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ORIGINAL ARTICLE

Impact of Physical Exercise and Food Habit on Type II Diabetes Mellitus Medicated Patients-A Cross Sectional Study

Tasfia Sharin[*1], Benojir Ahammed[2], MD. Toufiq Elahi[1], Muhammad Shamim Al Mamun[3], Dipak Kumar Paul[1]

[1]*Applied Nutrition and Food Technology, Islamic University, Kushtia-7003, Bangladesh*

[2]*Statistics Discipline, Khulna University, Khulna-9208, Bangladesh*

[3]*Chemistry Discipline, Khulna University, Khulna-9208, Bangladesh*

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KEYWORDS

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ABSTRACT: The study attempts at examining the impact of controlled food habit and regular physical exercise on type II diabetic hypertensive patients who were on medications for hyperglycemia and hypertension. A cross-sectional study was demonstrated, and 244 participants were selected from Khulna city of Bangladesh to meet the objective of the study. All the biochemical parameters such as blood sugar, glycated hemoglobin (HbA1c), triglyceride (TG), total cholesterol (TC), low density lipoprotein (LDL) and high-density lipoprotein (HDL) were taken from the blood test reports tested by the hospital. Among all the participants 46.7% were male, 53.3% were female and 61.1% were from urban community whilst 38.9% were from rural community, 29.92% were on medications with regular physical exercise and restricted diet jointly (M+E+F), 45.90% were dependent only on medications (M) and rest 24.18% were on medications with either regular exercise or food habit (M+E/F) for controlling diabetes. Chi-square and logistic regression analysis were used to portray the necessary associations. Chi-square values show significant association for fasting blood sugar (FBS) ($p<0.001$), blood sugar 2hr after breakfast ($p<0.001$), HbA1c ($p<0.001$), TG ($p<0.02$), TC ($p<0.01$) but insignificant for diastolic blood pressure ($p=0.522$), systolic blood pressure ($p=0.598$), HDL ($p=0.764$) and LDL ($p=0.213$) in respect of regular physical exercise and controlled food habit of the respondents. Logistic regression shows physical exercise and food habit are important determinants to control diabetes. Females are more prone to uncontrolled diabetes. Obesity and with increase in age, diabetes is hard to control. However, uncontrolled diabetes indulges dyslipidemia. This may be concluded from the conducted study that beside medication, regular physical exercise and controlled food habit help to control diabetes.

INTRODUCTION

Diabetes Mellitus (DM) is a chronic metabolic disorder that prevents the body to utilize glucose completely or partially. It is characterized by raised glucose concentration in the blood and alterations in carbohydrate, protein and fat metabolism. This can be due to failure in the formation of insulin or liberation or action. Since insulin is produced by the β cells of the islets of Langerhans, any receding in the number of functioning cells will decrease the amount of insulin that can be synthesized. Much diabetes can produce sufficient insulin but some stimulus to the islets tissue is needed in order that the secretion can take place [1-3].

*Corresponding author: tasfia.sp40@gmail.com (T. Sharin)
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The pandemic of diabetes has progressed in association with rapid cultural transforms, growing urbanization, dietary changes, decreased physical activities and other unhealthy lifestyles. Therefore, it may seem strange that the developing world, which is associated with hunger and malnutrition, is now experiencing an epidemic in type II diabetes. Asian people are genetically considered susceptible. However, increased affluence may unmask it. That is why the great concern is how to face this situation in the different segments of society. In Bangladesh, several studies were done to portray the condition of diabetes in rural areas, urbanizing rural community or comparing rural and urban communities [2-7]. Despite advances made in the prevention and management of cardiovascular disease, people with diabetes mellitus continue to have alarmingly high morbidity and mortality secondary to cardiovascular disease [8, 9].

Of late, type II diabetes mellitus is quite common all over the world [10] and it is on increase in Bangladesh. Long term uncontrolled diabetes induces many other complications [11] and people are getting frightened in the name of diabetes. Usually, people think if they intake drug regularly for controlling diabetes, only that will work. But diabetes remains under control when diabetic patients maintain a healthy and disciplined life that means by practicing healthy lifestyle e.g., planned food habit, regular physical exercise, weight management etc. [12].

