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EFFECTS OF FUNCTIONAL RESISTANCE TRAINING OVER BLOOD GLUCOSE LEVEL IN GESTATIONAL DIABETES MELLITUS

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ABSTRACT

BACKGROUND:

Gestational diabetes mellitus (GDM) is marked by glucose intolerance identified primarily during pregnancy. Globally, GDM incidence is rising annually, and during the past 20 years, the prevalence of the GDM has increased by more than 30% in low- and middle-income nations. In India, the estimated prevalence of GDM in expectant mothers is 0.80%.

METHODOLOGY:

Subjects who satisfied the inclusion and exclusion criteria were included in this study . After obtaining an informed consent, subjects were randomly allotted into two groups. Intervention group received Functional resistance training and the Control group received Routine antenatal care for a period of 12 weeks, pretest and posttest values of Fasting Blood Glucose and Postprandial blood glucose level were taken and tabulated .

RESULTS AND DISCUSSION:

Within group analysis shows a significant decrease in Fasting Blood Glucose and Postprandial blood glucose level after 12 weeks of intervention in both groups ($P<0.05$). Between group analysis shows Functional Resisted exercises reduces Fasting blood glucose level significantly than the control group ($p<0.05$).

CONCLUSION:

Functional resistance training is effective in reducing fasting blood glucose among Gestational Diabetes Women.

KEYWORDS:

Gestational Diabetes Mellitus, Blood glucose level, Resistance training, Antenatal care, physical activity.

INTRODUCTION

Gestational Diabetes Mellitus (GDM) is identified as any glucose intolerance primarily during second trimester of pregnancy. In GDM, Glucose instead of being absorbed by cells, gets accumulates in the bloodstream. [1].

Globally, GDM incidence is increasing year after year, and the disease has climbed by more than 30% in least- and moderate-income countries during the last twenty years. In India, estimated prevalence of GDM in expectant mothers had raised to 0.80% [2]. The incidence of GDM is rising in the most of Indian states, with the exception of Arunachal Pradesh, where it is declining from 1.61% to 0.87%. In Tamilnadu, GDM is found to be 10.5% according to World Health Organization criteria and fifteen percentage based on the The International Association of Diabetes and Pregnancy Study Groups criteria [3].

The development of GDM has been linked to a number of risk variables. Several risk factors may lead to the onset of GDM [4].These include using corticosteroids, poly cystic ovarian syndrome, previously history of GDM, being older than 35, obesity and over weight, uncontrolled diet, less physical activity, family history of diabetes [5,6].

Although risk factors are identified, exact cause for GDM is not confirmed yet,many theories exist for the causes and one such theory is placental hormones released during pregnancy eg:Cortisol,estrogen,human placental lactogen causes insulin resistance which indicates the inefficiency of the body to use the insulin effectivelywhich causes glucose to accumulate in blood.When the liver production of insulin cannot compensate the action of placental hormones,GDM results.

According to American Diabetes Association,pregnant women with no history of diabetes,screening test (Fasting Blood sugar and postprandial blood sugar) will be taken by 24 to 28 weeks of pregnancy

Gestational diabetes mellitus can lead to negative health outcomes for both mothers and infants. Following gestational diabetes, there is a 70% higher risk of acquiring type 2 diabetes within 28 years of giving birth. Pre-eclampsia, caesarean delivery, polyhydraminos, birth weights more than the 90th percentile, and neonatal hypoglycemia are few among the maternal and fetal complications. [7,8,9,10,11].

With all risk factors known, it becomes important to manage GDM for healthy pregnancy and postpartum.Exercise and diet are two important factors that helps to effectively manage the GDM [12]. Exercise is used as a preventive technique to reduce the incidence of GDM, and it has been the focus of the bulk of systematic reviews published on this subject [13,14,15,16]. According to earlier research, patients with GDM can reduce their blood glucose levels and minimize their risk of type 2 diabetes by 35.2% with proper diet and exercises.[17].

Recent evidence highlights that Gestational Diabetes risk can be lowered by making appropriate diet and activity choices as well as maintaining a healthy weight. This will lower the chance of future complications for both the mother and the offspring. Exercise is useful for GDM patients because it helps to manage blood glucose levels, prevents obesity, and lowers the risk of pregnancy complications [18,19,20].

Literature survey shows Insulin sensitivity improves with aerobic exercise and also lowers visceral adiposity [21,22,23]. Physical exercise demonstrated a greater use in reducing insulin sensitivity and inflammatory markers, but very less compliance is noted from patients to these exercises[24,25].

Thus this study was done to find the effect of Functional Resisted Exercises(FRT) which can be done at any place and at any time with minimal supervision and has shown better compliance in recent studies over Blood glucose level among GDM ssubjects.

