Original Article

DOI: 10.7860/JCDR/2021/46594.14924

Effectiveness of Exercises in Glycaemic Control and Maternal Outcome among Women with Gestational Diabetes Mellitus- A Pilot Study

Obstetrics and Gynaecology Section

REENA WILMA FRANK[1], KAIPANGALA RAJAGOPAL[2], DEVINA E RODRIGUES[3]

ABSTRACT

Introduction: Diabetes Mellitus (DM) is a common medical problem that is very often seen in pregnancy in the present era. Pregnant women should keep in mind their health and lifestyle considerations or else pregnancy will end up with many complications. Pre-existing factors and pregnancy factors will contribute and make pregnancy more complicated. Exercises are recommended as a healthy practice which prevents many diseases and provides a healthy life.

Aim: To evaluate the glycaemic level by focusing on exercises to improve the maternal outcome.

Materials and Methods: A Pilot study with Quasi-experimental pre-post control group design with 30 Gestational Diabetes Mellitus (GDM) women (15 in each group) were selected who met the inclusion and exclusion criteria. The study was conducted in tertiary care hospital between June 2019 and December 2019. Based on the convenience sampling technique, the setting was selected and a simple random technique was adopted to select the subjects. Fifteen subjects were included in each groups, both intervention and control group. Exercises were taught for the interventional group of women for 12 weeks. Regular treatment was continued for both groups which included medication, diet and regular walking. Pretest and post-test glycaemic scores were done for both the groups. Mann-whitney test, Analysis of Variance (ANOVA), post-hoc test, paired Eta square were also used and IBM Statistical Package for the Social Sciences (SPSS) version 23.0 was used.

Results: The study shows there was a significant difference in the preFasting Blood Sugar (FBS) and postFBS values in the intervention group p-value <0.027. The paired Eta square value was 0.303 which showed a moderate effect of the exercise on the glycaemic value in the interventional group. There was a significant difference in the pre glycosylated haemoglobin (HbA1c) and post HbA1c values in both the intervention and control group was p-value <0.023 and p-value <0.025, respectively. The maternal outcome shows increased severity of the complications in the control group while comparing with the intervention group such as pre-eclampsia, operative interference, and preterm deliveries. But there was no significant difference in the maternal outcome observed between intervention and control group p-value >0.05.

Conclusion: Regular moderate-intensity aerobic and resistance exercise training during pregnancy is associated with lower blood glucose level. Thus, study concluded that exercise has a moderate effect on glycaemic control.

Keywords: Aerobics, Fasting blood sugar, Pregnancy, Resistance exercises

INTRODUCTION

Pregnancy is the happiest event for every woman. There are joy and celebration in it and it is the time for a woman to receive good wishes and she is made to feel very important. During pregnancy health and lifestyle of the woman plays a vital role. Diabetes mellitus is a common medical condition complicating pregnancy [1]. It is expected that out of every 200 pregnancies, one is complicated by DM, and out of that, five pregnant women will develop GDM. It is associated with many complications, increased maternal mortality and morbidity, also long-term morbidity among mothers and their offsprings [2].

Many independent risk factors lead to pregnancy complications. Obesity and GDM have been recognised among them for several adverse maternal and fetal outcomes, including diabetes, hypertension, operative deliveries, macrosomia, and neonatal complications [3-5]. In India, the pregnant population is relatively at risk for developing diabetes and the prevalence rate is as high as 16.55% [6-8]. Physical activity improves glucose utilisation by increasing insulin sensitivity. Physical exercise is safe for pregnant women and it has been recommended that 30 minutes of duration or more on most days of the week, as a helpful adjunctive therapy for GDM. Physical activity during pregnancy will contribute to improved levels of maternal glucose tolerance and will help in preventing GDM [9-12]. Exercise, particularly activation of large muscles such as the quadriceps, stimulates glucose uptake in muscle, increases energy expenditure, and improves glucose transportation, which results in improved glucose tolerance [4,13,14]. Thus this study was aimed to assess the effectiveness of the resistance and aerobic exercises in stabilising blood glucose levels among women with GDM and its outcome on pregnancy.

