Antioxidant vitamins, with the ability to stabilize highly reactive free radicals, act as the first line of defense against free radical attack and lipid peroxidation. Vitamins E (α-tocopherol) and C, have differences in the contribution they make to antioxidant potential, as vitamin E is the major lipid soluble chain-breaking antioxidant in cell-membranes while vitamin C is an important aqueous phase antioxidant. Antioxidants may act synergistically, for instance, when vitamin C regenerates α-tocopherol from the tocopherol radical, this 'sacrificial' antioxidant acts more by sparing vitamin E than by recycling. The important role of vitamin C in gestational diabetes, suggests that changes in its concentration may influence susceptibility of vascular endothelium to oxygen toxicity. Thus, study on vitamin C concentration may provide a means of assessing the total capacity of the chain-breaking antioxidants to prevent lipid peroxidation in plasma and it might be important to evaluate the effectiveness of potential antioxidant defense systems in limiting scale. This study, further, provides evidence for the relationship between plasma vitamin C levels during the pregnancy and gestational diabetes (Suhail *et al* 2010).

The group eating the unhealthy "Western" diet with no added antioxidants had significantly higher rates of inflammation and oxidative stress than the other groups, and their offspring were larger and had higher rates of glucose intolerance. The Western diet group that consumed added antioxidants, however, produced offspring with markedly lower rates of glucose intolerance and no obesity (Huff 2011).

Normal human pregnancy is considered a state of enhanced oxidative stress. In pregnancy, it plays important roles in embryo development, implantation, placental development and function, fetal development, and labor. However, pathologic pregnancies, including gestational diabetes mellitus, are associated with a heightened level of oxidative stress, owing to both overproduction of free radicals and/or a defect in the antioxidant defenses. This has important implications on the mother, placental function, and fetal well-being. Increased antioxidant intake can reduce the complications of gestational diabetes mellitus in both mother and fetus. This review provides an overview and updated data on current understanding of the complications associated with oxidative changes in gestational diabetes mellitus (Lappas *et al* 2011).

Oxidative stress occurs in gestational diabetes and antioxidant defense mechanisms are inadequate. Serum levels of advanced oxidation protein products and malonyldialdehyde are higher in gestational diabetes mellitus patients when compared to healthy individuals, and may be useful markers in gestational diabetes mellitus. Various antioxidants have been developed for oxidative stress treatment in diabetes mellitus, including the use of vitamins and supplements as well as the use of some components of plants and fresh fruits which have demonstrated antioxidant effect in diabetes mellitus patients. In some recent studies, some drugs routinely used in the treatment of diabetes mellitus also demonstrated antioxidant effects. (Maitra *et al* 2012, Zatalia and Sanusi 2013).

## 3. Role of Physical Exercise

Physical activity has long been known for its role in improving glucose homeostasis through its direct or indirect impact on insulin sensitivity via several mechanisms. For instance, physical activity has independent effects on glucose disposal by increasing both insulin-mediated and non–insulin-mediated glucose disposal. Physical activity can also exert long-term effects on improvement in insulin sensitivity through increased fat-free mass. Furthermore, the benefits of preventing or delaying the onset of type 2 diabetes among non-pregnant individuals have been reported repeatedly. Therefore, physical activity may have the potential for preventing GDM and related adverse health outcomes. Along with nutrition therapy and insulin therapy it is also necessary to get regular physical exercise. Regular physical activity helps lower blood sugar by moving the glucose into the cells and also by increasing sensitivity to insulin. Aim for moderately vigorous exercise on most days of the week, but first consult with the doctor (Tobias *et al* 2011, Majumdar 2013).

Exercise training results in sustained insulin sensitivity and improves glucose clearance. Because these functions are altered in gestational diabetes, exercise should be considered not only optional, but preferable, because it obviates insulin therapy. During exercise, plasma concentrations of glucose counter regulatory hormones play an important role in maintaining glucose homeostasis. These hormones include norepinephrine, epinephrine, cortisol, glucagon, and growth hormone. Women who exercised weekly for >30 min at some time during pregnancy had a lower risk of gestational diabetes mellitus, although this result was shown for only morbidly obese women. In addition, data that were nationally representative of women with live births indicated that those who began physical activity during pregnancy had less risk of development of gestational diabetes mellitus than did those who were inactive during pregnancy. In the same study, women with activity levels above the median had a 67% lower risk of gestational diabetes mellitus than those who performed less physical activity. In a recent meta-analysis of 4401 women, which included 361 gestational diabetes mellitus cases, exercise in early pregnancy was related to a 24% decreased risk of gestational diabetes mellitus. (Bung *et al* 1991, Dye *et al* 1997).

Several studies have linked physical activity before and/or during pregnancy to a decreased risk of gestational diabetes mellitus. Compared with those who were inactive, women who participated in any recreational physical activity during the year before pregnancy experienced a 66 percent reduction in risk of gestational diabetes mellitus. Women who engaged in physical activity for <4.2 hours per week were 42 percent less likely to develop gestational diabetes mellitus. During the index pregnancy, 615 women (67.7 percent) reported participating in any recreational physical activity. Compared with inactive women, these women experienced a 31 percent reduction in risk of gestational diabetes mellitus. They reported that women who did not exercise during this time period, compared with active women, experienced a 1.9-fold increase in risk of gestational diabetes mellitus (Dempsey *et al* 2004).

