

## ORIGINAL RESEARCH

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## ANALYSIS OF PHYSICAL ACTIVITY PATTERNS AMONG TYPE-2 DIABETES MELLITUS: A CROSS-SECTIONAL STUDY

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## ABSTRACT

**Background:** The primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes in urban population. Diabetes mellitus is increasing at an alarming rate in India. It is evident that physical activity (walking) is beneficial in management of this disease. Walking can be effective in reducing weight, body mass index, waist hip circumference, body fat, blood pressure and thus cholesterol, high density lipoproteins ratio and may be effective in improving mood and quality of life. The objective of the present study was measuring the normal physical activity in terms of step counts done by the type-2 diabetes mellitus (T2DM) patients and analyse the dietary pattern followed by T2DM.

**Methods:** Eighty adults with type-2 diabetes mellitus were randomly allocated for observation of their normal daily physical activity using pedometer for whole day which means starting from early morning get up till bedtime in night. The subjects had been asked to count their steps in a particular activity also.

**Results:** The mean value of step count with standard deviation among females (n=31) was found to be  $9173.23 \pm 3862.025$  which was lesser than that among males (n=49) that is  $9695.49 \pm 5221.291$ . After measuring step count in any particular activity task, the mean value  $2583.35 \pm 2562.08$  was found to be more in males than females where mean value was found to be  $2197.13 \pm 1732.75$ . The mean step count among total sample (n=80) was  $9493.11 \pm 4721.626$  and mean particular activity step count was  $2433.69 \pm 2272.541$ .

**Discussion:** This study showed that some subjects were so aware of their disease that they were found to be highly active after knowing their disease and condition. On other hand, there were some subjects having sedentary lifestyle with their HbA1c at the high risk level. They thought it to be as it is for the rest of their life that it is incurable so this study helps them to make aware of the modified lifestyles and dietary habits with which they can control their glucose level, cholesterol by having a routine of some physical activity.

**Conclusion:** It can be concluded from the present study that physical activity among the subjects with Type II diabetes was very low and it supports the clinically proven facts by other studies that more the physical activities, more is the control in blood sugar level and cholesterol level in subjects with Type II diabetes.

**Keywords:** Type 2 diabetes, Glycemic control, Pedometer, Physical Activity.

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## INTRODUCTION

Diabetes mellitus is a serious disease and a cause for a growing public health concern in both developed and developing countries. According to International diabetes federation (IDF) 381.8 million people had diabetes in 2013 and this number is projected to increase up to 591.9 million by 2035.<sup>1</sup> Roughly, 80% of people with diabetes are in developing countries.<sup>2,3</sup> Recent studies of geographical and ethnical influences have shown that people of Indian origin are highly prone to diabetes.<sup>4</sup> As they manifest insulin resistance and the metabolic syndrome at younger age and at a higher magnitude than any other ethnic group.<sup>5</sup>

Globally the number of people with diabetes is expected to double between 2000 and 2030 while public awareness about this disease remains low<sup>6</sup> and the reason behind is ageing population, unplanned urbanization and globalization of trade and marketing.<sup>7</sup> Also several modifiable risk factors include a sedentary lifestyle, poor eating habits with refined food, overweight/obesity, high blood glucose, hypertension, smoking and a family history of T2DM lead to excess weight gain and insulin resistance which can provide a variety of abnormalities that are collectively termed as Metabolic syndrome.<sup>8</sup>

According to World Health Federation, physical inactivity increases the risk of hypertension by 30% and coronary heart disease by 22%.<sup>9</sup> Similarly, the focus of physical activity in the control of diabetes and its complications are lacking in India. Physical activity/exercise has long been recognised as a cornerstone for the treatment of patients with T2DM. Combined training thrice weekly in individuals with T2DM may be of greater benefits to blood glucose control.<sup>10</sup> An increase of energy expenditure by 2000 calories/week is associated with a reduction of 24% in the risk of developing the disease.<sup>11</sup>

A study showed that 150 minutes of physical activity in a week (30 minutes, 5 times a week) helped to prevent or delay T2DM. Similarly the Diabetes prevention programme<sup>12</sup> showed people with elevated blood glucose level who are at a risk of developing T2DM can reduce the risk by 58% through sustained modest intensity exercise, such as walking 30 minutes daily which requires no equipment, easy to perform, therefore the most common and most acceptable form of physical activity.

