Original Article

Role of physical activity for glycemic control among patients with type 2 diabetes mellitus

Hossain T[a], Hassan R[b], Shabnam M[c], Jabeen I[c], Biswas T[d], Akter CS[e]

ABSTRACT

Background: *Lifestyle modification and physical activity are very important parts of diabetes management. Regular physical activity has been shown to improve glycemic control through increased insulin sensitivity and glucose tolerance. The aims of this study were to assess the glycemic level and pattern of physical activity among type 2 diabetic patients.*

Methods: *This hospital-based cross-sectional study was carried out from July 2022 to October 2022 among 305 purposively recruited diabetic patients who came to receive care at the outpatient department of a teaching hospital in Dhaka, Bangladesh. A semi-structured questionnaire was used to describe socio-demographic information. Physical activity was assessed using the validated version of international physical activity questionnaire short form/ global physical activity questionnaire (IPAQ/GPAQ). Glycemic control was measured by HbA1C report done within 120 days of the interview. Blood pressure and body mass index were also measured at the time of inclusion. The physical activity level was categorized according to IPAQ scoring protocol as high level, moderate level and low level. Chi square test was carried out to determine the association of physical activity with type-2 DM, body mass index, glycemic and blood pressure control. Statistical significance was defined as $p<0.05$.*

Results: *Among the participants only 0.3% had high level of physical activity. Moderate level of physical activity was found among 32.8% and low level of physical activity has been found among 66.9%. Among the participants 92.1% spent their time sitting during the weekdays while the time spent at home, at work, while doing course or class and during leisure activities. Among them 21% had the maximum 10 hours sitting time during the last week. The study showed that the persons who spent walking on at least 7 days has negative correlation with blood glycemic level and among them who spent time on sitting has positive correlation with blood glycemic level.*

Nearly two thirds of the respondents were female. The mean age was 53.09 ± 12.15 years. Majority of the participants were from urban area (69.83%) and the rest are from rural (21.31%) and sub urban (8.2%) area. There was no significant relation of level physical activity with any sociodemographic factors except monthly income, which showed low monthly income was associated with higher level of physical activity.

Conclusion: *The findings of our study focus on developing more awareness and providing facilities for physical activity to achieve the glycemic goal.*

Key words: *diabetes mellitus, physical activity, sedentary behavior, glycaemic control.*

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Author information

a. Tanjina Hossain, Associate Professor, Department of Endocrinology and Metabolism, Green Life Medical College, Dhaka, Bangladesh.

b. Rashedul Hassan, Associate Professor, Department of Medicine, Green Life Medical College, Dhaka, Bangladesh.

c. Mahbuba Shabnam, Ishrat Jabeen, Assistant Professor, Department of Medicine, Green Life Medical College, Dhaka, Bangladesh.

d. Tonmoy Biswas, Registrar, Department of Medicine, Green Life Medical College, Dhaka, Bangladesh.

e. Chowdhury Shammi Akter, Medical Officer, Department of Medicine, Green Life Medical College, Dhaka, Bangladesh.

Address of correspondence: Tanjina Hossain, Associate Professor, Department of Endocrinology and Metabolism, Green Life Medical College, 32 Green Road, Dhaka 1205. E mail: tanjina75@gmail.com

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INTRODUCTION

Diabetes mellitus is the most common metabolic disorder worldwide and the global diabetes prevalence in 20–79 years in 2021 was estimated to be 10.5% (536.6 million people), going to rise to 12.2% (783.2 million) in 2045. The greatest relative increase in the prevalence of diabetes between 2021 and 2045 is expected to occur in middle-income countries (21.1%).[1]

According to international diabetes federation, there were about 13 million adults living with diabetes in Bangladesh in 2021, with prevalence of diabetes in adults 12.5%.[1]