MATERIALS AND METHODS

A pilot study with quasi-experimental study design was conducted among women with GDM at tertiary care Hospital of Father Muller Medical College and Hospital, Mangaluru, Karnataka, India, between June 2019 to December 2019. The sample size was calculated based on the study conducted by Wang C et al., and 30 women with GDM were recruited [15]. Ethical clearance was obtained protocol no: 2018/183 and FMMCIEC/CCM/492/2018, followed by prior permission from the hospital authorities of respective hospitals. The 30 GDM women were selected using a simple random sampling technique for the control and intervention groups. Women who were in the obstetrics Outpatient Department and were admitted to the maternal wards, fulfilled the inclusion criteria and were enrolled as study subjects.

Inclusion criteria: Study included the women in whom GDM is diagnosed when any two values are met or elevated in Glucose Tolerance Test (GTT) [16] and confirmed by the obstetrician with BMI 18.5-30 kg/m^2, were in their 24-26 weeks of gestation and were having smart phone.

Exclusion criteria: The women with a bad obstetric history like Previous Intrauterine Death (IUD), Intrauterine Growth Restriction (IUGR), repeated abortions, and preterm labour, Pregestational diabetes, practicing yoga, enrolled in the gym or any other exercise regimen other than walking, voluntarily opted for Lower (uterine) Segment Caesarean section (LSCS) and/or had a previous LSCS and contraindicated for aerobic exercise (According to ACOG criteria) were excluded [17].

The informed written consent was obtained from the study participants after explaining the client information sheet. A self-developed, semi-structured interview schedule was used to record the baseline profile of the women, and a pretest was conducted by sending the women's blood investigation to the laboratory for the glucose estimation of both the groups. Venous blood was drawn to the FBS, Post Prandial Blood Sugar (PPBS), and HbA1c test.

For the women in the interventional group, exercise were taught and observed by the trained and certified investigator on the 24th week and re-demonstrated by the subjects. The exercises were focused on the large muscles of the upper extremities. The duration of the total exercises was 45 minutes which includes the one-minute rest after every exercise. Initially, warm-up exercises were taught for five minutes and continued with aerobic exercises, which include forward pull-ups, upright row, and shoulder press. Shoulder T lifts, triceps extension, biceps curls, and lateral raise are the resistance exercises. Followed by cool-down exercises for five minutes. Borg Rating of Perceived Exertion Scale (Champaign, IL: Human Kinetics, 1998) [18] was used to maintain the intensity of exercises. Thereafter, the subjects performed it weekly thrice with the gap of two days between three schedules until completion of 35 weeks of gestation. On the first day of the recruitment, the video of the exercise was uploaded by sharing Wi-Fi connectivity to the subjects to perform these exercises. Once in a week exercises were supervised by the investigator and the remaining days in a week, a video of the exercises were uploaded to the subject's cell phone to perform. Subjects were asked to maintain a diary of their exercise regimen and they were motivated to perform exercises through telephonic reminders. Once in two weeks subjects were called to OPD and exercises were supervised.

For both the group regular hospital treatment was given which included medication, diet, and regular walking. Post-test was done by collecting venous blood for glycaemic scores of FBS and PPBS at 28th week, 32nd week, and 36th week, also blood for HbA1c collected at 36th week was tested at the hospital laboratory. Pregnancy outcome was measured 24 hours after the delivery by using a checklist, which includes complications of GDM, pre-eclampsia, polyhydramnios, maternal distress. One mother discontinued the exercises at 28 weeks due to an accident.

STATISTICAL ANALYSIS

Data were tabulated, analysed, and interpreted using descriptive and inferential statistics like frequency, percentage. Mann-Whitney test, ANOVA, post-hoc test, paired Eta square were also used and IBM Statistical Package for the Social Sciences (SPSS) version 23.0 was used.

RESULTS

[Table/Fig-1] shows the mean age of women was 28.07±2.712 years in the interventional group and 30.20±4.73 years in the control group. Out of 15 women in the interventional group, 20% of them and 33.3% in the control group had a history of GDM in the previous pregnancy. Sixty percent of women had a family history of diabetes, out of which 88.8% were first-degree relatives. Family history of hypertension was present among 66.66% of the women in the control group and all of them were first-degree relatives. On the contrary, in the interventional group, only 40% of the women had a family history of hypertension and among them, 83.33% were first-degree relatives. Concerning the glycemia values, 42.86% (n=14) of the women in the interventional group, and 51.72% (n=15) in the control group had a normal FBS. PPBS values show 93.3% of women had increased values in both groups. In an interventional group, 50% (n=14) of the women had a normal HbA1c whereas