### EXERCISE BENEFITS FOR T2DM

**GLYCEMIC CONTROL:** Improved insulin sensitivity for glucose transport in skeletal muscle

and adipose tissue after a short exercise bout results from (1) translocation of the glucose transporter protein GLUT4 from the endoplasmic reticulum to the cell surface and (2) an increase in the total quantity of GLUT4 i.e 4 days of vigorous training increased skeletal muscle GLUT4 content and insulin stimulates glucose transport by upto 100%. Improved insulin sensitivity is one of the most important health benefits that regular physical activity provides to the diabetic.

**PSYCHOLOGIC PROFILE:** Improved exercise capacity in diabetic relate to decrease anxiety, improved mood and self-esteem, increased sense of well-being and psychologic control, enhanced socialization and improved quality of life.

**OCCURRENCE OF TYPE-II DIABETES:** During the physical activity, the mechanism which occurs in the body is as follows - There is increase in membrane transporters in response to both insulin and exercise which results from an increase in glucose transporter type 4 (GLUT4) translocation. These stimuli recruit GLUT4 from different intracellular pools<sup>13</sup>. Also, T2DM individuals are usually insulin resistant but they are not resistant to the stimulatory effects of exercise on glucose utilization. So, T2DM subjects retain the capacity to translocate GLUT4 to the sarcolemma in response to exercise<sup>14</sup>. The functional recruitment of GLUT4 transporters coupled to elevated circulating glucose levels can actually lead to a greater rate of glucose utilization of muscle of people with T2DM. Exercise and insulin stimulate glucose utilization synergistically. The primary route of insulin mediated glucose metabolism at rest and in the post-exercise state is non-oxidative metabolism. Exercise, however shifts the route of insulin stimulated glucose disposal so that all the glucose consumed by muscle is oxidised.<sup>15</sup>

Since little is known about the physical activity and dietary habits of diabetics, it is difficult to evolve strategies to motivate diabetics to embrace a healthier lifestyle. Methods for measuring physical activity include accelerometer, room calorimeter, indirect-calorimeter, heart-rate monitoring and pedometer. The simplest among these tools is the pedometer which is also used in the study.

### PEDOMETER

Pedometers, which measure walking activity in the form of daily step counts, also serve as a motivator and have become popular components of physical activity interventions. Walking is an appropriate and safe form of physical activity which improves glucose utilization in inactive people diagnosed with T2DM.<sup>16</sup> Using a pedometer as a set step goal is of great interest, as this method of exercise

prescription does not involve an intensity recommendation and relies solely on increasing overall daily walking.<sup>17</sup> Feedback from pedometer step counts has been observed to trigger behavioural changes, as they raise awareness of current walking behaviour and can be used to motivate and self-monitor.<sup>18</sup>

A study showed that approximately >9000 steps/day were associated with body composition benefits and suggested that approximately <5000 steps/day were indicative of an index of sedentism related to unhealthy body composition.<sup>19</sup>

### SCALE FOR STEP COUNT TO IDENTIFY LIFE STYLE

Considering the importance of physical activity in predisposing individuals to diabetes, it is important to study the patterns of physical activity in diabetes. There is no study which shows the data of physical activity in terms of step-count in T2DM among North Indian (Punjab) population.

1) <5,000 steps/day; and	(sedentary)
2) 5,000-7,499 steps/day	(low active)
3) 7,500-9,999 steps/day	(somewhat active)
4) ≥10,000-12,499 steps / day	(active)
5) ≥12,500 steps/day	(highly active)

### AIMS AND OBJECTIVE

- This study was devised with the main objective of monitoring the daily physical activity in terms of step counts performed by T2DM patients.
- Secondary objective was to analyse the dietary habits of the T2DM patients.
- To study the step count record performed in the daily activity schedule of each individual T2DM patient.

- To estimate and monitor the step count with the help of pedometer in their daily routine.

### SIGNIFICANCE OF THE STUDY

Results of this research will identify key areas for further research for implementation of exercise training for prevention and control of this disease.

### INSTRUMENTATION AND OUTCOME MEASUREMENT

To carry out the study, following tools were used:

- Weighing machine (Camry Glass Electronic Personal Scale) to measure body weight to the nearest 0.1 kg.
- Stadiometer to measure height to the nearest 0.25 cm.
- Body mass index (BMI) was determined by body weight and height as kg/m<sup>2</sup>
- Pedometer used to measure step count of the subjects without any difficulty.