SAMPLE:

In this study Sample collection was started after Institutional Ethical Committee (IEC) clearance was obtained. A Single blinded (assessor blinded) Experimental study design was used to enrol patients with GDM .The assessor assessed all the GDM subjects with a standard performa and who satisfied the inclusion and exclusion criteria were included in the study. 350 GDM patients were assessed for eligibility criteria and over 256 members were excluded, i.e; 190 GDM patients did not meet the inclusion criteria, 40 members declined to participate and 26 participants were not included due to other reasons like gestional hypertension,cardiac anomalies etc . Finally, 94 subjects with GDM were selected and were obtained with informed consent,

Pre test measures of Fasting Blood Glucose (FBG) level and Post Prandial Blood Glucose (PPBG) level were measured from all subjects post which they are randomly allocated into 2 groups. Experimental group and control group using sealed envelope method. Codes for experimental and control groups were placed into sealed envelopes and the subjects who are interested to take part in the study were asked to pick one sealed envelope at their interest and they were allotted according to the codes they received. The even numbers were allotted as Experimental group where as odd numbers were allotted with control groups. Finally 47 subjects were allocated to Control Group- with antenatal care and 47 subjects to Intervention Group with Functional Resistance exercises(FRT).

INCLUSION CRITERIA :

Diagnosed case of Gestational Diabetes Mellitus, 24-32 weeks of Gestation ,Body mass index lower than 40kg/m2.

EXCLUSION CRITERIA:

Cardiac diseases **,**Restrictive ventilator defect**,** Vaginal bleeding**,** Uncontrolled hypertension, Incompetent cervix, Preeclampsia,Psychological issues,orthopaedic and spine problems that restricts lower limb movements,Placenta praevia,severe anaemia,Intra Uterine Growth Retardation,High risk pregnancy.

PROCEDURE:

Intervention group underwent FRT and control group underwent routine antenatal care. First session was carried out in the Obstetrics and Gynaecology ward at SRIHER hospital and the compliance to the exercise program was followed through online session. The exercise session was set 40-50 minutes in accordance with the guidelines of the American College of Obstetrics and Gynaecology(ACOG).All subjects were provided with below exercises in the same sequence.All these exercises were done by GDM subjects with 1kg dumbbell in each hand.

At the starting of each session, the patients were instructed to follow the warm-up exercises for 5 minutes. Breathing exercise, Biceps stretch, Triceps stretch , Pectoralis and Calf stretch for 3-5 repetitions, 10-15 seconds hold, 5 seconds rest.

During first week the main exercise such as, front squat, overhead press, bent-row, trunk twist, side-step squat, chest raise, dumbbell row were performed at the rate of 2 sets of 5-8 repetitionswith ninety second of rest between each set. During the third week it is increase as 3 sets of 7 repetitions. 4 sets of 9-10 repetitions was done from fifth week until 12 weeks . At the end of the session cool down exercises such as General relaxation exercise , total body stretching with 3-5 repetition, 10-15 seconds hold, 5 seconds rest was practised.

At the time of intervention, the patients were monitored for any adverse events such as dyspnea, vaginal bleeding, Palpitation, Severe headache, blurring of vision; if such adverse events occurred, the patients were instructed to stop exercising.

CONTROL GROUP

First session was carried out in Obstetrics and Gynaecology ward at SRIHER hospital, with routine antenatal care. Patients received routine antenatal exercises .The exercises are

scheduled as follows Deep breathing exercise, Bilateral upper limb stretches (Each 10 seconds hold, 10 repetitions), Hip adductor stretch (10 seconds hold), Hamstring stretch (10 seconds hold), Spine side stretch (10 seconds hold), and 30-40 minutes of walking was prescribed. Physical activity guidance given according to ACOG guidelines. Finally, Post test measures of FBG and PPBG were taken after 12 weeks.

STATISTICAL ANALYSIS:

Statistical analysis has been performed by Statistical Package for the Social Science software version 28.0. Descriptive statistics was calculated for baseline characteristics. For the test of normality the Shapiro-Wilk test was done. Non parametric tests has been done to find the significant difference between the pre and post-test scores. The post-test comparison between both the groups were calculated with mann whitney test at the significance level of $P<0.05$ was taken .

RESULTS :

Baseline characteristics was shown in Table 1 which shows characters of both the control & Intervention group like BMI, occupation, educational status and there exist no statistical difference which says that both groups has same base line .

