efron & Ravid 2018, 60.)

The data from primary sources were chosen for this thesis purpose. Laurea Finna and Libguides are two platforms from where all the data were collected. EBSCOhost, ScienceDirect (Elsevier), ProQuest Central, SAGE Premier are the databases used to search relevant research and articles. Different search words were used to avoid the risk of missing crucial finding. The keywords used for searching process were "gestational diabetes" OR "pregnancy diabetes" AND "Prevention & treatment" OR "Nutrition & Exercise" AND "Nursing Interventions". The table below shows the total search findings and relevant data that were selected for further analysis. During the search process, altogether 585 articles were discovered and among them 43 were selected based on the title and abstract learning. Afterall 12 most relevant articles were selected for further study and analysis. The selection process of the articles is presented through the table mentioned below.

Database	Search term	Limits	Total results	Accepted with title & abstract	Accepted
EBSCOhost	"Gestational diabetes" AND "Prevention & treatment" OR "nutrition & exercise" AND "Nursing interventions"	10 Y. English Academic Research and Review journals full text.	98	7	1
ScienceDirect	"Gestational diabetes" AND "Prevention & treatment" OR "nutrition & exercise" AND "Nursing interventions"	10 Y. English Academic Research and Review journals full text.	153	15	4
ProQuest	"Gestational diabetes" AND "Prevention & Treatment" OR "nutrition & exercise" AND "Nursing interventions"	10 Y. English Academic Research and Review journals full text.	220	11	3
SAGE Premier	"Gestational diabetes" AND "Prevention & Treatment" OR "nutrition & exercise" AND "Nursing interventions"	10 Y. English Academic Research and Review journals full text.	114	10	4
Total			585	43	12

Table 1: The literature search process, showing the number of retrieved articles and the different selection stages.

# 3.4 Inclusion and Exclusion Criteria

The inclusion and exclusion criteria limit the area for the systematic review which is done before the search process is implemented. Date, exposure of interest, geographic location of study, language, peer review, reported outcomes, setting, study design and type of publication are some main boundaries that belongs to inclusion and exclusion criteria. (Unimelb Libguides 2023.) During the research process of this thesis, the full-text English article with peer reviewed no older than 10 years (2013-2023) which were assessable through Laurea's credentials were only chosen. Articles older than 10 years, related to other types of diabetes, printed in other language than English and paid one were excluded in the selection process. This criterion was implemented to filter the unconcerned article and select the most relevant articles for the analysis. The selected approach is summarized through the table mentioned below.

Inclusion	Exclusion
Gestational diabetes mellitus	Type 1 and type 2 diabetes
Nutrition and exercise interventions	Self-care, education, and medications
Published in English language	Published other than English language
Full text articles	Articles without full-text available.
No older than 10 years (2013 - 2023)	Published before 2013
Free access through Laurea's credentials	Paid articles

Table 2: Inclusion and exclusion criteria while selecting the articles.

# 3.5 Data Appraisal

The data appraisal phase is conducted before the data synthesis during the literature review process, where all the accepted studies are reviewed accordingly to verify the compatibility with the research question and aim of the project by reducing the bias and increasing the accuracy of evidence-based information. In other words, it is an important phase in the research process that involves assessing the quality, dependability, and usefulness of data before it is used for analysis or decision-making, where accurate data evaluation guarantees that the information used is dependable and acceptable for the intended purpose. (Coughlan & Cronin 2021, 80.) During the data appraisal phase of this study, two authors individually went through each selected article and noted down the findings and vital information keeping in mind the inclusion and exclusion criteria, aim and research question. The third author then thoroughly re-checked the findings to minimize the possibility of biases and errors. The finalized studies were taken ahead for further analysis. The table with the list of the most relevant articles that were selected for analysis can be assessed through Appendix 1.

## 3.6 Data Extraction

Data extraction is the process that occurs during literature review research after the eligible studies have been identified but before the data analysis phase, in which the major components of studies are picked from the journal, articles and reports to synthesize and draw conclusions (Taylor, Mahtani & Aronson 2021; Schmidt et al. 2023). During this phase, the important information is obtained from the research that are confirmed as eligible for analysis and seek for results (HSLIB 2023). Extracting the data in appropriate way is crucial to minimize the risk of errors and bias as poor data will lead towards poor or unreliable output (Taylor et al. 2021).

While extracting the data from the selected resources, all three authors individually browsed through every article and recorded the necessary relevant information based on marked inclusion and exclusion criteria, aim and formulated research question. Lastly, all three authors reviewed together about their findings and raw data were stored together categorized under common scope which is expressed through the table below.

Raw Data	Scope
Nutrition and exercise together are counted as first step while managing gestational diabetes where nutritional nursing intervention is an effective method to control the blood glucose level (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014 & Koivusalo et al. 2016). Complex carbohydrates found in whole grains, fruits, vegetables, and legumes are preferable, as they release glucose into the bloodstream more gradually, helping to prevent sharp spikes in blood sugar (Tryggvadottir et al. 2015 & Lin et al. 2020).	
Carbohydrate intake should be dispersed as a daily meal frequency of three main meals and 2-3 minor meals or snacks throughout the day (Tryggvadottir et al. 2015 & Lv et al. 2019).	Diet & exercise
Dietary fiber consumption during pregnancy benefits many women by minimizing excessive weight gain, insulin resistance, and the risk of glucose intolerance (Tryggvadottir et al. 2015 & Lin et al. 2020 & Lv et al. 2019).	
Pregnant women are recommended to participate in 150 min of physical activity per week or 30 min at least 5 day per week that consist of walking, cycling, swimming, running, or resistance training by avoiding heavy strength training and educating patient about gestational diabetes and importance of exercise while managing it is found as helpful step (Cordero et al. 2015; Chen et al. 2021 & Wang et al. 2017).	
Guidance about monitoring blood sugar level regularly using glucometer and education about fasting and non-fasting sugar level is helpful to stay alert about own and fetus health (Sun & Zhao 2016; Cordero et al. 2015 & Koivusalo et al. 2016).	Glucose monitoring

