CHAPTER 2

2. LITERATURE REVIEW

A review of literature refers to activities involved in identifying and searching for information on a topic and developing and understanding the state of knowledge on the topic. An extensive review of literature relevant to the research was done in PUBMED, Journals, Books, Health and yoga website, Conference reports, American Diabetic Association and WHO reports to gain insight and collect maximum information for laying the foundation for this study.

The purpose of review of literature is to obtain comprehensive knowledge and in-depth information about the Yoga for Gestational Diabetes Mellitus among mothers with Gestational Diabetes Mellitus. This literature review will help in developing a broad conceptual context in to the research problem. This chapter consists of three sections

2.1 SECTION I : Theoretical literature related to Gestational Diabetes Mellitus

Literature related to

2.1.1 PART I: Gestational Diabetes Mellitus

2.1.2 PART II: Yoga for Gestational Diabetes Mellitus

2.2 SECTION II: Empirical literature related to Gestational Diabetes Mellitus and Yoga

Studies and literature related to

2.2.1 PART I : Incidence and prevalence of Gestational Diabetes Mellitus

2.2.2 PART II : Maternal and fetal complications of Gestational Diabetes Mellitus
2.2.3 PART III: Diet, Exercise, Medication and Yoga in the Management of Gestational Diabetes Mellitus

2.2.4 PART IV: Effect of yoga on Diabetes Mellitus and Gestational Diabetes Mellitus

2.2.5 PART V: Effect of yoga on Gestational Diabetes Mellitus

2.3 SECTION III: Conceptual framework based on Ernestine weidenbach’s Helping art of Clinical nursing theory (1964) model.
2.1 SECTION I : Theoretical literature related to Gestational Diabetes Mellitus

2.1.1 PART I: Literature related to Gestational Diabetes Mellitus

Definition

1. Gestational Diabetes Mellitus may be defined as the abnormal carbohydrate tolerance with the onset or first detection during the present pregnancy at 24 to 28 weeks of gestation.[65]

2. Gestational Diabetes Mellitus refers to a genetically and clinically heterogenous group of disorders that share carbohydrate intolerance in common and are diagnosed during pregnancy.[66]

Incidence

1 to 14% of all pregnancies are complicated by diabetes mellitus and 90% of them were Gestational Diabetes Mellitus and Polyhydramnios. It course in 10 to 20% of GDM mothers. Near 50 percent of women with Gestational Diabetes Mellitus will develop type 2 diabetes mellitus over a period of 5 -20 years. Chance of having diabetes children is about 6% when the father is diabetic, it raises to 20 % if both the parents are diabetic.[67]

The potential candidates for Gestational Diabetes Mellitus are

Positive family history of diabetes (Parents or sibling), family history should include uncles, aunts and grandparents, having a previous birth of an overweight baby of 4 kg or more, Previous stillbirth with pancreatic islet hyperplasia revealed on autopsy, Unexplained perinatal loss, Presence of polyhydramnios or recurrent vaginal candidiasis in present Pregnancy, Persistent glycosuria, Age over 30, Obesity, Ethnic group (East Asian, Pacific Island ancestry). [68]
Carbohydrate Metabolism during pregnancy

Metabolic adaptations occur during pregnancy because the fetus depends on the mother for an uninterrupted supply of metabolic fuel, mainly glucose, in order to meet its growth demand. Pregnancy is characterized by maternal hyperinsulinaemia and insulin resistance, which becomes most marked in the third trimester. Beginning in early pregnancy, there are constantly elevated estrogen and progesterone hormone levels, which stimulate the pancreatic beta cells, resulting in their hyperplasia and hyperinsulinaemia. This leads to increased tissue glycogen, decreased hepatic glucose production, increased peripheral glucose utilization (including fetal uptake), and a decreased maternal fasting glucose level, described as accelerated starvation. The overall effect is anabolic. As pregnancy advances, levels of human placental lactogen increase and along with the cortisol to counter the effects of insulin, resulting in resistance. After meals, a state of facilitated anabolism ensures, with higher levels of triglycerides, prolonged hyperglycemia and enhanced lipolysis. Increased maternal use of fat for energy spares glucose for fetal consumption.[69]

Pathophysiology

The precise mechanisms underlying Gestational Diabetes Mellitus remain unknown. The hallmark of GDM is increased insulin resistance. Pregnancy hormones and other factors are thought to interfere with the action of insulin as it binds to the insulin receptor. The interference probably occurs at the level of the cell signaling pathway behind the insulin receptor. Since insulin promotes the entry of glucose into most cells, insulin resistance prevents glucose from entering the cells properly. As a result, glucose remains in the bloodstream, where glucose levels rise. More insulin is needed to overcome this resistance; about 1.5 to 2.5 times more insulin is produced than in a normal pregnancy.[70]
Signs and symptoms

Blurred vision, Fatigue, Frequent infection including those of bladder, vagina and skin, Increased thirst, Increased urination, Nausea and Vomiting, Weight loss despite normal appetite, Unhealed ulcer, Fruity odour breath, Frequent abdominal pain, Increased perspiration, Itchy skin, Rough skin, Poor skin turgor, Coated tongue, Bleeding gums[70]

Screening and diagnosis

Screening strategy for detection of GDM is

1. Low risk: Absence of risk factors
2. Average risk: Some risk factors
3. High risk: Blood glucose test as soon as feasible

Screening for GDM should follow one of the two approaches:

One-step approach: 100 gm oral glucose tolerance test (OGTT)

In this test, the patient blood is given a 100 gm solution of glucose and then the venous blood glucose is measured at 1, 2 and 3 hours after administration of the glucose to monitor response. The test must be given in the morning after an overnight fast (8 to 14 hours of nothing to eat) and after at least 3 days of unrestricted diet and physical activity. If two or more of the following criteria are met, the individual is diagnosed with GDM:

1. Fasting glucose : ≥ 95 mg/dl
2. Glucose after 1 hour : ≥ 180 mg/dl
3. Glucose after 2 hours : ≥ 155 mg/dl
4. Glucose after 3 hours : ≥ 140 mg/dl
Two-step approach: 50 gm oral glucose challenge test (GCT and OGTT)

The patient is first screened for glucose intolerance with the 50 gm oral glucose challenge test (using the same protocol as for the 100 gm OGTT) and if his or her blood glucose levels do not fall below 140 mg/dl within 1 hour after administration, an OGTT is then performed. The American Diabetes Association states that the threshold value of 140 mg/dl cutoff point identifies 80% of women with GDM.

Urinary glucose testing

Women with GDM may have high glucose levels in their urine (glycosuria). Although dipstick testing is widely practiced, it performs poorly and routine dipstick testing has not been shown to cause under diagnosis where universal screening is performed. Increased glomerular filtration rates during pregnancy contribute to some 50% of women having glucose in their urine on dipstick test at some point during their pregnancy. The sensitivity of glycosuria for GDM in the first 2 trimester is only around 10% and the positive predictive value is around 20%.[71]

Complications

Maternal complications

1. During pregnancy
   Hypoglycemia, Ketoacidosis, Hyperglycemia, Urinary tract infection, Candidal vaginosis, Progression of maternal diabetic retinopathy, Worsening of nephropathy, Spontaneous abortions, Pre-eclampsia, Polyhydramnious

2. During delivery
   Preterm labour (infection, Polyhydramnious may be the cause), Shoulder dystocia, Prolonged labour, Increase incidence of operative or instrumental deliveries, Trauma
3. Postpartal

Postpartum sepsis, Subinvolution of uterus, Postpartal haemorrhage-traumatic (due to instrumental delivery, extension of episiotomy)/ atonic (due to uterine over distension)

4. Delay- May develop Diabetes Mellitus in later life (1/3rd)

Foetal and Neonatal complications

Congenital anomalies

a. Central nervous system,
   Spinabifïda, Anencephaly, Encephalocele, Hydrocephalus, Microcephaly, Holoprosencephaly, Meningomyelocele

b. Cardiac
   Transposition of great vessels, Atrial septal defect, Ventricular septal defect, Aortic coarctation, Patent ductus arteriosus, Cardiomegaly

c. Renal
   Renal atresia/agenesis, Ureteral duplication, Hydronephrosis

d. Retinal anomalies

e. Gastrointestinal tract
   Anal atresia, Duodenal atresia, Small left colon syndrome, Single umbilical artery

f. Skeletal and Spine
   Caudal regression syndrome, Foetal macrosomia, Intrauterine growth restriction, Intrauterine fetal death, Birth trauma, Birth asphyxia, Neonatal hyperviscosity syndrome, Neonatal hypoglycemia, Neonatal hypocalcemia, Neonatal
Management

Aim of Management

1. Achieving a euglycemic state similar to a non-pregnant patient and its maintenance.
2. Avoiding iatrogenic prematurity
3. Monitoring for intrauterine foetal jeopardy
4. Eliminating maternal complications
5. Patient education

a. Diet: Dietary regulation is the first line treatment for Gestational Diabetics. According to current recommendations of the ACOG, the calorie consumptions should be 2000 to 4000 kcal/day or 38kcal/kg body weight and 300kcal/day above basal requirements. The constituents of the diet may be
   1. 50 -60% carbohydrates
   2. 12-20% proteins(30 gm additional per day or 1.3gm/kg body weight per day)
   3. Less than 10% saturated fat, up to 10% Polyunsaturated fat and the remainder as monounsaturated fat
   4. Restrict cholesterol
   5. Avoid sugar
   6. Routine hematinic and calcium supplements

b. Exercise: Exercise is an important component of in establishing and maintaining glucose control; improved insulin sensitivity is evident after 4 weeks of exercise (ADA.2001; Cunningham and others,2005). It definitely improves physical and
psychological well being of the patient. Exercise must be avoided at the peak time of insulin action. [74]

c. Insulin: Insulin is often mandatory in pregnant diabetics, where a rigid blood glucose profile is essential. The ideal glucose levels are considered to be as follows

- Before breakfast: 60 – 90 mg/dl
- Before meals: 60 -105 mg/dl
- 2 hour after meals: ≤ 120 mg/dl
- 2 am to 6 am: >60 mg/dl

The indications for use of insulin in Gestational diabetics are

- FBS ≥ 100 mg/dl on two consecutive checks
- 1 hour PPBS: ≥ 140 mg/dl

An average starting dose is between 20 to 30 units, divided into two thirds intermediate-acting insulin and one third regular insulin. Adjustments are necessary based on such variable as follows: Dosage is less if started before third trimester related to less insulin resistance. Dosage is increased in obese women because of increased insulin resistance.[75]

### Calculation guidelines for insulin during pregnancy

<table>
<thead>
<tr>
<th>Trimester</th>
<th>Insulin Dosage (Units/kg Body weight)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre pregnant</td>
<td>0.5-0.6</td>
</tr>
<tr>
<td>First trimester</td>
<td>0.7 -0.8</td>
</tr>
<tr>
<td>Second trimester</td>
<td>0.8-1.0</td>
</tr>
<tr>
<td>Third trimester until 36 weeks</td>
<td>0.9-1.2</td>
</tr>
<tr>
<td>Postpartum</td>
<td>0.6</td>
</tr>
</tbody>
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d. Preterm labour management

Nifedipine is the preferred tocolytic drug as to effectiveness and safety. Magnesium sulfate or indomethacin may also be used to allow for the administration of corticosteroids. If corticosteroids are needed to enhance the fetal lung maturity,
close assessment of maternal glucose levels and IV insulin may be necessary. The daily dose of insulin may need to be doubled. Because beta-sympathetics can stimulate hyperglycemia and even cause ketoacidosis, their use is not recommended for the patient with Diabetes.

e. Intra partum management

The woman with well-controlled diabetes who has no complications does not need to deliver before term if the fetus is not macrosomic and the biophysical profile is reassuring. Early delivery may be necessary if the women has not had good glucose control, has a history of a still birth, or has developed complications such as a hypertensive disorder of pregnancy or vasculopathy or if the fetal estimated weight is LGA or there is an indication of fetal compromise in any of these case, an induction or caesarean birth may be scheduled.

Insulin infusions if it is needed continuously 25 units of regular insulin are added to 250 mg of normal saline. The IV rate and supplemental regular insulin vary based on every 1 to 2 hour capillary blood glucose value.

f. Post-partum management

At delivery there is an abrupt loss of the antagonistic placental hormones and suppression of the anterior pituitary growth hormone. Therefore there is a significant decrease in insulin need during the immediate post partum period. Insulin requirements for the patient with GDM disappear in 90% of the Women(ADA,2000).

Frequent blood glucose monitoring is necessary for first 48 hours post-partum to determine the individual Patient’s insulin need. Ongoing and long term follow up is needed. Women who have had GDM have a 40% to 60% risk of developing type 2 Diabetes Mellitus with in next 20 years. Maintaining a normal weight and exercising regularly have been shown to decrease the risk of 25%.[76]
g. Patient education

1. The dietary and exercise recommendations
2. Self-monitoring of blood glucose
3. Self-administration of insulin and adjustment of insulin dose
4. Identification and treatment of hypoglycemia (Patient and family members)
5. Incorporate safe physical activity
6. Development of techniques to reduce stress and cope with the denial.[76]

2.1.2 PART II: Literature related to Yoga for Gestational Diabetes Mellitus

Yoga is an ancient Indian form of exercise with a holistic approach, meaning it tackles a person's well-being as a whole - mind and body - unlike other forms of exercise. Yoga's roots can be traced back at least five thousand years and the name means to join, or to unite. It consists of different poses, called asanas, that should be held steady, while controlling the breathing. The breathing techniques, which are central to yoga, are called pranayamas. Each asana has its own benefits and targets different areas. The philosophy behind yoga is that by daily practice, people will become more centered and relieved from stress and be able to tone the body at the same time. [77]

Diabetes is a disease of disturbed carbohydrate metabolism. Diabetes in various forms affects up to 5 percent of the world's population. Of the different ways in which diabetes manifests itself, noninsulin-dependent diabetes mellitus (NIDDM) and Gestational Diabetes Mellitus are probably the most commonly encountered genetic disease. NIDDM or Type II diabetes is multifactorial, depending also on an environmental factor including obesity, sedentary lifestyles and nutritional imbalances. Away from prescription medication, home remedies, and natural cures we have alternative treatments too like Yoga, and Pranayama. Yoga has shown some beneficial results in treating diabetes. The yoga exercises that are prescribed for diabetics is different from hatha yoga exercise because it involves positions tailored to treat certain conditions, as well as meditation, relaxation and stretching exercises.
Diabetes can pose a serious problem for a pregnant woman. The risks could vary from premature labour to urinary tract infection, elevated blood pressure to possibility of delivery by caesarean section. The risks to the baby can be that he is extraordinarily large and fat leading to a difficult birthing, increased risk of congenital abnormality, low blood sugar at birth or prolonged jaundice. In the second and third trimesters of pregnancy the insulin requirement of the mother increases by 2 to 3 times. Yogi’s therapeutic management of diabetes over many years has shown that, in conjunction with specific yoga practices, the more a diabetic can regularize their meals and their energy output, the less in-between meals will be required. The same principle applies to the pregnant woman, with or without.

