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ORIGINAL ARTICLE

Comparative study of structured physical exercise and metformin on glycemic control and body mass on obese type 2 diabetic

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Abstract

Background: Type 2 diabetes is a chronic condition characterized by high blood glucose levels and is associated with various health complications. Physical exercise and metformin are commonly used interventions to manage type 2 diabetes. This study was designed to systematically examine the effect of physical exercise and metformin on glycemic control with glycosylated hemoglobin (HbA1c) and body mass in an adult patient with type 2 diabetes. A randomized controlled trial was conducted on 699 participants who were divided into two groups. The 1st group received structured physical exercise, while the 2nd group received metformin therapy. Both interventions were given for the duration of 24 weeks. The outcome was evaluated by measuring weight, BMI, fasting blood glucose levels, HbA1c, and lipid profile levels before and after the interventions. The results showed that both interventions were effective in improving glycemic control. However, the structured physical exercise groups showed a statistically significant reduction in fasting blood glucose, HbA1c, BMI, and lipid profile parameters when compared to the metformin group. Especially the lipid profile, HDL-cholesterol showed no significant change with the metformin group. These findings suggest that physical exercise and metformin can be effective interventions for managing type 2 diabetes and that physical exercise may be particularly beneficial for improving insulin sensitivity. Additionally, the physical exercise group also showed improvements in cardiovascular fitness and body composition. It can be concluded that this study suggested that structured physical exercise can be an effective alternative therapy to metformin for obese individuals with type 2 diabetes in improving glycemic control & other cardiovascular risk factors. Further studies are needed to explore the long-term effects of these interventions on glycemic control and body mass in type 2 diabetes. Further study has to be carried out and explore the optimal dose and duration of physical exercise for improving glycemic control and body mass in type 2 diabetics in long term. As well as new drugs and its benefit with physical exercise in combination.

Keywords: Type 2 diabetes, physical exercise, glycemic control.

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Introduction

Type 2 Diabetes mellitus (T2DM) is the most common form of diabetes. T2DM newly diagnosed patients may have been hyperglycaemic for about one to two years before the diagnosis is established. Most patients with T2DM are obese when they develop diabetes, which aggravates insulin resistance.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

Diabetes has become an alarming problem in many developing countries like China and India. According to WHO the prevalence of diabetes is growing most rapidly in low and middle-income countries. The rapid socioeconomic change with urbanization and industrialization, with the sedentary lifestyle, has become the major factor of the global increase in the diabetes epidemic. Other risk factors such as population growth and unhealthy eating habits, all play important roles.

Diabetes due to its complications has become one of the leading causes of mortality. The southeast Asian region has the highest death ratio contributed to diabetes. In adults with one to two million deaths in 2019. India has contributed to more than one million death related to diabetes and its other complications. There is an urgent need for the development of strategies to prevent the emerging epidemic of T2DM. Several factors contribute to T2DM most important being rapid epidemiological transition due to urbanization and lifestyle change identification of individuals at risk is essential for planning and preventive measures. First of all, it is to prevent T2DM and once it is detected control of hyperglycemia and prevent future devastating microvascular and macrovascular complications is a must. This is by monitoring hyperglycemia control, lipid profile monitoring, and decreasing weight in obese T2DM.

Glycemic control can be improved by restricting caloric intake which is decreasing carbohydrate intake and lipids. At the same time, it is important to provide an appropriate treatment like exercise or the use of oral antidiabetic therapy. The main goal of therapy in T2DM is to reduce glycemic parameters, HbA1c, controlling all lipid parameter weight reduction and other parameters which can lead to other complications in a later stage.

Structured physical exercise has been shown to result in a reduction in body mass while also affecting cardiovascular parameters. Aerobic exercise is also known as cardio or endurance exercise which increases the heart rate and breathing rate. Aerobic exercise includes walking, jogging, cycling, swimming, and dancing. A minimum of 150 minutes of moderate-intensity aerobic exercise per week is a must with no more than 2 consecutive days without exercise.