The economic costs of diabetes are high due to the treatment of complications associated with the disease. In Bangladesh, these costs have been estimated to US$1.5 billion annually.[2] In a study, it was seen that in Bangladesh only 18.8% of participants were classified as having good control (HbA1c <7%), 19.78% had fair control (HbA1c 7-8%), 62% had poor glycemic control (HbA1c>8%). The mean (±SD) HbA1c was 9.0% (±2.2%).[3]

It is evident that lifestyle modification including nutritional therapy and physical activity are important part of diabetes management. Regular physical activity has been shown to improve glycemic control through increased insulin sensitivity and glucose tolerance.[4] Exercise has proven benefit to bring changes in glycemic markers such as insulin resistance, HbA1C and fasting insulin in Type 2 diabetes. Along with these changes, exercise can favorably alter the lipid profile, blood pressure and inflammatory markers.[5] Reduction in visceral and abdominal fat as a result of regular exercise and physical activity contributes insulin resistance improvement. The results of aerobic, resistance and combined exercise showed a change in cytokine/adipokine level as well as a decrease in insulin resistance in obese people.[6] The specific benefits of resistance training in older adults with diabetes are it can combat age and diabetes-related sarcopenia, prevent loss of muscle and bone mass, reduce resting metabolic rate accompanying hypocaloric dieting, increase glucose uptake and storage in skeletal muscle, reduce visceral fat depots, reduce C-reactive protein and provide beneficial effects on resting blood pressure, functional status, mobility, sleep, peripheral vascular disease, peripheral neuropathy, cognitive function and depressive symptoms.[7,8,9]

American diabetes association recommends physical activity more than 150 min/week and dietary intervention in order to attain 5–7% weight loss within 3–6 months for prevention of Type 2 diabetes. Similarly, the diabetes prevention program (DPP) has recommended a series of behavioral and lifestyle modifications to achieve and maintain at least 7% of weight loss and 150 min of physical activity per week, with an intensity like brisk walking.[10] On the other hand, world health organization (WHO)′s 'Global Recommendations on Physical Activity for Health' states that all adults should undertake 150–300 min of moderate-intensity, or 75–150 min of vigorous-intensity physical activity, or some equivalent combination of moderate-intensity and vigorous-intensity aerobic physical activity, per week.[11] It is recommended that Type 1 and type 2 diabetic adults should follow moderate- to high-intensity aerobic exercise for 150 min or more per week in at least 3 sessions per week and a 2-day rest for recovery. Performing high-intensity or interval training depending on individual fitness level may need shorter duration: at least 75 min/week and 2–3 sessions/week of strength training on nonconsecutive days is also recommended. Additionally in order to increase flexibility, muscular strength and balance, flexibility and balance training such as yoga and tai chi are recommended 2–3 times/week for older adults with diabetes.[12]

Sedentary behavior and behaviors with low energy expenditure (television watching, desk work, etc.) has a significant population-wide influence on cardio-metabolic health.[13,14] In people with or at risk for developing Type 2 diabetes, extended sedentary time is also associated with poorer glycemic control and clustered metabolic risk.[15-17]

Despite all these, a large number of people worldwide are leading an inactive lifestyle. In the South-East Asian region, 15% of adults are not meeting the WHO recommended levels of physical activity.[18]

Insufficient physical activity has significant implications for the poor glycemic control and economic burden associated with diabetes. Given the established relationships between inactivity and glycemic and metabolic control in diabetes, it is crucial to collect physical activity prevalence data from Bangladeshi people with diabetes. The objective of the study was to assess the pattern of physical activity and its impact on

glycemic control among people with diabetes in Bangladesh.

METHODS

The study was done among 305 purposively recruited diabetic patients who came to the outpatient of Green Life medical College and Hospital, Dhaka, Bangladesh. Study duration was 4 months starting from July 2022. Socio-demographic information was taken in a semi-structured questionnaire form. Physical activity was assessed using the validated version of international physical activity questionnaire short form/ global physical activity questionnaire (IPAQ/GPAQ).[19,20] Glycemic control was measured by the record of HbA1C level done within last 120 days. Blood pressure was measured at the time of inclusion. Body mass index (BMI) was measured by dividing weight in kilogram by height in meter square.