Pretest median value of FBG level(114.00 mg/dl) was reduced to 94.00 mg/dl post exercise intervention and pretest median value of PPBS (161.00 mg/dl) was reduced to 110.00 mg/dl in control group.(Table 2). Thus it shows a statistically significant effect of routine care on FBG and PPBG level in control group ($P<0.05$). FBG mean rank value has improved from 2.46 to 1.13 and PPBG mean rank has improved from 3.89 to 2.52 which shows a statistically significant improvement in both the outcome ($P<0.05$).(Graph 2)

In Intervention group the median of FBG in pre-test is 119.00 mg/dl which was reduced to 84.00 mg/dl after exercise intervention . Pretest median of PPBG is 160.00 mg/dl which was reduced to 107.00 mg/dl after 12 weeks of intervention. Thus it shows a statistically significant effect of FRT on FBG and PPBG in control group ($P<0.05$).(Table 3) .Graph 3 shows that the FBG mean rank value has improved from 2.68 to 1.04 and PPBG has improved from 3.98 to 2.30 which shows a statistically significant improvement($p<0.05$)

Comparison of FBG &PPBG levels between groups (n=94) shows that there was a statistically significant difference between groups in post test values of fasting blood glucose level ($P<0.05$) but there is no statistically significant difference in post prandial blood glucose level values ($P>0.05$).(Table 4) Graph 4 & 5 shows the mean rank in control group is 54.3 and intervention group is 40.6 which shows satistically significant reduction of FBG in intervention than control group and the mean rank in control group is 50.1 and intervention group is 44.9 which shows better reduction of PPBS in intervention than control group.

DISCUSSION:

Functional Resistance training increases muscle strength by making work against a force or weight. It works under the principle of Over load, Specificity, Progression/periodization, Individuality, Reversibility.

This study shows a statistically significant reduction in FBS post exercises in control group for a period of 12 weeks . This results goes in hand with Arsianti RW who found a significant reduction in blood sugar level post stretching among type2 diabetic individuals and Mitsumuto who found a two fold increase in glucose uptake by muscles after a period of stretching protocol.

This can be explained by the fact that the stretched muscle is no more dormant,it increases heat production, oxygen consumption ,glycogen breakdown and lactic acid accumulation. This promotes the activation route for adenosine monophosphate kinase (AMPK) and glucose transporter (GLUT 4).In the control group, exercise-induced increase in nitric oxide result in enhanced glucose transport, which may have affected glucose levels.

There was a significant reduction in fasting blood sugar level post FRT for a period of 12 weeks, this can be better explained by the physiology that GLUT4 translocation is induced by contraction of muscle, resulting in increased glucose transport into the muscle. Furthermore, contraction stimulates blood flow, which improves glucose dispersion into the interstitial space and GLUT4 is also recruited by insulin to the muscle's surface.

During exercise, muscle glycogen stores are depleted, resulting in a glucose or glucose-6-phosphate gradient which increase the rate of glucose entry in to the muscle.Exercises enhances GLUT4 expression,oxidative capability and improves signals of insulin receptor , resulting in better insulin action.It also improves glucose storage and oxidation. Thus FRT increases insulin sensitivity there by reducing FBS.

There was significant reduction in PPBS post exercises in control group which can be explained by the fact that protein b kinase is stimulated with stretching which may influence glycemic control by improving muscle glucose uptake , Exercise impacts glucose homeostasis for up to 48 hours depending on biochemical alterations in skeletal muscle signaling.There was a significant reduction of PPBS post FRT which can be very well explained with the physiology of resisted exercises on glucose metabolism.

On comparison, FRT shows a better significant reduction of FBS than control group.Skeletal muscle plays a major part in taking up sugar from the bloodstream. Generally, the basal metabolic rate increases with more resistance training. In case of FRT in GDM, patients will utilize more glucose & allow the insulin to utilize it better. Research suggest that while comparing cardio exercise training with resistance training, Cardio training initially reduces the blood sugar level but then seems to rebound & have no significant effect, but resistance training has a statistically significant reduction in blood glucose level.

The results goes in hand with Zhao Huifen ,2022concludes Moderate intensity resistance training was effective in improving blood glucose management and weight gain in GDM patients.

Moderate resistance training increases mean O2 consumption. Authors suggest that linear relationship exists between Resistance training intensities & increases acute energy expenditure. It improves the glucose level, free fatty acid level . Resistance training benefits long term glycaemic control & insulin sensitivity.