Patients who received personalized glucose monitoring advice and documenting have improved their habits for food selection and physical activity impacting positively while managing gestational diabetes (Sun & Zhao 2016; Xu et al. 2023; Hawkins et al. 2014; Cordero et al. 2015 & Koivusalo et al. 2016).	
Regular follow-up plays critical role in managing gestational diabetes including patient's psychological status (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014 & Lv et al. 2019).	
Regular visit, checking blood sugar level, Feedback on outcomes, planning with multi professional team, changes in prescription, individual and family counseling were beneficial to stay motivated and act accordingly to keep the sugar level stable (Hawkins et al. 2014; Koivusalo et al. 2016; Chen et al. 2021 & Lv et al. 2019).	Regular Follow-up
By incorporating the internet and technology into the care continuum, nurses improve healthcare delivery efficiency and provide pregnant women with the knowledge and resources they need to properly manage their gestational diabetes, resulting in improved outcomes for both mother and baby in the womb (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021 & Chen et al. 2021).	Utilizing internet and technology
Every patient needs individual care and plan where involvement of multi- professional team is crucial (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014 & Cordero et al. 2015). Nurses suggests and make referral on early stage to a certified dietician and exercise expert for appropriate evaluation regarding needs of individualized nutrition and exercise plan (Cordero et al. 2015; Wang et al. 2017 & Lv et al. 2019).	Referral to dietician and exercise expert.
Nurses developed a personalized treatment plan in collaboration with other health care teams that includes dietary advice, exercise routines, blood sugar monitoring schedules, and potential medication management while controlling gestational diabetes, with patients' preferences considered (Tandon et al. 2022; Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014; Koivusalo et al. 2016; Chen et al. 2021; Wang et al. 2017 & Lv et al. 2019).	Making individual treatment plan.
Psychological and emotional support by nurses to women with gestational diabetes has positive effect on stress reduction and stay motivated (Tryggvadottir et al. 2015; Xu et al. 2023; Lin et al. 2020; Hawkins et al. 2014 & Lv et al. 2019).	
Guidance about stress management techniques with different intervention like breathing exercise, relaxation, and awareness about impact of ignorance of women mental health to mother and family member is helpful while managing gestational diabetes (Tryggvadottir et al. 2015 & Lv et al. 2019).	Mental and family support
Guiding, motivating, and supporting family members is crucial while managing gestational diabetes as their knowledge and care is vital for pregnant women (Tryggvadottir et al. 2015 & Lin et al. 2020).	

Table 3: Raw data extracted from selected articles for analysis.

### 3.7 Data Analysis

After the completion of data extraction, the data analysis phase began, where the extracted data were interpreted to seek results and draw conclusion. The data analysis during this research is done by using the inductive thematic approach of analysis which is a qualitative data analysis method commonly used in social sciences, humanities, and other fields where researchers aim to explore complex, rich, and contextual data. The aim of thematic approach is to find the identify the themes from the literature where it is considered as critical factor that the outcome is derived from the mentioned literatures (Coughlan & Cronin 2021, 114).

During the data analysis stage, 12 articles were interpreted where the common data were grouped under subcategories and codes. Total 7 codes were derived from the data organizing process that are aligned under 2 subthemes with main theme as nursing interventions on nutrition and exercise while managing gestational diabetes. The figure below shows the thematic analysis illustration of nursing interventions on nutrition and exercise in the management of pregnancy diabetes.



Figure 3: Thematic analysis presentation of nursing interventions on nutrition and exercise while managing gestational diabetes.

#### 4 Findings

## 4.1 Education and counselling

Education and counselling are essential nursing interventions during the management of pregnancy diabetes that help to promote health, make wise decisions, and be motivated where several roles of nurses including teaching and counselling the patient is crucial (Berman et al. 2016, 41). These approaches provide knowledge, skills, and emotional support to patients and their families, allowing them to make informed decisions, manage with health issues, and maintain optimal well-being. Teaching patient about nutrition and exercise, glucose monitoring timings and techniques and following the outcomes might be an effective approach to manage it. (Mensah, ten Ham-Baloyi, van Rooyen & Jardien-Baboo 2019.) Under this sub-theme, there are four codes (diet and exercise, glucose monitoring, regular follow up, and utilizing internet & technology) that are mentioned below accordingly.

### 4.1.1 Diet and exercise

Six out of twelve selected articles show that nursing intervention as education and counselling about diet and exercise plays a vital role in managing gestational diabetes mellitus (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014 & Koivusalo et al. 2016). The study by Sun & Zhao (2016, 125) found a lower incidence of gestational diabetes in the intervention group who were provided education and counselling about dietary management and exercise as a nursing intervention at weeks 8-12 and every month in the second trimester. Xu et al. (2023, 3) observed in their study that, the nursing intervention about dietary guidance, health education and physical activity helped pregnant women to reduce stress and anxiety and improve the intake of prenatal nutrition preventing metabolic abnormalities and lowering the incidence of pregnancy diabetes. Among 251 selected patients, 128 women were in the intervention group who were provided dietary and exercise guidance resulting in a decline in the incidence of gestational diabetes by 46.9% compared to the control group. The study by Lin et al. (2020, 4-6) indicated the association between education about dietary patterns and exercise with lower risk of gestational diabetes where 139 women were separated as observation groups, received structured and individually modified education on adequate dietary patterns, exercise, and weight control through face-to-face education session and via internet as well.