Surveys are useful in describing the characteristics of a large population. No other research method can provide this broad capability, which ensures a more accurate sample to gather targeted results in which to draw conclusions and make important decisions. The data, from a survey, can show the current state of a company or a city on an issue. Several reports have been reported such as importance of diabetes mellitus in relation with other cardiovascular diseases [13], mycological survey and total aflatoxin analyze in silage from Qaemshahr city [14], effect of oil pollution on plants was visualized by survey work [15], and the effect of mycotoxins in wheat from Iran was also reported [16].

Recently, a pilot cross-sectional survey on awareness and practice regarding Type 2 Diabetes mellitus and its management with Yoga was conducted by Naresh Kumar P et al. [17]. Kyung Hee Lee et al. reported a survey work on hypertension and diabetes mellitus as risk factors for asthma in Korean adults [18]. Prevalence of diabetes mellitus and its associated unfavorable outcomes in patients with acute respiratory syndromes due to coronaviruses infection was published by Isabel Pinedo-Torres et al [19]. A survey research was conducted on predictor risk of diabetes mellitus in Indonesia in previous report [20]. The prevalence and risk factors of stroke among Sudanese individuals with diabetes was conducted through survey analysis [21]. In addition, national wide survey on DM was carried out in Bangladesh which was published in previous reports [22, 23]. However, survey result on diabetes mellitus particularly on specific region like Khulna, has not been reported yet.

Here, this survey study attempts at examining the impact of controlled food habit and regular physical exercise on type II diabetic hypertensive patients who were on medications for hyperglycemia and hypertension in Khulna, Bangladesh. A few selected demographic characteristics were employed to uncover the influence of these factors on type II diabetes mellitus. It was a cross-sectional study and to meet the objective of the study, 244 participants were selected. A questionnaire was applied to assemble the relevant data for the lifestyle of the participants and other biochemical parameters such as blood sugar, glycated hemoglobin (HbA1c), triglyceride (TG), total cholesterol (TC), low density lipoprotein (LDL) and high-density lipoprotein (HDL) were recorded from the book provided by the hospital. Chi-square and logistic regression analysis have been used to portray the necessary associations, namely physical exercise and food habit are important determinants for control of

diabetes, females are more prone to uncontrolled diabetes, obesity and with increase in ages diabetes is hard to control as well as uncontrolled diabetes indulges dyslipidemia. Overall, this study was conducted to visualize the status of DM in that area as well as to raise awareness among people for disciplined lifestyle. We believe this study will help people to be more careful about the physical exercise and food habit along with the medication.

MATERIALS AND METHODS

The study was a cross-sectional study, and the findings were used to estimate the impact of controlled food habit and regular physical exercise on type II diabetic hypertensive patients who were taking drug. Study subjects were selected randomly, and data regarding their lifestyle were collected by personal interview method according to the open-ended questionnaire [24]. Type II diabetes mellitus patients who were taking medications for hypertension and hyperglycemia were considered. The IBM SPSS Statistics 20 version of software for data analysis was used. The total study subjects were 244 and it was conducted in Khulna town at Khulna Diabetic Hospital, irrespective of gender, religion, and races for 1 year.

The criteria recommended by WHO was followed to diagnose DM [3, 25] (shown in Table 1). Fasting blood glucose (FBG) ≥6.1 mmol/l and blood glucose 2 hours after 75 gm glucose ingestion ≥11.1 mmol/l were used to classify DM cases. Fasting blood glucose 5.6–6.0 mmol/l was diagnosed as glycemia, while blood glucose 2 hours after 75 gm glucose 7.8- 11.0 mmol/l was diagnosed as impaired glucose tolerance (IGT) (Table 1). And all these analytical data were collected by observing the book provided by the hospital to patients. The value of TG, TC, LDL, and HDL were taken from the blood test reports provided by the doctor to patients. Another parameter is HbA1c which stands for glycated hemoglobin, is a form of hemoglobin that is measured primarily to identify the three-month average plasma glucose concentration. The test is limited to a three-month average because the lifespan of a red blood cell is four months (120 days). However, since RBCs do not all undergo lysis at the same time, HbA1c is taken as a limited measure of 3 months. In diabetes mellitus, higher amounts of glycated hemoglobin, indicating poorer control of blood glucose levels have been associated with cardiovascular diseases, nephropathy, neuropathy and retinopathy. And after diagnosis of diabetes mellitus, is it either under control or not, it can be understood by the HbA1c level.

