Impact of pedometer based physical activity on glycemic control and body composition of type 2 diabetes mellitus patients

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ABSTRACT

Introduction: Exercise therapy is considered as a cornerstone for the management of type 2 diabetes mellitus patients. Pedometers have been used to track the walking progress and to motivate physical activity in type 2 diabetes mellitus patients. The main aim of the study was to investigate whether administration of physical activity using pedometer can reduce HbA1c levels in type 2 diabetes mellitus patients.

Materials and Methods: Study participants were 34, type 2 diabetes mellitus patients, aged between 35 to 55 years. They were randomly divided into experimental (n=17) and control group (n=17). Subjects in the experimental group walked 10,000steps/day for 12 weeks. The subjects in the control group did not undergo any intervention. HbA1c level, blood pressure, body fat percentage, body mass index, waist hip ratio and quality of life were measured for both groups before and after intervention.

Results: The study result showed that there was a significant reduction in HbA1c levels (p=<0.001) and significant improvement in quality of life (p=<0.001) in the experimental group after 12 weeks of pedometer based physical activity. However, no significant decrease was found with respect to the body fat percentage, body mass index, waist hip ratio and blood pressure in the experimental group.

Conclusion: Pedometer based physical activity improves the glycemic control and the quality of life in type 2 diabetes mellitus patients.

Keywords: Pedometer; type 2 diabetes mellitus; HbA1c; physical activity.

INTRODUCTION

According to World Health Organization's prediction, 57.2 million people will be affected by diabetes in India through the year 2025 (1). Some lifestyle factors as if obesity, physical inactivity and poor diet make diabetes an evolving threat to both developed and developing countries (2). Aerobic training improves insulin sensitivity and lipid profiles in type 2 diabetes mellitus patients (3).Walking appears to be the preferred activity among sedentary individuals taking up physical activity (4, 5). Walking improves glucose utilization in type 2 diabetes mellitus patients. It is also widely accepted as a safer form of physical activity (6).

Physical activity trackers generally measure an array of fitness related metrics namely the number of steps covered, heart rate, quality of sleep, etc. They range from wristbands to smart watches. Pedometers are low cost devices that respond to vertical acceleration of the hip during gait cycles and thereby measures physical activity with standard accuracy (7). This type of physical activity does not rely on any mode of exercise intensity rather than increasing daily steps of walking (5). Many studies have used pedometers as a measurement tool of physical activity through walking (7, 8). Though there is no recent analysis of pedometer's effectiveness in increasing physical activity in type 2 diabetes mellitus patients when compared to other methods, they have been widely used to track their progress and to motivate physical activity in type 2 diabetes mellitus patients (6).

The crucial goal of all health interventions is to improve the quality of life. The key determining factor for improvement of quality of life in type 2 diabetic patients is the systemic effects of diabetes mellitus. Some studies of scientific interventions recommend that improving patient's capability of having a control over their health condition and improving their health status results in improved quality of life (9). Not many studies have highlighted the importance of pedometer in motivating the physical activity of type 2 diabetes patients. Therefore, this study aims to prove how pedometer usage can benefit type 2 diabetes mellitus patients in improving their glycemic status and quality of life.

METHODOLOGY

After obtaining clearance from Institutional Ethics Committee of Sri Ramachandra Institute of Higher Education and Research, the subjects were enrolled into the study. Study participants were type 2 diabetes mellitus (T2DM) patients of age group from 35 to 55 years on oral hypoglycemic drugs, visiting Diabetes Clinic of Sri Ramachandra Medical College and Research Institute. This particular age group was selected because of the fact that any physical activity promotion in this group would help in the optimal management of diabetes and averting its long-term

complications. Our study exclusively targets type 2 diabetes mellitus patients since the beneficial effects induced by physical activity on glycemic control has not been convincingly proven in type I diabetes by previous studies. Exclusion criteria comprised of patients having conditions that would interfere with physical activity or having any long-term complication of diabetes. Informed written consent was collected from the study participants. The study participants (n=34) were randomly divided into experimental group (n=17) and control group (n=17). For subjects in both experimental and control group, Hba1c level was measured using their blood samples. Blood pressure and anthropometric variables were measured, and the subjects of both groups were asked to fill the quality of life questionnaire specific for diabetes mellitus. Each subject in the experimental group wore a PINGKO Outdoor Multi-Function Portable Sport Pedometer for majority time of the day and was instructed regarding proper placement of the pedometer on the waist. The pedometer was reset to zero on every morning.