An investigation done by Deng et al. (2022, 836) made the conclusion that patient education on diet and exercise can lower the risk of gestational diabetes in pregnant women. In this study, 94 pregnant women were studied with 47 pregnant women as the observation group. Altogether 7 interventions were implemented with the frequency of 2 weeks where the test group received dietary and activity guidance from 14 weeks of gestation until the 75-g OGTT was recorded at 24 to 28 weeks of gestation. As a result, the probability of gestational diabetes differed between the observation group (23.9%) and the control group (51.1%). Hawkins et al. (2014, 108) also conducted a study about nutritional and exercise interventions and their result confirmed the improvement in fasting glucose and insulin resistance in women with gestational diabetes. According to this study, a nursing intervention such as prescribing a low-carbohydrate diet and inspiring women with gestational diabetes to exercise lowered FPG, the risk of postprandial hyperglycemia, and the need for insulin to treat hyperglycemia. The result was derived from the analysis of 68 participants women with gestational diabetes. The article by Koivusalo et al. (2016, 24) found an inverse relationship between patient guidance on nutrition and exercise and the incidence of gestational diabetes. During the intervention phase, the selected group were provided with individualized dietary and physical activity guidance resulting in a decline in the incidence of gestational diabetes in the intervention group (13.9%) compared to the control group (21.6%).

Two out of twelve articles have mainly emphasized education and guidance on nutrition as an effective nursing intervention while managing gestational diabetes (Tryggvadottir et al. 2016 & Lv et al. 2019). In the study by Tryggvadottir et al. (2016, 237), 168 participants were recruited where average food intake in g/day and total energy intake kcal/day were calculated for each patient and the finding stated the clear connection between a controlled diet and lower risk of gestational diabetes mellitus. Research by Lv et al. (2019, 46) where 134 patients with gestational diabetes were participants and among them 67 were intervention group, emphasized the nutritional nursing intervention as an effective method to control the blood glucose level that reduces the incidence of pregnant complications. In this intervention process, all pregnant women were guided about diet and nutrition in an individualized way based on their height, weight, and eating habits. They were also advised to avoid overeating and eat small meals 5 to 6 times a day.

Three out of twelve studies mainly highlight education and guidance on exercise as crucial nursing intervention while managing gestational diabetes (Cordero et al. 2015; Chen et al. 2021 & Wang et al. 2017). A clinical randomized controlled trial performed by Cordero et al. (2015, 1328) justifies that the exercise program during pregnancy lowered the prevalence of gestational diabetes by retaining glucose tolerance. 101 patients were observed as the intervention group where they exercised for 60 and 50 min on land and in water, respectively, three times per week resulting in better glucose tolerance. Research by Chen et al. (2021, 2-4) has confirmed that exercise-based individualized nursing intervention can effectively improve blood sugar, insulin resistance, pregnancy outcomes, and mental condition as well. During the project, 139 patients with gestational diabetes were selected for the study keeping 79 patients as the observation group and 60 patients as the control group. The intervention group was provided individual guidance on exercise, and they were authorized to

make an online appointment to ask, discuss, and obtain answers through a network platform provided by the hospital. The article by Wang et al. (2017, 340) concluded their finding as patient education and guidance on exercise has a significant effect on reduction of gestational diabetes. Among the 300 participants, 150 were in the intervention group who were engaged in a supervised cycling program at least 3 sessions per week.

Among all the selected articles, the finding in one study by Tandon et al. (2022, 4-7) suggested the need for additional approaches as the intervention on diet and physical activity was not effective in improving glycemic metabolism. During this project, 1612 (800 women in the intervention group) women with recent pregnancy diabetes were participants whereas a 12-month intervention was mainly focused on education and guidance on diet and physical activity involving group and individual sessions. The authors have also mentioned about COVID-19 as it might have impacted on the delivery model.

## 4.1.2 Glucose monitoring

Five of twelve studies have revealed a low incidence of gestational diabetes and effectively maintained blood sugar levels in those who have received education and individualized sessions about glucose monitoring methods and the meaning of the blood sugar values where the nurses have explained with evidence-based findings (Sun & Zhao 2016; Koivusalo et al. 2016; Hawkins et al. 2014; Xu et al. 2023 & Cordero et al. 2015). Nursing intervention as educating patients about glucose monitoring is critical in gestational diabetes because it provides pregnant moms with the knowledge and skills, they need to care for their health and the health of the fetus (Sun & Zhao 2016 & Mensah et al. 2019). Knowing how to accurately monitor glucose levels allows women with pregnancy diabetes to take proactive management of their health, make healthier dietary choices, and consider physical activity. It also promotes self-confidence, allowing pregnant women to actively participate in their healthcare journey, resulting in better pregnancies. (Xu et al. 2023.)

While teaching patients about glucose monitoring, nurses explain when and how often glucose levels need to be monitored (before and after meals), demonstrate how to use a glucose meter correctly and record it either on a sheet or glucose monitoring app. The patients must also be informed about target glucose level ranges before and after meals (fasting glucose < 5,3 mmol, 1 hr. after meal <7,8 mmol and 2 hr. after meal <6,7 mmol) along with the meaning of high and low glucose levels and actions needs to be taken in these situations (Sun & Zhao 2016; Mensah et al. 2019 & Hawkins et al. 2014). In the studies by Koivusalo et al. (2016) and Cordero et al. (2015), the blood sugar level and blood pressure were recorded regularly, and the intervention group were also taught to measure fasting and after-meal sugar levels.

#### 4.1.3 Regular follow-up

Among twelve studies selected for analysis purposes, eight of them have represented the education and guidance based on regular follow-up as a vital nursing intervention in the optimal management of gestational diabetes (Sun & Zhao 2016; Xu et al. 2023; Lin et al. 2020; Deng et al. 2021; Hawkins et al. 2014; Koivusalo et al. 2016; Lv et al. 2019 & Chen et al. 2021). In the study by Sun and Zhao (2016, 126), the intervention group were provided personalized feedback based on their 5-day records, and weekly follow-up call, or email were also implemented every week between antenatal visits. In the intervention phase of research by Xu et al. (2023, 2), Lin et al. (2020, 4) & Deng et al. (2022, 840), the common group (WeChat) was formed to share guidance based on output where patients were able to share their progress and communicate with care-team easily.