Yoga has 5 vital tools for pregnancy. When followed together, they work wonders on health and capability to have a smooth pregnancy. Smooth pregnancy and a natural childbirth are just some of the benefits of yoga. But more importantly, yoga does wonders on the physical and mental development of the fetus. Ensuring a healthy baby is every woman’s dream and yoga helps to do that.

The five vital tools are

1. **Yoga Exercises** – These gently work on the reproductive organs and pelvis to ensure a smooth pregnancy and a relatively easy childbirth. At the subtle level, these ensure optimum supply of blood and nutrients to the developing fetus.

2. **Breathing or Pranayama** – These powerful techniques ensure the abundant supply of oxygen and a better life force for the child. The methods work on the fitness during pregnancy.

3. **Mudras and Bandhas** – The psycho-physical stimulation of these gestures and locks have powerful effects on a woman’s reproductive organs.

4. **Meditation** – As a therapeutic tool, meditation will help to resolve the deepest of neuroses, fears and conflicts, which are so common during pregnancy. Meditation brings with it an incredible awareness which helps to connect with her child
5 Deep Relaxation – Yoga Nidra (Yogic sleep) is particularly effective during pregnancy for physical and mental relaxation as well as for childbirth preparation.[78,79]

Yoga and pregnancy

Yoga can help women get through their pregnancy with minimal discomfort. It also helps the birth and post-delivery stages generally, pregnant mothers who do yoga exercises appear healthier, both in mind and body. Their bodies are more flexible, which enables them to adapt to various positions when in labour and the ligaments are more elastic, which in turn can help to reduce labour pain.' Yoga helps to prepare for the birth - it encourages breath and body awareness, reduces worry and teaches women to adapt to new situations' and yoga continues to have benefits after pregnancy, too. Postnatal yoga, which can be started about six weeks after the birth, strengthens abdominal muscles and the pelvic floor. It also helps to get back to the pre-pregnancy shape faster.

There are many techniques that can be practiced during pregnancy which are safe and help to eliminate the discomforts. Simple techniques such as asana, pranayama and meditation increase the circulation, improve the digestion system eliminating gastric discomfort, acidity and indigestion, and reduce joint pain and all other complications which can arise during pregnancy.

Yogic breathing is notable as it is associated to stress relief technique. Yogic technique of breathing is an alternative method aimed at diabetes cure. It can also be referred as a compliment to traditional methods of treating diabetes. The basic concept of Pranayama is regulating breathing and thereby blood circulation system. In this process, it is emphasized that more of Oxygen should be inhaled and carbon dioxide expelled off. When we have sufficient Oxygen inhaled, it begins to work well in inducing the blood circulation in improving human metabolism and the net result goes to the pancreas to function properly for insulin secretion. It is painless and costs nothing to spend except to spare sufficient time to inhale unpolluted healthy air. This process does help fight diabetes and maintain a sound body with sound mind.[2]
Pranayama

Will strengthen the nervous system, bring balance to the autonomic nervous system and enhance voluntary control over the respiratory system. Some common examples are nadi shodhana, bastrika (up to third month only), bhramary and ujjayi pranayama. Yoga nidra (psychic sleep), meditation, ajapa japa, ashwini mudra, vajroli mudra and moola bandha and shavasana also increase the relaxed state of the mind and help with self-analysis. Shavasana increases the knowledge of inhalation and exhalation and thus will improve the state of the mind and body during pregnancy. When practiced along with kumbhaka (breath retention) and jalandhara bandha (throat lock), it increases the lung capacity and strength. Pranayama also helps you to develop breath awareness and awareness of thoughts thus improving mental state.

Asanas

These three groups of pawanmukhta groups, basic asanas (postures), increase flexibility and prepare the mind and body. Toe bending (padanguli naman), ankle rotation (goolf chakra), base position (prarambhik sthiti), ankle rotation (goolf chakra), ankle crank (gulf ghurnan), knee bending (janu naman), knee rotation (janu chakra), half butterfly (ardha titali), full butterfly (purna titali), hand clenching (mushhtika bandhana), wrist bending (manibandha naman), wrist joint rotation (manibandha chakra), elbow bending (kahuni naman), flapping fish shoulder socket rotation (skandha chakra), head movement (greeva sanchalana), shashank asana, cat pose (marjari asana), tiger (vyaghrasana), cow's face (gomukha), hero meditation (dhyana veerasana), spinal twist (maru wakarna) and half spinal (ardh- machendra).

The concept of asanas in Yoga system commences with Pawanmuktasana series. The main idea behind these asanas is to provide suppleness in the areas of body joints. We cannot practice these asanas properly without allowing suitable suppleness in the joints. Pawanamuktasana offers right practice for making the joints supple. This asana is quite important for those people who aspire to do something great in the field of higher stages Yoga. We cannot go for higher stages asanas
without proper practice of this asana. The proper practice of this asana provides flexibility in the joints and removes the hardness of the muscles. We cannot forego this asana as the subtle effect of this easy and natural practice affects the entire body and mind.

Etymologically this word - pawanmuktasana signifies three aspects which are pawana namely air, wind or the vital breath, mukta is free and asana means the sitting posture; thus this is a yoga posture through which the stagnant air of the body joints is expelled. These stagnant airs are the reason behind arthritis. The practice of this asana has a positive and subtle impact even regarding the heart ailments and high blood pressure. The best part is that one can perform this regardless of any age consideration. Therefore, these days this is being applied as naturopathy and has become a popular part of modern medicine.

As most of the diseases are psychological, Yoga is a method through which we can get into the hidden facts of mind. Yoga provides agility and vigour and sets one stress free in just a few moments. This helps in restraining the mind and in the development of consciousness through which one can realize the main reason behind the stress. Further depending upon the skill, knowledge and personality one can also get the solution. Yoga raises the level of consciousness and establishes a better understanding between the mind and the body. This removes every dilemma and physical afflictions.

Treating diabetes requires a multi-faceted approach. It takes more than changing the eating habits to get the blood glucose levels under control. One important aspect is to ensure that choose an activity which can help to reduce the blood sugar levels. For this, yoga is said to be helpful.

The benefits of doing yoga are tremendous. A yoga lifestyle is known for being natural and healthy for the mother, due to the increased attention to the whole body, rather than just specific parts of the body. This is great for diabetes, because diabetes affects the entire body, rather than just one part. Yoga can help improve the immune system and the circulatory system. It also helps to reduce stress and anxiety.
and increase energy flow to the body. All of these works together to reduce the blood sugar levels.

Yoga provides a natural way to get in touch with our body. It helps the muscles to absorb the extra blood glucose that is in our body, thus allowing the pancreas and liver to work more efficiently. Yoga can also encourage the pancreas to produce more insulin, which can help to reduce your blood sugar levels significantly. The inward introspection that is encouraged in the yoga lifestyle helps our entire body to work in harmony, reducing blood sugar levels and other symptoms of diabetes. A yoga lifestyle usually involves healthy eating. Hence, a diet that is high in fruits, vegetables, and whole grains is emphasized.

Changes in blood sugar levels can have a profound impact on various functions of our body. Yoga is one exercise that can help bring our entire body, mind, and soul into harmony. Consider practicing yoga regularly as an important tool to control diabetes. Yoga provides an alternate source of healing for diabetes. Yoga helps to strengthen the immune system, improves blood circulation and the flow of vital energy or prana to the internal organs of the body. The secretion of stress hormones, due to faulty diet, hectic lifestyle or wrong thinking is controlled by the practice of yoga.

Effect of yoga asanas on blood sugar level

Yogic exercises cause the muscles to absorb the excess glucose in the blood, thereby reducing the blood sugar level. They help the pancreas and liver to function effectively, which regulates the blood sugar levels. Asanas help in rejuvenating the pancreatic cells, thereby assisting insulin secretion. The muscular movements also help in bringing down the blood sugar levels. Asanas induce relaxation, which also plays a key role in the healthy functioning of the internal organs of the body. Yogic exercises are perhaps the only exercises that bring us close to the inner being or the soul, which is essentially spiritual in nature. Practitioners of yoga, pranayama and meditation, usually find a shift in their attitude towards life.
The results of yoga asanas are best when they are executed without exertion, in a non-striving manner. Ideally, the movements should be fluid and harmonious. The natural poses assumed in yoga practice bring peace to the mind of the practitioner. Asanas can be practiced with any classical music played at the background. They make the practice enjoyable. It is important to be conscious of the movements and understand the limits of one’s own flexibility. Straining beyond one’s own means is certainly not recommended.[80]
2.2 Section II: Empirical literature related to Gestational Diabetes Mellitus and yoga

2.2.1 Part I : Studies and literature related to incidence and prevalence of Gestational Diabetes Mellitus

Majid Manafi conducted a study on Gestational diabetes in Iranian women. Rising incidence of Gestational diabetes mellitus (GDM) has been reported in the recent years and it has become an important public health problem, mainly among women aged 35-39 years. The objective was to evaluate the frequency of GDM in the females who are living in the northwest of Iran. Two hundred and fifty pregnant women at 24-28th weeks of gestation were screened using 50 g oral glucose challenge test (OGCT), and the subjects with blood sugar levels equal or greater than 130 mg/dl were referred to diagnostic 100 g oral glucose tolerance test (OGTT). GDM was diagnosed according to Carpenter and Coustan criteria. The findings were eighty six women (34.4%) with positive result of screening test were selected for subsequent OGTT with 100goral glucose. GDM was diagnosed in twenty four women (9.6 %) with at least 2 abnormal values. Frequencies of GDM in the older subjects or the subjects with high pre-pregnancy or 24-28th weeks’ body mass index (BMI) were significantly higher than younger pregnant females or the subjects with low BMI. The study concluded that prevalence of GDM was 11.9%, which is higher than earlier reports and implicates that the prevalence of Gestational Diabetes Mellitus has markedly been increasing in Iran and associated with maternal age and body mass index.[81]

Sonali Sain conducted a descriptive, cross-sectional study to find out the magnitude of gestational diabetes by selective screening using “American Diabetes Association (ADA) risk approach strategy” and distribution of risk factors of gestational diabetes among the mothers attending the antenatal clinic of Singur Rural Hospital. Pregnant women with gestational age between 24-28 weeks were interviewed using a predesigned schedule adapted from American Diabetes Association and WHO guidelines and their clinical and obstetrical examination was done. Mothers identified with at least 1 risk factor were advised for screening by
Glucose Challenge test (GCT). Those with a positive result were confirmed by Glucose Tolerance Test. Out of 625 antenatal mothers, majority i.e. 60.32% of the mothers were exposed to low risk for developing gestational diabetes. Among 248 (39.68%) mothers who had at least one risk factor, 20.56% were GCT positive amounting to 8.16% of the total population. 11.69% of the mothers with positive risk factors were GTT positive amounting to 56.86% of GCT positive mothers. This accounted for 4.64% of the total study population. Thus this method of preliminary screening for risk factors of gestational diabetes undertaken in all antenatal mothers followed by confirmatory testing in those found to be risk factor positive can provide a feasible alternative in increasing the yield for detection of gestational diabetes particularly in a low resource setting.[82]

Mamta Bhatt, et al conducted a case control study on determinants of gestational diabetes mellitus in a district tertiary care hospital in south India. The objective was to study the determinants of Gestational Diabetes Mellitus. It was a case-control study and conducted at Sri Avittom Thirunal Hospital, Thiruvananthapuram district, Kerala, South India. The study participants were 300 GDM women as cases and 300 age-matched controls. The study variables were socio demographic characteristics, pre-pregnancy Body Mass Index (BMI), menstrual history, obstetric history, infertility history, family history of diabetes in first degree relatives, recurrent urinary tract infection (UTI), and moniliasis. The statistical package are T-test, Fishers Exact Test, Chi square test, Adjusted Odds Ratio with 95% CI was used and the results were Pre-pregnancy BMI ≥ 25 (P < 0.001, OR = 2.7), irregular menstrual cycle (P = 0.006), treatment for infertility (P = 0.001, OR = 3.3), family history of diabetes (P = 0.001, OR = 4.5), history of diabetes in mother (P = 0.003), previous pregnancy losses (P = 0.04), past GDM (P = 0.035), prematurity (P = 0.01), pre-eclampsia (P = 0.04), polyhydramnios (P < 0.001, OR = 6.0), UTI (P < 0.001, OR = 3.2), and moniliasis (P < 0.001, OR = 7.6) were significantly associated with present GDM. To conclude this study early identification of women at risk of GDM and prompt treatment is recommended to prevent complications.[83]
Kwak SH, et al conducted a study on a genome-wide association study of gestational diabetes mellitus in Korean women. Knowledge regarding the genetic risk loci for gestational diabetes mellitus (GDM) is still limited. In this study, they performed a two-stage genome-wide association analysis in Korean women. In the stage 1 genome scan, 468 women with GDM and 1,242 non diabetic control women were compared using 2.19 million genotyped or imputed markers. They selected 11 loci for further genotyping in stage 2 samples of 931 case and 783 control subjects. The joint effect of stage 1 plus stage 2 studies was analyzed by meta-analysis. They also investigated the effect of known type 2 diabetes variants in GDM. Two loci known to be associated with type 2 diabetes had a genome-wide significant association with GDM in the joint analysis. rs7754840, a variant in CDKAL1, had the strongest association with GDM (odds ratio 1.518; P=6.65×10(-16)). A variant near MTNR1B, rs10830962, was also significantly associated with the risk of GDM (1.454; P=2.49×10(-13)). The study found that there was an excess of association between known type 2 diabetes variants and GDM above what is expected under the null hypothesis. In conclusion, they have confirmed that genetic variants in CDKAL1 and near MTNR1B are strongly associated with GDM in Korean women. There seems to be a shared genetic basis between GDM and type 2 diabetes.[84]