Before going to bed, the subject recorded the steps accumulated during the day in an activity log. They were asked to cover 10,000 steps/day on five or more days of the week for 12 weeks. We have chosen 10,000 daily step count as a mode of moderate intensity physical activity (10). The American College of Sports Medicine has recommended that every adult should accumulate at least of 150 minutes of moderate intensity physical activity on five or more days of the week (11). The compliance of the study was checked every week through phone conversation. The control group was asked to maintain their normal activity levels throughout the intervention period. No dietary intervention was done for both the groups during the study period. Participants were asked to follow their regular diet throughout the study. After 12 weeks, during the subject's outpatient visit, HbA1c level was measured again for both experimental and control groups. Anthropometric measurements and quality of life assessments were repeated after 12 weeks.

Blood sample

The HbA1c level measures the non-enzymatic glycation of hemoglobin A that represents the exposure of hemoglobin to glucose throughout 120 days (12). A reasonable HbA1C goal for many non-pregnant adults with T2DM is <7% as per American Diabetes Association (ADA) "Standards of Medical Care in Diabetes" (13). Blood sample was collected to examine the levels of HbA1c before and after 12 weeks.

Blood pressure

Systolic and diastolic blood pressure were measured for experimental and control groups both before and after 12 weeks using sphygmomanometer.

Body composition

Body mass index was calculated using SECA machine. Skin fold measurements were taken with a Harpenden caliper at the following sites: biceps, triceps, subscapular and suprailiac. Percentage body fat was calculated by using Durnin and Womersley equation (14). These measurements were done both before and after 12 weeks.

Waist-hip ratio

Waist circumference and waist-hip ratio is the marker of abdominal obesity. Waist circumference was measured at the lower margin of the least palpable rib. Hip circumference was measured around the widest portion of the buttocks. Waist hip ratio was calculated.

Quality of life questionnaire

The subjects were asked to fill the Ferrans and Powers Quality of Life Index – Diabetes III Version both before and after 12 weeks. The following scores were calculated (1) Total Quality of Life Score (2) Health and functioning subscale score, (3) Social and economic subscale score, (4) Psychological/spiritual sub-scale score, and (5) Family subscale score (15). Total score of the instrument can vary from 0 to 30. Highest values represent better quality of life.

RESULTS

Table 1 shows that there is no significant difference in Age, Height, Weight, BMI, BF%, Waist hip ratio and Hba1c between both the groups. (Table 1)

Table 1: Baseline values

Parameters	Experimental group	Control group
Age (Yrs)	48.07±4.19	47.23±7.10
Weight (Kg)	67.87±9.45	69.37±10.32
Height (cm)	157.5±0.10	158±0.06
BMI (Kg/m^2)	27.75±3.47	27.91±4.42
BF%	29.17±6.32	28.22±6.30
Waist: hip	0.88±0.07	0.87±0.07
HbA1c (%)	9.0±0.01	8.21±0.79
SBP (mmHg)	127.5±16	123.43±11.28
DBP (mmHg)	76.87±7.68	78.12±9.49
QOL	24.24±2.82	19.42±6.38

Table 1 shows the mean and standard deviation of the baseline values of both experimental and control group.

Mean % difference was calculated for all parameters. For BMI, BF %, WHR, HbA1c, and QOL Mean % difference was calculated by deducting post intervention value from pre value.

As HbA1c and Blood pressure did not follow normal distribution, Non-parametric test (Mann -Whitney U test) was used to find differences between two groups. Paired 't' test was used for other parameters. Changes in selected parameters after 12 weeks of intervention are presented in the Table 2.

Table 2: Pre and post interventional changes between experimental and control group

Parameters	Experimental group Mean±SD	Control group Mean±SD	P value
BMI	0.49±1.28	-0.73±5.20	.372
BF%	1.84±1.74	-1.70±8.3	.116
WHR	0.03±0.02	0.02±0.08	.742
HbA1c	0.44±0.37	-1.06±0.77	<0.01*
SBP	3.43±9.43	1.25±13.7	.603
DBP	-0.62±6.80	-1.56±11.21	.574
QOL	2.85±1.35	0.07±2.32	<0.01*

* Significant at the level of p value≤ 0.01

There is a significant reduction (p=<0.01) in HbA1c levels of experimental group after 3 months of intervention when compared to the baseline levels. Paired 't' test reveals that there is a significant improvement (p=<0.01) in quality of life of intervention group when compared to the control group (Fig. 1). After intervention, there is a slight reduction in body mass index, body fat % and waist hip ratio of Hba1c of experimental group when compared to control group. However, this difference is not statistically significant. No change is seen in systolic and diastolic blood pressure of both the groups.