Hawkins et al. (2014, 109-110) observed that the intervention group were motivated to follow updated guidelines as they were provided personalized and telephone-based counselling sessions based on current outcomes. According to Koivusalo et al. (2016, 26), the intervention group visited the study nurse three more times as follow-up care than a standard national practice which was found beneficial to draw a more accurate plan based on current follow-up findings. In the article by Lv et al. (2019, 47) & Chen et al. (2021, 2-3), the observation group were followed by an obstetric professional dietician and physicians regularly (1 visit every 1-2 weeks) and further guidance were offered and adjusted according to the current weight, gestational age, fetal size, and blood glucose level resulting positive outcome while managing gestational diabetes mellitus.

# 4.1.4 Utilizing internet and technology

Five of the twelve selected studies have common findings that, educating and guiding patients about the utilization of the internet and technology is a very useful nursing intervention and it has significance value in managing gestational diabetes mellitus (Deng et al. 2022; Sun & Zhao 2016; Chen et al. 2021; Lin et al. 2019 & Xu et al. 2023). During the study by Deng et al. (2022, 838-840) & Lin et al. (2019, 4), the nurses handled the program including follow-up, recordkeeping, and WeChat group interaction with the help of internet portal and application that resulted in the reduction in occurring pregnancy diabetes to observation group (23.9%) and from the control group (51.1%). The patients were guided and educated to use electronic platforms during the process. Another research by Sun & Zhao (2016, 126) where further counselling and personalized comments were also delivered based on their 5-day records including follow-up phone calls or emails every week. As a result, only 28.1% of the patients from the intervention have faced the incidence of gestational diabetes compared to a control group that was 55.9%.

The study by Chen et al. (2021, 2-3) where 79 clients were approached with the internet combined with exercise-based personalized nursing intervention among 139 participants concluded that it can effectively improve the blood glucose and insulin resistance of women with gestational diabetes. Through a network platform the hospital supplied, patients and their families were able to ask questions and schedule an online appointment along the process. In the article by Xu et al. (2023, 2-3), pregnant women from the experimental group were encouraged to join a WeChat group that was set up by medical teams, doctors, nurses, psychologists, and nutritionists. The group answered the questions of the patients and food choices resulting in a reduction in the risk of gestational diabetes by 46.9%. Wang et al. (2017, 341), Tandon et al. (2022, 4), Tryggvadottir et al. (2016, 238) & Lv et al. (2019, 47) utilized the phone call, text messages and email to reach and inform patients about updates and guidelines while managing gestational diabetes mellitus.

# 4.2 Support and motivation

Support and motivation are essential components while managing gestational diabetes. Dealing with a pregnancy with it can be difficult and stressful, but with the correct support system and drive, women can manage their illness successfully, decrease risks, and maintain a safe pregnancy (Rasmussen et al. 2020).

## 4.2.1 Referral to dietician and exercise expert

Nine of the twelve studies that were chosen for analysis support the assertion of referring patients to dieticians and exercise experts for better nutrition and exercise plans as crucial nursing intervention because every individual has different levels of needs based on their age, height, lifestyle, and pregnancy months (Xu et al. 2023; Lin et al. 2020; Deng et al. 2022; Sun & Zhao 2016; Chen et al. 2021; Hawkins et al. 2014; Lv et al. 2019; Wang et al. 2017 & Cordero et al. 2015). Research demonstrated by Xu et al. (2023, 2-3) where the individualized assessment and prescription about nutrition and exercise done by experts ended up deduction in risk of gestational diabetes by 46%. Lin et al. (2020, 4) also concluded that intervention implemented on diet and exercise through diet and exercise specialists was a fruitful act in managing gestational diabetes and reducing adverse maternal outcomes. During the research by Deng et al. (2022, 839-840) & Sun & Zhao (2016, 126), the nutritionists computed the daily consumption of different meals, energy, and the three major nutrients per person based on each pregnant woman's weight and activity level.

Moreover, the articles by Wang et al. (2017, 341) & Cordero et al. (2021, 1328) highlighted the positive effects of physical activity while managing gestational diabetes where the intervention group were engaged in an exercise program, and all the sessions were supervised by a qualified fitness expert with the assistance of obstetrician. As a nursing intervention in the articles by Chen et al. (2021, 2-3); Hawkins et al. (2014, 109-110) & Lv et al. (2019, 47-48), the observation groups were guided to follow individualized nutrition and exercise plan that was designed by specialists and regular supervision was implemented to follow the outcome leading towards a positive outcome while managing gestational diabetes mellitus.

# 4.2.2 Making individualized treatment plan

Ten of all 12 articles reviewed for analysis have pointed the nursing intervention as making individualized treatment plans for patients is crucial while managing gestational diabetes mellitus (Hawkins et al. 2014; Xu et al. 2023; Lin et al. 2020; Deng et al. 2022; Sun & Zhao 2016; Chen et al. 2021; Lv et al. 2019; Wang et al. 2017; Koivusalo et al. 2016 & Tandon et al. 2022). The study by Hawkins et al. (2014, 110-111) found the treatment plan built from evidence-based approaches had improved the patient's condition which was modified according to the patient's individual needs. The treatment plan based on personal needs not only helped to manage blood sugar levels, but it also reduced the stress and anxiety in pregnant women with gestational diabetes where the patients were individually guided for a balanced dietary pattern, moderate physical activity, and weight control (Xu et al. 2023 & Lin et al. 2020). According to the articles by Deng et al. (2022, 839) & Sun & Zhao (2016, 126), the study nurse acquired a complete nutrition and activity history from the patients in the initial phase and the treatment plan was generated that included recording of weight gain, encouraging goal setting, reinforcing positive lifestyle change, promoting self-monitoring, follow-up by doctors and experts resulting improved glycemic index where the nurses, nutritionist, and exercise experts had worked out on nutrition and exercise plan for every patient.