On comparison, this study shows that there was no significant difference in PPBS values

reduction between both the groups. But clinical effect is higher with FRT,this results goes in hand with research which quotes.Resistance training is associated with longer persistent reductions in post-exercise glycemia than aerobic exercise.(Jan 2013)

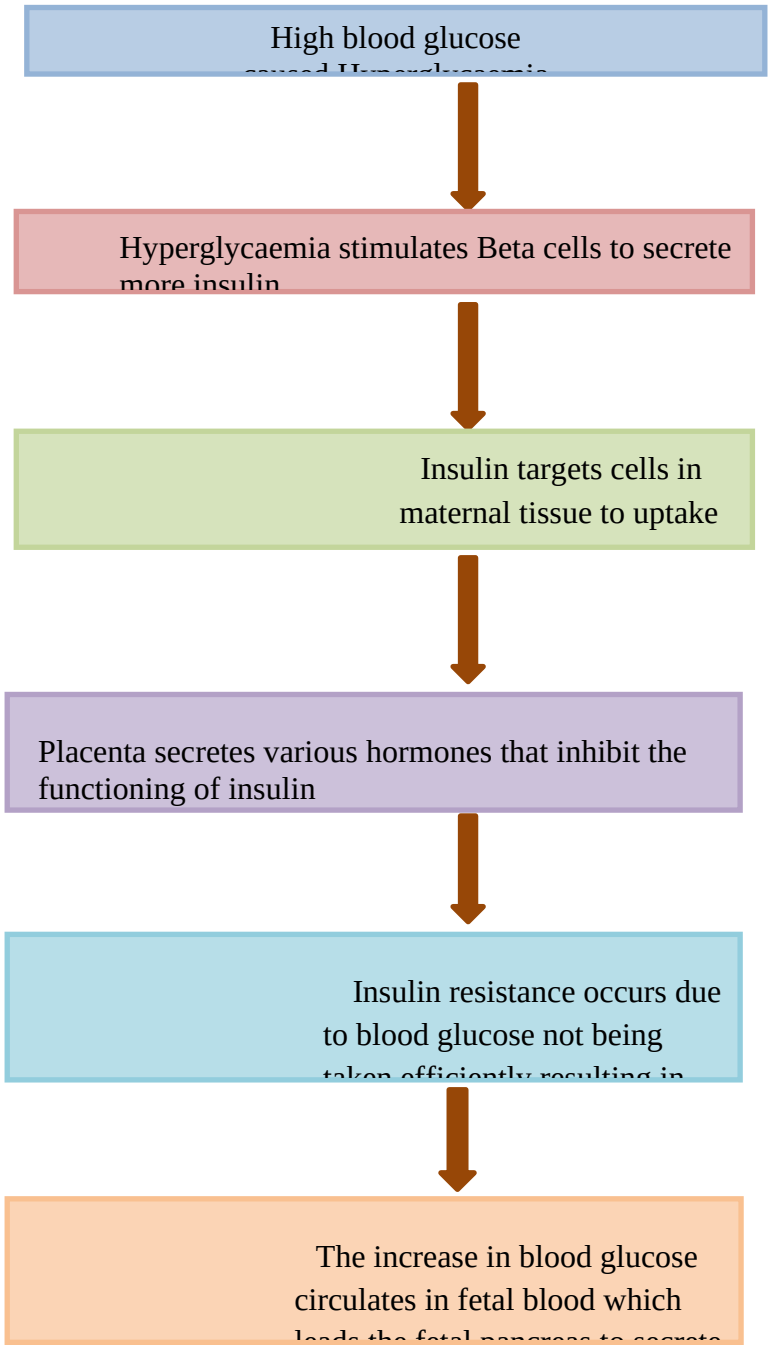


FIGURE 1: Pathophysiology of GDM

FIGURE 2 : Intervention group exercise protocol

MODES	**EXERCISE**	**TIME (SEC/MIN)**	**REPS, SETS AND REST PERIOD.**
Warm up	Breathing exercise, biceps stretch, triceps stretch , pectoralis and calf stretch	5 Minutes	3-5 reps, 10-15 sec hold, 5 sec rest.
Main exercise	Front squat, overhead press, bent-row, trunk twist, side-step squat, chest raise, dumbbell row.	30 Minutes	1st week – 2 sets of 5-8 repetitions. 3rd week – 3 sets of 7 repetitions. 5th week – 4 sets of 9-10 repetitions.(90 seconds of rest between each set)
Cool down	General relaxation exercise , total body stretching.	5 Minutes	3-5 reps, 10-15 sec hold, 5 sec rest.

