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RESEARCH ARTICLE

Physical activity pattern and its impact on glycemic control among patients with type-2 diabetes mellitus attending an integrated diabetes and gestational diabetes clinic of Eastern India

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ABSTRACT

Background: India is popularly known as "world diabetes capital" and is presently home of about 72.9 million diabetes patients. Physical activity (PA) is defined as "Bodily movement produced by the contraction of skeletal muscle that requires energy expenditure in excess of resting energy expenditure" and exercise is defined as "A subset of PA: planned, structured, and repetitive bodily movement performed to improve or maintain one or more components of physical fitness." **Aims and Objectives:** This study aims to assess the PA level of type 2 diabetes mellitus (T2DM) patients and its impact on their glycemic control attending integrated diabetes and gestational diabetes clinic (IDGDC) of a tertiary health-care facility of Eastern India. **Materials and Methods:** An institution-based, observational, cross-sectional study was conducted among 347 T2DM patients attending IDGDC from May 2019 to June 2019. Venous blood sample for glycated hemoglobin (HbA1c) estimation was collected and medical records were reviewed to collect data regarding clinicosocial data. Data were analyzed using the Statistical Package for the Social Sciences for Windows (version 20.0). All statistical tests were two tailed and $P < 0.05$ was considered statistically significant. **Results:** About 50.0% of male had good glycemic control and only 32.1% of female had good glycemic control. About 34.9% of the study population had high PA followed by 34.0% and 31.1% who had low and moderate PA, respectively. **Conclusion:** There is high frequency of poor glycemic control as about 57.1% of study populations had HbA1c >7.0%. About three-fifth of the study population had either moderate or high PA.

KEY WORDS: Physical Activity; Glycated Hemoglobin; Type 2 Diabetes Mellitus; Central Obesity

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INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder resulting from either insulin resistance or relative or absolute insulin deficiency.[1] India is popularly known as "world diabetes capital" and is presently home of about 72.9 million diabetes patients, if corrective steps are not taken on time the number of people with diabetes will be 134 million by 2045.[2] Non-modifiable risk factors for type 2 DM (T2DM) include race, genetic predisposition, and increasing age. Apart from non-modifiable risk factors, four key behavioral risk factors, namely, physical inactivity, unhealthy diet, tobacco consumption, and increasing use of alcohol are important modifiable risk factors for T2DM.[3] Overweight/obesity is other important modifiable risk factors for T2DM.[4] Poorly controlled DM is associated with high morbidity, mortality, and increased health-care cost to the diabetes patients than non-diabetes people.[5-7] Poorly managed DM will increase the burden of both microvascular and macrovascular complications. Poorly controlled diabetes is also associated with increased foot complications[8] and depression[9] resulting in poor quality of life. Evidence suggests that regular physical activity (PA) is not only associated with substantial decrease in cardiovascular and all-cause mortality, it also reduces the risk of T2DM, cardiovascular disease, and some types of cancer (breast or colon cancer) and improves well-being.[10-14] PA is defined as "Bodily movement produced by the contraction of skeletal muscle that requires energy expenditure in excess of resting energy expenditure" and exercise is defined as "A subset of PA: Planned, structured, and repetitive bodily movement performed to improve or maintain one or more components of physical fitness.[15]" In a study, PA was negatively associated with mean fasting and post-load plasma insulin concentrations in two populations who were at risk for diabetes.[16] Many studies reported an important role of supervised exercise interventions in improving glycemic and lipid profiles.[17-19] PA can be easily assessed using global PA questionnaire (GPAQ) developed by the World Health Organization (WHO).[20] GPAQ contains 16 questions and assesses PA in three domains, namely, occupation, travel, and leisure activity. Apart from measuring total PA, GPAQ can assess PA in each domain separately. GPAQ has been used extensively and has been validated in nine populations including Asian Indians.[21]

Diabetes awareness and you is a non-profit social welfare organization working in the field of DM, runs chain of "chronic care model"[22] based integrated diabetes and gestational diabetes clinic (IDGDC) in various parts of West Bengal, India. One such IDGDC is operational at IQ City Medical College and Multispecialty Hospital, Durgapur, West Bengal. The IDGDC serves to 500 DM patients every month. This study aims to assess the PA level of T2DM patients attending IDGDC and its impact on their glycemic profiles.

MATERIALS AND METHODS

Study Setting

This study was conducted at IDGDC, IQ City Medical College and Multispecialty Hospital, Durgapur.