Variables	Interventional group		Control group		p-value
	n	%	n	%	
Mean age (years)	28.07±2.712		30.20±4.73		
Age (years)					
20-25	2	13.3	2	13.3	0.30
26-30	11	73.3	7	46.7	
31-35	2	13.3	3	20	
36-40	0	0	3	20	
Parity					
Nulli para	8	53.3	7	46.7	0.01*
Primi para	6	40	2	13.3	
Multi para	0	0	6	40	
Grandmulti para	1	6.7	0	0	
Education level					
Primary education	3	20	6	40	0.52
High school	6	40	6	40	
Higher secondary/ Diploma	5	33.3	3	20	
Degree and above	1	6.7	0	0	
Occupation					
Homemaker	13	86.7	13	86.7	0.70
Employed	2	13.3	2	13.3	
History of GDM					
Yes	3	20	5	33.3	0.71
No	9	60	7	46.7	
Not applicable	3	20	3	20	
Family history of diabetes mellitus					
Yes	9	60	6	40	0.23
No	6	40	9	60	
If yes, specify the member					
First degree relative	8	88.8	6	100	0.60
Second degree relative	1	11.2	0	0	
Third-degree relative	0		0	0	
Family history of hypertension					
Yes	6	40	5	33.34	0.50
No	9	60	10	66.66	
If yes, specify the member					
First degree relative	5	83.33	5	100	0.54
Second degree relative	1	16.67	0	0	
Third degree relative	0	0	0	0	
History of Polycystic Ovary Syndrome (PCOS)					
Yes	1	6.7	1	6.7	0.75
No	14	93.3	14	93.3	
BMI (Pre pregnancy)					
Normal	6	40	5	33.3	0.50
Overweight	9	60	10	66.7	

[Table/Fig-1]: Distribution of baseline characteristics and homogeneity of the subjects. N=15+15; p-value<0.05, *Significant. ANOVA was used

only 20% (n=3) of the women in the control group. The glycaemic scores p-value >0.05. Hence, it is inferred that there was a similarity in glycaemic level among the interventional and control group, so both the groups were comparable in terms of glycaemic values.

[Table/Fig-2] shows there is a significant difference in the Pre FBS and post FBS values in the intervention group (F=6.097, df=3.42) p-value <0.027. In control group there is no significant difference in FBS values at various time points (F=0.397, df=3.42) p-value >0.756. Paired Eta square shows 0.303 which is a moderate beneficial effect of the exercise on the glycaemic value in the interventional group.

Group	Variable	Mean±SD	F value	Df	p-value	Effect size
Intervention (n=14)#	FBS pre	101.47±20.99	6.097	3.42	0.027*	0.303
	28 weeks	95.33±14.41				
	32 weeks	88.20±10.64				
	36 weeks	86.33±9.23				
Control (n=15)	FBS pre	104.60±23.22	0.397	3.42	0.756	0.028
	28 weeks	98.13±19.60				
	32 weeks	99.27±15.77				
	36 weeks	101.47±22.92				

[Table/Fig-2]: Comparison of FBS level within the groups at various time points.
*p-value <0.05 is significant; *Significant; #One mother discontinued the exercises at 28 weeks due to an accident. Anova was used

[Table/Fig-3] shows that there is a significant difference between the 24 weeks FBS and 36 weeks FBS scores p-value=0.027 in the intervention group.

Variables	Paired difference Mean±SD	p-value
FBS 24 weeks-28 weeks	6.13±11.6	0.359
FBS 24 weeks-32 weeks	13.27±21.449	0.187
FBS 24 weeks-36 week	15.13±17.336	0.027*
FBS 28 weeks-32 weeks	7.13±15.408	0.568
FBS 28 weeks-36 weeks	9.00±13.969	0.154
FBS 32 weeks-36 weeks	1.87±9.716	1.000

[Table/Fig-3]: Post-hoc comparison of FBS scores in intervention group.
*p-value <0.05 is significant

[Table/Fig-4] shows there was a significant difference in the pre PPBS and post PPBS values in the intervention group (F=9.359, df=3.42) p-value <0.008 and control group (F=5.802, df=3.42) p-value <0.002.