Resistance and flexible exercise are also included at least twice per week. Resistance exercises include push-up squats while flexibility includes shoulder and arm stretches, and calf and hip stretches. Along with all exercises warm and cool-down periods should be included. All the people with T2 diabetes were consulted on health care before starting an exercise program.

Metformin is one of the established therapy for the treatment of type 2 diabetes. Metformin suppresses hepatic glucose production and delays glucose absorption from the gastrointestinal tract. This is evidence of improvement in insulin sensitivity and cardiovascular risk factors (2). The decision to use oral antidiabetic therapy is generally made after a trial of exercise and nutritional therapy or unless the initial random glucose level is higher than 300mg/dl.

Metformin reduces serum glucose levels through a nonpancreatic mechanism without increasing insulin secretion. It increases the effect of insulin hence also termed an “Insulin sensitizer”. Metformin activates the enzyme adenosine monophosphate kinase (AMPK) resulting in the inhibition of a key enzyme involved in gluconeogenesis and glycogen synthesis in the liver. (17) Furthermore metformin increases the use of peripheral glucose through increased non-oxidative glucose disposal to skeletal muscle. It usually does not cause hypoglycemia so it becomes one of the largely used antidiabetic drugs.

Material And Methods

The study was systematically reviewed for randomized control trial to study the effect of structured physical exercise and metformin effect upon glycemic control body mass and some other biochemical parameters in obese type 2 diabetes.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

The history of diabetes was based on the patient's self-report or a prior physician's diagnosis. The two groups included in the study were obese and type 2 diabetic. Group 1 followed structured exercise and group 2 was given metformin 850mg orally per day. Their weight BMI glycemic parameter HbA1c and lipid profile were monitored at baseline and after 6 months.

Care was taken during the one-hour fasting stage before the daily exercise. Dietician recorded the daily food intake and the anthropometric data to keep a check.

Inclusion criteria for the study group:

- Prior physician approval
- Age >= 28 years
- T2DM diagnosis established and confirmed
- No previous participation in regular exercise or metformin as medicine

Exclusion criteria for the study group:

- If the patient shifted to another medication
- Patient's were other pre-existing medical disabilities, CVD, regular contraindicated medication intake
- Patient's on lipid-lowering or weight-reducing therapy

Obesity was defined accordingly by the value of BMI which are according to the recommendation of the Indian council of medical research for India.

Results

In this study, the total number of participants was 241 in group 1 were given structured physical exercise, and in group 2 of 458 participants were on metformin 850mg/per day. Their anthropometric parameters that are weight and BMI was monitored and the biochemical parameter including glycemic parameter, HbA1c, and lipid profile was monitored at baseline and 6 months

Table 1: Anthropometric parameter of group 1 and group 2 at baseline and 6 months with mean ± SD with P value.

	Group 1				**Group 2**			
	Baseline		**6 months**		**Baseline**		**6 months**	
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**
Weight (Kg)	80.34	11.22	76.20	10.03	92.05	12.40	83.67	9.82
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
BMI (kg/m^2)	29.53	3.66	27.88	3.10	31.79	3.45	28.73	2.21
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Shows the mean values of group1(n=241) with structured physical exercise and group2(n=458) on metformin. The weight, BMI shows significant changes in both the groups from baseline to 6 months.

Table 2: Biochemical parameters including FBS, PP_2BS, HbA1c, and lipid profile.

	Group 1				**Group 2**			
	Baseline		**6 months**		**Baseline**		**6 months**	
	Mean	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**	**Mean**	**±SD**
FBS	138.46	4.64	127.70	4.50	189.41	9.15	119.88	4.18
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
PP_2BS	160.52	4.54	146.79	8.32	243.70	7.48	163.10	4.32
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