Ma RC, Chan JC reported on Pregnancy and diabetes scenario around the world. They expressed that Asians adopting a modern lifestyle have a higher risk of diabetes than their white counterparts living in high-income countries. Asian ethnicity is an independent risk factor for gestational diabetes mellitus (GDM), which is associated with a 2-fold increased risk of diabetes. In this burgeoning epidemic of diabetes, 40 million people in China are affected, with the most rapid rate of increase in disease prevalence in the young to middle-aged group. This rising trend of young onset diabetes is largely driven by the rising prevalence of childhood obesity/metabolic syndrome. In Asia, both low and high birth weights are independent risk factors for diabetes and metabolic syndrome. Apart from the high prevalence of maternal history of diabetes in women with diabetes, the metabolic milieu of GDM may have long-term effects on the metabolic profile and future risk of diabetes in the offspring. This complex interplay between environmental, genetic,
and perinatal factors puts both mothers with a history of GDM and their offspring at risk of diabetes and metabolic syndrome, thus setting up a vicious cycle of "diabetes begetting diabetes." Given the public health burden of diabetes in low-income nations such as China, there is an urgent need to design and implement large-scale awareness and intervention programs targeted at these mother-offspring pairs to interrupt this Trans generational effect of diabetes and the socioeconomic and humanistic impacts. [85]

Seshiah V., et al conducted a study on Gestational diabetes mellitus in India. This study was performed in the antenatal clinic of Government Maternity Hospital, Chennai, India. During the antenatal checkup in second or third trimester, mother was given 50 gm oral glucose load and blood sample was collected after one hour in the antenatal clinic. This test was performed on 1251 pregnant women. They were requested to come after 72 hours for the 75 gm OGTT recommended by WHO. Among the 1251 women, 891 responded. The blood sample was taken in the fasting state and at 2 hours after 75 gm of oral glucose. Diagnosis was based on the WHO criteria for gestational diabetes mellitus (GDM). The result showed that the mean age of these pregnant women was 23+/4 years. There was a significant increase in the prevalence of GDM in relation to gravida. The effect of BMI did not quite reach statistical significance (chi2 (df=1) = 3.659, P = 0.055), but a model of linear trend was significant. Of the 1251 women who underwent the 50 gm oral glucose challenge test, 670 (53.55%) had one hour plasma glucose > or = 130 mg/dl. Among the 891 pregnant women who had 75 gms OGTT, 168 (18.9%) were diagnosed as GDM, taking both FPG > or = 126 mg/dl and/or 2 hr PPG > or = 140 mg/dl as cut-off values. Taking only 2 hr plasma glucose for analysis, 144 (16.2%) had a value > or = 140 mg/dl. A similar study was conducted in different parts of the country taking only the 2 hr 75 gm post-glucose value of > or = 140 mg/dl as diagnostic criteria for GDM. Of the total number of pregnant women (n = 3674) screened, 16.55% of them found to have GDM. This study has documented the increased prevalence of GDM in Indian population necessitating universal screening for glucose intolerance in pregnancy. Using 2 hr plasma glucose > or = 140 mg/dl as a
one step procedure is simple and economical, particularly for the countries ethnically more prone to high prevalence of diabetes. [86]

**Vibeke Anna, et al** conducted a study on socio demographic correlates of the increasing trend in prevalence of Gestational Diabetes Mellitus in a large population of women between 1995 and 2005. The objective of the study was to identify women at risk of developing GDM. They examined socio demographic correlates and changes in the prevalence of GDM among all births between 1995 and 2005 in Australia's largest state. A computerized database of all births \( n = 956,738 \) between 1995 and 2005 in New South Wales, Australia, was used in a multivariate logistic regression that examined the association between socio demographic characteristics and the occurrence of GDM. The result showed between 1995 and 2005, the prevalence of GDM increased by 45%, from 3.0 to 4.4%. Women born in South Asia had the highest adjusted odds ratio (OR) of any region \( (4.33 \ [95\% \ CI \ 4.12–4.55]) \) relative to women born in Australia. Women living in the three lowest socioeconomic quartiles had higher adjusted ORs for GDM relative to women in the highest quartile \( (1.54 \ [1.50–1.59], \ 1.74 \ [1.69–1.8], \ and \ 1.65 \ [1.60–1.70] \) for decreasing socioeconomic status quartiles). Increasing age was strongly associated with GDM, with women aged >40 years having an adjusted OR of 6.13 \( (95\% \ CI \ 5.79–6.49) \) relative to women in their early 20s. Parity was associated with a small reduced risk. There was no association between smoking and GDM. To conclude this study the Maternal age, socioeconomic position, and ethnicity are important correlates of GDM. [87]

**Wahi P., et al** conducted a study on Prevalence of gestational diabetes mellitus (GDM) and its outcomes in Jammu region. The aim of the study was to evaluate the prevalence and outcomes of gestational diabetes mellitus (GDM) from Jammu region. During the period of study, women at 24th to 28th week of gestation were investigated for the presence of GDM according to Diabetes In Pregnancy Study Group India (DIPSII) guidelines. The maternal and fetal outcomes were recorded and compared with (a) non-diabetic control group and (b) non-interventional untreated GDM group. The study reported that the overall prevalence
of GDM was found to be 6.94%. In the untreated group, family history of diabetes was 24.19%, caesarean section 22.58% and preterm delivery 16.13%, whereas the prevalence of macrosomia was 16.2% and shoulder dystocia 6.45%. These figures were found to be significantly higher when compared to the data obtained from the treated GDM group which was as follows: caesarean section 8.5%, preterm delivery 4.2%, macrosomia 10% and shoulder dystocia 1.2%. The study emphasizes the importance of screening for GDM and timely optimum intervention for a significant positive effect on both maternal as well as foetal outcomes in pregnancy.[88]

Verma AK., et al conducted a study on Gestational Diabetes in rural women of Jammu. The objective was to study the influence of the socio-economic status of the women and gestational diabetes in a rural area. A rural health block under the Government Medical College was selected randomly as a setting. Block comprised of 8 zones and 24 sub centers for health care deliverance. Out of 200 Anganwadi centers (AWCs) 9 were excluded as they catered to urban populace. Giving due representation to all the 8 zones of the block, 100 AWCs were selected randomly and all the expectant mothers in the respective AWC were registered for the study. The group was interviewed, physically examined and screened according to pre-structured and pre-tested proformas. Every woman was contacted thrice for the purpose consecutively for three days. For assessing the level of activity, subjects were categorized as sedentary, moderate workers and heavy workers according to recommendation of WHO expert committee. Urinalysis was done for sugar by URS-IG uristix strips (urine reagent strips for the semiquantitative and qualitative detection of glucose). On the first day of contact the subject was asked to remain fasting over night. Next day, subject was asked to drink 75 grams of glucose in 300 ml of water in 5-7 minutes. Capillary whole blood sugar (CWBS) was estimated after two hours of OGTT as per WHO guidelines using Accu-Chek-Glucometer. 455 women were registered in all. 11 having thyromegaly were excluded. 38 could not be contacted or did not consent for OGTT leaving 406 as study population. The mean CWBS was 103.7 ± 22.8 mg/dl (95% CI 101.01-106.30). 380 subjects were normoglycemic, while 26 had blood sugar between 140 to 200 mg/dl. For risk analysis of age, the subjects were grouped into 25 years of age. The association of age and diabetes was
found to be statistically non-significant. 61.58% of our population was matriculate or had received higher education. However, level of literacy showed no bearing on the glycemic state of the expectant mothers. Though, the main occupation of study area was agriculture, 358 (88.18%) of mothers were housewives, maximum engaged in moderate physical work. The occupation was the only variable in this study which had the significant statistical influence on the diabetic state of the mother. Maximum 76.3% (318) women had income in the lowest category but the association between various income groups and glycemic state was statistically non-significant ($P >0.05$). To conclude that there was moderate prevalence of GDM in this study.[89]

Seshiah V., et al conducted a community based study on prevalence of Gestational Diabetes Mellitus in South India (Tamil Nadu). The aim of the study was to ascertain the prevalence of GDM. They conducted a prospective screening for GDM in the urban, semi urban and rural areas. All pregnant women irrespective of gestational weeks underwent a 75g glucose challenge test in the fasting state. Diagnosis of GDM was made if the 2hr plasma glucose was $\geq 140\text{mg/dl}$ (WHO criteria). The result of the study was a total of 4151, 3960 and 3945 pregnant women were screened in urban, semi urban and rural areas, respectively. GDM was detected in 739(17.8%) women in urban, 548(13.8%) in semi urban and 392(9.9%)in rural areas. Out of 1679 GDM women, 1204(72%) were detected in first visit and the remaining 28% in subsequent visits. A significant increase ($P< 0.0001$) in the prevalence of GDM was observed with family history of diabetes, increased maternal age and BMI. A trend for increased prevalence of GDM was observed in women with less physical activity, however, not statistically significant. To conclude in this community based study, the prevalence of GDM varied in the urban, semi urban and rural areas. Age $\geq 25$ years, BMI $\geq 25$ and family history of diabetes were found to be risk factors for GDM.[90]

Clausen T D.,et al conducted a study to assess the prevalence of type 2 diabetes and pre diabetes in adult off spring of women with GDM and found that the prevalence of type 2 diabetes and pre diabetes was 7.76(95%) in women with GDM and 4.02 in women without GDM. And to conclude that a hyperglycemic intrauterine
environment appears to be involved in the pathogenesis of type 2 diabetes, pre
diabetes in adult off spring of primarily with either diet treated GDM or type 1
diabetes during pregnancy.[91]

**Hossein – Nezhad A** conducted a study to assess the prevalence of
GDM and pregnancy outcomes in Iranian women and found that there were 114
women (4.7%) who had GDM; women with GDM had a significantly higher parity
and body mass index than non diabetic women with GDM were also more likely to
have a family history of diabetes and a history of poor obstetric outcome, of the 114,
women, 27(23.6%) were younger than 25 years old, and 16(14.0%) had as
recognizable risk factor for diabetes.[92]

**Hunt K.J** examined the prevalence and trends in the prevalence of
GDM. The prevalence of GDM in a population is reflective of the prevalence of the
type 2 diabetes within that population. In low – risk populations, such as those found
in Sweden, the prevalence in population – based studies is lower than 2% even when
universal testing is offered, where as studies in high – risk populations such as the
native American cree, Northern California Asians reported prevalence rates ranging
from 4.9% to 12.8% prevalence rates for GDM obtained from hospital based studies.
Similarly single hospital based study in Australia reporting prevalence’s ranging
from 3.0% in Anglo – Celtic women to 17.0% in Indian women.[93]

**Rebarber A** conducted a study to assess the increased incidence of GDM
in women receiving prophylactic 17 alpha – hydroxyprogesterone corporate for
prevention of recurrent preterm birth, the objective was to determine the incidence of
gestational diabetes (GDM) is altered in women receiving weekly 17 alpha-
hydroxyprogesterone caproate (17P) prophylaxis for the prevention of recurrent
preterm birth. Singleton gestations having a history of preterm delivery were
identified from a database containing prospectively collected information from
women receiving outpatient nursing services related to a high-risk pregnancy.
Included were patients enrolled for outpatient management at <27 weeks' gestation
with documented pregnancy outcome and delivery at >28 weeks. Patients with pre-
existing diabetes were excluded. The incidence of GDM was compared between
patients receiving prophylactic intramuscular 17P (250mg weekly injection initiated between 16.0 and 20.9 weeks gestation) and those that did not. The results were Maternal body-mass-index and age were similar. The incidence of GDM was 12.9% in the 17P group (n=557) compared with 4.9% in controls (n=1524), p<0.001; Odds Ratio (95% CI) 2.9 (2.1, 4.1). The study concluded that the use of 17P for the prevention of recurrent preterm delivery is associated with an increased risk of developing GDM. Early GDM screening is appropriate for women receiving 17P prophylaxis. [94]

**Sumeksri P** conducted a study to assess the prevalence of GDM in pregnant women aged 30 – 34 years old who were screened by glucose challenge test (GCT) and found that there were 1332 pregnancies enrolled into the study. The 564 pregnant women were eligible for GCT with 228 positive results. 32 cases of GDM were detected with the prevalence of 5.7%. In the GDM group the percentage of the common risk factors were family DM (28.1%) glucosuria (12.5%). The prevalence rate of GDM was 5.7% The GDM class A1 were 23 cases (4.1%) and GDM class A2 were 9 cases (1.6%). [95]