Throughout the study by Chen et al. (2021, 3), the care plan for patients was also formulated based on the patient's own condition and the nurses were arranged to keep real-time attention on the patient's blood sugar levels to take required action on adjustment measures on time led towards improved blood sugar levels effectively. Lv et al. (2019, 47) revealed that the nursing care plan was designed on a personal basis as an effective approach to managing gestational diabetes the observation group were advised to consume nutrition according to glycemic load and the implementation controlled the blood sugar level in a remarkable way. In the studies by Wang et al. (2017, 341) & Koivusalo et al. (2016, 25), a personalized care plan was designed in a way where patients were instructed about nutrition

and exercise with an aim to achieve that kept pregnant women motivated to move forwards leading towards improved blood sugar level. Even though the finding by Tandon et al. (2022, 8) stated no improvement in blood sugar level through intervention in nutrition and exercise, creating individual care plan were mentioned as a valuable step in managing gestational diabetes.

# 4.2.3 Mental and Family support

Altogether five of twelve articles highlighted nursing intervention as mental and family support plays a significant role in managing gestational diabetes mellitus (Hawkins et al. 2014; Tryggvadottir et al. 2023; Lin et al. 2020; Chen et al. 2021 & Xu et al. 2023). In the research by Hawkins et al. (2014, 109-110), the family members were encouraged by nurses to participate during the meetings and activities as they can act as peers and move together to handle the required changes either for nutrition or exercise. By doing this, the pregnant women stay motivated and won't feel alone in the journey of being parents. Nurses often recognize the emotional issues that often accompany a diagnosis of gestational diabetes and they establish a safe environment for pregnant women to voice their fears and anxiety by providing compassionate listening, counselling, and resources (Tryggvadottir et al. 2023, 238). According to Lin et al. (2020, 7), involving the family members while managing gestational diabetes who are well-informed about pregnancy diabetes gave emotional support and helped with food and lifestyle modifications.

During the study by Chen et al. (2021, 2-3), the patients' families were also granted access to book online appointments and raise questions and nurses were arranged for post-guidance on psychology that ended up with an improvement in blood sugar levels and overall health status. Involvement of nearest ones while managing gestational diabetes had conveyed pregnancy precaution in patients and assisted in omitting negative feelings by maintaining a positive attitude towards being parents (Xu et al. 2023, 2). During this intervention phase, the patient's relatives were encouraged to participate in educational training and assist the patient to perform the task based on guidance by nurses and experts. This intervention reduced the stress and anxiety in pregnant women and motivated them to improve their parental nutrition.

#### 5 Discussions of Results

Altogether 12 articles were picked for analysis that were most relevant to the topic. The outcome of this study revealed the nursing interventions on nutrition and exercise as very useful act to manage gestational diabetes mellitus through several approaches. The findings are derived after deep study of each selected article by all the authors.

In this study, education and counselling about diet and exercise were found as forefront steps taken while managing gestational diabetes mellitus. After the pregnant women are diagnosed with it, the level of nutrition consumption and the amount of physical activity done for fitness is assessed as the very first approach by nurses before making any further plans (Sun & Zhao 2016, 126). The authors agree with this statement as treatment without medical intervention must be a priority if there is a possibility. Several studies like Sun & Zhao (2016); Xu et al. (2023); Lin et al. (2020); Deng et al. (2021); Hawkins et al. (2014) & Koivusalo et al. (2016) have a common point as guidance about nutrition and exercise can help regulate blood glucose levels, improve insulin sensitivity, and balance overall health and well-being for both the mother and the unborn baby. The recommendation about low glycemic load diets, and fiber-rich diets that include green vegetables, whole-grain products, fruits, and less red meat in regular meals seemed very influential from the author's point of view.

Wang et al. (2015) & Lin et al. (2020) expressed nursing guidance on exercise being beneficial during pregnancy to reduce BMI, which is one of the leading causes of gestational diabetes, and it may combat adverse outcomes like preterm birth, low birth weight and macrosomia. According to Cremona et al. (2018) & Cordero et al. (2015), exercise interventions could stimulate insulin sensitivity that improves glycemic control and prevent the possibility of gestational diabetes. The American Diabetes Association (ADA) recommends exercise for approximately 30 minutes on most days to improve the glycemic control (Dipla et al. 2021). It would be helpful to have specific guidelines based on the patient's individual situation. However, planning in a corporation with experts seems safe intervention.

After analysis of selected articles, the authors found patient education and counselling about blood glucose levels and its monitoring methods contribute to both the pregnant mother and her unborn child's general well-being and promote a healthier pregnancy because it acts as an alarm for patients to be alert. The articles by Sun & Zhao (2016); Koivusalo et al. (2016); Hawkins et al. (2014); Xu et al. (2023) & Cordero et al. (2015) mentioned the importance of educating patients about blood sugar monitoring as it enables pregnant women with gestational diabetes to learn about how different diets, physical exercise, and lifestyle variables impact their blood sugar levels that develops a feeling of duty and accountability, driving people to stick to suggested food and lifestyle changes.

The authors identified the education and guidance based on the regular follow-up as one of the most crucial nursing interventions while managing gestational diabetes, where eight of the selected articles had supported this argument. According to Sun & Zhao (2016, 126), through regular follow-up, nurses can constantly monitor the mother's blood glucose levels, track the success of the treatment plan, and detect any deviations or difficulties through planned checkups and consistent communication. The author also felt that follow-up visits serve as a platform for ongoing education, allowing nurses to remind dietary advice, exercise outcomes, and self-monitoring procedures and provide pregnant moms discuss their experiences, and seek emotional support.