Study Type

This was an institution-based, observational study.

Study Design

This was a cross-sectional study design.

Study Period

This study was from May to June 2019.

Study Duration

The study duration was 2 months.

Ethical Clearance

This study was ethically cleared by the Institutional Ethics Committee of IQ City Medical College and Multispecialty Hospital, Durgapur.

Study Population

T2DM patients attending IDGDC at IQ City Medical College and Multispecialty Hospital, Durgapur, India.

Inclusion Criteria

Eighteen years and <70 years were included in the study.

Exclusion Criteria

Patients on steroids, chronic liver failure, patients with physical disabilities, acute hyperglycemia were excluded from the study.

Sample Size

The sample size was 347.

Sampling Technique

Systematic random sampling (SRS). Sample size was calculated as per the WHO guidelines, using formula 4PQ/d for cross-sectional study design.[23] The prevalence of low, moderate, and high PA among T2DM patients was found to be 28.6%, 47.3%, and 24.1%, respectively.[24] The prevalence of high-level PA was lowest (24.1%) and has been used to calculate maximum sample size for this study. Hence, considering the prevalence (P) of high PA among T2DM patients, Q=1−P, absolute precision of 20 with 95% confidence interval (d = 20% of P), and 10% non-response rate, minimum sample size came to be 347. Sample interval of SRS was predefined, based on the patient attendance record of the previous month.

Study Tool

- Pre-designed, pre-tested, semi-structured schedule prepared with the help of GPAQ[20]
- Relevant medical records.

Operational Definitions

Physical activity[20]

Metabolic equivalents (METs) are commonly used to express the intensity of PA. Applying MET values to activity levels allow us to calculate total PA. MET is the ratio of a person's working metabolic rate relative to the resting metabolic rate. One MET is defined as the energy cost of sitting quietly and is equivalent to a caloric consumption of 1 kcal/kg/h. It is estimated that, compared to sitting quietly, a person's caloric consumption is 4 times as high when being moderately active and 8 times as high when being vigorously active. For person's overall energy expenditure calculation using GPAQ data, total activity time was multiplied by 4 MET and 8 MET for moderate and vigorous-intensity activity, respectively. For the calculation of a categorical indicator, the total time spent in PA during a typical week, the number of days as well as the intensity of the PA is taken into account. Individuals were classified as active if, they were involved in at least 75 min/week of vigorous-intensity PA or 150 min/week of moderate-intensity exercise or achieving at least 600 MET/week by an equivalent combination of moderate- and vigorous-intensity PA.

In addition to the above classification, the three levels of PA suggested for classifying populations are inactive/low activity (<600 MET min/week), moderate activity (600–1200 MET min/week), and highly active (>1200 MET min/week).

Body mass index (BMI) classification[25]

BMI was calculated using the formula, Weight (in kg)/Height^2 (in m). BMI has been classified as follows:

- Underweight: BMI <18.5
- Normal: 18.5–24.99
- Overweight: BMI 25.00–29.99
- Obese: BMI ≥30

Glycemic control

As per the American Diabetes Association (ADA), Glycated hemoglobin (HbA1c) ≤7.0% was defined as good glycemic control and HbA1c >7 was considered poor glycemic control.[26]

Outcome Variables

- Physical activity (active/inactive) and its grading (low, moderate, and high) among the study population
- Impact of PA on glycemic indicator (HbA1c) of the study participants if any.

Study Technique

Written informed consent was taken from all study participants. Relevant medical records were reviewed to collect data regarding clinicosocial data and past medical records of the study subjects. Venous blood sample for blood sugar and HbA1c estimation was collected to maintain full aseptic condition. Estimation of plasma glucose and HbA1c has been done as per the WHO guidelines.[27] Anthropometric measurements were taken as per the standard WHO protocols.[25] PA was classified as per the WHO-GPAQ guidelines.[20] Glycemic control was classified as per the ADA.[26]

Statistical Analysis

Data were codified and analyzed using the Statistical Package for the Social Sciences for Windows (version 20.0). The frequency of hyperglycemia and other clinicosocial variables