### PROCEDURE

- Pre study medical screening was done for all subjects and subjects were recruited after they fulfilled the inclusion criteria and signed the consent form and then all reports of HbA1c of the subjects were checked.
- Detailed history of the patient was taken including age, past medical history and medication used.
- The subjects were instructed for the use of pedometer while doing various physical activities.
- Step counts of the subject for daily physical activities and any particular activity apart from the daily routine were checked at the end of the day.
- After successful completion of the study in T2DM population, the normal physical activity required and diet chart to the patient for rest of their life were suggested to them.



**ETHICAL APPROVAL:** The study was given approval by Institutional Ethics Committee, Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar.

### STATISTICAL ANALYSIS OF THE DATA

The arithmetic mean, standard deviation and standard error were used to prepare summary of the statistics. The data was analyzed for statistical significance using statistical package for social sciences (SPSS) software.

- I. The special statistical tests used to analyse a data for level of significance were –

- II. One way analysis of variance for different subject design (ANOVA) - which tells us if there exist significant or non-significant differences in the results from the different conditions. By calculating f value, P value is looked for in the table at the appropriate degree of freedom.
- III. Chi-square test ( $\chi^2$ ) – It is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance.
- IV. Pearson correlation - It is widely used as a measure of the degree of linear dependence between two variables.

### RESULTS

TABLE-1.1

PARAMETERS	MALES (MEAN $\pm$ S.D)(N = 49)	FEMALES (MEAN $\pm$ S.D) (N = 31)	TOTAL (MEAN $\pm$ S.D) (N = 80)
AGE(Yr.)	55.82 $\pm$ 4.91	55.03 $\pm$ 4.73	55.51 $\pm$ 4.82
HBA1C(%)	6.89 $\pm$ 0.82	7.06 $\pm$ 0.89	6.96 $\pm$ 0.85
BMI(k/m <sup>2</sup> )	27.37 $\pm$ 3.17	30.23 $\pm$ 3.71	28.48 $\pm$ 3.64
STEP COUNT	9695.49 $\pm$ 5221.29	9173.23 $\pm$ 3862.02	9493.11 $\pm$ 4721.62
PARTICULAR ACTIVITY STEP	2583.35 $\pm$ 2562.08	2197.13 $\pm$ 1732.74	2433.69 $\pm$ 2272.54

Table 1.1 depicts the data distribution of mean values and standard deviation of male sample, female sample and total sample size for

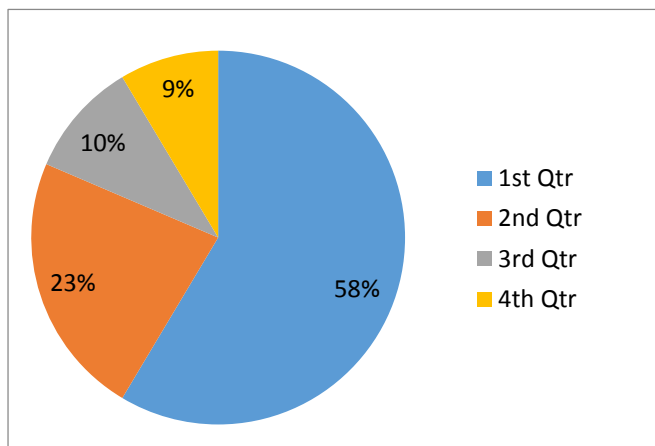
anthropometric measurements (age, BMI) and physical activity (step count and particular activity step).

TABLE-1.2

Step count	Hba1c <5.7		Hba1c 5.7-6.4		Hba1c 6.5-7		Hba1c 7.1-8.5	
	Male	Female	Male	Female	Male	Female	Male	Female
< 5000	0	0	4	0	1	0	5	4
5000-7499	1	0	4	4	2	1	4	4
7500-9999	0	1	1	1	4	2	1	2
10,000-12499	0	0	1	2	2	4	1	0
>12500	0	0	6	2	9	2	3	2

Table 1.2 shows the correlation between the physical activity (life style) and Hba1c for males and females. The maximum number of male i.e 5 falling in the category of Hba1c ranging from 7.1-8.5 (high risk) leading to a sedentary life style (< 5000 steps/day) where as there are 6 males falling in the category of Hba1c 5.7-6.4 (pre-diabetic) leading to a very active life style (>12,500). The normal range of HbA1c (<5.7) only 1 female were found who is somewhat active. In the high-risk HbA1c category 4 females are found sedentary, 4 are found low-active, 2 were somewhat active and 2 are highly active.