During this era of the internet and technology, educating and guiding patients with gestational diabetes about using the internet and technology plays an important role in managing it. In five of the selected studies (Deng et al. 2022; Sun & Zhao 2016; Chen et al. 2021; Lin et al. 2019 & Xu et al. 2023), patients were guided to utilize the internet and online portals to keep and share their records and questions. According to Xu et al. (2023) & Lin et al. (2019), patients had quick access to critical resources such as personalized food plans, exercise recommendations, and educational materials through user-friendly mobile applications and internet platforms where several follow-ups and counselling sessions by nurses were conducted through phone call and video calling platforms. Nowadays monitoring glucose levels has become easy due to new technological devices that keep patients motivated. For example, FreeStyle Libre is becoming popular these days as one can easily know or follow their glucose level through the smartphone without finger pricks. There are several online forums where patients can join and get benefits from the information and experiences shared by other patients. The Finnish Diabetes Association (Diabetesliitto) is one association in Finland where patients with diabetes can join and have the latest information and courses about diabetes and its care.

According to the analysis of the authors of this thesis, referring patients with gestational diabetes to a dietician and exercise specialist is a useful nursing intervention for ensuring thorough and successful management of pregnancy diabetes where nine of twelve selected articles supported this finding. Nurses improved the quality of care offered to pregnant women by cooperating with these specialized specialists, adjusting nutrition requirements and exercise routines to specific needs and medical requirements (Xu et al. 2023). Dieticians play an important role in developing personalized nutrition intake plans that emphasize balanced meals to keep blood sugar levels steady. Their knowledge and expertise guarantee that moms acquire appropriate nutrition for both their own health and the growth of their unborn child. (Lv et al. 2019 & Sun & Zhao 2016.) Similarly, exercise professionals, on the other hand, contribute to the design of safe and suitable physical activity (Chen et al. 2017).

Moreover, the authors revealed the personalized treatment plan as the heart of nursing intervention in gestational diabetes management, supported by ten out of twelve articles for analysis purposes. Nurses work together with healthcare practitioners to construct complete plans, equipped with a thorough awareness of both medical intricacies and particular patient requirements. These programs are methodically constructed and include food restrictions, exercise plans, blood sugar monitoring schedules, and medication procedures if needed (Sun & Zhao 2016). As every person has a different weight, height, background, and health status, the individualized diet plan by a dietician is necessary to avoid over or undernutrition that might affect the mother and fetus inversely (Chen et al. 2021). Similarly, visiting an exercise expert having knowledge of gestational diabetes to draw an individual activity plan that suits the best for the intended outcome by avoiding risky approaches is recommended by nurses (Wang et al. 2017).

In this study process, the authors realized the influence of emotional well-being on the overall health of pregnant women. Mental support and family support are highlighted as essential factors while managing gestational diabetes where five of the selected studies (Hawkins et al. 2014; Tryggvadottir et al. 2023; Lin et al. 2020; Chen et al. 2021 & Xu et al. 2023) have a common finding. The psychological state of pregnant women may differ from the general due to several hormonal changes where the occurrence of gestational diabetes mellitus might add extra mental burden (Chen et al. 2021). During this state, mental support from nurses and family members has a huge impact on establishing stable health conditions (Lin et al. 2020 & Xu et al. 2023).

While analyzing the selected articles, except one article by Tandon et al. (2022), all other studies have common conclusion, "the nursing intervention on nutrition and exercise through educating patients and providing various supports is a key factor in managing gestational diabetes mellitus". However, the authors of this thesis were unable to find specific guidelines about the nutrition requirement and exercise guidelines based on women's weight, height, age, and week of pregnancy as the amount of nutrition needed varies from person to person. For a common woman, it might be difficult to calculate the amount of carbohydrates, protein or fat during every meal and it can be stressful as well as one should focus on calculating calories rather than enjoying the meal (Rasmussen et al. 2020). Therefore, the authors realize the need for further detailed studies to draw concrete guidelines about nutritional requirements and exercise plans based on patient individual needs while managing gestational diabetes mellitus.

#### 6 Conclusion and recommendations

Summing up the study, Gestational diabetes mellitus is a rise in blood sugar level that is greater than the marked ceiling, is common health complication diagnosed in pregnant women during 24 - 28 weeks of pregnancy and if not prevented or treated on time, might lead towards catastrophic outcomes for both the mother and the fetus. Eleven out of 12 studies have identified nursing interventions on nutrition and exercise as crucial forefront approaches to adapt while managing gestational diabetes mellitus. The authors intended to study, analyze, and find evidence on outcomes of nursing interventions on nutrition and exercise, where almost all the selected studies have common findings of having an affirmative effect on managing gestational diabetes. The identified nursing interventions about nutrition and exercise must be approached only through the consultation of clinical dieticians and exercise experts to minimize the adverse output caused by wrong approach or common approach based on the fact, that every individual has a different level of metabolism and needs according to their age, height, weight, and months of pregnancy. Nursing interventions like patient education about diet and exercise, glucose monitoring, regular follow-up, utilization of the internet and technology, supporting patients by referring to specialists, designing individual treatment plans and mental support were findings in the management of gestational diabetes mellitus.

The authors of this research were not able to find any specific guidelines related to nutrition intervention or exercise intervention that are specially designed for women with gestational diabetes mellitus with the age, height, weight, and pregnancy weeks. Therefore, the authors recommend more specific research related to nutrition and exercise intervention while managing it that includes factors like age, height, weight, and pregnancy weeks, which would probably be helpful for the nurses to draw a more concrete evidence-based treatment plan. The authors also recommend the development of such a platform or application where the patient could enter their information like age, height, weight, pregnancy weeks, locality of living etc. and get real-time evidence-based instructions from the trustful database worldwide as in the modern era, the use and dependency over technology and smart devices seems to be rising.