**Keshavarz.M., et al** conducted a study on Gestational diabetes in Iran: incidence, risk factors and pregnancy outcomes. The objective of this study was to determine the incidence of gestational diabetes mellitus (GDM) and compare fetal, maternal and neonatal complications amongst women with GDM and pregnant women with normal glucose tolerance in an urban Iranian population. In a prospective cohort study, universal screening for gestational diabetes mellitus was performed for 1310 pregnant women who were referred from private clinics and community health care centers to Fatemiyeh Hospital in Shahrood City. Screening was performed with a 50 g oral Glucose Challenge Test (GCT) with 130 mg/dl cut-off point, then a diagnostic 100 g Oral Glucose Tolerance Test (OGTT) was done according to Carpenter and Coustan criteria. The incidence of GDM was 4.8%. There were differences in risk factors such as age >30 years, family history of diabetes, obesity, previous macrosomia, glycosuria between the two groups (P<0.001). Women with GDM had a higher rate of stillbirth (P<0.001; odds ratio 17.1, 95%
CI=4.5-65.5), hydramnios (P<0.001; odds ratio 15.5, 95% CI=4.8-50.5), gestational hypertension (P<0.001; odds ratio 6, 95% CI=2.3-15.3), macrosomia (P<0.05; odds ratio 3.2, 95% CI=1.2-8.6) and caesarean section (P<0.001). They have found that the incidence of GDM in an urban Iranian population is similar to developed countries.[96]

Kamla-Raj conducted a study on Incidence of Gestational Diabetes in General Population. A retrospective study of possible risk factors associated with Gestational Diabetes screening was undertaken on 980 mothers between the age group of 20 to and 30 years. Women who delivered their babies at the Government Maternity Hospital, Nayapul, and Nilofer Hospital, Red hills, Hyderabad were included in this study. Personal information, medical histories and socio-economic status were examined to identify factors which could increase the risk of GDM. They discovered influencing genetic factors in 2 out of 7 patients had genetic factors influencing the cause for women with GDM. All the affected women showed history of intrauterine abnormalities. Interestingly, the predominant Blood Group B in the area was associated with lower risk of GDM. This data conflicts with previous suggestions of higher incidence of Gestational Diabetes in ethnic South Asian populations. A prevalence of 0.71% of GDM in a time period of 7 days, small population size and covering single area is substantially significant.[97]

Abdul Hamid Zargar., et al conducted a study on prevalence of Gestational Diabetes Mellitus in Kashmiri women from the Indian subcontinent. This prospective study was carried out to determine the prevalence of gestational diabetes mellitus (GDM) in Kashmiri women and to assess the effect of various demographic factors. Two thousand pregnant women (divided into groups A and B, being the first and last 1000 consecutive women) attending various antenatal clinics in six districts of Kashmir valley were screened for GDM by 1 h 50 g oral glucose challenge test. Four hundred and fourteen (20.8%) women (216 from group A and 198 from group B) had an abnormal screening test and proceeded to oral glucose tolerance testing. Women from group A had a 3 h 100 gram oral glucose tolerance test (OGTT) and GDM was as classified by Carpenter and Coustan. A 2 h 75 g OGTT was performed on group B subjects and WHO criteria applied for diagnosis of GDM. The overall
prevalence of GDM was 3.8% (3.1% in group A versus 4.4% in group B—\(P\)-value 0.071). GDM prevalence steadily increased with age (from 1.7% in women below 25 years to 18% in women 35 years or older). GDM occurred more frequently in women who were residing in urban areas, had borne three or more children, had history of abortion(s) or GDM during previous pregnancies, had given birth to a macrosomic baby, or had a family history of diabetes mellitus. Women with obesity, hypertension, osmotic symptoms, proteinuria or hydramnios had a higher prevalence of GDM.[98]

**Ghattu V., et al** conducted a study on gestational diabetes and the incidence of diabetes in the 5 years following the index pregnancy in South Indian women. This study was carried out to examine the incidence of diabetes and the factors associated with this in a cohort of South Indian women 5 years after they were examined for gestational diabetes (GDM). Women (\(N = 630\)) whose GDM status was determined (Carpenter-Coustan criteria; GDM: \(N = 41\)) delivered live babies without major anomalies at the Holdsworth Memorial Hospital, Mysore. Of these, 526 women (GDM: \(N = 35\)) available for follow-up after 5 years underwent a 2-h oral glucose tolerance test and detailed anthropometry. Diabetes was determined using WHO criteria, and Metabolic Syndrome using IDF criteria recommended for south Asian women. The incidence of diabetes (37% versus 2%) and Metabolic Syndrome (60% versus 26%) was considerably higher in women with previous GDM compared to non-GDM women. GDM women who developed diabetes had lower gestational insulin area-under-the-curve (\(P = 0.05\)). They had larger waist-to-hip ratio, skinfolds, body mass index, and lower 30-min insulin increment at follow-up than other GDM women. In all, history of diabetes in first-degree relatives was independently associated with higher incidence of diabetes (\(P < 0.001\)). The findings suggest that diabetes and cardiovascular risks are high in women with previous GDM.[99]

**Xiong X., et al** conducted a study on prevalence, risk factors, maternal and infant outcomes of Gestational diabetes mellitus. The objective of was to study the prevalence, risk factors, and maternal and infant outcomes of women with
gestational diabetes mellitus (GDM). A retrospective cohort study was performed based on 111563 pregnancies delivered between 1991 through 1997 in 39 hospitals in northern and central Alberta, Canada. Multivariate logistic regression was used to estimate the odds ratios with 95% confidence intervals, and to control for confounding variables. The result shows that the prevalence of GDM was 2.5%. Risk factors for GDM included age >35 years, obesity, history of prior neonatal death, and prior cesarean section. Teenage mothers and women who drank alcohol were less likely to have GDM. Mothers with GDM were at increased risk of presenting with pre-eclampsia, premature rupture of membranes, cesarean section, and preterm delivery. Infants born to mothers with GDM were at higher risk of being macrosomic or large-for-gestational-age.[100]

Beischer NA., et al conducted a study to determine the incidence and severity of GDM according to country to birth in women living in Australia and study reports that Gestational diabetes mellitus (GDM) was diagnosed in 1928 of 35,253 (5.5%) tested pregnancies at the Mercy Maternity Hospital in Melbourne between 1979 and the end of 1988. Compared with women born in Australia and New Zealand, the incidence of GDM was significantly greater in women born on the Indian subcontinent (15%); in women born in Africa (9.4%), Vietnam (7.3%), Mediterranean countries (7.3%), and Egypt and Arabic countries (7.2%); and in Chinese (13.9%) and other Asian (10.9%) women. There was no significant difference for women born in the United Kingdom and northern Europe (5.2%), Oceania (5.7%), North America (4.0%), or South America (2.2%). With the World Health Organization criteria as a guide to the severity of hyperglycemia, compared with mothers born in Australia and New Zealand, there were significant increases in the incidences of the more severe grades of GDM in parturients born in the Mediterranean region, Asia, the Indian subcontinent, Egypt, and Arabic countries. The incidence of GDM increased significantly in all racial groups, rising from 3.3% during 1979–1983 to 7.5% during 1984–1988. [101]

Dana Dabelea,. et al performed a study on increasing prevalence of Gestational Diabetes Mellitus (GDM) over time and by birth Cohort Kaiser Permanente of Colorado GDM Screening Program. The aim of the study was to
examine temporal trends in GDM among diverse ethnic groups. Kaiser Permanente of Colorado (KPCO) has used a standard protocol to universally screen for GDM since 1994. This report was based on 36,403 KPCO singleton pregnancies occurring between 1994 and 2002 and examines trends in GDM prevalence among women with diverse ethnic backgrounds. The prevalence of GDM among KPCO members doubled from 1994 to 2002 (2.1–4.1%, \( P < 0.001 \)), with significant increases in all racial/ethnic groups. In logistic regression, year of diagnosis (odds ratio [OR] and 95% CI per 1 year = 1.12 [1.09–1.14]), mother’s age (OR per 5 years = 1.7 [1.6–1.8]) and ethnicity other than non-Hispanic white (OR = 2.1 [1.9–2.4]) were all significantly associated with GDM. Birth year remained significant (OR = 1.06, \( P = 0.006 \)), even after adjusting for prior GDM history. This study shows that the prevalence of GDM is increasing in a universally screened multiethnic population. The increasing GDM prevalence suggests that the vicious cycle of diabetes in pregnancy initially described among Pima Indians may also be occurring among other U.S. ethnic groups. [102]

Siribaddana SH., et al conducted a study on the prevalence of Gestational Diabetes in a Sri Lankan antenatal clinic. The objective of study was to ascertain the prevalence of GDM in a Sri Lankan pregnant population by using the 75 g oral glucose tolerance test (GTT) and WHO criteria. To establish the predictive value of a 50 g glucose challenge test (GCT) compared to the GTT and to compare the outcome of pregnancy in GDM with 'non-diabetic pregnancy' (NDP). The study design was Prospective study on a cohort of pregnant women attending antenatal clinics at Sri Jayawardenepura General Hospital (SJGH). The results of the 721 patients, 131 (18%) had a positive GCT. 40 (5.5%) patients had GDM. If a one-hour GCT of 7.8 mmol/l was considered suspicious of GDM the sensitivity of the glucose challenge test was 63% and the specificity 84%. Statistically significant differences in the prevalence was found when the women were > 35 years [Relative risk (RR) = 3.87 (95% CI-2.06 to 7.27)] or the body mass index > or = 25. (RR = 2.45 (95 CI-1.30 to 4.61) Presence or absence of high parity, family history of diabetes or recurrent abortions had no significant impact on the prevalence of GDM. Mean birth weight was higher (\( p < 0.05 \)) in GDM (3615 SD 103) than in NDP (2898 SD 143.6).
The likelihood of having a caesarean section was higher (p < 0.01, Relative risk (RR) 2.50, 95% CI 1.56-3.95) in GDM when compared to NDP. A higher incidence of hydramnios (p < 0.01 RR 3.41 95% CI 1.44-8.05) was recorded in GDM when compared to NDP. To conclude the prevalence of GDM in the antenatal clinics at SJGH is 5.5%. Traditional risk factors did not predict GDM. GDM is associated with a higher risk of caesarean section, hydramnios and macrosomia. Hence screening for GDM should be performed in all pregnant women at 24 to 28 weeks of pregnancy using a GCT.[103]

Ramachandran A., et al conducted a study to assess the prevalence of diabetes in Southern Indian women during pregnancy. Nine hundred and fifty women having ≥ 24 weeks of gestation, attending two general gynaecology centres for antenatal check-ups were screened. Initially, the screening test with 1-h plasma glucose sampling following 50 g glucose load was done and those with glucose values ≥ 140 mg/dl were subjected to a 3-h oral glucose tolerance test (OGTT) with 100 g glucose load. Among the 950 women, 6 were known diabetic subjects. Of the other 944, 89 were positive on screening test and 67 of them reported for OGTT. Four were detected to have gestational diabetes mellitus (GDM) (O'Sullivan and Mahan's criteria). Therefore the prevalence’s of total diabetes and GDM were 1.19% and 0.56%, respectively.[104]

2.2.2 PART II: Studies and Literature related to Maternal and fetal complications of Gestational Diabetes Mellitus

Negrato CA., et al conducted a study on adverse pregnancy outcomes in women with diabetes and they reported that Pregnancy affects both the maternal and fetal metabolism and even in non-diabetic women exerts a diabetogenic effect. Among pregnant women, 2 to 17.8% develop gestational diabetes. Pregnancy can also occur in women with preexisting diabetes that can predispose the fetus to many alterations in organogenesis, growth restriction and the mother to some diabetes-related complications like retinopathy and nephropathy or accelerate the course of these complications if they are already present. Women with gestational diabetes generally start their treatment with diet and lifestyle modification; when these
changes fail in keeping an optimal glycemic control, then insulin therapy must be considered. Women with type 2 diabetes in use of oral hypoglycemic agents are advised to change to insulin therapy. Those with preexisting type 1 diabetes must start an intensive glycemic control, preferably before conception. All these procedures are performed aiming to keep glycemic levels normal or near-normal as possible to avoid the occurrence of adverse perinatal outcomes to the mother and to the fetus. The aim of this review is to reinforce the need to improve the knowledge on reproductive health of women with diabetes during gestation and to understand what are the reasons for them failing to attend for pre-pregnancy care programs, and to understand the underlying mechanisms of adverse fetal and maternal outcomes, which in turn may lead to strategies for its prevention. [105]

Angadi Rajasab Nilofer, et al conducted a study on screening in high-risk group of gestational diabetes mellitus with its maternal and fetal outcomes. This study was done to screen the high-risk pregnancy group for GDM, to find the incidence and to correlate the incidence with the maternal and fetal outcomes. The study was done in a tertiary care hospital and teaching institute. It was a prospective cohort study. Selective screening for GDM was done in 150 pregnant women with high-risk factors. Screening was done with 50 g glucose challenge test (GCT) after 18 weeks, and if GCT was negative then the test was repeated after 28 weeks of pregnancy. The patients who were having an abnormal GCT were subjected to 100 g oral glucose tolerance test (OGTT). All GDM patients were followed up and treated with diet and/or insulin therapy till delivery to know maternal and fetal outcomes. The period of study was from April 2008 to March 2009. The Results were 7.3% of study population was OGCT positive. 6% of the study population was OGTT positive. Age >25 years, obesity, family history of DM, and past history of GDM were the risk factors significantly associated with GDM. One newborn had hypoglycemia and one had hyperbilirubinemia. The fetal and maternal outcome in GDM patients was good in this study due to early diagnosis and intervention. The study concluded that women with GDM are at an increased risk for adverse obstetric and perinatal outcome. The increased morbidity in GDM is preventable by meticulous antenatal care. [106]
Wahabi HA., et al performed a study on Pre-existing diabetes mellitus and adverse pregnancy outcomes. The objectives of this study were to determine the prevalence of PDM and to investigate the maternal and the neonatal outcomes of women with PDM. This is a retrospective cohort study for women who delivered in King Khalid University Hospital (KKUH) during the period of January 1st to the 31st of December 2008. The pregnancy outcomes of the women with PDM were compared to the outcomes of all non-diabetic women who delivered during the same study period. The study reports that a total of 3157 deliveries met the inclusion criteria. Out of the study population 116 (3.7%) women had PDM. There were 66 (57%) women with T1DM and 50 (43%) women with T2DM. Compared to non-diabetic women those with PGMD were significantly older, of higher parity, and they had more previous miscarriages. Women with PDM were more likely to be delivered by emergency cesarean section (C/S), OR 2.67, 95% confidence intervals (CI) (1.63-4.32), P < 0.001, or elective C/S, OR 6.73, 95% CI (3.99-11.31), P < 0.001. The neonates of the mothers with PDM were significantly heavier, P < 0.001; and more frequently macrosomic; or 3.97, 95% CI (2.03-7.65), P = 0.002. They more frequently have APGAR scores <7 in 5 minutes, or 2.61, 95% CI (0.89-7.05), P 0.057 and more likely to be delivered at <37 gestation weeks, or 2.24, 95% CI (1.37-3.67), P 0.003. The stillbirth rate was 2.6 times more among the women with PDM group; however the difference did not reach statistical significance, P 0.084. The study concluded that PDM is associated with increased risk for C/S delivery, macrosomia, stillbirth, preterm delivery and low APGAR scores at 5 min.[107]