Figure 1: STEP COUNT MEAN VALUE OF MALES AND FEMALES ACCORDING TO HbA1c STANDARD RANGE



The above figure shows the correlation between mean step count of males and females according to HbA1c standard range. The 58%, 2<sup>nd</sup> Qtr 23% is pre-diabetic (5.7-6.4), 3<sup>rd</sup> Qtr is 10% for high-risk (7.1-8.5) and the 4<sup>th</sup> Qtr 9%.

**DISCUSSION**

Diabetes has emerged as a major healthcare problem in India and it is estimated that every fifth person with diabetes will be an Indian <sup>20</sup>. The awareness regarding physical inactivity and sedantarism in the etiology of diabetes is lacking as emphasized by *Surgeon General's* report on physical activity which showed only about 15% engage in regular, vigorous physical activity during leisure time, 3 times a week for at least 30 minutes

and more than 60% do not engage in physical activity regularly. 25% leads sedentary lives i.e. they do not exercise at all and 22% engage in light to moderate physical activity during leisure time i.e. 5 times per week for at least 30min. Physical inactivity occurs more among women than men, blacks and Hispanics than whites, older than younger adults <sup>21</sup>. Out of 30 different methods to assess physical activity including direct and indirect calorimetry, self reports and questionnaires, job classifications, physiologic markers, behavioural observations, mechanical or electronic monitors and activity surveys, one is pedometer. Pedometer serves as biofeedback methods to provide feedback to the patient about his activity and any improvement in the same and in this study we monitored the effectiveness of pedometer. Pedometer based interventions have produced significant improvements in physical activity, weight management, blood pressure and lipid profile.

**PHYSICAL ACTIVITY AND GLYCEMIC OUTCOMES**

The main aim of our study was to investigate if using pedometer to monitor walking would be standardised. Therefore, here the researcher tried to analyse the patterns of daily physical activity in terms of pedometer step counts and dietary patterns in T2DM patients.

In the present study of sample of 80, 49 males and 31 females were there and the mean value of blood glucose among males and females were found to be 116.98 and 117.26 with standard deviation of 23.414 and 21.758 respectively. Taking HbA1c into account, only 1 male and 1 female each have value of <5.7 that means normal. But there are 16 males and 9 females which fall in category of pre-diabetic, 18 males and 12 females fall in category of HbA1c 6.5 to 7.0 whereas 14 males and 12 females are at very high risk having their HbA1c ranging from 7.1 to 8.5. This data showed that how badly people with T2DM at high risk of complications in Punjab, India. The step count, which subjects take, varies from person to person. Sedentary adults take less



than 5000 steps per day. A healthy number of steps per day for an adult are more than 9000, which is associated with body composition benefits. It is found that keeping a record of activity using pedometers can help people with T2DM track their goal. <sup>22</sup>

Further, physical activity is associated with multiple health benefits including improvement in obesity, coronary artery disease, hypertension, lipid profiles <sup>11</sup>. Therefore in the present study cholesterol level was also taken into account. The mean value of cholesterol in males (n=49) was found to be  $191.96 \pm 51.01$  whereas in females (n=31), it was  $220.84 \pm 55.21$  and in overall sample (n=80) the mean value with standard deviation was measured to be  $203.15 \pm 54.21$ .

After measuring step count in any particular activity task, the mean value was found to be more in males than females.

A perusal of relevant literature indicates that pedometer has been used in this study in T2DM. This study helps the researcher to assess the lifestyle of the subjects with T2DM whether it is sedentary, low active, somewhat active, active or highly active. This study showed that some subjects are so aware of their disease that they were found to be highly active after knowing their disease and condition. On other hand, there are some subjects having sedentary lifestyle with their HbA1c at the high risk level. They thought it to be as it is for the rest of their life that it is incurable so this study helps them to make aware of the modified lifestyles and dietary habits with which they can control their glucose level, cholesterol by having a routine of some physical activity. It acts as a biofeedback for the subjects from whom they can learn to be more active and fit, to lead a healthier life rather than keeping it bound to be at a bed.

## CONCLUSION

Walking along with pedometer improves the physical activity of the T2DM population and the metabolic profile of adults with T2DM. Walking along with pedometer results in significant changes in BMI. The findings of the present study demonstrate the efficacy of walking with pedometer help in reduction of HbA1c, obesity, FBG and improve general wellbeing. Pedometer is a very good biofeedback apparatus, and due to its easy availability it can be used at later stage to enhance their physical capability.

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