Table 1: Clinicosocial characteristics of the study population, *n*=347

Clinicosocial characteristics	*n* (%)
Age group	
20–40 years	37 (10.7)
41–60 years	202 (58.2)
≥61 years	108 (31.1)
Sex	
Male	210 (60.5)
Female	137 (39.5)
Residence	
Urban	196 (56.5)
Rural	151 (43.5)
Educational status	
Illiterate	55 (15.8)
Up to Class V	27 (7.8)
Class VI–X	121 (34.9)
>Class X	144 (41.5)
BMI (kg/m^2)	
Normal (18.5–24.99)	116 (33.4)
Overweight (25.00–29.99)	138 (39.8)
Obese (≥30.00)	144 (41.5)
Waist circumference	
Male <90 cm, female <80 cm	123 (35.4)
Male ≥90 cm, female ≥80 cm	224 (64.6)
Glycated hemoglobin	
≤7.0%	149 (42.9)
>7.0%	198 (57.1)
Physical activity level	
Low	118 (34.0)
Moderate	108 (31.1)
High	121 (34.9)

was calculated. Pie chart and simple bar diagrams were used to show the frequency of hyperglycemia and classification of hyperglycemia, respectively. Chi-square test was used to show association between categorical variables. All statistical tests were two tailed and $P < 0.05$ was considered statistically significant.

RESULTS

About 58.2% of the study population was in the age group of 40–60 years followed by 31.1% and 10.7% who were in the age group of ≥61 years and 20–40 years, respectively [Table 1]. About 60.5% of them were male and 39.5% of them were female. About 56.5% and 43.5% lived in urban and rural areas, respectively. About 41.5% of our study population were educated up to >X class followed by 34.9% and 7.8% who received education up to Class VI–X and up to Class V, respectively. About 15.9% of the study population was illiterate [Table 1]. Only 33.4% of them had normal BMI, 39.8% and 26.8% of them had their BMI in overweight and obese range, respectively. About 64.6% of them had central obesity (waist circumferences: Male ≥90 cm; female ≥80cm) [Table 1]. About 42.9% of the study population had good glycemic control (HbA1c ≤7.0%) as compared to 57.1% who had >7.0% HbA1c level [Table 1]. About 34.9% of the study population had high PA followed by 34.0% and 31.1% who had low and moderate PA, respectively [Table 1 and Figure 1]. About 59.5% of those who were in the age group

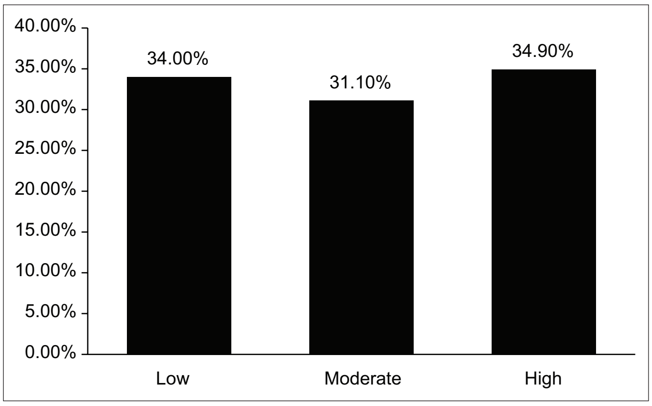

Figure 1: Simple bar diagram showing physical activity level of the study population, *n*=347

Table 2: Association between clinicosocial determinants and hyperglycemia (*n*=347)

C-S factors	Glycated hemoglobin		Total *n* (%)	χ^2 (df)	*P* value
	≤7.0 (%)	>7.0 (%)			
Age group					
20–40 years	22 (59.5)	15 (40.5)	37 (100.0)	18.1 (2)	0.000
41–60 years	98 (48.5)	104 (51.5)	202 (100.0)		
≥61 years	29 (26.9)	79 (73.1)	108 (100.0)		
Sex					
Male	105 (50.0)	105 (50.0)	110 (100.0)	10.8 (1)	0.001
Female	44 (32.1)	93 (67.9)	137 (100.0)		
Residence					
Urban	106 (54.1)	90 (45.9)	196 (100.0)	22.8 (1)	0.000
Rural	43 (28.5)	108 (71.5)	151 (100.0)		
Educational status					
Illiterate	10 (18.2)	45 (81.8)	55 (100.0)	29.6 (3)	0.000
Up to Class V	4 (14.8)	23 (85.2)	27 (100.0)		
Class VI–X	60 (49.6)	61 (50.4)	121 (100.0)		
>Class X	75 (52.1)	69 (47.9)	144 (100.0)		
BMI (kg/m^2)					
Normal (18.5–24.99)	64 (55.2)	52 (44.8)	116 (100.0)	12.6 (2)	0.002
Overweight (25.00–29.99)	56 (40.6)	82 (59.4)	138 (100.0)		
Obese (≥30.00)	29 (31.2)	64 (68.8)	93 (100.0)		
Central obesity					
No (WC: Male <90 cm, female <80 cm)	69 (56.1)	54 (43.9)	123 (100.0)	13.5 (1)	0.000
Yes (WC: Male ≥90 cm, female ≥80 cm)	80 (35.7)	144 (64.3)	224 (100.0)		
Physical activity					
Low	17 (14.4)	101 (85.6)	118 (100.0)	153.4 (2)	0.000
Moderate	26 (24.1)	82 (75.9)	108 (100.0)		
High	106 (87.6)	15 (12.4)	121 (100.0)		

