

COMPARATIVE ANALYSIS OF ALTERATION IN CONCENTRATION OF INSULIN, GLUCOSE, GLYCATED HEMOGLOBIN AND LIPID COMPONENTS IN DIABETIC PATIENTS CARRYING OUT DIFFERENT EXERCISE REGIMENTS

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ABSTRACT

Physical activity of certain momentum or continuous periodic exercise reported to facilitate glucose metabolism, controls insulin sensitivity and regulation, resulting in consistent lipid metabolism and hepatic glucose uptake. The present study describes comparative analysis of three groups of controlled diabetic patients who regularly performed low, moderate and high intensity exercises on Glucose, lipids, Insulin and glycated hemoglobin. Sixty male adult diabetic patients, segregated into three groups, depending upon type and intensity of exercise they are routinely following, low (L), moderate (M) and high (H). Basic metabolic Indices (BMI), age, fasting glucose (Glu), cholesterol (CHOL), triglyceride (TG), low density lipoproteins (LDL), high density lipoprotein (HDL), glycated hemoglobin (HbA1c) and insulin were analyzed according to standard methods and compared statistically. Highly significant difference ($P < 0.0001$) in all parameters was noted when low intensity group compared with moderate intensity group, moderate with high intensity and low with high intensity. Furthermore, moderate and high intensity exercise showed considerable significant normalization effect on fasting Insulin levels ($P < 0.00001$). Data suggests direct conclusive effects of physical activity at cellular level metabolism activation, pro-activity of endothelial mechanism and blood hemostasis.

Key words: Physical activity, glucose metabolism, Insulin

INTRODUCTION

Insulin is a metabolic hormone, mostly anabolic for biochemical components other than glucose (Lin *et al.*, 2022). In diabetic condition, insulin resistance appears, which is known to be one of the co-morbid with deleterious consequences. Dyslipidemia, hyperglycemia, visceral obesity, hypertriglyceridemia, hypertension, metabolic dysfunction and extended inflammatory outcomes are few consequential clinical conditions that result after insulin resistance (Freeman and Pennings, 2021). Hyperinsulinemia is one of the more adverse outcomes of uncontrolled diabetes or metabolic syndrome, especially in fasting state, resulting in cardiac myopathies, lipoprotein abnormalities and hypertension-related renal dysfunction (Lin *et al.*, 2022). In last decade or so, physical therapist, clinicians, endocrinologists showed much interest in controlling insulin resistance, diabetic condition, and metabolic syndromes by using physical activity, exercise, swimming and cycling, depending on the type of patients and required activity regiments (Lin *et al.* 2022). Several previous studies reported physical inactivity and multiple sclerosis, treatment of Diabetes mellitus with exercise, epidemiological evidence exhibiting low physical activity and occurrence of Type 2 Diabetes mellitus (Manson *et al.*, 1991; Roberts *et al.*, 2013; Aune *et al.* 2015). Routine physical activity of certain momentum and continuous periodic exercise facilitate glucose metabolism, and controls insulin sensitivity, promotes insulin regulation resulting in beneficial changes in lipid metabolism, hepatic glucose uptake (Lin *et al.*, 2022). Multiple studies demonstrated that routine periodic physical activity in form of mild, moderate or vigorous exercises increases cardio-respiratory suitability regulates insulin activity and thus helps in controlling diabetic condition and its metabolic anomalies (Chruch 2010; Zhang *et al.*, 2017; Lin *et al.*, 2022). Present study detailed comparative analysis of insulin concentration, glucose, cholesterol, triglyceride and low-density lipoprotein levels in three groups of controlled diabetic patients who are on diabetes medication, metformin, and regularly performs low, moderate and high intensity exercises.

MATERIALS AND METHODS

Sixty adult diabetic patients, all males, aged 28 to 47, under metformin (Glucophage) medication, minimum of 1 years to maximum of 3 years duration, 350 mg to 750 mg OD, daily, were selected for present study. Study period was June 2022 to September 2022. These sixty individuals were segregated into three groups, depending upon the type and intensity of exercise they are routinely following, low (L), moderate (M) and high (H). Exercise regiments were detailed in a study reported earlier by our research group (Azeemi *et al.*, 2021) and followed as per protocols provided in a recent study (Collins *et al.*, 2022). Basic metabolic Indices (BMI), age and related parameters were collected and analyzed. Fasting glucose (Glu), cholesterol (CHOL), triglyceride (TG), low density lipoproteins (LDL), high density lipoprotein (HDL), glycated hemoglobin (HbA1c) and insulin were analyzed according to standard methods described earlier (Azeemi *et al.*, 2020). Data were compared with each other such that Low exercise group vs Moderate, Moderate vs High and so on. Results are expressed as mean \pm SD and statistical analyses as $P < 0.05$ as significant, using One way ANOVA including Tukey's HSD (honestly significant difference).

RESULTS

Results are summarized in Table 1. It is obvious from the statistical analysis that moderate and high intensity exercise regiments by diabetic individuals do control metabolic indices, lipid components and facilitate normalization of insulin levels. Highly significant difference ($P < 0.0001$) in all parameters viz, glucose, insulin, TG, CHOL, LDL and HDL was noted when low intensity group compared with moderate intensity group, moderate with high intensity and low with high intensity (Table 1). Exercise details, that the individuals were following are Low intensity = 30 min to 45 min Brisk walk, one set of 15 squats; moderate = 30 minutes mild jogging on trade mill, one set of 15 squats and high intensity = 30 minutes, Aerobic exercise, 30 minutes jogging on trade mill and 3 repeat sets of 15 squats. BMI doesn't seem to show any significant difference between Low and Moderate, whereas suitable significance ($P < 0.004$ to $P < 0.0004$) was noted when comparison done M vs H and L vs H. Furthermore, moderate and high intensity exercise showed considerable significant normalization effect on fasting Insulin level ($P < 0.00001$).