#### 7 Ethical considerations & Reliability

Ethical implications are an essential part of the research process as they ensure that the research is conducted in a responsible and respectful manner and that it does not harm any individuals or groups involved in the study (Chetty 2016). In Finland, The National Advisory Board on Social Welfare and Health Care Ethics (ETENE), The National Committee on Medical Research Ethics (TUKIJA), The Advisory Board on Biotechnology (BTNK), The Finnish National Advisory Board on Research Ethics (TENK), are some of the boards who provide and supervise ethical guidelines in their own area of interest. According to TENK (2021), "Ethical review means advance scrutiny and evaluation of a research plan in the light of the ethical practices generally followed in that particular discipline of science, with special emphasis on preventing any harm that the research or its results might cause to the research subject."

During this thesis process, ethical consideration was followed at every step. All the research articles and literature review materials were selected from reliable sources. The ideas and knowledge taken from other authors and researchers are respected by citing their publications according to the guidelines. There was not any social or mental harm that occurred during the research and the findings are transparent. All the references are mentioned according to Laurea's latest guideline published in September 2023 which is available in the student intranet.

Reliability is one of the vital factors of any research as it is related to findings, analyzing, making conclusions and decisions. Reliability is the term used to describe the consistency and stability of research findings as it must yield consistent findings when replicated or repeated using the same techniques and procedures. The reliability of research is crucial in ensuring that its findings and conclusions are correct, reliable, and insightful for future study and decision-making. (Carmines & Zeller 1979, 11.)

In this thesis, the aim was clearly defined, and the data were picked from very reliable sources to draw a conclusion for readers. The outcome was reviewed by supervisor teachers as well. Both the Finnish and international evidence-based information were considered during the research process to maintain the quality and accuracy of the product. The information from all sources is mentioned as a reference to match the reliability or trace the information if needed. The credibility of used sources used during this research process also meets the criteria mentioned by the Finnish National Board on Research Integrity TENK, Laurea UAS guidelines, THL and the Ministry of Social Affairs and Health Finland.

#### 8 Limitations

Following the aim to provide an understanding of nursing interventions on nutrition and exercise while managing gestational diabetes mellitus, the authors have accessed many latest research articles and textbooks. As the topic itself is very broad, there were some limitations that were considered to make the research smooth, and some limitations occurred due to the type of research materials searched.

Firstly, this research purpose was restricted to pregnant women who are diagnosed with gestational diabetes or are at risk of having gestational diabetes. Therefore, the findings cannot be generalized to other types of diabetes or general women without pregnancy. Secondly, the review includes all original trials, regardless of the criteria used to randomize participants, research technique, treatment dosage, or length that might have led to lowquality research. No statistical analysis was done by us to evaluate the quality of interventions. Thirdly, the restrictive inclusion criteria might have affected the ability to find more reliable evidence-based data. The search criteria for literature review articles were restricted to the English language, Full text and no older than 10 years where the database must be assessable through Laurea's credentials. The authors have kept the research in the boundary of nutrition and exercise. Type 1 and type 2 diabetes were out of the scope of this study. The medical intervention and other social and psychological interventions were out of scope. There are no limits about patient age, area of residence, number of pregnancies, height or weight and having diabetes in family members. Lastly, the level of quality for the selected studies was not determined and assessed due to a lack of strict criteria for using only original research.

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ChatGPT & QuillBot has been used to edit the language of this text.

# Figures

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# Tables

Table 1: The literature search process, showing the number of retrieved articles and the different selection stages.

Table 2: Inclusion and exclusion criteria while selecting the articles.

Table 3: Raw data extracted from selected articles for analysis.

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Appendix 1: Articles used for the research and their findings.

Articles	Title of research	Location and Research Date	Research categorization criteria	۸im	Conclusion
Reference	The offesed en	Research Date	Research categorization criteria		conclusion
1. Tandon et al. 2022.	Effects of a Lifestyle Intervention to Prevent Deterioration in Glycemic Status Among South Asian Women with Recent Gestational Diabetes.	South Asia (India, Sri Lanka, and Bangladesh). From November 2017 to January 2020.	Randomized clinical trial of 1601 women with recent gestational diabetes where 801 women were in intervention group. A 12-month lifestyle intervention focused on diet and physical activity. Statistical analysis method was implemented to express results.	To investigate if lifestyle intervention could prevent glycemic deterioration among women with recent gestational diabetes in South Asia.	Lifestyle intervention did not prevent glycemic deterioration among women with recent gestational diabetes.
2. Tryggvadotti r, Medek, Birgisdottir, Geirsson & Gunnarsdotti r 2015.	Association between healthy maternal dietary pattern and risk for gestational diabetes mellitus.	Iceland. From April 2012 to October 2013.	<ul><li>168 pregnant women were recruited for observation.</li><li>Nursing interventions on diet.</li><li>Statistical analysis was utilized for findings.</li></ul>	To investigate the association between maternal dietary patterns and gestational diabetes.	A careful eating plan during pregnancy has been linked to a decreased risk of gestational diabetes mellitus, particularly in women who were already at a higher risk.
3. Sun & Zhao 2016.	The effectiveness of lifestyle intervention in early pregnancy to prevent gestational diabetes mellitus in Chinese overweight and obese women.	China. From March 2013 and August 2013.	Samples of 74 women in gestational weeks 8-12 with a BMI ≥ 24 kg/m <sup>2</sup> were enrolled. Exercise and dietary based nursing interventions. Findings were defined through statistical analysis approach.	To assess whether a lifestyle intervention in early pregnancy can reduce the incidence of gestational diabetes and excessive gestational weight gain.	Early pregnancy lifestyle changes can prevent excessive maternal weight gain in overweight and obese pregnant women and lower the prevalence of gestational diabetes.
4. Xu et al. 2023.	Lifestyle interventions to prevent adverse pregnancy outcomes in women at high risk for gestational diabetes mellitus: a randomized controlled trial.	China. From December 2020 to February 2022.	<ul><li>251 women with high risk of gestational diabetes were included where 128 were in intervention group.</li><li>Nursing interventions on diet and weight management.</li><li>Statistical analysis was done where data were compared using either chi/square test or Fisher's exact test.</li></ul>	To investigate the impact of lifestyle interventions in women at high risk of gestational diabetes mellitus.	This intervention helped women control their weight throughout pregnancy and consume adequate nutrition that lower the risk of excessive or insufficient weight gain, which ultimately lowered the incidence of gestational diabetes.