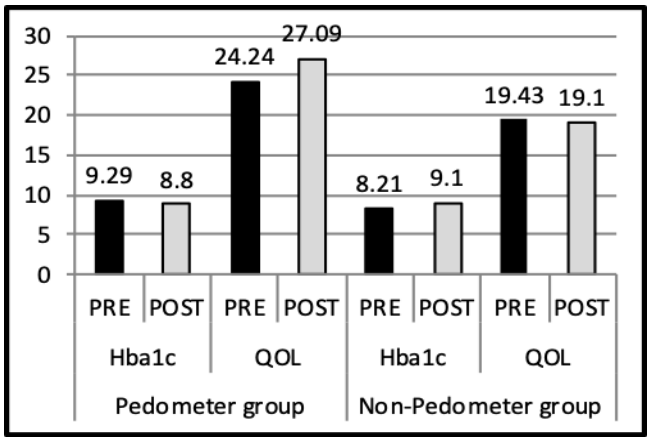

Fig. 1: Pre and Post intervention changes in Hba1c and QOL of both experimental and control group

DISCUSSION

The aim of this study was to determine whether the pedometer based physical activity improves glycemic control, body composition and quality of life in type 2 diabetes mellitus patients. It is evident from the study findings that usage of pedometer significantly reduces Hba1c levels and improves quality of life in type 2 diabetes mellitus patients. Our findings are in accordance with other studies conducted so far.

The study of Meeks *et al.,* showed that there was a significant decrease in waist circumference after 4 weeks of pedometer based walking (16). In a study conducted by Araiza *et al.,* there was a reduction in waist circumference in the active group after 6 weeks of intervention (7). Our study also documented very similar findings. As abdominal obesity is more pronounced in Indians, waist hip ratio and waist circumference act as important risk predictors of type 2 diabetes mellitus (17).

According to Shenoy *et al.,* the effects of walking program using pedometers and heart rate monitors on type 2 diabetes mellitus patients for 8 weeks, documented a 3.9% decrease in BMI of intervention group when compared with the control group (18). We also perceived the same trend in body mass index in our experimental group.

In the study of Osei-tutu *et al.,* comparison was done between continuous and intermittent walking patterns. The study result showed that there was a significant difference in body fat percentage (19). Our study findings did not reveal any significant improvement in body fat percentage of experimental group.

The studies conducted in New Zealand and Los Angeles found that the combination of aerobic and resistance exercises had a positive impact on glycosylated hemoglobin (HbA1c) levels (20, 21).The intervention in the form of aerobic exercise for 12 weeks improved blood glucose regulation (HbA1c) (22). In our study, Hba1c levels decreased in the experimental group after walking 10,000 steps/ day for 12 weeks when compared to the control group. Likewise, in the study of van dyck *et al.*, HbA1c improved significantly in type 2 diabetes mellitus patients who increased greater than or equal to 4000 steps per day between baseline and post measurements (23).

There was a reduction in the risk of hypertension when the total daily activity is increased in Japanese male workers (24). Our study failed to show any significant improvement in blood pressure levels in both the groups after intervention. Our findings are in accordance with the study of Paul Araiza *et al.*, where the subjects (type 2 diabetic patients) walked 10,000 steps/day for 6 weeks using pedometer (7).

Endurance training increases insulin sensitivity by raising the number of GLUT4 molecules moving to the plasma membrane in response to a given moderate plasma insulin concentration. This is probably done through an increase in signal molecules of the P13K cascade. It is also because of this effect on insulin sensitivity that exercise helps Type 2 Diabetes Mellitus patients to control their plasma glucose concentration.

Exercise therapy has been reported to be effective in improving quality of life (25). Quality of life is an important outcome in its own right, as it may influence the patient's self-care activities, which may consequently affect their diabetes control and management (26). From one study it is evident that there is a significant improvement in quality of life in experimental group who walked for 8 weeks when compared to the control group (Non pedometer group) (27). Quality of life index of our pedometer-using group improved largely after the intervention.
The number of dropouts (1) was approximately equal between the two study groups, minimizing a possible bias between the groups. The dietary intake and medications like oral hypo-glycemic drugs can be stated as confounding factors in this study. In addition, the other drawback of this study could be, not measuring the baseline activity of both experimental and control group. To summarize, pedometer based physical activity improves glycemic control and quality of life in type 2 diabetes mellitus patients.

CONCLUSION

Pedometer based physical activity improves the glycemic control and the quality of life in Type 2 Diabetes Mellitus patients. In addition, it can act as a motivational tool to reduce the sedentary behavior and to promote exercise adherence in Type 2 diabetes mellitus patients. Covering a minimum of 10,000 steps/ day using pedometer can curb the menace of life-style related disorders in the general population. Further studies are warranted on a large scale to confirm the dose–response relationship between physical activity and cardiovascular health in our population.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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