DISCUSSION

Present study describes the effects of various exercise regiments, low, moderate and high intensity on concentration of insulin, glucose, glycated hemoglobin (HbA1c) and lipid components in diabetic's patients who are in controlled status and on daily OD metformin (glucophage) medication. Data revealed significant effects of high and moderate intensity exercise on glucose, insulin, HbA1c, cholesterol and lipoprotein (HDL, LDL) concentrations, suggesting appreciable regulation of carbohydrate metabolism, insulin secretion, and lipid metabolism. Recent and past studies reported that exercise, subsequent weight loss and improved BMI enriches cardio-pulmonary function resulting in controlled status of diabetic patients, inclusive of insulin activity and glucose homeostasis (Coker *et al.*, 2006; DiPietro *et al.*, 2006; Malin *et al.*, 2013; Collins *et al.*, 2022). It was also argued that different intensities of exercise also has variable effects ensuing wide spectrum of alterations (Houmard *et al.*, 2004; Sigal *et al.*, 2007; Chruich *et al.*, 2010; AbouAssi *et al.*, 2015; Collins *et al.*, 2022; Fitzpatrick *et al.*, 2022). Having caloric restriction, and following medication regiments, inclusive of regular exercise of different intensities, noted to induce better and sustainable changes in body composition, metabolic profile, glucose homeostasis and insulin sensitivity (Collins *et al.*, 2022; Fitzpatrick *et al.*, 2022; Lin *et al.*, 2022). Changes (or normalization, lowering effects) that we have noted in our study such as lowered (within normal reference range) insulin level in high intensity exercise group have been verified by other earlier studies as well (Collins *et al.*, Lin *et al.*, 2022), advocating correlation of physical activity and better, healthier metabolic profile. Moreover, lipid indices, such as TAG, cholesterol, HDL levels and more specifically LDL concentration were also noted to be in more towards normal reference range in all exercise groups in ratio H>M>L. Glycated hemoglobin-HbA1c, indicator of glucose hemostasis during last 120 days, also seems to be nearer to normal range in high intensity exercise group than moderate and low, suggesting proportionate relationship of intense physical activity, endothelial mechanism and insulin action (Azeemi *et al.*, 2020, 2021; Collin *et al.*, 2022;).

Table 1. Comparative analysis of alteration on concentration of insulin and lipid components in diabetic patients performing different exercise regiments.

Components	Exercise regiments and groups		
	Low intensity (L) N = 20	Moderate intensity (M) N = 20	High Intensity (H) N = 20
Age years	35.95 ± 5.51	34.05 ± 4.95	36.05 ± 5.65
BMI Normal range: 18.5 kg/m ² - 25 kg/m ²	20.35 ± 2.25	20.14 ± 1.75	18.95 ± 1.17
	L vs M Q = 0.15 (p < 0.99389)	M vs H Q = 4.33 (p < 0.00934)	L vs H Q = 4.48 (p < 0.00694)
Sugar (fasting)	113.40 ± 5.164	106.06 ± 3.67	97.2 ± 4.25
< 100 mg/dl	L VS M Q = 7.46 (p < 0.00001)	M VS H Q = 16.44 (p < 0.00000)	L VS H Q = 8.98 (p < 0.00000)
Cholesterol	149.65 ± 9.47	125.53 ± 5.36	111.71 ± 5.76
≤ 200 mg/dl	L VS M Q = 15.23 (p < 0.000001)	M VS H Q = 23.54 (p < 0.000001)	L VS H Q = 8.30 (p < 0.000001)
Triglyceride	226.3 ± 9.34	182.70 ± 8.87	162.7 ± 8.99
70-150 mg/dl	L VS M Q = 21.49 (p < 0.000001)	M VS H Q = 31.35 (p < 0.000001)	L VS H Q = 9.86 (p < 0.000001)
HDL	32.8 ± 2.94	42.65 ± 2.90	49.85 ± 5.23
≥ 35 mg/dl	L VS M Q = 11.43 (p < 0.000001)	M VS H Q = 19.79 (p < 0.000001)	L VS H Q = 8.36 (p < 0.000001)
LDL	143.45 ± 14.44	126.15 ± 11.46	114.25 ± 9.61
≤ 130 mg/d	L VS M Q = 6.55 (p < 0.00006)	M VS H Q = 10.99 (p < 0.00000)	L VS H Q = 4.43 (p < 0.00757)
Insulin (fasting) 2-20 μmole/mL	18 20.9 ± 1.86	16 16.9 ± 2.31	10 11.10 ± 1.16
	L VS M Q = 9.71 (p < 0.000001)	M VS H Q = 23.79 (p < 0.000001)	L VS H Q = 14.08 (p < 0.000001)
HbA1c	7.54 ± 0.40	6.7 ± 0.30	5.9 ± 0.24
4.0 -5.6%	L VS M Q = 11.53 (p < 0.000001)	M VS H Q = 22.43 (p < 0.000001)	L VS H Q = 10.91 (p < 0.000001)

P < 0.05 is significant, results are expressed as mean ± SD. Comparative statistical analysis performed as L vs M, M vs H and L vs H using One way ANOVA including Tukey's HSD

CONCLUSION

The present study described the effects of low, moderate and high intensity exercise on glucose, insulin, lipid components and HbA1c in a group of diabetic patients.. Data manifested significant difference in concentration of these biochemical components and insulin, suggesting direct conclusive effects of physical activity, cellular level metabolism activation, pro-activity of endothelial mechanism and blood hemostasis.

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