Baiju R. Shah., et al conducted a study on increased risk of Cardiovascular disease in young women following Gestational Diabetes Mellitus. The objective of study was to determine whether women with Gestational Diabetes Mellitus (GDM) have an increased risk of cardiovascular disease (CVD) following pregnancy. All women aged 20–49 years with live births between April 1994 and March 1997 in Ontario, Canada, were identified. Women with GDM were matched with 10 women without GDM and were followed for CVD. The matched cohorts included 8,191 women with GDM and 81,262 women without GDM. Mean age at entry was 31 years, and median follow-up was 11.5 years. The hazard ratio for CVD
events was 1.71 (95% CI 1.08–2.69). After adjustment for subsequent type 2 diabetes, the hazard ratio was attenuated (1.13 [95% CI 0.67–1.89]). The study concluded that young women with GDM had a substantially increased risk for CVD compared with women without GDM. Much of this increased risk was attributable to subsequent development of type 2 diabetes.[108]

Chodick G., et al. done a population-based study on the risk of overt diabetes mellitus among women with gestational diabetes. The aim of the study was to determine the incidence of postpartum diabetes mellitus in the years following a diagnosis of gestational diabetes mellitus (GDM) and to determine whether the severity of GDM, represented by the magnitude of the deviation of diagnostic tests from the normal values or requirement for medications, is associated with the development of diabetes. A retrospective cohort study was performed among 185 416 pregnant women who had glucose challenge test or 3 h oral glucose tolerance test (OGTT) in a large health maintenance organization in Israel. Subsequent diagnosis of diabetes was ascertained by using an automated patient registry. A total of 11 270 subjects were diagnosed with GDM, comprising 6.07% of the cohort. During a total follow-up period of 1 049 334 person-years there were 1067 (16.9 per 1000 person-years) and 1125 (1.1 per 1000 person-years) diagnoses of postpartum diabetes among GDM and non-GDM women, respectively. The cumulative risk of incident diabetes in GDM patients with up to 10 years of follow-up was 15.7%, compared with 1% among the non-GDM population. Gestational diabetes mellitus was associated with nearly an eightfold higher risk of postpartum diabetes after adjusting for important confounders, such as socioeconomic status and body mass index. Among women with a history of GDM, the number of abnormal OGTT values and use of insulin were associated with a substantially higher risk for developing diabetes. The study concluded that three or four abnormal OGTT values and GDM requiring insulin or oral hypoglycemic medications are important predictors of postpartum diabetes risk in women with a history of GDM.[109]

Annunziata Lapolla., et al. conducted a multicenter study on Gestational diabetes mellitus in Italy. This prospective study evaluated the impact of
gestational diabetes on maternal and fetal outcome in a large cohort of women with gestational diabetes mellitus (GDM) followed up using standardized clinical criteria. Between 1999 and 2003, they collected 3465 GDM women from 31 Italian regional obstetric or diabetes centers, recording the time and mode of delivery, gestational hypertension, pre-eclampsia, eclampsia, congenital malformations, and neonatal mortality, comparing findings with the Italian general pregnant population. The rate of cesarean sections was 34.9% and macrosomia 8.7% (33.2 and 7.4%, respectively, in the general population, p = ns). The stillbirth and neonatal mortality rates were no different in GDM patients and normal pregnancies (0.34% vs. 0.30%, p = 0.176 and 0.29% vs. 0.32%, p = 0.748), but the former had twice as many newborn with congenital malformations (2.05% vs. 0.89%, p < 0.01; CI 1.64–2.62). A prognostic model for the outcome of pregnancy was built and the concurrent occurrence of several conditions was deemed as a positive outcome. Pregnancies which did not meet one or more of the above criteria were classified as “complicated”. On multivariate logistic analysis, only the week of gestation when GDM was diagnosed and pre pregnancy BMI were independent predictors of a complicated pregnancy. The study concluded that when correctly diagnosed and treated during pregnancy, women with GDM have a pregnancy outcome similar to the general pregnant population, except for a greater likelihood of congenital malformations in the newborn, probably due to unrecognized prior diabetes. Pre-pregnancy obesity plays an important part in raising the risk of adverse perinatal outcomes in GDM patients.[110]

Kumar, R., et al conducted a prospective cohort study to determine whether Gestational Diabetes Mellitus modifies the risk of early childhood atopic manifestations, including atopic dermatitis and allergen sensitization in children’s memorial hospital, Chicago. This study includes 680 children from the Boston Birth Cohort. Mother-child dyads were recruited at birth and followed prospectively to a mean age of 3.2±2.3 years with study visits aligned with the pediatric primary care schedule. The primary outcomes were physician diagnosed atopic dermatitis on standardized medical record abstraction and allergen sensitization based on Immunocap to 7 common foods and 5 common aeroallergens (sIgE≥0.10 kUA/L, Phadia). Gestational diabetes was determined by standardized medical record review.
Logistic regression analysis, stratified by term/preterm status, evaluated the association of gestational diabetes with atopic dermatitis and allergen sensitization respectively, controlling for maternal pre-pregnancy BMI, fetal growth, and pertinent covariates. Of the 680 children, 488 were term and 192 were preterm (<37 weeks gestation). Overall, 4.9% of the mothers developed gestational diabetes. Among the 680 children, 34.4% developed atopic dermatitis and 51% developed allergen sensitization. In term births, gestational diabetes was significantly associated with atopic dermatitis (OR, 95%CI=7.2, 1.5-34.5) and allergen sensitization (OR, 95%CI=5.7, 1.2-28.0). Adjusting for fetal growth had little effect. The association with sensitization was driven primarily by food sensitization (OR, 95%CI=8.3, 1.6-43.3). The above associations were not observed in preterm births. The result showed that in term births GDM increased the risk of atopic dermatitis and early childhood allergen sensitization independently of maternal pre-pregnancy body mass index and fetal growth.[111]

\textbf{Heiskanen., et al} conducted a study to evaluate the influence of Gestational Diabetes Mellitus on haemodynamics and cardiovascular autonomic regulation at rest and their responses to head –up tilt (HUT). The study is prospective study conducted in Baltimore hospital, USA and selected 79 pregnant women (51 with GDM, 28 without GDM) during the third trimester of pregnancy and after parturition. The results suggest that pregnancy modulates cardiovascular autonomic regulation and hemodynamics equally in subjects with GDM and without GDM, suggesting that metabolic disorder during pregnancy does not result in cardiovascular dysfunction when GDM is in good balance.[112]

\textbf{Lee AJ, et al} conducted a retrospective cohort study using survival analysis on Gestational diabetes mellitus: clinical predictors and long-term risk of developing type 2 diabetes. The objective of the study was to determine the long-term risk of type 2 diabetes following a pregnancy complicated by Gestational Diabetes Mellitus (GDM) and to assess what maternal antepartum, postpartum, and neonatal factors are predictive of later development of type 2 diabetes. This was a retrospective cohort study using survival analysis on 5,470 GDM patients and 783 control subjects who presented for postnatal follow-up at the Mercy Hospital for
Women between 1971 and 2003. The results were risk of developing diabetes increased with time of follow-up for both groups and was 9.6 times greater for patients with GDM. The cumulative risk of developing type 2 diabetes for the GDM patients was 25.8% at 15 years postdiagnosis. Predictive factors for the development of type 2 diabetes were use of insulin (hazard ratio 3.5), Asian origin compared with Caucasian (2.1), and 1-h blood glucose (1.3 for every 1 mmol increase above 10.1 mmol). BMI was associated with an increased risk of developing type 2 diabetes but did not meet the assumption of proportional hazards required for valid inference when using Cox proportional hazards. The study concluded that While specific predictive factors for the later development of type 2 diabetes can be identified in the index pregnancy, women with a history of GDM, as a group, are worthy of long-term follow-up to ameliorate their excess cardiovascular risk.[113]

**Julie Robitaille, Althea M Grant** conducted a study on the genetics of gestational diabetes mellitus and to assess the evidence for relationship with type 2 diabetes mellitus. The study reported that Gestational diabetes is a major public health problem because of its prevalence, its associated complications during pregnancy, and its increased risk for type 2 diabetes later in life. Insulin resistance is one of many physiological changes occurring during pregnancy, and when insulin resistance is accompanied by pancreatic beta-cell insufficiency, gestational diabetes may develop. Several lines of evidence suggest that gestational diabetes shares a common etiology with type 2 diabetes and support the hypothesis that gestational diabetes serves as a window to reveal a predisposition to type 2 diabetes. Pregnancy is an environmental stressor that may catalyze the progression to a diabetic state in genetically predisposed women; therefore, identification of these women during pregnancy could decrease the occurrence of type 2 diabetes through targeted prevention. This review presents an overview of the genetics of gestational diabetes, focusing on human association studies with candidate genes common to both type 2 diabetes and gestational diabetes.[114]

**Wright et al** conducted a cohort study in Mymensingh Medical Hospital Bangkok to examine associations of maternal glucose tolerance during
pregnancy with offspring adiposity and SBP at age 3 years among 1,238 mother-child pairs in project viva. The result showed that 4% of the mothers had GDM. 9.3% of 3-year-old children were obese and the children exposed to GDM had higher SBP (3.2 mmHg, 95% confidence interval and greater adiposity when assessed by the sum of skinfolds 95%, but not by BMI z-score 95%). The findings suggested that the children exposed to GDM have higher adiposity, which may mediate the higher SBP in these children. [115]

**Kim-Catherine, et al** conducted a retrospective study on comparison of inflammatory markers among women with a history of Gestational Diabetes Mellitus (hGDM), women with diagnosed diabetes, and unaffected women in a population-based sample. Investigator conducted cross-sectional analyses of 6,346 non-pregnant women in the third National Health and Nutrition Examination Survey (1988-1994). The result suggest that women with diagnosed diabetes have less favorable inflammation profiles than unaffected women and greater ferritin levels than women with hGDM. After adjustment, women with hGDM who have developed have inflammation profiles similar to those of unaffected women. [116]

**Courtens W., et al** conducted a study on Unilateral bowing of long bones and multiple congenital anomalies in a child born to a mother with GDM. This study was conducted in Nigerian centre at Italy among 1000 mothers and the result showed that new born baby with multiple congenital anomalies consisting of major Skeletal anomalies restricted to the cleft palate, Ventricular and atrial septal defect, short neck, dysplastic low set ears and large birth weight and provide evidence that GDM could be teratogenic. [117]

**Ingrid Ostlund** conducted a study on Maternal and Fetal Outcomes if Gestational impaired glucose tolerance is not treated. The objective was to evaluate whether there is increased maternal or neonatal morbidity in connection with impaired glucose tolerance (IGT) during pregnancy when the condition is not treated. During the study period of 1997–2001, in a defined geographical area in Sweden, the diagnostic criteria for gestational diabetes mellitus (GDM) were limited to the criteria for diabetes. Prospectively, 213 women who were identified with IGT during
pregnancy were undiagnosed and untreated. Data on maternal and fetal outcome was collected from records. For each case subject, four control subjects were taken from the same delivery department. The proportion of women who underwent cesarean section was significantly higher in the case subjects than in the control subjects and was independently associated with IGT. The adjusted odds ratio (OR) was 1.9 (95% CI 1.2–2.9). The proportion of infants who were large for gestational age (LGA), defined as birth weight >2 SDs greater than the mean for gestation and sex, was independently significantly associated with untreated IGT during pregnancy (OR 7.3, 95% CI 4.1–12.7). Admission to a neonatal intensive care unit (NICU) for 2 days or longer was more common (adjusted OR 2.0, 95% CI 1.1–3.8). 71.3% of the children in the IGT group and 87.3% of the control subjects had no neonatal complications. The study concluded that there was increased independent association between cesarean section rates, prematurity, LGA, and macrosomic infants born to mothers with untreated IGT. Most of the children were healthy, but there was still increased morbidity.[118]

Zawiejska conducted a study on Components of metabolic syndrome and their impact on fetal growth in women with gestational diabetes mellitus. It is a retrospective study and the study group included 357 women of diagnosed Gestational Diabetes Mellitus (GDM). The following parameters were studied. Maternal pregnancy, BMI, 75gm OGTT results, HbA1c, Triglycerides, Total HDL and LDL, Neonatal birth weight and the prevalence of being large for gestational age. Study analysis showed that a significant association between birth weight and HbA1c, Triglycerides, Fasting OGTT. A significant increase in birth weight and the prevalence for Large for Gestational age was 83.3% and was related to number of altered metabolic factors. The study concluded that fetal growth in a diabetic pregnancy is a complex process and maternal metabolic parameters other than glucose level should be addressed to reduce the risk of fetal complications in these groups.[119]
2.2.3 PART III: Studies and literature related to Diet, Exercise, Medication and Yoga in the Management of Gestational Diabetes Mellitus