Both male and female between 18 to 69 years age who have been diagnosed as type 2 DM at least for one year were included in the study. Pregnant women with diabetes, people with type 1 DM and people with any debilitating disorder unable to perform physical activity were excluded from the study. A written informed consent was taken from each subject before interview. The study was approved by the Ethical Committee of the Institute on 25.08.2024 (ref no GMC/Ethical/2022/02).

After completion of data collection each question was checked for completeness. After the data cleaning, a statistical software statistical package for the social sciences (SPSS) version-26 was used for data analysis. It started with descriptive analysis. Means and standard deviations were calculated for continuous variables while frequencies and percentage were calculated in categorical variables, simultaneously bivariate analysis was done to find out the relationship between variables. The statistical significance was defined as $p<0.05$.

The physical activity level was categorized according to international physical activity questionnaire short form (IPAQ) scoring protocol as high level, moderate level and low level. Category 2 or moderate level activity was defined when any of the following 3 criteria was met: a) 3 or more of vigorous activity of at least 20 minutes per day or, b) 5 or more days of moderate intensity activity or walking of at least 30 minutes per day or, c) 5 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum of at least 600 MET-min/week. Category 3 or high level of activity was defined when any of the following 2 criteria was met: a) vigorous intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week or b) 7 or more days of any combination of walking, moderate intensity or vigorous intensity activities achieving a minimum of at least 3000 MET-minutes/week. The individuals who do not meet criteria for categories 2 or 3 were considered as having low level of activity.

RESULTS

Sociodemographic characteristics of the participants:

Total patients were 305.

Among the participants, about two third are female. The age of the participants ranged from 26 to 80 years with a mean of 53.09 ± 12.15 years. Socio-demographic characteristics are shown in Table-I.

Three fourth of the participants (80.0%) have family income more than 30,000 BDT, and only 3% has less than 10,000 BDT. About two third of the participants (77.7%) has positive family history of diabetes where as 5.9% are unaware of the family history of diabetes.

Table I. Sociodemographic characteristics of the participants (N=305)

Variables		Frequency	Percentage
Gender	Male	104	34.1
	Female	201	65.9
Habitat	Urban	213	69.8
	Rural	65	21.3
	Suburban	25	8.2
Religion	Islam	278	91.1
	Hindu	23	7.5
	Christian	4	1.3
Employment	Sedentary worker	71	23.3
Status	Worker with physical activity	22	7.2
	Housewife	176	57.7
	Student	2	0.7
	Unemployment	34	11.1

Among all the participants blood pressure was recorded in 298 participants and we found 87.9% had controlled blood pressure.

Level of physical activity of participants

The level of physical activity among participants was assessed, revealing that:

- High level of physical activity (more than 7 days) was observed in only 0.3% of participants.
- Moderate level of physical activity (3-5 or more days) was observed in 32.8% of participants.
- Low level of physical activity (less than 3 days) was found in 66.9% of participants.

Table II. Relation between key socio-demographic variables and physical activity and HbA1c (N=305)

Socio-Demographic Characteristic	Duration of physical activity	HbA1c
Age	0.080	0.048
Gender	0.016	-0.039
Habitat	0.089	-0.012
Religion	0.017	-0.013
Education	0.156*	-0.126
Employment	0.085	-0.020
Marital status	-0.146**	0.052
Monthly income	0.048	-0.054

The correlation was significant at the 0.01* level and at 0.05** level (2-tailed).