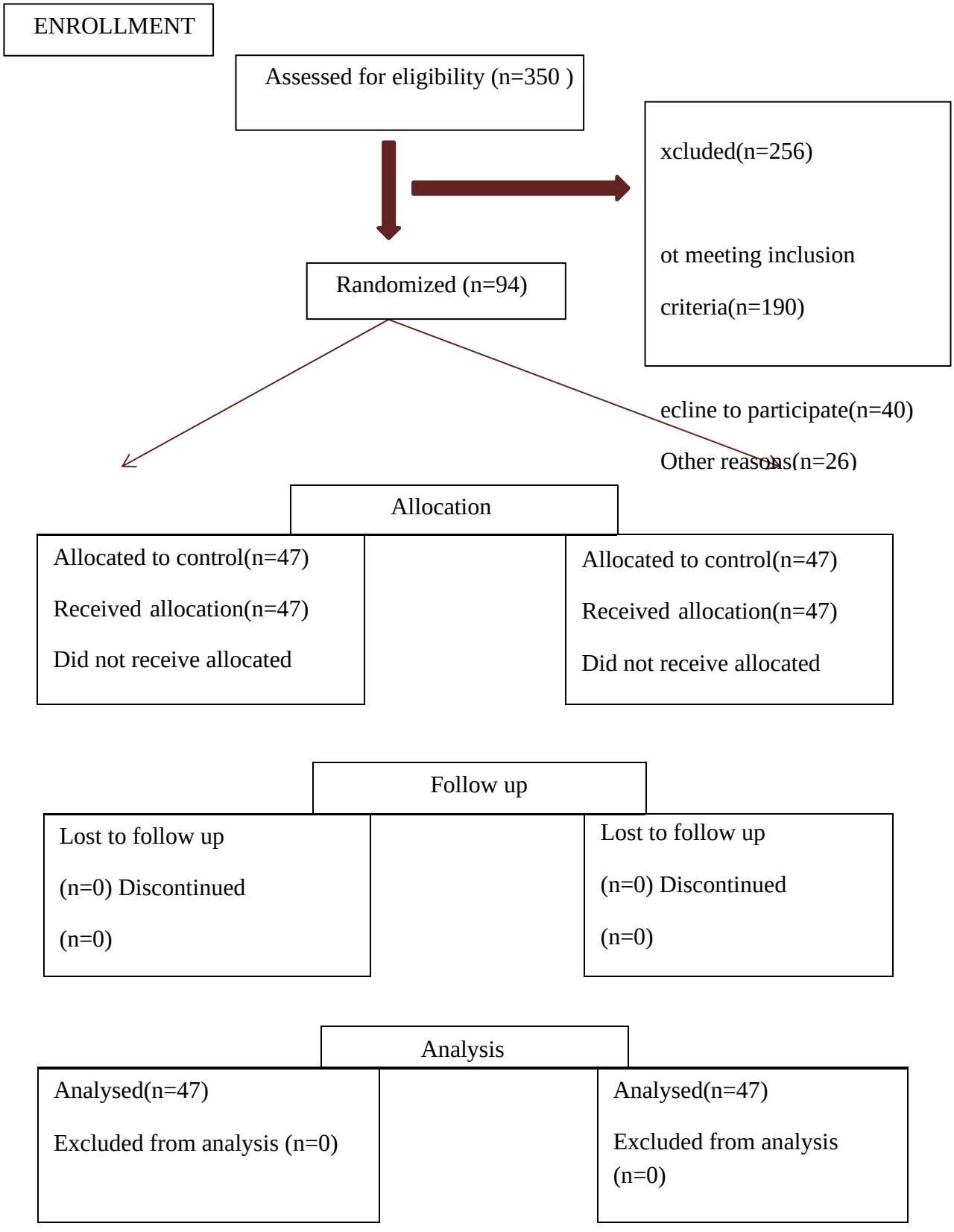
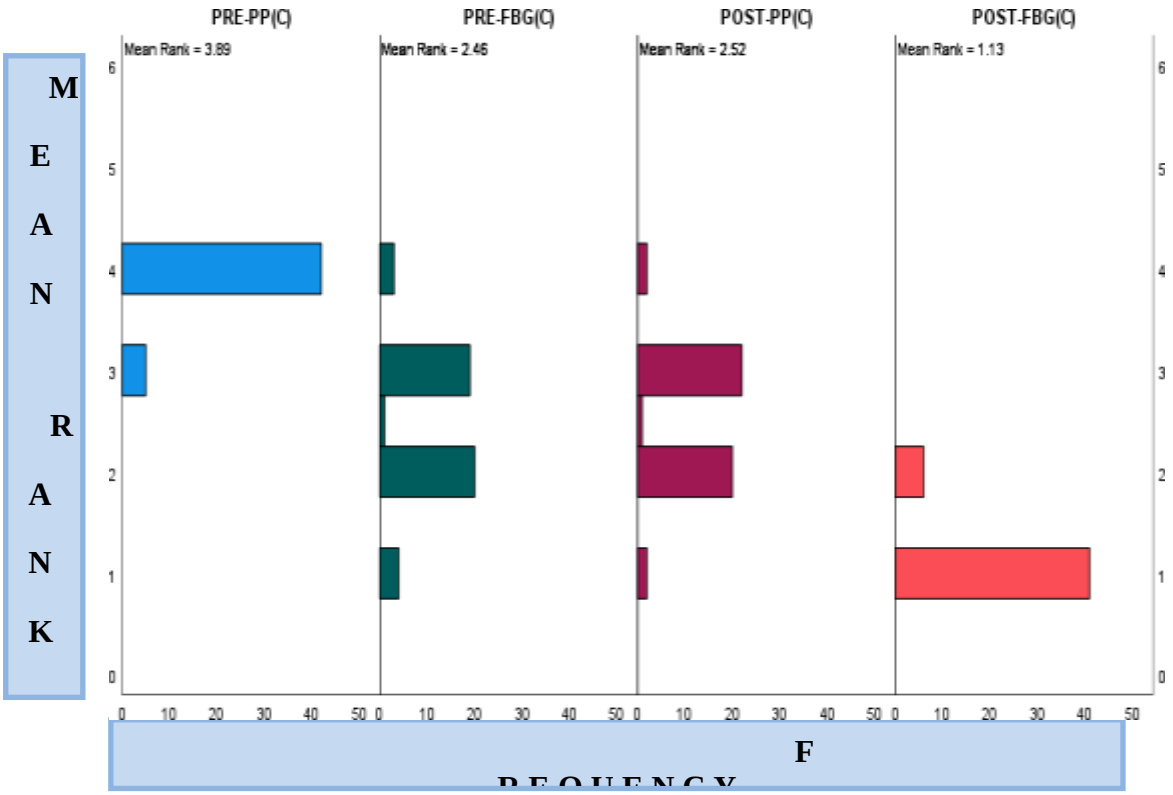