Table 1. Diabetes diagnostic criteria for oral glucose tolerance test (OGTT).

Condition	2-hour glucose (mmol/l)	Fasting glucose (mmol/l)	HbA1c (%)
Normal	<7.8	<6.1	<6.0
Impaired fasting glucose (IFG)	<7.8	6.1 to 6.9	6.0-6.4
Impaired glucose tolerance (IGT)	≥7.8	<7.0	6.0-6.4
Diabetes mellitus (DM)	≥11.1	≥7.0	≥6.5

RESULTS AND DISCUSSION

The study was conducted to reveal the impact of physical exercise and controlled food habit on type II diabetic hypertensive patients who were taking drugs for hyperglycemia and hypertension. The study also anticipated influence of some social demographic characteristics of the respondents on type II diabetes mellitus. The study reveals that among 244 participants, 114 were male participants and 130 were female

participants, that mean 46.7% were male and the rest of 53.3% were female. Among all the selected participants 61.1% were from urban community whereas 38.9% were from rural community (Figure 1a).

Figure 1b represents the age distribution, majority of the participants (48%) were in the age group 41-55 years followed by 36.5% were in the age group 56-70 years, 9.8% from the age group 26-40 years, 4.1% from ≥71 years and the rest 1.6% were in the age group ≤25 years. Moreover majority (47.1%) of the respondents were from normal Body Mass Index (BMI) group followed by 40.6% were from overweight group, 8.6% were from obese group, while 2.9% was severe obese and the rest 0.8% were below normal, shown in Figure 1c. By the time elapsed, we found that majority of the participants (30.7%) was from <2 years of duration of diabetes group, 2nd majority (30.3%) from 2-5 years of diabetes followed by 25.4% were from 5-10 years of diabetes duration and the rest 13.5% were from >10 years duration of diabetes.