Group	Variable	Mean±SD	F value	Df	p-value	Effect size
Intervention (n=14)	PPBS pre	160.87±27.08	9.359	3.42	0.008*	0.401
	PPBS 28 weeks	142.27±18.45				
	PPBS 32 weeks	146.93±22.32				
	PPBS 36 weeks	118.53±23.82				
Control (n=15)	PPBS pre	172.93±49.53	5.802	3.42	0.002*	0.293
	PPBS 28 weeks	159.80±21.19				
	PPBS 32 weeks	132.40±27.04				
	PPBS 36 weeks	145.20±22.92				

[Table/Fig-4]: Comparison of PPBS scores within the group at various time points.
p-value <0.05; *Significant ANOVA was used

[Table/Fig-5] shows that there is a statistically significant difference between the 24 weeks PPBS and 36 weeks PPBS scores p-value=0.016 which is highly significant. In 28 weeks and 36 weeks, scores p-value=0.002 in the intervention group. In the control group, 28 weeks PPBS and 32 weeks show significant difference p-value=0.028.

[Table/Fig-6] shows that there is a highly significant p-value=0.01 difference between the Post PPBS (28 weeks) and post PPBS

Variable	Group	Paired difference Mean±SD	p-values
PPBS 24 weeks-28 weeks	Intervention	18.60±37.72	0.461
	Control	13.13±44.16	1.000
PPBS 24 weeks-32 weeks	Intervention	33.93±54.18	0.069
	Control	40.53±52.66	0.060
PPBS 24 weeks-36 weeks	Intervention	42.33±45.05	0.016*
	Control	27.73±47.84	0.249
PPBS 28 weeks-32 weeks	Intervention	15.33±22.60	0.119
	Control	27.40±31.63	0.028*
PPBS 28 weeks-36 weeks	Intervention	23.73±19.37	0.002**
	Control	14.60±33.23	0.666
PPBS 32 weeks-36 weeks	Intervention	8.40±16.92	0.450
	Control	-12.80±21.94	0.242

[Table/Fig-5]: Post-hoc comparison of PPBS scores between intervention and control group.
p-value <0.05; *significant; **highly significant

Variables	Group	Paired difference		Mann Whitney test Z value	p-value
		Mean	SD		
FBS 24 weeks-FBS 28 weeks	Intervention	6.13	11.06	0.06	0.960
	Control	6.47	19.62		
FBS 24 weeks-FBS 32 weeks	Intervention	13.27	21.45	0.86	0.400
	Control	5.33	28.42		
FBS 24 weeks-FBS 36 weeks	Intervention	15.13	17.34	1.39	0.170
	Control	3.13	28.45		
FBS 28 weeks-FBS 32 weeks	Intervention	7.13	15.41	1.11	0.280
	Control	-1.13	24.48		
FBS 28 weeks-FBS 36 weeks	Intervention	9.00	13.97	1.59	0.120
	Control	-3.33	26.65		
FBS 32 weeks-FBS 36 weeks	Intervention	1.87	9.72	0.73	0.470
	Control	-2.20	19.12		
PPBS 24 weeks-PPBS 28 weeks	Intervention	18.60	37.72	0.36	0.720
	Control	13.13	44.16		
PPBS 24 weeks-PPBS 32 weeks	Intervention	33.93	54.18	0.37	0.720
	Control	40.53	52.66		
PPBS 24 weeks-PPBS 36 weeks	Intervention	42.33	45.05	0.86	0.400
	Control	27.73	47.84		
PPBS 28 weeks-PPBS 32 weeks	Intervention	15.33	22.60	1.20	0.240
	Control	27.40	31.63		
PPBS 28 weeks-PPBS 36 weeks	Intervention	23.73	19.37	0.92	0.370
	Control	14.60	33.23		
PPBS 32 weeks-PPBS 36 weeks	Intervention	8.40	16.92	2.96	0.01**
	Control	-12.80	21.94		
HbA1c 24 weeks-HbA1c 36 weeks	Intervention	0.71	1.08	0.14	0.890
	Control	0.66	1.02		

[Table/Fig-6]: Comparisons of FBS, PPBS, and HbA1c scores between the intervention and control group at various timepoints.
N=14+15; *p-value <0.05 is significant