HbA1c	7.23	0.58	6.78	0.64	8.58	0.43	7.73	0.38
P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
TGS	162.73	12.94	147.95	10.59	181.88	20.23	165.45	15.27
P value	0.05	0.05	0.05	0.05	0.001	0.001	0.001	0.001
TC	197.26	10.71	183.42	10.25	225.90	35.83	213.98	32.83
P value	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
HDL-C	43.86	4.92	46.00	3.50	43.50	4.91	44.90	4.10
P value	<0.001	<0.001	<0.001	<0.001	0.05	0.05	0.05	0.05
LDL-C	120.85	10.51	111.07	16.56	146.24	34.52	126.29	26.35
P value	0.05	0.05	0.05	0.05	<0.001	<0.001	<0.001	<0.001

Shows the mean values of group1(n=241) and group2(n=458) on glycemic parameters and lipid profile at baseline and 6 months. In group1 glycemic parameters were significant($p<0.001$). From baseline to 6 months, whereas triglyceride and total cholesterol were less significant($p<0.05$). In group2 glycemic parameter were significant ($p<0.001$) but lipid profile total cholesterol was non-significant ($p>0.05$)

Table 3: Comparision of Group 1 and Group 2 at baseline and 6 months Baseline

	Group 1		**Group 2**		**P value**
	Baseline		**Baseline**		
	Mean	**±SD**	**Mean**	**±SD**	
Weight (Kg)	80.34	11.22	92.05	12.40	<0.001
BMI (kg/m^2)	29.53	3.66	31.79	3.45	<0.001

6 months

	Group 1		**Group 2**		**P value**
	6 months		**6 months**		
	Mean	**±SD**	**Mean**	**±SD**	
Weight (Kg)	76.20	10.03	83.67	9.82	<0.001
BMI (kg/m^2)	27.88	3.10	28.73	2.21	<0.001

Table 4: Comparision of the biochemical parameter of Group 1 and Group 2 at baseline and 6 months Baseline

	Group 1		**Group 2**		**P value**
	Baseline		**Baseline**		
	Mean	**±SD**	**Mean**	**±SD**	
FBS	138.46	4.64	189.41	9.15	<0.001
PP_2BS	160.52	4.54	243.70	7.48	<0.001
HBA1C	7.23	0.58	8.58	0.43	<0.001
TGS	162.73	12.94	181.88	20.23	<0.001
TC	197.26	10.71	225.90	35.83	<0.001
HDL-C	43.86	4.92	43.05	4.19	<0.001
LDL-C	120.85	10.51	146.24	34.52	<0.001
VLDL-C	32.55	2.59	36.61	4.07	<0.001

6 months

	Group 1		**Group 2**		**P value**
	6 months		**6 months**		
	Mean	**±SD**	**Mean**	**±SD**	

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

FBS	127.70	4.50	119.88	4.81	<0.001
PP_2BS	146.79	8.32	163.10	4.32	<0.001
HBA1C	6.78	0.64	7.73	0.38	<0.001
TGS	147.95	10.59	165.45	15.27	<0.001
TC	183.42	10.25	213.98	32.83	<0.001
HDL-C	46.00	3.50	44.90	4.10	<0.001
LDL-C	111.07	16.56	126.29	26.35	<0.001
VLDL-C	29.59	2.12	42.80	6.57	<0.001

Discussion

The impacts of T2DM are considered a life-long disease as it increases morbidity and mortality and decreases the quality of life (21). At the same time the disease and its complication cause a heavy economic burden for diabetic patients themselves, their families as well as society. The goal of this study was to determine the structured exercise and metformin benefits on glycemic control body mass and lipid profile. In the study, group1 and group2 showed a significant change (P<0.001) in weight and BMI when compared to baseline at 6 months. The other study also showed that weight loss was significant (P<0.001) in the intervention group where the program included exercise plus nutritional changes (22).

This phenomenon could be explained by a hypothesis suggesting that exercise training recruits twitching in skeletal muscle fiber, which leads to greater hypertrophy. In addition, body mass provides increased glycogen storage capacity for other mechanisms, which results in improved insulin sensitivity. Loss of visceral fat may be an important benefit of exercise that leads to a significant improvement in metabolic indices.