FIGURE 3: CONSORT CHART

FIGURE 5:

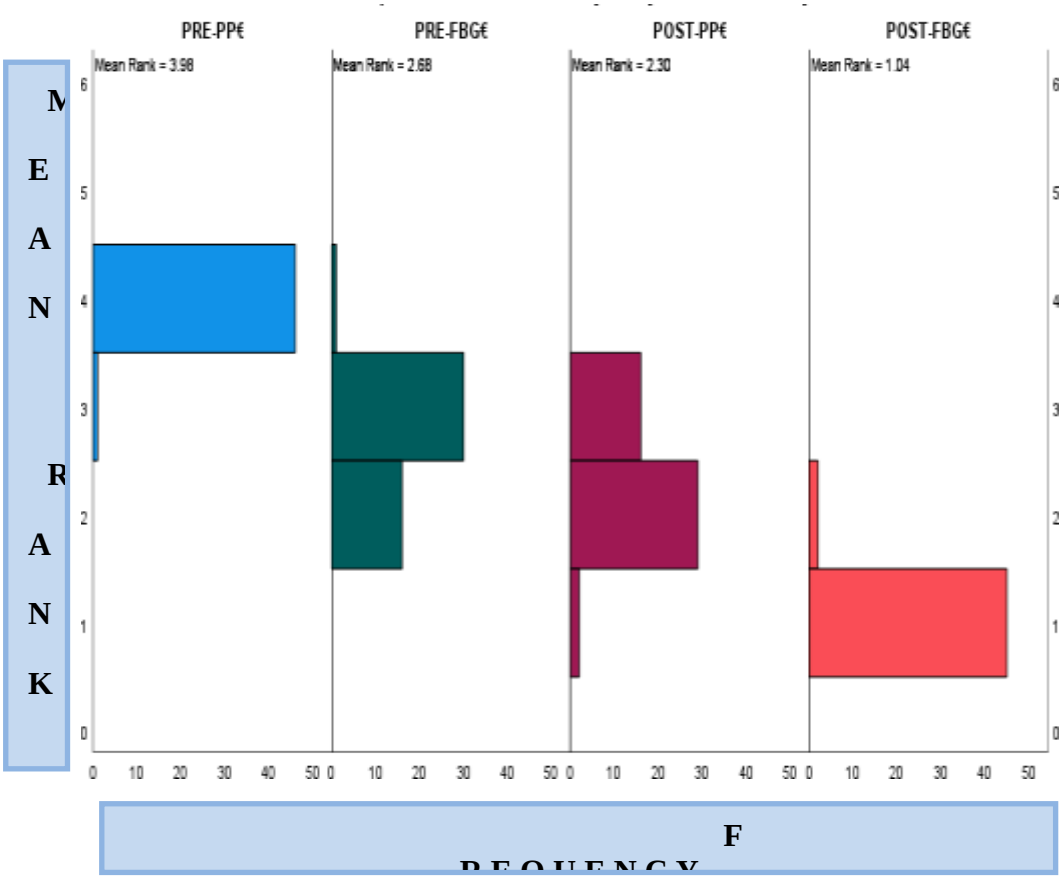
Pre test and post test values of Fasting Blood Glucose levels and Post Prandial Blood Glucose level within control group