Authors concluded that the recumbent bicycle and upper body ergometer were the safest forms of aerobic exercise for pregnant women. A potential benefit of exercise in women with gestational diabetes mellitus is improved glycemic control. One small trial randomized women with gestational diabetes mellitus to diet and exercise with an arm ergometer versus diet alone for 6 weeks. Researchers found that the diet-and-exercise group had a significant decrease in glycated hemoglobin levels and in both fasting and 1-hour plasma glucose levels during a glucose challenge test compared to the diet-alone group. Based on the potential benefits of exercise in women with gestational diabetes mellitus, the American Diabetes Association recommends starting or continuing a program of moderate exercise in women without medical or obstetrical contraindications. In addition, certain types of exercise appear to have potential benefits in women without any contraindications (Setji *et al* 2005).

Another study advocates the usefulness of exercise in the treatment of gestational diabetes and suggest that exercise could decrease the risk of gestational diabetes mellitus. Caloric restriction and exercise result in limited weight gain in obese subjects with gestational diabetes mellitus, less macrosomic neonates, and no adverse pregnancy outcomes. (Weissgerber *et al* 2006, Artal *et al* 2007).

Total physical activity before pregnancy or during early pregnancy was significantly associated with a lower risk of gestational diabetes mellitus. Higher levels of physical activity before pregnancy or in early pregnancy are associated with a significantly lower risk of developing gestational diabetes mellitus. Accumulative evidence has suggested that physical activity during pregnancy may be related to gestational diabetes mellitus. By increasing insulin sensitivity and improving glucose tolerance via several mechanisms, physical activity has a beneficial effect on many aspects of insulin resistance syndromes. After an episode of physical activity, insulin sensitivity was improved for up to 48 hours by increasing cellular sensitivity to circulating insulin. In addition to this acute effect, longer-term, even relatively modest, increases in habitual physical activity induce adaptations that can profoundly affect glucose tolerance and potentially decrease gestational diabetes mellitus risk. Long-term improvement in glucose tolerance and increased insulin sensitivity may also result from physical activity induced decreases in fat mass and increases in lean muscle mass. (Tobias 2011, Tobias *et al* 2011, Zhang and Ning 2011).

A supervised program of moderate-intensity exercise performed throughout pregnancy was associated with a reduction in the rate of cesarean, instrumental deliveries and can be recommended for healthy women in pregnancy. Physical activity during pregnancy may prevent both gestational diabetes mellitus and possibly later-onset type 2 diabetes, and engaging in regular physical activity before pregnancy frequently has been associated with a reduced risk of developing gestational diabetes mellitus. In a recent clinical trial, a moderate physical activity program performed thrice weekly during pregnancy was found to improve levels of maternal glucose tolerance in healthy, pregnant women and higher levels of physical activity participation before pregnancy or in early pregnancy significantly lower the risk of developing gestational diabetes mellitus. Women at high risk for gestational diabetes mellitus may be able to prevent it with lifestyle management during pregnancy. In those who develop gestational diabetes mellitus, dietary improvements and regular physical activity are frequently sufficient to manage hyperglycemia, although insulin and oral medications may be used when these changes are not enough. Management of blood glucose levels ensures better pregnancy outcomes and improves the health of both the mother and the fetus. 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. (Barakat *et al* 2012, Colberg 2013)

Engaging in regular physical activity before pregnancy frequently has been associated with a reduced risk of developing gestational diabetes mellitus. A prospective cohort study among 21765 women in the Nurses' Health Study II showed that physical activity before pregnancy is associated with a risk reduction in gestational diabetes mellitus, and both intense exercise and moderate activity (*e.g.*, brisk walking) bestow a similar risk reduction. Even engaging in leisure time physical activity in advance of becoming pregnant may reduce glucose intolerance during the pregnancy. Being physically active during pregnancy may prevent both gestational diabetes mellitus and possibly later-onset type 2 diabetes. Women who perform recreational physical activity during the year before becoming pregnant experience a reduced risk, but participating in any physical activity during the first 20 week of pregnancy has been shown to lead to close to a 50 percent risk reduction in gestational diabetes mellitus. Engaging in physical activity both before and during pregnancy likely leads to the greatest reduction in gestational diabetes mellitus risk. Engaging in 30 min of moderate intensity physical activity on most days of the week, reaching a minimal total of 150 min per week, has been adopted as a recommendation for pregnant women without medical or obstetrical complications. Health benefits can be derived from daily sessions lasting 20 to 45 min. Compared with less vigorous activities, engaging in an exercise intensity that is at least 60 percent of heart rate reserve during pregnancy, while gradually increasing physical activity increases energy expenditure, reduces the risk of gestational diabetes mellitus, and the more vigorous the exercise, the less total exercise time is required. Prolonged duration physical activity (*i.e.*, lasting over 60 to 90 min when done continuously) usually is not recommended for pregnant women due to heightened concern over possible hypoglycemia or hyperthermia. (Colberg *et al* 2013)

Majority (64%) of respondents were currently exercising during pregnancy and 51% exercised 2–3 times/week. Among the five questions testing knowledge about prenatal exercise, majority (range 60 to 92%) were aware of recommendations. About half had a BMI ≥30. Knowledge about benefits of exercise during pregnancy did not differ significantly between obese and non-obese. Yoga was tried significantly more among non-obese, 65% believed it is beneficial, and 40% had attempted yoga before pregnancy. In our population, the majority believes that exercise,

including yoga, is beneficial and they are active. (Babbar and Chauhan 2014).

## 4. Conclusion

It can be concluded from the research studies that the antioxidants and physical exercise play a great role in the management of gestational diabetes.

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