Maternal outcome	Intervention group		Control group		p-value
	n	%	n	%	
Pre-eclampsia					
Yes	3	21.4	8	53.3	0.082
No	11	78.6	7	46.7	
Polyhydramnios					
Yes	0	0	2	13.3	0.259
No	14	100	13	86.7	
Prolonged labour					
Yes	1	7.1	0	0	0.483
No	13	92.9	15	100	

Shoulder dystocia					
Yes	1	7.1	0	0	0.483
No	13	92.9	15	100	
Perineal injuries					
Yes	1	7.1	1	6.7	0.741
No	13	92.9	14	93.3	
Cesarean section					
Yes	6	42.9	9	60	0.291
No	8	57.1	6	40	
Preterm delivery					
Yes	2	14.3	6	40	0.129
No	12	85.7	9	60	
Pregnancy weight gain >11kg					
Yes	2	14.3	6	40	0.129
No	12	85.7	9	60	

[Table/Fig-7]: Maternal outcome between the intervention and control group.
N=14+15; *p-value <0.05 significant; ANOVA was used

(32 weeks) among the intervention and control groups. Hence, the null hypothesis is rejected and the research hypothesis is accepted.

Data presented in the [Table/Fig-7] shows that there is no significant difference in the maternal outcome observed between intervention and control group p-value >0.05.

[Table/Fig-8] shows there is a significant difference between parity p-value=0.038, history of PCOS p-value=0.026 and BMI p-value=0.030 with HbA1c values.

DISCUSSION

In the present study, the mean age of women was 28.07±2.712 years in the interventional group and 30.20±4.73 years in the control group. These findings were congruent to the findings of the study conducted by Kokic IS et al., where they assessed the acute responses to structured aerobic and resistance exercise in women with GDM. The mean age of the women was 32.8±3.8, prepregnancy body mass index was 24.4±4.9 kg/m^2, and 50% of them were nulliparous [19].

Variables			Intervention			Control		
			Mean±SD	F value	p-value	Mean±SD	F value	p-value
FBS	Age (years)	20-30	102±23	1.202	0.353	109±25	0.043	0.850
		31-40	96±1			98±20		
	Parity	Nulli Para	104±25	1.364	0.327	115±27	0.636	0.483
		Other	99±17			96±15		
	Family history DM	Yes	103±20	0.387	0.578	115±28	0.007	0.937
		No	99±25			98±18		
	Family history HTN	Yes	98±22	0.532	0.519	109±16	0.045	0.846
		No	104±21			102±26		
	History PCOS	Yes	74	0.284	0.631	115	0.012	0.918
		No	103±20			104±24		
	BMI (kg/m^2)	18.5-24.9	85±8	1.605	0.295	116±30	0.000	0.994
		25-29.9	113±20			99±18		
PPBS	Age (years)	20-30	158±28	0.850	0.425	186±54	1.045	0.382
		31-40	178±6			154±39		
	Parity	Nulli Para	152±16	0.087	0.788	190±48	0.080	0.796
		Other	171±35			158±49		
	Family history DM	Yes	164±32	0.347	0.597	191±53	0.937	0.405
		No	157±19			161±47		
	Family history of HTN	Yes	164±35	1.502	0.308	178±25	0.705	0.463
		No	159±23			171±59		
	History PCOS	Yes	145	0.097	0.776	189	1.613	0.294
		No	162±28			172±51		
	BMI (kg/m^2)	18.5-24.9	157±13	0.068	0.812	189±60	1.986	0.254
		25-29.9	163±34			165±45		
HbA1c	Age (years)	20-30	6.4±1.4	7.018	0.077	7.5±1.4	0.135	0.737
		31-40	5.7±.7			6.9±.5		
	Parity	Nulli Para	6.4±1.7	12.579	0.038	7.2±1.6	0.977	0.396
		Other	6.2±.8			7.3±.7		
	Family history DM	Yes	6.3±1.1	5.271	0.105	7.0±1.2	0.020	0.897
		No	6.2±1.7			7.4±1.2		
	Family history HTN	Yes	6.0±1.1	0.382	0.580	6.4±.7	0.631	0.485
		No	6.4±1.5			7.6±1.1		
	History PCOS	Yes	6.5	17.173	0.026	6.2	0.229	0.665
		No	6.3±1.4			7.3±1.1		
	BMI (kg/m^2)	18.5-24.9	5.3±.7	15.368	0.030	7.1±1.3	0.002	0.965
		25-29.9	6.9±1.2			7.3±1.1		