This chart shows the FBG mean rank value has improved from 2.46 to 1.13 and PPBG has improved from 3.89 to 2.52 which shows a statistically significant improvement ($p<0.05$)

FIGURE 6:

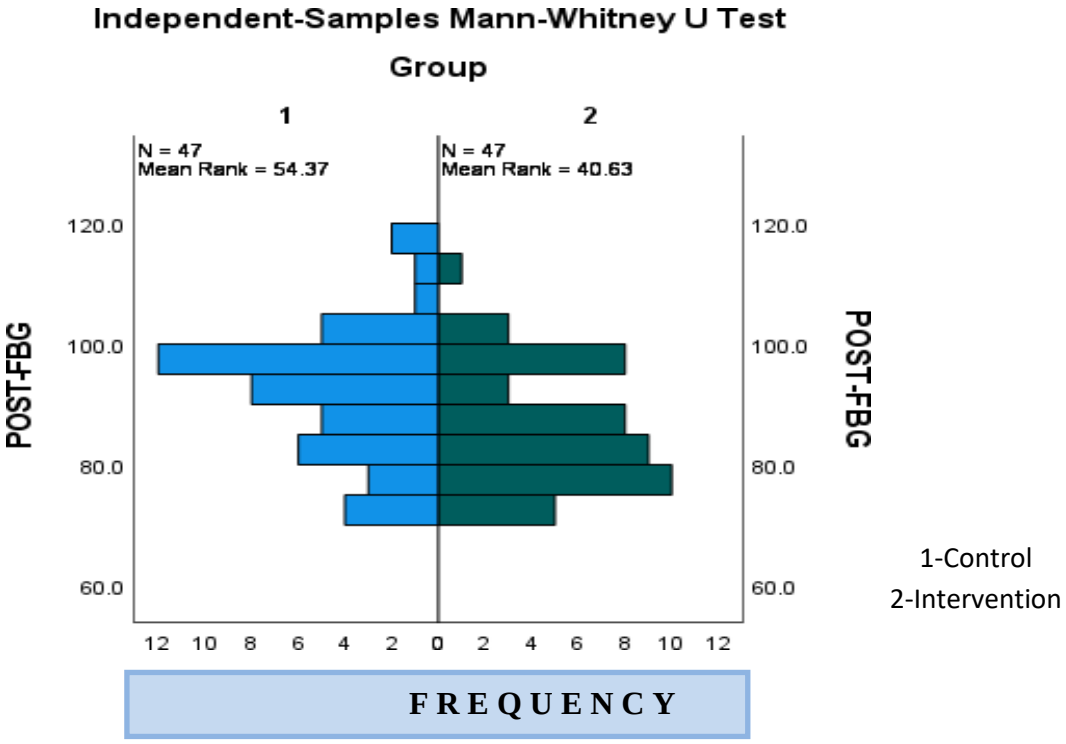
Pre test and post test values of Fasting Blood Glucose levels and Post Prandial Blood Glucose level within Intervention group



This chart shows the FBG mean rank value has improved from 2.68 to 1.04 and PPBG has improved from 3.98 to 2.30 which shows a statistically significant improvement($p<0.05$)

FIGURE 7:

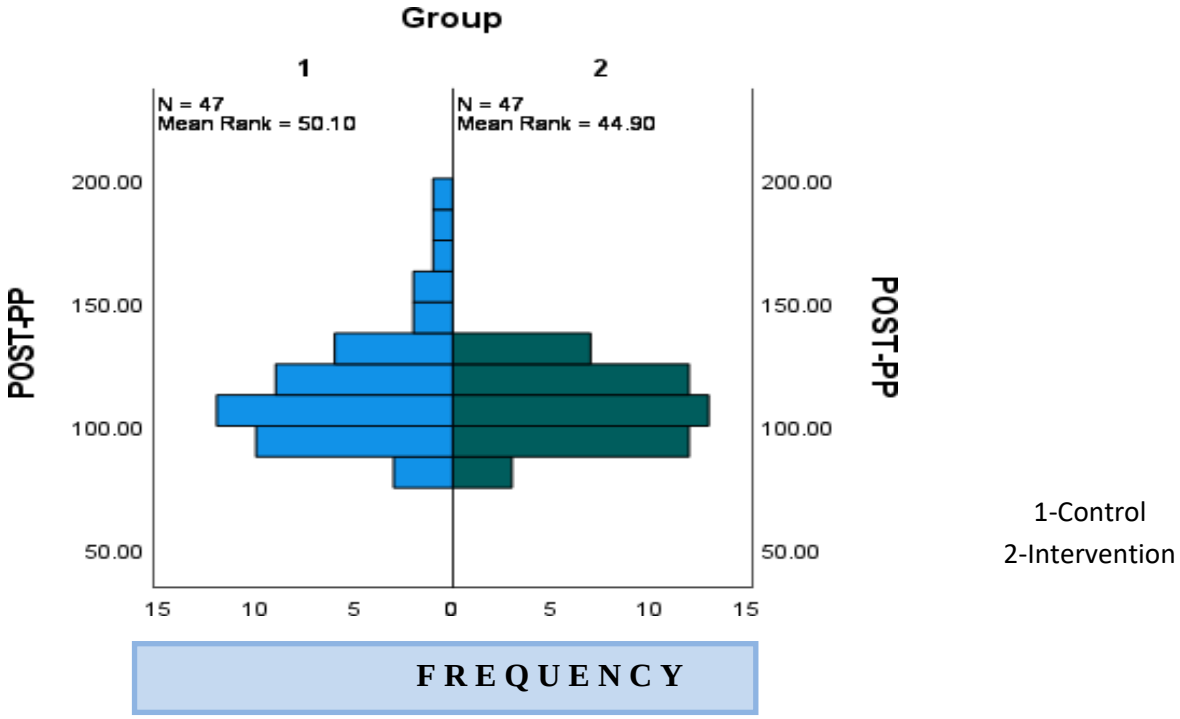
Between group analysis of Fasting Blood Glucose levels