The age of the participants has non-significant positive (r = 0.080 and 0.048, p = 0.16 and 0.494) but very weak correlation with duration physical activity and glycemic level (HbA1c) while gender of the participants has very weak, non-significant and positive correlation (r= 0.016 and -0.039, p= 0.776 and 0.575) with duration of physical activity but negatively correlated with HbA1c. Participants residence (habitat) has both positive and negative correlation (r= 0.089 and -0.012, p= 0.123 and 0.865) with duration of physical activity and HbA1c but these are very weak and non-significant. The religion of the participants has both positive and negative correlation (r= 0.017 and -0.013, p= 0.761 and 0.856) with duration of physical activity and HbA1c but these are very weak and non-significant as well. Participants' education is weakly and positively correlated (r= 0.085 and -0.126, p= 0.007 and 0.073) with duration of physical activity and glycemic level (HbA1c) and this correlation is significant. Participants employment status is weekly, positively correlated (r= 0.156 and -0.020, p= 0.140 and 0.778) with duration of physical activity and negatively with glycemic level (HbA1c) but the relation is not significant. Marital status of the participants has weak and both negative and positive significant correlation (r= -0.146 and 0.052, p= 0.011 and0.465) with duration of physical activity and glycemic level (HbA1c). Monthly income of participant has positive correlation (r= 0.048 and -0.054, p= .403 and 0.444) with duration of physical activity and negative with glycemic level (HbA1c) and this relation is non-significant.

Therefore, Table II revealed that

- Education had positive and significant relation with the duration of physical activity, implying that higher educational status was associated with increased physical activity levels.
- Another finding, marital status had negative and significant relation with duration of duration of physical activity that stated that unmarried, widowed and separated persons are more physically active than married.
- However, other socio-demographic variables, including age, gender, habitat, religion, and education, did not show a significant correlation with physical activity levels. Similarly, HbA1C levels were not significantly correlated with any socio-demographic variables, indicating no relationship between demographic information and blood glycemic levels among the participants.

Table III shows distribution of hours per day sitting on week days

We found a large portion of participants spent significant time sitting during weekdays (Table III). This includes the time spent on sitting at a desk, visiting friends, reading or sitting or lying down to watch television.

Table III. Hours per day spent sitting on week days (N=281)

Hours per day spent sitting on week day	Frequency (n= 281)	Percent (%)
≤5	10	3.5
6-10	189	67.25
11-15	79	28.11
16 and above	3	1.06

Table IV. Relationship between physical activity and glycemic control

Variables	Pearson correlation (Physical Activity)		
Glycemic	IPAQ 5	IPAQ 6	IPAQ 7
control (HbA1c)	.035	-1.51	.047

The correlation was significant at the 0.01 level and at 0.05 level (2-tailed).

IPAQ= International Physical Activity Questionnaire

IPAQ 5 = Number of days participants walked for at least 10 minutes at a time during the last 7 days.

IPAQ 6 = Amount of time usually spend walking on one of those days by participants.

IPAQ 7 = During the last 7 days, amount of time participants spent sitting on a week day

We tried to find out the relation between the physical activity and glycemic level (HbA1c). The Pearson correlation analysis revealed:

- The amount of time spent walking by participants on one of the 7 days (IPAQ-6) was negatively correlated with blood glycemic levels (HbA1c), indicating a strong inverse relationship.
- The number of days participants walked for at least 10 minutes at a time during the last 7 days (IPAQ-5) was positively correlated with glycemic control, although the correlation was weak.
- The time participants spent sitting on a weekday during the last 7 days (IPAQ-7) was positively and moderately correlated with glycemic control, suggesting that more sitting time was associated with higher blood glycemic levels.

DISCUSSION

Exercise alone in patients with T2DM have proved to be effective in improvements in the management of blood glucose levels, body weight, lipids, blood pressure, cardiovascular disease, mortality, and overall quality of life.[21] But many individuals with type 2 diabetes do not meet the recommended exercise level per week. A study in USA with 871 individuals with type 2DM showed that only 44.2%, 42.6% and 65.1% of white, african amercian, and hispanic individuals respectively, met the recommended threshold of exercise.[22] Our study also showed that 66.9% participants had low level of activity and only 1% had High level of physical activity. The highest hour of walking is 2 hours among 20% of the participants who used to walk for at least 10 minutes at a time during last 7 days. In a previous study done in Dhaka by *Uddin et al* in 2017 among Bangladeshi young adults showed that only seventeen percent of the participants were meeting moderate-to-vigorous physical activity (MVPA) recommendations with a significantly higher proportion of males than females (27 vs. 6%, $p < .0001$). That means four out of five young adults in Dhaka city did not meet the physical activity recommendations. [23]