5. Lin, Yang, Zhang & Wei 2020.	Lifestyle intervention to prevent gestational diabetes mellitus and adverse maternal outcomes among pregnant women at high risk for gestational diabetes mellitus.	China. From July to December 2018.	A total of 281 women (139 in the intervention group and 142 controls) were included. Nutrition and exercise-based nursing interventions. Statistical analysis was done where data were compared using either chi/square test or Fisher's exact test. Data comparisons were done through student t-test.	To evaluate how a lifestyle intervention affects the incidence of gestational diabetes mellitus.	The lifestyle intervention comprising dietary modification and daily exercise is associated with lower risks of gestational diabetes. The incidence of gestational diabetes was lower in intervention group.
6. Deng et al. 2021.	Effects of Diet and Exercise Interventions to Prevent Gestational Diabetes in Pregnant Women with High-Risk Factors in China: A Randomized Controlled Study.	China. From October 2018 to September 2019.	Total 94 pregnant women. 47 were in intervention group. Diet and exercise-based nursing interventions. Statistical analysis was done with software SPSS. Data were compared using t-test. Cross tabulated data were analysed by c2 test.	To ascertain if diet and exercise programs can lower the incidence of gestational diabetes mellitus in high-risk pregnant individuals.	In high-risk pregnant women, diet and exercise interventions can lower the incidence of gestational diabetes mellitus.
7. Hawkins et al. 2014.	A pregnancy lifestyle intervention to prevent gestational diabetes risk factors in overweight Hispanic women.	USA. From August 2010 to April 2012.	Total 68 pregnant women were enrolled for survey. Exercise and nutrition-based nursing interventions. Data analysis was done statistically.	To pilot the feasibility of physical activity and diet to reduce the risk factors of gestational diabetes.	Lifestyle intervention is feasible and may help attenuate pregnancy-related decreases in vigorous physical activity.
8. Cordero, Mottola, Vargas, Blanco & Barakat 2015.	Exercise Is Associated with a Reduction in Gestational Diabetes Mellitus.	Spain. 2015.	<ul><li>342 pregnant women were in selected for study with 101 as intervention group.</li><li>Exercise-based nursing interventions.</li><li>Statistical analysis was performed using software SPSS.</li></ul>	To assess the effectiveness of a maternal exercise program in preventing gestational diabetes mellitus.	By maintaining glucose tolerance, the exercise regimen followed throughout pregnancy decreased the occurrence of gestational diabetes.

9. Koivusalo et al. 2016.	Gestational diabetes mellitus can be prevented by lifestyle intervention: The Finnish gestational diabetes prevention study. A randomized controlled multicenter trial.	Finland. Between the years 2008 and 2014.	<ul><li>269 pregnant women were included in trial. Nutrition and exercise-based nursing interventions.</li><li>Statistical analysis was carried during research using software SPSS.</li></ul>	To determine whether a moderate lifestyle intervention can prevent gestational diabetes mellitus in pregnant women.	In high-risk pregnant women, a moderate, tailored lifestyle intervention decreased the incidence of gestational diabetes by 39%.
10. Chen et al. 2021.	Effect of the internet combined with exercise-based individualized nursing intervention in patients with gestational diabetes mellitus.	China. From July 2019 to February 2021.	Total 139 patients with gestational diabetes where 79 patients were in observation group. Internet combined with exercise-based individualized nursing intervention. Statistical analysis was done with software SPSS. Data were compared using chi-square test and t- test.	To ascertain the clinical potency of an exercise- based, tailored nursing intervention in conjunction with the internet for patients with gestational diabetes.	Internet use with exercise- based, tailored nursing care can considerably reduce blood glucose, insulin resistance in gestational diabetes patients.
11. Wang et al. 2017.	A randomized clinical trial of exercise during pregnancy to prevent gestational diabetes mellitus and improve pregnancy outcome in overweight and obese pregnant women.	China. From December 204 through July 2016.	<ul><li>300 pregnant women with risk of gestational diabetes were included in investigation where 150 were in intervention group.</li><li>Exercise-based nursing interventions.</li><li>Data were analyzed using statistical software SPSS.</li></ul>	To investigate the potential benefits of early pregnancy exercise in preventing gestational diabetes mellitus.	The risk of gestational diabetes was significantly reduced in overweight and obese pregnant women who exercised three times a week.
12. Lv, Yu, Chi & Wang 2019.	Effects of nutritional nursing intervention based on glycemic load for patient with gestational diabetes mellitus.	China. From March 2015 to March 2017.	<ul> <li>134 patients with gestational diabetes were participants where 67 were in observation.</li> <li>Nutritional nursing intervention.</li> <li>Statistical analysis was done with software SPSS.</li> <li>Data were compared using chi-square test and t-test.</li> </ul>	To establish the effects of nutritional nursing intervention based on glycemic load (GL) for patients with gestational diabetes.	A GL-based nutritional nursing intervention can successfully regulate blood glucose levels, lower the risk of pregnancy problems, and enhance the quality of the pregnancy.