Sheri R Colberg reported on prescribing physical activity to prevent and manage gestational diabetes. Gestational diabetes mellitus (GDM) is the most prevalent metabolic disorder during pregnancy. Women diagnosed with GDM have a substantially greater risk of developing type 2 diabetes within 5-10 years after delivery, and the risk is increased by excess body weight. Uncontrolled hyperglycemia during pregnancy is potentially harmful to both mother and fetus, resulting in a greater need for Caesarian-section deliveries, delivery of larger infants with more excess body fat, a greater risk of infant death and stillbirth, and an elevated risk of infant hypoglycemia immediately after birth. Fortunately, engaging in physical activity prior to and during pregnancy may lower the risk of developing GDM. Pregnant women should also be advised how to safely increase their physical activity during pregnancy and the postpartum period. An initial approach to becoming more physically active can simply be to encourage women to incorporate more unstructured physical activity into daily living, both before and during pregnancy. Giving women an appropriate exercise prescription can encourage them to participate in physical activity safely and effectively throughout pregnancy to prevent and/or manage GDM. Engaging in 30 min of moderate intensity physical activity on most, if not all, days of the week has been adopted as a recommendation for all pregnant women.[120]

Touch Research Institute, University of Miami Medical School, United States, Fielding Graduate University, United States conducted a review of recent research on prenatal exercise, studies from several different countries suggest that only approximately 40% of pregnant women exercise, even though about 92% are encouraged by their physicians to exercise, albeit with some 69% of the women being advised to limit their exercise. A moderate exercise regime reputedly increases infant birth weight to within the normal range, but only if exercise is decreased in late pregnancy. Lower intensity exercise such as water aerobics has decreased low back pain more than land-based physical exercise. Heart rate and blood pressure have been lower following yoga than walking, and complications like pregnancy-induced
hypertension with associated intrauterine growth retardation and prematurity have been less frequent following yoga. Potential underlying mechanisms for exercise effects are that stimulating pressure receptors during exercise increases vagal activity which, in turn, decreases cortisol, increases serotonin and decreases substance P, leading to decreased pain. Decreased cortisol is particularly important in as much as cortisol negatively affects immune function and is a significant predictor of prematurity.[121]

Chasan-Taber L conducted a study on Physical activity and dietary behaviors associated with weight gain and impaired glucose tolerance among pregnant Latinas and the study reported that pregnancy has been proposed as a critical period for the development of subsequent maternal overweight and/or obesity. Excessive gestational weight gain is, in turn, associated with maternal complications such as cesarean delivery, hypertension, preeclampsia, impaired glucose tolerance, and gestational diabetes mellitus. Although there is substantial evidence that targeting at-risk groups for type 2 diabetes prevention is effective if lifestyle changes are made, relatively little attention has been paid to the prevention of excessive gestational weight gain and impaired glucose tolerance during pregnancy. Latinos are the largest minority group in the United States, with the highest birth and immigration rates of any minority group and are disproportionately affected by overweight and obesity. However, due to cultural factors, socioeconomic factors, and language barriers, Latinos have had limited access to public health interventions that promote healthy lifestyles. Therefore, the objective of this article is to review the scientific evidence regarding the association between physical activity, dietary behaviors, and gestational weight gain and impaired glucose tolerance among Latinas. A second objective is to discuss how lifestyle interventions including weight management through diet and exercise could be successful in reducing the risk of excessive gestational weight gain and gestational diabetes mellitus. Finally, recommendations are provided for future lifestyle intervention programs in this population with a focus on translation and dissemination of research findings.[122]

Price BB., et al conducted a Prospective randomized controlled trial to assess the benefits and possible risks of aerobic exercise during pregnancy. The
sample size was sedentary antenatal (AN) and active aerobic AN mother. The duration of the study was 12 to 14 weeks to 36 weeks, 45 to 60 minutes/day, 4 days/week. The result shows that Statistically significant improvement was found in fitness and delivery outcomes in active aerobic AN mother group.[123]

**Barakat.R, cordero Y** done a study on the influence of an exercise program performed by healthy pregnant women on maternal glucose tolerance. The sample size was 83 healthy pregnant women (40 in Experimental group and 43 in Control group). The duration of Physical activity was three sessions/week throughout the pregnancy. The results depicted significant differences were found between study groups on the 50 g MGS. Values corresponding to the EG (103.8 ± 20.4 mg/dl) were better than those of the CG (126.9 ± 29.5 mg/dl), p=0.000. In addition, no differences in maternal weight gain and no cases of gestational diabetes in EG versus 3 in CG (7%) (p>0.05) were found. The study concluded that moderate Physical activity programme performed during pregnancy improves levels of maternal glucose tolerance.[124]

**Deirdre k. Tobias., et al** performed a meta-analysis on Physical Activity before and during Pregnancy and risk of Gestational Diabetes Mellitus. They aimed to systematically review and synthesize the current evidence on the relation between physical activity and the development of GDM. Medline, EMBASE, and Cochrane Reviews were searched from inception to 31 March 2010. Studies assessing the relationship between physical activity and subsequent development of GDM were included. Characteristics including study design, country, GDM diagnostic criteria, ascertainment of physical activity, and timing of exposure (pre pregnancy or early pregnancy), adjusted relative risks, CIs, and statistical methods were extracted independently by two reviewers. Their search identified seven pre pregnancy and five early pregnancy studies, including five prospective cohorts, two retrospective case-control studies, and two cross-sectional study designs. Pre pregnancy physical activity was assessed in 34,929 total participants, which included 2,813 cases of GDM, giving a pooled odds ratio (OR) of 0.45 (95%CI0.28–0.75) when the highest versus lowest categories were compared. Exercise in early pregnancy was assessed in 4,401 total participants, which included 361 cases of GDM, and was also significantly
protective (0.76 [95% CI 0.70–0.83]). The study concluded that higher levels of physical activity before pregnancy or in early pregnancy are associated with a significantly lower risk of developing GDM.[125]

Oostdam N., et al. done a systematic review and meta-analysis on Interventions for preventing gestational diabetes mellitus and the study reported that the prevalence of gestational diabetes mellitus (GDM) is increasing worldwide. GDM is associated with increased risks for mother and child during pregnancy and in later life. The aim of this article is to systematically review literature on the effectiveness of interventions to prevent GDM. Controlled trials found in PubMed, EMBASE, or CENTRAL were selected. The primary outcome was GDM, and relevant secondary outcomes were maternal fasting blood glucose and large-for-gestational age (LGA) or macrosomia. Data were combined in meta-analyses, and the quality of evidence for the effectiveness of the interventions was assessed in a GRADE approach. Results were Nineteen studies evaluating six types of interventions were included. Dietary counseling significantly reduced GDM incidence compared to standard care. None of the interventions was effective in lowering maternal fasting blood glucose. Low glycemic index (LGI) diet advice and an exercise program significantly reduced the risk of macrosomia. The quality of evidence for these outcomes was low. The results indicated that there may be some benefits of dietary counseling, an LGI diet advice, or an exercise program.[126]

Şen E, Şirin A conducted a review on role of diet and exercise on Gestational diabetes management and it was reported that Gestational Diabetes Mellitus (GDM); is defined as glucose tolerance disorder appeared first time or noticed in pregnancy. GDM is observed in 3-5% of all pregnancies. While consider with complicate gestational diabetes of 135000 pregnancies in world, this is predicted as 15000-75000 pregnancies in Turkey. It is occurred that importance of arrangement as quality and quantity of nutrition on diabetic pregnancies when considered fasting ketosis, postprandial hyperglycemia and obesity on diabetic pregnant. Exercise is a factor on continuation and protect of glucose control. It is found that exercise glucose tolerance increase, insulin requirement decrease. Nurses are professionals who have importance place on subjects definition of women who
under risk for diabetes, nutrition counseling, apply adaptation to given exercise programme of pregnant and encourage preventive strategies for progress or advance of diabetes.[127]

Morisset, A.-S., et al performed a review of studies on weight management in prevention of gestational diabetes mellitus and the study reported that entering pregnancy with overweight, obesity or gaining excessive gestational weight could increase the risk of gestational diabetes mellitus (GDM), which is associated with negative consequences for both the mother and the offspring. The objective of this article was to review scientific evidence regarding the association between obesity and GDM, and how weight management through nutritional prevention strategies could prove successful in reducing the risk for GDM. Studies published between January 1975 and January 2009 on the relationship between GDM, pre-pregnancy body mass index (BMI), gestational weight gain and nutritional prevention strategies were included in this review. Results from these reports suggest that maternal obesity assessed by pre-pregnancy BMI is associated with an increased risk of GDM. They also show an association between gestational weight gain and increased risk for GDM. Higher dietary fat and lower carbohydrate intakes during pregnancy appear to be associated with a higher risk for GDM, independent of pre-pregnancy BMI. Some studies showed that restricting energy and carbohydrates could minimize gestational weight gain. However, a firm conclusion on the most effective nutritional intervention for the control of gestational weight gain and glycaemic responses could not be reached based on available studies. In light of the studies reviewed, they concluded that weight management through nutritional prevention strategies could be successful in reducing the risk of GDM.[128]

Doran F and Brien AP done a study to explore the women’s issues on the importance of physical activity during pregnancy with GDM and explored that the women were concerned that they had not received enough information from various health agencies and agents during pregnancy. The women identified several benefits and barrier to physical activity when they pregnant and explained how they felt about physical activity when pregnant. Few women had a clear understanding of
how physical activity should be incorporated in the gestational diabetes mellitus mother’s life style period.[129]

Cuilin Zhang., et al conducted study to assess the pre gravid and gravid physical activity and sedentary behaviors in relation to the risk for GDM and its complication and documented 1428 incident GDM cases. After controlling for body mass index dietary factors and other covariates, there was a significant inverse association between vigorous activity and the risk of GDM. The multivariable relative risk (RR) comparing the highest with the lowest quantile of vigorous activity was 0.77. Among women who did not perform vigorous activity, brisk walking pace was associated with significantly lower GDM risk and its complication compared with an easy pace. Women who spent 20 hrs /week or more watching television but did not perform vigorous activity had a significantly higher GDM risk and its complications than women who spent less than 2 hrs/week watching television and were physically active. So this study provides strong evidence that regular physical activity before pregnancy is associated with lower GDM risk and regular physical activity during pregnancy with GDM maintains normal glucose level and prevents its complications.[130]

Sunsanevitayakul P et al conducted an evaluative study to assess the effectiveness of the ambulatory program for glycemic control of women with GDM. A total of 33 women with GDM whose FBS from OGTT > or = 105 mg/dl were scheduled to attend weekly ambulatory care for dietary therapy with their family. After ambulatory program, 14 of 33 cases (42.4%) achieved good glycemic control without hospitalization. Another 6 cases (18.2%) did not need insulin therapy after admission for 3 days intensive dietary therapy. Altogether, 20 out of 33 cases (60.6%) of GDM whose FBS for OGTT > or = 105 mg/dl could avoid insulin therapy after attending the ambulatory program alone or with additional 3 days intensive dietary therapy course. The study reported that ambulatory dietary therapy programme has shown to be effective in achieving good glycemic control and avoiding unnecessary insulin therapy and admission in most cases of women with GDM.[131]
Danielle Symons Downs., et al conducted a study on understanding exercise beliefs and behaviors in women with Gestational Diabetes Mellitus. The purpose of this study was to examine the exercise beliefs and behaviors of postpartum women who had gestational diabetes mellitus (GDM) during a recent pregnancy. Postpartum women with GDM (n = 28) completed a mail survey assessing their self-reported exercise beliefs (advantages, barriers, and important social influences) and behaviors. It was found from the study that 1) the strongest perceived advantage of exercise during pregnancy was controlling blood glucose and postpartum it was controlling weight, 2) the most common barrier to exercise during pregnancy was fatigue and postpartum it was a lack of time, 3) women’s husband/partner most strongly influenced their exercise during pregnancy and postpartum, 4) women exercised more during the postpartum period than before or during pregnancy, and 5) the number of exercise advantages was positively associated with women’s pregnancy and postpartum exercise behavior. The conclusions drawn from the study were to increase exercise behavior and to reduce the risk of type 2 diabetes in women with GDM, researchers and health care professionals are encouraged to use women’s exercise beliefs, that is, advantages, social influences, and perceived barriers to exercise, as a framework for designing effective diabetes treatment and prevention programs.[132]

Schaefer – Graf M performed a study to assess the modified therapy for GDM using high risk and low – risk fetal abdominal circumference growth to select strict versus relaxed maternal glycemic targets. The traditional treatment goal for (GDM) has been to achieve ‘normal’ range value, for maternal glucose by diet and or insulin therapy adapting a strategy successful in treating pre gestational diabetes during pregnancy. Intensive insulin therapy to achieve strict euglycemia in GDM pregnancies had improved perinatal morbidity; however it has not eliminated the excess rate of macrosomia compared with the reference populations. The obesity risk in early childhood in offspring boon to mothers with GDM has been correlated with the birth weight and parental obesity, and those children who were large for gestational age (LGA) at birth had obesity rates close to 40% compared with 25% in those born with normal weight. Third trimester fetal abdominal circumference (AC)
and measurements less than the 90th percentile for gestational age have been associated with a birth macrosomia risk <5% in term diet controlled GDM pregnancy. AC growth at 18–20 weeks in pregestational diabetic pregnancies also predicts subsequent relative macrosomia at birth, suggesting that significant hyperglycemia earlier in gestation may produce fetal overgrowth. These studies suggest that fetal AC growth or single observations relative AC dimensions in mid pregnancy may be used to modify pregnancy intervention and provide a simple assessment of the effect of maternal diabetes on the fetus.[133]