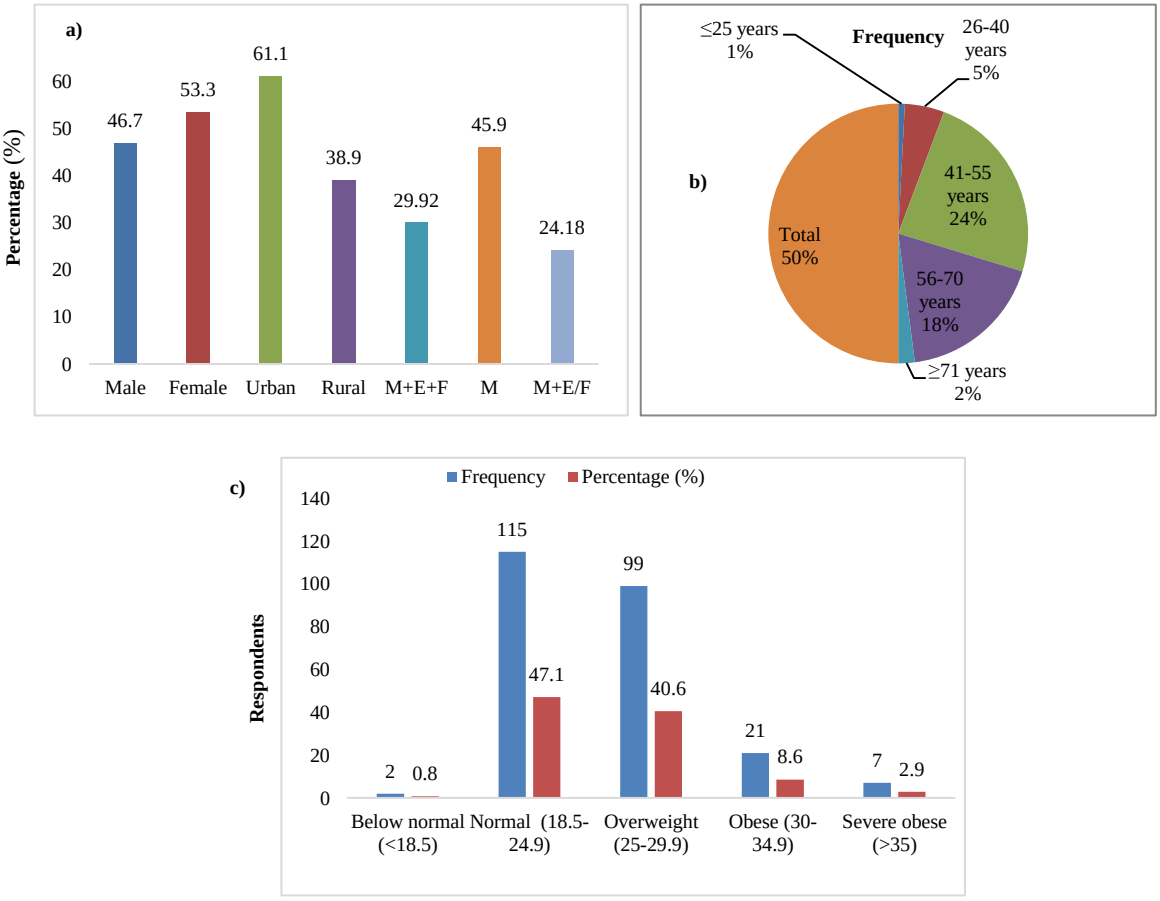

Figure 1. (a) Percentage distribution of the respondents (b) Age distribution of respondents (c) BMI distribution of respondents.

This discrepancy may be due to the facts that rural participants perform more physical activities and take less fatty or junk foods in comparison to the urban participants, as a result urban people are more prone to type II diabetes mellitus.

From the survey data we monitored, 50% were taking

regular physical exercise and the rest 50% were not taking regular exercise and the majority of the participants 66.4% were in the group not maintaining restricted diet and the rest 33.4% were in the group maintaining restricted diet. However, this discloses that participants who were maintaining both exercise and food habit, among them 11.48% had control level of FBS and 5.33% had uncontrolled level of FBS, but the participants taking neither exercise nor restricted diet, from them 0.00% and 44.67% had control and uncontrolled level of FBS respectively. And respondents who were taking either of them, for that case 19.26% had uncontrolled FBS level and these variations are statistically significant, p=0.000 (Table 2).

Table 2. Association of blood sugar and glycated hemoglobin with physical exercise and restricted diet.

Factors	Numerical values	Taking Regular Physical Exercise and Controlled Food Habit			Significance	
		Both (M+E+F) (%)	None (M) (%)	Any (M+E/F) (%)	$\chi 2$ value	p-value
Fasting blood sugar level of respondent (mg/dl)	Control (≤6.0)	11.48	0.00	0.41	142.772	0.000
	Fair control (6.1-6.9)	13.11	1.23	4.51		
	Uncontrolled (≥7.0)	5.33	44.67	19.26		
Blood Sugar 2hr after breakfast (mg/dl)	Control (≤7.7)	5.33	0.41	0.00	151.221	0.000
	Fair control (7.8-11.0)	20.90	2.05	3.28		
	Uncontrolled (≥11.1)	3.69	43.44	20.90		
Glycated hemoglobin level (%)	Control (≤7.0)	23.77	0.00	9.43	226.747	0.000
	Fair Control (7.1 -8.0)	5.33	3.69	13.11		
	Uncontrolled (>8.0)	0.82	42.21	1.64		