[Table/Fig-8]: Association between FBS, PPBS and HbA1c scores with selected baseline variables.
N=14+15; p-value <0.05;* significant; ANOVA was used

In the present study Post-hoc test observes that there was a statistically significant difference between the 24 weeks PPBS and 36 weeks PPBS scores. Similar study results are shown with the conventional treatment group and aerobic exercise which, reduced fasting blood glucose (WMD=-0.35, 95% CI: -0.62 to -0.08, I2=87%), postprandial blood glucose (WMD=-0.62, 95% CI:-0.95 to -0.29, I2=84%) and HbA1c levels (WMD=-0.35, 95% CI:-0.49 to -0.20, I2=71%) in patients with GDM [20]. A different form of exercise has been included within the resistance exercise modality in Thailand for eight weeks, the studied population performed this exercise twice a week for 50 minutes. The variables analysed are fasting, postprandial glucose, and HbA1c. These three variables are lower in the intervention group, with a significant difference (p-value=0.012; p-value=0.001; p-value=0.038, respectively) [21].

Results show that there is no significant difference in the maternal outcome observed between the intervention and control group p-value >0.05. Similar results show in the study conducted by De Barros MC et al., on resistance exercise and glycaemic control in women with GDM. The 2 groups were similar in terms of the variables measured at the time of delivery (p-value >0.05). No difference in the frequency of caesarean section was observed between groups (n=21 of 32 in EG vs n=24 of 32 in CG; p-value=0.412) [22]. Exercise during pregnancy especially aerobic and resistance exercises was beneficial to the GDM women to reduce their glycaemic level at 36 weeks and to improve the maternal outcome.

Limitation(s)

Even though exercise had a good effect on the glycaemic level there was some drawback in the study. The sample size of the study was small, so generalisation was difficult and prediction of risk on maternal outcome could not be evaluated. Further studies can be done on various pattern of exercises which is moderate intensity will help to control the glucose level during pregnancy.

CONCLUSION(S)

Maternal fitness is essential during pregnancy and delivery for a better maternal outcome. Regular moderate-intensity exercise training during pregnancy is associated with both a lower blood glucose level PPBS and maternal weight gain and also provides physical fitness. Characteristics of effective exercise programs for management of GDM appear to be exercise performed at a moderate intensity and for a minimum of three times a week. Exercise during pregnancy with gestational diabetes will improve maternal outcomes.

REFERENCES

[1] Martinez SG, Hermoso AG, Leon RP, Bueno CA, Lopez MS, Vizcaino VM. Effectiveness of physical activity interventions on preventing gestational diabetes mellitus and excessive maternal weight gain: A meta-analysis. BJOG. 2015;122:1167-74.

[2] Thathagari V, Doddaiah V, Raghavenda B. A study of prevalence and determinants of gestational diabetes mellitus. Int J Reprod Contracept Obstet Gynecol. 2016;5:1331-35.

[3] Hopkins SA, Artal R. The role exercise in reducing the risks of gestational diabetic mellitus. Women's Health. 2013;9(6):569-81.

[4] Harrison AL, Shields N, Taylor NF, Frawley HC. Exercise improves glycaemic control in women diagnosed with gestational diabetes mellitus: A systematic review. Journal of Physiotherapy. 2016;62:188-96.

[5] Aune D, Sen A, Henriksen T, Saugstad OD, Tonstad S. Physical activity and the risk of gestational diabetes mellitus: A systematic review and dose–response meta-analysis of epidemiological studies. Eur J Epidemiol. 2016;31:967-97.

[6] National Diabetes Education Program. 2011. Diabetes Risk After Gestational Diabetes. http://ndep.nih.gov/media/fs_post-gdm.pdf).

[7] Ben-Haroush A, Yogev Y, Hod M. Epidemiology of gestational diabetes mellitus. Textbook of Diabetes and Pregnancy. 2003:85-6.

[8] Seshiah V, Balaji V, Madhuri S Balaji, Panneerselvam A, Kapur A. Pregnancy and Diabetes Scenario around the World: India. Int J Gynaecol Obstet. 2009;104 suppl 1:S35-38.

[9] da Silva JR Jr, Borges PS, Agra KF, Pontes IA, Alves JG. Effects of an aquatic physical exercise program on glycemic control and perinatal outcomes of gestational diabetes: Study protocol for a randomized controlled trial. Trials. 2013;14:390.