Dempsey JC., et al conducted a case-control study of maternal recreational physical activity and risk of gestational diabetes mellitus. This study explored the relation between recreational physical activity performed during the year before and during the first 20 weeks of pregnancy and the risk of GDM. 155 GDM cases and 386 normotensive, non-diabetic pregnant controls provided information about the type, intensity, frequency, and duration of physical activity performed during these time periods. Women who participated in any recreational physical activity during the first 20 weeks of pregnancy, as compared with inactive women, experienced a 48% reduction in risk of GDM (odds ratio [OR] = 0.52; 95% confidence interval [CI] 0.33-0.80). The number of hours spent performing recreational activities and the energy expended were related to a decrease in GDM risk. No clear patterns related to distance walked and pace of walking emerged. Daily stair climbing, when compared with no stair climbing, was associated with a 49-78% reduction in GDM risk (P for trend <0.011). Recreational physical activity performed during the year before the index pregnancy was also associated with statistically significant reductions in GDM risk, but women who engaged in physical activity during both time periods experienced the greatest reduction in risk (OR = 0.40; 95% CI 0.23-0.68). These data suggest that recreational physical activity performed before and/or during pregnancy is associated with a reduced risk of GDM.[134]
2.2.4 PART IV: Studies and literature related to effect of yoga on Diabetes Mellitus and Gestational Diabetes Mellitus

Alexander G., et al done a study on Patterns of yoga practice and physical activity following a yoga intervention for adults with or at risk for type 2 diabetes. The study described patterns of yoga practice and examined differences in physical activity over time between individuals with or at risk for type 2 diabetes who completed an 8-week yoga intervention compared with controls. A longitudinal comparative design measured the effect of a yoga intervention on yoga practice and physical activity, using data at baseline and postintervention months 3, 6, and 15. The results were disparate patterns of yoga practice occurred between intervention and control participants over time, but the subjective definition of yoga practice limits interpretation. Multilevel model estimates indicated that treatment group did not have a significant influence in the rate of change in physical activity over the study period. While age and education were not significant individual predictors, the inclusion of these variables in the model did improve fit. Findings indicated that an 8-week yoga intervention had little effect on physical activity over time.[135]

Badr Aljasir Maggie Bryson., et al performed a systematic review on Yoga practice for the management of Type II Diabetes Mellitus in adults and the study reported that the effect of practicing yoga for the management of type II Diabetes was assessed in this systematic review through searching related electronic databases and the grey literature to the end of May 2007 using Ovid. All randomized controlled clinical trials (RCTs) comparing yoga practice with other type of intervention or with regular practice or both, were included regardless of language or type of publication. Each study was assessed for quality by two independent reviewers. Mean difference was used for summarizing the effect of each study outcomes with 95% confidence intervals. Pooling of the studies did not take place due to the wide clinical variation between the studies. Publication bias was assessed by statistical methods. Five trials with 363 participants met the inclusion criteria with medium to high risk of bias and different intervention characteristics. The studies’ results show improvement in outcomes among patients with diabetes type II. These improvements were mainly among short term or immediate diabetes outcomes and
not all were statistically significant. The results were inconclusive and not significant for the long-term outcomes. No adverse effects were reported in any of the included studies. Short-term benefits for patients with diabetes may be achieved from practicing yoga.[136]

Kyizom T., et al conducted a study on effect of pranayama & yoga-asana on cognitive brain functions in type 2 diabetes-P3 event related evoked potential (ERP). The aim of the study was to assess the electrophysiological evidence of delayed cognition which is measured by P300, an evoked potential is observed in Diabetes mellitus. P300(or P3) is a component of endogenous cerebral evoked response that assesses higher functions of the brain. This study aims to see the role of pranayama and yoga-asana on P300 latency and amplitude in type 2 diabetic patients. Sixty patients of type 2 diabetes were recruited from diabetic clinic and divided into two groups - control group on only conventional medical therapy and yoga-group on conventional medical therapy along with pranayama and yoga-asana. Basal recordings of P300 and blood glucose were taken at the time of recruitment and second recordings repeated after forty five days for both the groups. P300 was recorded on Nihon Kohden Neuropack mu MEB 9100 using auditory "odd-ball paradigm". The data were analyzed using repeated measures analysis of variance (ANOVA) followed by Tukey's test at 5 per cent level of significance. Statistically significant improvement in the latency and the amplitude of N200, P300 was observed in the yoga group as compared to the control group. These data suggest that yoga has a beneficial effect on P300 and thus can be incorporated along with the conventional medical therapy for improving cognitive brain functions in diabetes.[137]

Amita S., et al conducted a study on Effect of yoga-nidra on blood glucose level in diabetic patients. An objective of this study was to evaluate the effect of Yoga-Nidra on blood glucose level in diabetic patients. This study was conducted on 41, middle aged, type-2 diabetic patients, who were on oral hypoglycaemic. These patients were divided in to two groups: (a) 20 patients on oral hypoglycaemic with yoga-nidra, and (b) 21 were on oral hypoglycaemic alone. Yoga-nidra practiced for 30 minutes daily up to 90 days, parameters were recorded
every 30th day. Results of this study showed that most of the symptoms were subsided (P < 0.004, significant), and fall of mean blood glucose level was significant after 3-month of Yoga-nidra. This fall was 21.3mg/dl, P < 0.0007, (from 159 +/- 12.27 to 137.7 +/- 23.15,) in fasting and 17.95 mg/dl, P = 0.02, (from 255.45 +/- 16.85 to 237.5 +/- 30.54) in post prandial glucose level. Results of this study suggest that subjects on Yoga-nidra with drug regimen had better control in their fluctuating blood glucose and symptoms associated with diabetes, compared to those were on oral hypoglycaemics alone.[138]

Kosuri M, Sridhar GR conducted a study on yoga practice in diabetes improves physical and psychological outcomes. The aim of the study was to examine the effect of yoga practice on clinical and psychological outcomes in subjects with type 2 diabetes mellitus. In a 40 day Yoga camp at the Institute of Yoga and consciousness, ambulatory subjects with Type 2 DM not having significant complications (n=35) participated. Clinical, biochemical and psychological wellbeing were studied at baseline and at the end of the camp. The results were, there was a reduction in body mass index(BMI) (26.514±3.355 to25.771±3.40;p<0.001) and anxiety (6.20± 3.72 to 4.29 ± 4.46;p<0.05) and an improvement in total general wellbeing (48.6±11.13 to52.66± 12.87;p<0.05).The study concluded that yoga practice for 40 days reduced BMI, improved wellbeing and reduced anxiety.[139]

Hemant H Mahapure., et al done a study on effect of yogic exercise on super oxide dismutase levels in diabetics and the study reported that reactive oxygen species are known to aggravate disease progression. To counteract their harmful effects, the body produces various antioxidant enzymes, viz , superoxide dismutase, glutathione reductase etc. Literature reviews revealed that exercises help to enhance antioxidant enzyme systems; hence, yogic exercises may be useful to combat various diseases. This study aims to record the efficacy of yoga on superoxide dismutase, glycosylated hemoglobin (Hb) and fasting blood glucose levels in diabetics. Forty diabetics aged 40-55 years were assigned to experimental (30) and control (10) groups. The experimental subjects underwent a Yoga program comprising of various Asanas (isometric type exercises) and Pranayamas (breathing exercises) along with regular anti-diabetic therapy whereas the control group received anti-diabetic therapy
only. Heparinized blood samples were used to determine erythrocyte superoxide dismutase (SOD) activity and glycosylated Hb levels and fasting blood specimens collected in fluoride Vacutainers were used for assessing blood glucose. Data were analyzed by using 2 x 2 x 3 Factorial ANOVA followed by Scheffe's posthoc test. The results revealed that Yogic exercise enhanced the levels of Superoxide dismutase and reduced glycosylated Hb and glucose levels in the experimental group as compared to the control group. The findings concluded that Yogic exercises have enhanced the antioxidant defense mechanism in diabetics by reducing oxidative stress.[140]

Singh S., et al conducted a study on influence of pranayamas and yoga-asanas on serum insulin, blood glucose and lipid profile in type 2 diabetes. A distinguishable feature of type 2 diabetes besides hyperglycemia and deranged lipid profile is an impaired insulin secretion, peripheral insulin resistance and obesity which has become a major health concern worldwide. India with an estimated 31million diabetics in 2000 and 79millions by the yr 2030 has the highest number of type 2 diabetics in the world. In this study, they aimed to see if yoga-asanas and pranayamas have any influence in modifying certain biochemical parameters. Sixty patients of uncomplicated type 2 diabetes (age 35-60 yrs of 1-10 yrs duration) were divided into two groups: Group 1 (n=30): performed yoga along with the conventional hypoglycemic medicines and group 2 (n=30): patients who only received conventional medicines. Duration of the study was 45 days. Basal recordings of blood glucose (fasting and post-prandial), lipid profile and serum insulin were taken at the time of recruitment and the second reading after forty five days. Results showed a significant improvement in all the biochemical parameters in group 1 while group 2 showed significant improvement in only few parameters, thus suggesting a beneficial effect of yoga regimen on these parameters in diabetic patients.[141]

Sahay B K conducted a study on role of yoga in Diabetes. The purpose of this study was to asses the effect of yoga on diabetes. A multitude of short and long-term studies were conducted. Participants in these studies were diagnosed with diabetes, either Type 1 or Type 2, and were compared with a control group of those
without diabetes. Anyone with complications such as retinopathy and nephropathy were excluded from the studies. Participants partook in varying types of yoga and were given advice on their diet. Baseline investigations were made after 10 days to exclude effect of dietary therapy. Health was tracked either at 1 month, 6 months or throughout a 7 year long-term study. Measurements of glucose levels, body composition (taken by skinfold measurements), exercise tolerance (determined by oxygen consumption and duration of exercise), blood pressure, and cholesterol were taken before and after yoga treatment. Yoga was not performed on the days of testing. There was a significant drop in the blood glucose levels for participants. At the end of 6 months, the participants had a significant decrease in body fat and increase in lean body mass. Participants over 66 years old achieved good glycemic control which they maintained for 7 years. After 90 days of practicing yoga, those with diabetes were able to reduce their systolic blood pressure from an average of 144 to 130.70, and diastolic from 95.70 to 86.90. Those without diabetes had a significant drop in blood pressure as well. There was a significant decrease in LDL and an increase in HDL cholesterol. Throughout the studies, participants were able to increase the duration and intensity of their yoga exercise, with improvement showing in just 2 months. Many were also able to reduce their medication intake. Based on the results of the multiple studies, yoga has a positive impact on controlling diabetes. The benefits of yoga can reduce the onset of Type 2 diabetes by reducing free fatty acids and insulin resistance.[142]

Malhotra V., et al conducted a study on beneficial effect of yoga in diabetes. Twenty NIDDM subjects (mild to moderate diabetics) in the age group of 30-60 years were selected from the out-patient clinic of G.T.B. hospital. They were on a 40 days yoga asana regime under the supervision of a yoga expert. 13 specific Yoga asanas < or = done by Type 2 Diabetes Patients included. Surya Namaskar, Trikonasana, Tadasana, Sukhasana, Padmasana, Bhasrika Pranayama, Pashimottanasana, Ardhmatsyendrasana, Pawanmuktasana, Bhujangasana, Vajrasana, Dhanurasana and Shavasana are beneficial for diabetes mellitus. Serum insulin, plasma fasting and one hour postprandial blood glucose levels and anthropometric parameters were measured before and after yoga asanas. The results
indicate that there was significant decrease in fasting glucose levels from basal 208.3 +/− 20.0 to 171.7 +/− 19.5 mg/dl and one hour postprandial blood glucose levels decreased from 295.3 +/− 22.0 to 269.7 +/− 19.9 mg/dl. The exact mechanism as to how these postures and controlled breathing interact with somatoendocrine mechanism affecting insulin kinetics was worked out. A significant decrease in waist-hip ratio and changes in insulin levels were also observed, suggesting a positive effect of yoga asanas on glucose utilisation and fat redistribution in NIDDM. Yoga asanas may be used as an adjunct with diet and drugs in the management of Type 2 diabetes.\[143\]

Singh S., et al conducted a study on role of yoga in modifying certain cardiovascular functions in type 2 diabetic patients. The objective of the study was to assess the effect of forty days of Yogic exercises on cardiac functions in Type 2 Diabetics. To study the effect of forty days of Yogic exercises on blood glucose level, glycosylated hemoglobin the study done in twenty-four Type 2 DM cases provides metabolic and clinical evidence of improvement in glycaemic control and autonomic functions. These middle-aged subjects were type II diabetics on anti hyperglycaemic and dietary regimen. Their baseline fasting and postprandial blood glucose and glycosylated Hb were monitored along with autonomic function studies. The expert gave these patients training in yoga asanas and they pursued those 30-40 min/day for 40 days under guidance. These asanas consisted of 13 well known postures, done in a sequence. After 40 days of yoga asanas regimen, the parameters were repeated. The results indicate that there was significant decrease in fasting blood glucose levels from basal 190.08 +/− 18.54 in mg/dl to 141.5 +/− 16.3 in mg/dl after yoga regimen. The post prandial blood glucose levels decreased from 276.54 +/− 20.62 in mg/dl to 201.75 +/− 21.24 in mg/dl, glycosylated hemoglobin showed a decrease from 9.03 +/− 0.29% to 7.83 +/− 0.53% after yoga regimen. The pulse rate, systolic and diastolic blood pressure decreased significantly (from 86.45 +/− 2.0 to 77.65 +/− 2.5 pulse/min, from 142.0 +/− 3.9 to 126.0 +/− 3.2 mm of Hg and from 86.7 +/− 2.5 mm of Hg to 75.5 +/− 2.1 mm of Hg after yoga regimen respectively). Corrected QT interval (QTc) decreased from 0.42 +/− 0.0 to 0.40 +/− 0.0. These
findings suggest that better glycaemic control and stable autonomic functions can be obtained in Type 2 DM cases with yoga asanas and pranayama,[144]