of 20–40 years had good glycemic control as compared to 48.5% and 26.9% who were in the age group of 41–60 years and ≥61 years, respectively. Increasing age was significantly associated with poor glycemic control [Table 2]. About 50.0% of male had good glycemic control and only 32.1% of female had good glycemic control. Female gender had significantly lower percentage of good glycemic control as compared to their male counterparts. The study population from urban area had significantly higher percentage of good glycemic control than their rural counterparts [Table 2]. Increasing education was found to be significantly associated with higher percentage of good glycemic control [Table 2]. About 55.2%, 40.6%, and 31.2% of the study population who is HbA1c was ≤7.0% had their BMI in normal, overweight, and obese range, respectively. About 56.1% of the study population who did not have central obesity achieved HbA1c ≤7.0% as compared to only 35.7% who had central obesity. Increasing BMI and central obesity were significantly associated with higher percentage of poor glycemic control [Table 2]. About 87.6% of the study population who had high PA achieved HbA1c ≤7.0%. Increasing PA was significantly associated with good glycemic control [Table 2].

DISCUSSION

Poorly controlled DM results in both macrovascular and microvascular complications of DM. There can be various factors for poor glycemic control such as non-compliance to medicines, unhealthy lifestyle, and clinical inertia. Apart from unhealthy food habits, physical inactivity is one of the most important unhealthy lifestyles leading to the development of non-communicable diseases. Physical inactivity is also associated with poor glycemic control. In this study, about two-fifth of the study population had good glycemic control and about three-fifth of them had HbA1c >7.0%. About one-third of the study population had low PA, one-third had moderate PA, and one-third of them had high PA. Increasing age, female gender, rural residence, poor educational status, increasing BMI, central obesity, and low PA were found to be significant risk factors for poor glycemic control.

Younger age group had good glycemic control than their elder counterparts. Increasing age was found to be a significant risk for poor glycemic control. The findings of this study are in agreement of many other researches.[4,28,29] About 50.0% of the male study population had HbA1c ≤7.0% as compared to only 32.1% of their female counterparts. Female gender was found to a significant risk factor for poor glycemic control. A Swedish study reported better glycemic control among men than women.[30] A cross-sectional study from the USA also reported similar findings.[31] Findings from health and retirement study of 1619 adults with T2DM showed that women had worse glycemic control than men despite having better adherence to diet and medicines.[32] Rural residence and less education were found to be significant risk factors for poor glycemic control. Less awareness coupled with poor accessibility to health care in rural areas and less self-care due to poor education may be the reasons of poor glycemic control among rural and less educated study populations. Many other epidemiological studies have reported similar findings.[33-35] Overweight, obesity, and central obesity were significantly associated with poor glycemic control. High BMI and central obesity are well-established comorbidities of diabetes and poor glycemic control.[36-38] Moderate to high PA was reported by about 65.0% of the study population. Almost similar prevalence of 60.0% PA was reported by Pati *et al*.[39] reported that 87.6% of the study population who had high PA achieved HbA1c ≤7.0% as compared to 24.1% and 14.4% who had moderate and low PA, respectively. Increasing PA was significantly associated with good glycemic control. The role of PA in good glycemic control as well as in preventing and delaying the development of T2DM from pre-diabetes is well documented in scientific researches.[17-19,40]

Limitations of the study include short duration of study and failure to document reasons of physical inactivity. Results of this cannot be generalized as the study has been conducted at a referral hospital which is bound to get more complicated cases and consequent more chances of getting poor glycemic control among the study population.

CONCLUSION

There is high frequency of poor glycemic control as about 57.1% of the study populations had HbA1c >7.0%. About three-fifth of the study population had either moderate or high PA. Increasing age, female gender, rural residence, poor educational status, increasing BMI, central obesity, and low PA were found to be significant risk factors for poor glycemic control.

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