A similar study done with 3137 participants in another asian most populous city Bangkok suggest that less than one-fifth (17.9%) of Bangkok residents may achieve the recommended levels of physical activity engage in low levels of sedentary behavior, the combination with the greatest benefit for health. However, two-thirds of participants reported sufficient physical activity but still engaged in high levels of sedentary behavior.[24] A cross sectional analysis from India among 190 participants (110 men and 80 women) with diabetes showed that 78.9% of participants thought that physical activity was important for control of diabetes, but only 54.7% of respondents did regular physical activity every week, and physical activity was more frequent in men (63.6%).[25]

A multicenter pan-India cluster sampled trial was done in India and published in 2021. It included a survey to identify all individuals at a high risk for diabetes, using a validated instrument called the Indian Diabetes Risk Score (IDRS). They analyzed the data from 2,33,805 individuals; the mean age was 41.4 years (SD 13.4). Of these, 50.6% were females and 49.4% were males; 45.8% were from rural areas

and 54% from urban areas. The survey showed that 20% and 37% of the population in India are not active or mildly active, respectively, and thus 57% of the surveyed population do not meet the physical activity regimen recommended by the WHO. Individuals living in urban localities were proportionately more inactive (21.7% vs. 18.8%) or mildly active (38.9% vs. 34.8%) than the rural people. Interestingly, the known diabetics were found to be physically inactive (28.3% vs. 19.8%) when compared with those unaware of their diabetic status.[26]

Our study found no significant relationship in difference of gender or habitat or other socio demographic variables with the level of physical activity but there was significant relationship between monthly income and physical activity level. The low monthly income was associated with increased physical activity level among the participants. Moreover, our study found no significant relationship between HbA1c and socio demographic variables like gender, habitat, education status or religion.

Our study suggest that physical inactivity is one of the important reasons of poor control of diabetes in this region and higher rate of complications. Our study reveals that the persons who spent walking on at least 7 days has negative correlation with HbA1c level and who spent time on sitting has positive correlation with HbA1c level, that means the more sitting time there is increased blood HbA1c level and vice versa. In our study 92.1% participants spent their time sitting during the weekdays which included the time spent at home, at work, while doing course work and during leisure time. This includes time spent on sitting at a desk, visiting friends, reading or sitting or lying down to watch television. This proves the higher sedentary time level among the diabetic populations in this region which is an important cause of poor glycemic control.

Evidence supports that all individuals should reduce the amount of time spent being sedentary (eg seated work at computer or watching television) and should break up bouts of sedentary activity (>30 minutes) by brief standing, walking or performing other light physical activities.[27,28]

Clinical trials have provided strong evidence for the HbA1c lowering effect of physical activity and combined aerobic and resistance exercise in adults with type 2 diabetes.[29]

Very few physicians prescribe physical activity as a therapy for diabetes because there is a lack of information on how to implement such therapies properly.[30] It is necessary for physicians to evaluate baseline physical activity and time spent in sedentary behavior (quiet sitting, lying and leaning) in people with diabetes. For patients who do not meet activity guidelines, should be encouraged to increase physical activity (walking, yoga, housework, gardening, swimming, and dancing) above baseline.[31]

Conclusion

The limitations of the study are that we did not evaluate the factors responsible behind the lack of physical activity among our patients, and also did not follow the consistence of the activity among the participants. The physical activity pattern may be different in other areas like in rural areas or outside the capital city which should be investigated. But our findings clearly highlight the need for targeted interventions to facilitate physical activity and reduce sedentary behavior at home and workplaces, for better glycemic control.

Author's contribution: TH planned the study. All authors read and approved the final version for publication.

Conflicts of interest: Nothing to declare.

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