[10] Bgeginski R, Ribeiro PAB, Mottola MF, Ramos JGL. Effects of weekly supervised exercise or physical activity counseling on fasting blood glucose in women diagnosed with gestational diabetes mellitus: A systematic review and meta-analysis of randomized trials. J Diabetes. 2017;9(11):1023-32.

[11] Cordero Y, Mottola MF, Vargas J, Blanco M, Barakat R. Exercise is associated with a reduction in gestational diabetes mellitus. Med Sci Sports Exerc. 2015;47(7):1328-33.

[12] Kgosidialwa O, Egan AM, Carmody L, Kirwan B, Gunning P, Dunne FP. Treatment with diet and exercise for women with gestational diabetes mellitus diagnosed using IADPSG criteria. J Clin Endocrinol Metab. 2015;100(12):4629-36.

[13] Santos JM, Ribeiro SB, Gaya AR, Appell HJ, Duarte JA. Skeletal muscle pathways of contraction-enhanced glucose uptake. Int J Sports Med. 2008;29:785-94.

[14] Richter EA, Kiens B, Saltin B, Christensen NJ, Savard G. Skeletal muscle glucose uptake during dynamic exercise in humans: Role of muscle mass. Am J Physiol. 1988;254:555-61.

[15] Wang C, Wei Y, Zhang X, Zhang Y, Xu, Sun Y, et al. A randomised clinical trial of exercise during pregnancy to prevent gestational diabetic mellitus and improve pregnancy outcome in overweight and obese pregnant women. American Journal of Obstetrics and Gynaecology. 2017;216(4):340-51.

[16] American Diabetes Association. Summary of Revisions: Standards of Medical Care in Diabetes-2020. Diabetes Care. 2020;43(Suppl 1):S4-S6. [Medline].

[17] Artal R. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. British Journal of Sports Medicine. 2003;37(1):06-12.

[18] Anon. n.d. "Borg's Perceived Exertion and Pain Scales. - PsycNET." Retrieved December 15, 2020 (https://psycnet.apa.org/record/1998-07179-000).

[19] Kokic IS, Ivanisevic M, Kokic T, Simunic B, Pisot R. Acute responses to structured aerobic and resistance exercise in women with gestational diabetes mellitus. Scandinavian Journal of Medicine & Science in Sports. 2018;28(7):1793-800.

[20] Huang X, Huang J, Wu J, Li M, Yang Z, Liu L, et al. Different exercises for pregnant women with gestational diabetes: A meta-analysis of randomized controlled trials. J Sports Med Phys Fitness [Internet]. 2020 Mar [cited 2020 Jul 25];60(3). Available from: https://www.minervamedica.it/index2.php?show=R40Y2020N03A0464.

[21] Laredo-Aguilera JA, Gallardo-Bravo M, Rabanales-Sotos JA, Cobo-Cuenca AI, Carmona-Torres JM. Physical activity programs during pregnancy are effective for the control of gestational diabetes mellitus. IJERPH. 2020;17(17):6151.

[22] De Barros MC, Lopes MAB, Francisco RPV, Sapienza AD, Zugaib M. Resistance exercise and glycemic control in women with gestational diabetes mellitus. American Journal of Obstetrics and Gynecology. 2010;203(6):556.e01-06.

PARTICULARS OF CONTRIBUTORS:

1. Lecturer, Department of Obstetrics and Gynaecology Nursing, Father Muller College of Nursing, Mangaluru, Karnataka, India.
2. Professor and Head, Department of Obstetrics and Gynaecology, Srinivas Institute of Medical Science and Research Center, Mangaluru, Karnataka, India.
3. Professor and Head, Department of Nursing Research, Father Muller College of Nursing, Mangaluru, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Reena Wilma Frank,
Lecturer, Department of Obstetrics and Gynaecology Nursing, Charitable Institutions, Kankanady, Mangaluru-575002, Karnataka, India.
E-mail: rinwil21@fathermuller.in

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Sep 09, 2020
- Manual Googling: Feb 11, 2021
- iThenticate Software: Mar 15, 2021 (12%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Sep 04, 2020**
Date of Peer Review: **Nov 11, 2020**
Date of Acceptance: **Feb 15, 2021**
Date of Publishing: **May 01, 2021**