This chart show the mean rank in control group is 54.3 and intervention group is 40.6 which shows better reduction of FBG in intervention than control group

FIGURE 8:

Between group analysis of Post Prandial Blood Glucose level



This chart show the mean rank in control group is 50.1 and intervention group is 44.9 which shows better reduction of PPBS in intervention than control group

TABLE 1 : Baseline Characters of both the control & Intervention group:

DESCRIPTIVE CHARACTERISTICS (n=47)		CONTROL	INTERVENTION
VARIABLES		MEAN± SD	MEAN ±SD
AGE		28.43 ± 3.126	27.26 ± 3.467
BMI		1.70 ± .462	1.45 ± .544
Occupation		1.74 ± .441	1.83 ± .380
		1.81 ± .647	2.02 ± .531
	FREQUENCY		
BMI	Normal	70%	40.4%
	Over weight	30%	57.4%
	Obese	0%	6.3%
Occupation	Unemployed	74.4%	82.9%
	Employed	23.4%	17.02%
Education status	Schooling	55.3%	72.3%
	Under Graduate	29.7%	8.5%
	Post Graduate	12.7%	12.7%

TABLE 2 :

Pre test and post test values of Fasting Blood Glucose levels and Post Prandial Blood Glucose level within control group

	N	Median	Std. Error	Z value	Sig.
Fasting Blood Glucose level Pre-test Control	47	114.0000	.266	-5.543	.000
Fasting Blood Glucose level Post-test Control	47	94.00	.266		
Post prandial Blood Glucose level Pre-test Control	47	161.0000	.266	-6.126	.000
Post prandial Blood Glucose level Post-test Control	47	110.00	.266		

P<0.05

This table shows that there was a significant effect of routine care on Fasting Blood Glucose and Post prandial blood glucose level in control group ($p<0.05$)

TABLE 3:

Pre test and post test values of Fasting Blood Glucose levels and Post Prandial Blood Glucose level within Intervention group

	N	Median	Std. Error	Z value	Sig.
Fasting Blood Glucose level Pre-test Intervention	47	119.00	.266	-6.710	.000
Fasting Blood Glucose level Post-test Intervention	47	84.000	.266		
Post prandial Blood Glucose level Pre-test Intervention	47	160.000	.266	-6.710	.000
Post prandial Blood Glucose level Post-test Intervention	47	107.0000	.266		

$p<0.05$

This table shows that there was a significant effect of Functional Resisted Training on Fasting Blood Glucose and Post prandial blood glucose level in Intervention group ($p<0.05$)

TABLE 4:

Between group analysis of Fasting Blood Glucose levels and Post Prandial Blood Glucose level

VARIABLE		MEDIAN	STD. ERROR	Z VALUE	P VALUE
Fasting Blood Glucose level	PRE - test	117.0000	.266	-1.373	.170
	POST- test	88.500	.266	-2.444	.015
Post parandial Blood Glucose level	PRE- test	161.0000	.266	-.499	.618
	POST- test	108.0000	.266	-.923	.356

$p<0.05$

This table shows that there was a statistically significant difference between groups in posttest values of FBG ($p<0.05$) but there is no statistically significant difference in PPBG values($p>0.05$)

CONCLUSION:

Functional resistance training has a significant effect in reducing Fasting Blood glucose level and a good clinical effect in reducing Post Prandial Blood Glucose levels in patients with GDM

LIMITATIONS AND RECOMMENDATIONS:

• Limited number of samples

• Can increase the offline session follow up .

• Can include Hba1c as the outcome measures

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