Khalsa S B S conducted a bibliometric analysis of published research studies on Yoga as a therapeutic intervention and the study reported that although yoga is historically a spiritual discipline, it has also been used clinically as a therapeutic intervention. A bibliometric analysis on the biomedical journal literature involving research on the clinical application of yoga has revealed an increase in publication frequency over the past 3 decades with a substantial and growing use of randomized controlled trials. Types of medical conditions have included psychopathological (e.g. depression, anxiety), cardiovascular (e.g. hypertension, heart disease), respiratory (e.g. asthma), diabetes and a variety of others. A majority of this research has been conducted by Indian investigators and published in Indian journals, particularly yoga specialty journals, although recent trends indicate increasing contributions from investigators in the U.S. and England. Yoga therapy is a relatively novel and emerging clinical discipline within the broad category of mind-body medicine, whose growth is consistent with the burgeoning popularity of yoga in the West and the increasing worldwide use of alternative medicine.[145]

2.2.5 PART V: Studies and literature related to effect of yoga on Gestational Diabetes Mellitus

Rakhshani A., et al conducted a randomized controlled trial on the effects of yoga in prevention of pregnancy complications in high-risk pregnancies. This randomized controlled trial investigated the effects of yoga in prevention of pregnancy complications in high-risk pregnancies for the first time. 68 high-risk pregnant women were recruited from two maternity hospitals in Bengaluru, India and were randomized into yoga and control groups. The yoga group (n = 30) received standard care plus one-hour yoga sessions, three times a week, from the 12th to the 28th week of gestation. The control group (n = 38) received standard care plus conventional antenatal exercises (walking) during the same period. The results were significantly fewer pregnancy induced hypertension (PIH), preeclampsia, gestational diabetes (GDM) and intrauterine growth restriction (IUGR) cases were observed in
the yoga group (p = 0.018, 0.042, 0.049, 0.05 respectively). Significantly fewer
Small for Gestational Age (SGA) babies and newborns with low APGAR scores (p = 0.006) were born in the yoga group (p = 0.033). This first randomized study of yoga in high-risk pregnancy has shown that yoga can potentially be an effective therapy in reducing hypertensive related complications of pregnancy and improving fetal outcomes.[146]

Gibson K S., et al conducted a study on Maternal weight gain in women who develop gestational diabetes mellitus. The objective was to assess maternal weight gain before 24 weeks in women developing gestational diabetes mellitus (GDM) compared with controls with normal glucose tolerance. This was a retrospective cohort study of maternal weight gain. Women developing GDM were matched to three controls by self-reported pre pregnancy body mass index (BMI), maternal age, race, and parity. Women without documented pregravid or 22- to 24-week weights and multiple gestations were excluded. The primary outcome was weight gain through 24 weeks of gestation. The results were six hundred fifty-two women (163 in the GDM group and 489 controls) underwent chart review. There were no significant differences in race (36% compared with 36% African American, P=.99), age (28.7±6.3 years compared with 29.4±6.9 years, P=.26) or pre pregnancy BMI (31.7±8.2 compared with 31.8±8.6, P=.88). Maternal weight gain was higher in the GDM group than in the control group (14.8 compared with 11.2 lb, P<.001). When controlling for pre pregnancy BMI, overweight (18.6 compared with 12.9 lb, P<.004), and obese (12.6 compared with 8.8 lb, P<.008), GDM participants gained significantly more weight by 24 weeks. Both diet-controlled (A1) and insulin-requiring (A2) GDM had higher weight gain compared with controls (control compared with A1: 11.2 compared with 15.3 lb, P=.029; control compared with A2: 11.2 compared with 14.6 lb, P=.018. No difference was found between A1 and A2 patients (P=.942). The study concluded that Women who develop GDM have higher gestational weight gain through 24 weeks. Gestational weight gain is a significant risk factor for GDM in the overweight or obese patient but not in patients who were underweight or had a normal BMI before pregnancy.[147]
Beddoe A E, Lee KA, Weiss SJ had done a study to measure the effects of mindfulness based yoga intervention on sleep in pregnant women. The sample size was 15 primi mothers. The duration of the intervention was 7 weeks mindfulness meditation and prenatal hatha yoga classes. The study concluded that Yoga diminishes the total number of awakenings at night and improves sleep efficiency.[148]

Narendran S performed a study to assess the efficacy of yoga on pregnancy outcome. The objective of the study was to assess the efficacy of yoga on pregnancy outcomes. Three hundred thirty five (335) women attending the antenatal clinic at Gunasheela Surgical and Maternity Hospital in Bangalore, India, were enrolled between 18 and 20 weeks of pregnancy in a prospective, matched, observational study; 169 women in the yoga group and 166 women in the control group. Women were matched for age, parity, body weight, and Doppler velocimetry scores of umbilical and uterine arteries. Yoga practices, including physical postures, breathing, and meditation were practiced by the yoga group one hour daily, from the date of entry into the study until delivery. The control group walked 30 minutes twice a day (standard obstetric advice) during the study period. Compliance in both groups was ensured by frequent telephone calls and strict maintenance of an activity diary. Birth weight and gestational age at delivery were primary outcomes. The number of babies with birth weight $\geq 2500$ grams was significantly higher ($p < 0.01$) in the yoga group. Preterm labor was significantly lower ($p < 0.0006$) in the yoga group. Complications such as isolated intrauterine growth restriction (IUGR) ($p < 0.003$) and pregnancy-induced hypertension (PIH) with associated IUGR ($p < 0.025$) were also significantly lower in the yoga group. There were no significant adverse effects noted in the yoga group. The study concluded that an integrated approach to yoga during pregnancy is safe. It improves birth weight, decreases preterm labor, and decreases IUGR either in isolation or associated with PIH, with no increased complications.[149]

Gaffney L, Smith CA conducted a study on use of complementary therapies in pregnancy: the perceptions of obstetricians and midwives in South Australia. The objective was to examine South Australian obstetricians and midwives
attitudes towards the use of complementary and alternative medicines (CAM) during pregnancy, to examine their referral patterns and their views on the usefulness and safety of these therapies during pregnancy. All members of the South Australian branch of the Royal Australian and New Zealand College of Obstetricians and Gynecologists and a 50% sample of midwives belonging to the South Australian Branch of The Australian College of Midwives were sent a postal self-completion questionnaire. A response rate of 78% was obtained. Only 14% of doctors considered CAM were a threat to public health. Over 90% of midwives and obstetricians thought they should have some knowledge about CAM. A greater proportion of obstetricians (72%) held a view there needs to be an evidence base for CAM compared with 26% of midwives. The majority of obstetricians (68%) and midwives (78%) had formally referred a patient for use of one of the complementary therapies. Over 70% of obstetricians and midwives considered massage, acupuncture, vitamins, yoga, meditation and hypnosis to be useful and safe to use during pregnancy. The study concluded that the majority of clinician's held positive views towards CAM and considered some complementary therapies to be useful and safe for use during pregnancy. [150]
2.3 SECTION III : Conceptual framework based on Ernestine weidenbach’s Helping art of Clinical nursing theory (1964) model

A Conceptual framework is a basic structure that consists of certain abstract blocks which represent the Observational, the experiential and the analytical aspects of a process or system being conceived. The interconnection of these blocks completes the framework for certain outcomes[151]. The Framework provides the Perspective from which the investigator views the problem.

The study is based on the concept that Continuous and Intensive practice of Yoga (Sukshma vyayamas, Pranayama and Dhyanam) by the Mothers with Gestational Diabetes Mellitus are able to control and maintain the Clinical Parameters of Gestational Diabetes Mellitus. The investigator adopted the weidenbach’s helping art of Clinical nursing theory (1964) as a base for developing the Conceptual framework [152]. Ernestine Weidenbach proposes helping art of Clinical Nursing theory in 1964 for Nursing, which describes a desired situation and way to attain it. It directs action towards the explicit goal. This theory has 3 factors.

1. Central Purpose
2. Prescription
3. Realities

1. Central purpose – It refers to what the nurse wants to accomplish. It is the overall goal towards which a nurse strives; it transcends the immediate intent of the assignment or task by specifically directing activities toward the patient’s good. In this study the central purpose is to control and maintain the clinical parameters of Gestational Diabetes Mellitus through Yoga among Mothers with Gestational Diabetes Mellitus.

2. Prescriptions – It refers to plan of care for a patient. It specifies both the nature of action that will most likely lead to fulfillment of the nurse’s central purpose and the thinking process that determines it. A prescription may indicate the broad general actions appropriate to implement the basic concepts as well as suggest the kind of behavior needed to carry out these actions in accordance with the central purpose.
The nature of action in this study is yoga (Sukshma vyayama, Pranayama and Meditation) to be practiced daily by the antenatal mother with Gestational Diabetes Mellitus for 30-40 minutes from 24\textsuperscript{th} week to till delivery (Total 16 weeks for study group) which includes a weekly once group session as a reassessment and reinforcement.

3. **Realities** – It refers to the Physical, Physiological, emotional and Spiritual factors that come into play in situation involving nursing action. The five realities identified by Weidenbach’s are Agent, Recipient, Goal, Means and Activities and Frame work.

The Conceptualization of nursing practice according to this theory consists of 3 steps as follows:

Step I : Identifying the Need for help.

Step II : Ministering the Needed help.

Step III: Validating that the need for help was met.

**Step I : Identifying the Need for help**

This Step involves determining the need for help. Selection of the Antenatal Mother with Gestational Diabetes Mellitus for the study based on the Inclusion, exclusion criteria. Matching of the samples done based on the level of Gestational diabetes Mellitus. Non probability purposive sampling technique is used and Control group assessment is completed prior to the study group. Pre assessment level of clinical parameters (Fasting and Post Prandial Blood sugar, Urine Sugar, and weight gain) and Demographic and Obstetrical variables are assessed for both the groups at 24\textsuperscript{th} week.

**Step II : Ministering the Needed help**

After the pre assessment of clinical parameters in Study group and Control group, teaching about Yogic position (Sukshma Vyayamas) & demonstration of steps for Study group by the investigator who is a Certified yoga teacher (5 groups - each group 22 in number) for 6 days continuously (30-40 mints/ day) thereafter weekly once group session from 25\textsuperscript{th} week to till delivery is planned with the routine
hospital treatment for study group whereas the control group received only hospital routine treatment with counseling on diet and exercise.

**Agent** : Investigator  
**Recipient** : Antenatal Mother with Gestational Diabetes mellitus  
**Goal** : To Control and Maintain the Clinical Parameters of Gestational Diabetes Mellitus  
**Means** : Yoga (Sukshma Vyayamas, Pranayamam and Dhyanam)  
**Framework** : Government General Hospital, Tambaram

**Step III : Validating that the need for help was met**

It is accomplished by Means of Post assessment level of clinical parameters (Fasting and Post Prandial Blood sugar, Urine Sugar, and weight gain) which is assessed at 28th, 32nd and 36th week and maternal, fetal and neonatal outcome are assessed after delivery for both the groups.

**CHAPTER SUMMARY**

**Chapter-2** dealt the Section I and II which presented the overviews of literature that support the study, Section III presented the Conceptual framework.

**Chapter-3:** Is devoted to the methodology which includes aspects like Research approach, Research design, Variables in the study, Setting, Population, Sample, Sample size and its calculation, Sampling technique, Criteria for sample selection, Development and description of the tool and its scoring procedure, Description of intervention, Intervention fidelity, Pilot study, Validity of the tool, Reliability, Ethical consideration, Data collection procedure, Drop outs and its analysis and Plan for data analysis.
CENTRAL PURPOSE- To Control and Maintain the Clinical parameters of Gestational Diabetes Mellitus through Yoga among Mothers with Gestational Diabetes Mellitus

IDENTIFYING NEED FOR HELP

ASSESSMENT OF
1. DEMOGRAPHIC VARIABLES
2. OBSTETRICAL VARIABLES
   A. PAST OBSTETRICAL VARIABLES
   B. PRESENT OBSTETRICAL VARIABLES

AGENT
NURSE INVESTIGATOR

RECIPIENT
ANTENATAL MOTHERS WITH GESTATIONAL DIABETES MELLITUS
FULFILLING INCLUSION CRITERIA

FRAMEWORK
GOVERNMENT GENERAL HOSPITAL, TAMBARAM

MEANS
STUDY GROUP
ROUTINE HOSPITAL MEASURES WITH YOGA:
(30-40 minutes from 24 weeks to till delivery)
1. SUKSHMA VYAYAMAS (20-25mts)
2. NADI SHODANA PRANAYAMA (5-10mts)
3. DHYANAM (5 mts)

CONTROL GROUP
1. ROUTINE HOSPITAL MEASURES

ASSESSMENT OF LEVEL OF CLINICAL PARAMETERS BEFORE YOGA (24th week)
1. FASTING, POSTPRANDIAL BLOOD GLUCOSE,
2. FASTING, POSTPRANDIAL URINE SUGAR
3. WEIGHT

CONTROL GROUP

ASSESSMENT OF LEVEL OF CLINICAL PARAMETERS AFTER YOGA (28, 32, 36th week)
1. SUKSHMA VYAYAMAS
2. NADI SHODANA PRANAYAMA
3. DHYANAM

REINFORCEMENT
1. REDUCTION IN THE FASTING, POST PRANDIAL BLOOD GLUCOSE & URINE SUGAR LEVEL
2. NORMAL WEIGHT GAIN
3. FAVOURABLE MATERNAL FETAL & NEONATAL OUTCOME

REASSESSMENT
1. NO REDUCTION IN THE FASTING, POST PRANDIAL BLOOD GLUCOSE & URINE SUGAR LEVEL.
2. ABNORMAL WEIGHT GAIN
3. UNFAVOURABLE MATERNAL FETAL & NEONATAL OUTCOME

CONCEPTUAL FRAMEWORK BASED ON ERNESTINE WIEDENBACH’S HELPING ART OF CLINICAL NURSING THEORY (1964)