Metformin used by group 2 also showed a decrease in weight and BMI which was significant (P<0.001) from baseline to 6 months. The UK prospective diabetic study (UKPDS) demonstrated that metformin is as effective as sulfonylurea in controlling the blood glucose levels in obese patients with T2DM. Metformin yielded a stable patient body weight, cardiovascular protection, and a better patient survival rate when compared with sulfonylurea or insulin therapy. Therefore metformin is now accepted as a first-line drug for type 2 diabetes obese patients (3).

The structured physical exercise in group 1 and metformin in group 2, showed a significant (P<0.001) change in glycemic parameters including HbA1c at baseline to 6 months. Metformin has been shown effectively reduce fasting, post-prandial blood glucose, and glycosylated hemoglobin (HbA1c). (4) Metformin achieves a glucose-lowering effect, due to its multi-faceted action on peripheral tissues. It acts in the liver pancreas muscle fat and intestine. (5) There was a significant effect of metformin usage on HbA1c level independent of the moderate physical; activity lowered HbA1c significantly (P=0.007) and achieved the HbA1c to clinical target <7% (13).

The amount of glycosylated hemoglobin correlates well with fasting and postprandial blood glucose level. It is presently one of the most widely applied tests in the management of T2DM and it is the best-surrogated marker for setting goals for treatments

The most common lipid abnormality in T2DM is increased plasma triglyceride and low-level HDL-C. Dyslipidemia and insulin resistance are associated with increased fat and visceral adiposity (14). Exercise training can increase insulin sensitivity improve abs=normal lipid profile and consequently improve visceral adiposity (15). In group 1 slightly higher lipid parameters were present at baseline which showed a significant decrease (P<0.05) in lipid parameters at 6 months with a significant increase in HDL-C. Another study found a decrease in total cholesterol with both aerobic and yoga training but no change was seen in HDL-C and LDL-C. (16) In group 2 all lipid parameters were much higher at baseline and metformin showed no significant change in total cholesterol (P>0.05) and was less significant (P<0.05)

ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

in HDL-C. Metformin alone has less effect on lipid profile in our study. An increase in glucose clearance via the gut and other nonhepatic tissues is also associated with metformin (6, 7, 8). Whereas exercise enhances skeletal muscle glucose uptake by elevating contraction which mediates glucose transporter 4 (GLUT 4) translocation (9). Treatment of patients with T2DM begins with monotherapy usually metformin.

Conclusion

Both structured physical exercise and metformin can be effective interventions for managing type 2 diabetes. They showed a significant improvement in glycemic control and body mass. However physical exercise may be particularly beneficial for improving insulin sensitivity. The result of this study is consistent with a previous study that has reported the benefit of physical exercise and metformin in type 2 diabetes (18). The reduction in glycemic parameters (FBS, PP_2BS), HbA1c, and body mass are significant. It is an important study to be correlated as even a small reduction in HbA1c level can significantly reduce the risk of diabetic-related complications. The lack of significant difference between physical exercise and metformin in improving glycemic control suggests that both interventions can be equally effective however physical exercise may have an additional benefit for improving insulin sensitivity (19). This is in correlation with our study.

Insulin resistance is a key feature of type 2 diabetes and improving insulin sensitivity can reduce the risk of diabetes-related complications (20).

This study has some limitations that should be considered as it includes a relatively small population for analysis. Secondly, the duration of intervention should be of a longer time period. The ultimate goal is to control diabetes optimally so that long-term microvascular and macrovascular complications are minimized. The finding of this study support use of structured physical exercise in patients with glucose intolerance or impaired fasting glucose and obesity to reduce weight and prevent diabetes. Also managing type 2 diabetes with non-pharmacological interventions.

Further study has to be carried out and explore the optimal dose and the duration of physical exercise for improving glycemic control and body mass in type 2 diabetes in long term. As well as the study of new drugs and their benefits with physical activity in combination has to be studied.

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ISSN: 0975-3583,0976-2833 VOL14, ISSUE 03, 2023

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