The study also brings out that (Table 2) respondents who were taking both regular exercise and restricted diet among them11.48% had control level of fasting blood sugar whereas only 5.33% people had uncontrolled fasting sugar in this group. Moreover, people who were dependent only on medications, among them 44.67% had uncontrolled blood sugar level but surprisingly none of them had control fasting blood sugar level (0.00%) and this contrast show statistically significant output (p=0.000). In addition, respondents who were taking both regular exercise and restricted diet among them 5.33% had control level of blood sugar 2hr after breakfast and only 3.69% had uncontrolled level but who were taking none of them, in that case only 0.41% had controlled blood sugar level and 43.44% had uncontrolled blood sugar level 2hr after breakfast. These differences show statistically significant relation where p=.000. The study also exposes those respondents who were taking both exercise and controlled food habit had highest majority (23.77%) of control level of HbA1c, otherwise lowest level of uncontrolled (0.82%) HbA1c but who were taking none of them, only 0.00% had control HbA1c level as well as 42.21% uncontrolled level of HbA1c. These variations show statistically significant association as well, p=.000 (Table 2). These findings are comparable with another study was conducted in china [26]. In addition, sedentary lifestyle was found significantly related to diabetes in this study, which is consistent with other survey, reported previously [27, 28].

On the other hand, Table 3 shows diastolic blood pressure and systolic blood pressure showed statistically insignificant association with food habit and physical exercise where p values are 0.522 and 0.598 respectively, this contrast may be because of selection of respondents taking medications for hypertension.

Again, the study uncovered those respondents taking both exercise and controlled food habit, among them 25.41% had desirable TG level followed by 2.46% had risk level and 2.05% had high risk level of TG and these values were 28.69%, 11.89% and 5.33% respectively for respondents taking none of restricted diet and physical exercise. These differences showed statistically significant association, where p=0.013 (Table 4). Similarly, the present study uncovered those respondents taking both exercise and food habit properly, among them 25.00% had desirable TC level followed by 4.10% had risk level and 0.82% had high risk level of TC and these values were 28.69%, 9.84% and 7.38% respectively for respondents taking none of them. These variations also showed significant association statistically, p=0.009 (Table 4).

Table 3. Association of blood pressure with physical exercise and controlled food habit.

Factors	Numerical values	Taking Regular Physical Exercise and Controlled Food Habit			Significance	
		Both (%)	None (%)	Any (%)	$\chi 2$ value	p-value
Diastolic bp (mm/Hg)	Normal (≤80)	25.00	40.57	20.08	3.217	0.522
	Pre-hypertension (81-89)	3.69	2.87	2.05		
	Hypertension (≥90)	1.23	2.46	2.05		
Systolic bp (mm/Hg)	Normal (101-120)	6.15	7.38	3.28	2.764	0.598
	Prehypertension (121–139)	22.54	34.84	18.44		
	Hypertension (≥140)	1.23	3.69	2.46		

Moreover, logistic regression for selected variables affects the check of diabetes mellitus of the patients. It uncovered those females were 1.141 times more prone to uncontrolled diabetes, which contradict another study where it was said males were 1.389 times more likely to develop diabetes as compared to the females [27]. It also showed, rural community cannot check the diabetes properly, may be due to lack of awareness and education. It appears from the study that with increase in age, especially at 41-55 years diabetes is tough to control. This finding somewhat correlates with another study of Bangladesh [28]. The present study additionally disclosed that severe obese people are much more prone to uncontrolled level of diabetes.

Table 4. Association of lipid profile with exercise and restricted diet.

Factors	Numerical values	Taking Regular Physical Exercise and Controlled Food Habit			Significance	
		Both (M+E+F) (%)	None (M) (%)	Any (M+E/F) (%)	$\chi 2$ value	p-value
TG (mg/dl))	Desirable (≤150)	25.41	28.69	15.57	12.681	0.013
	Risk (151-199)	2.46	11.89	6.56		
	High risk (≥200)	2.05	5.33	2.05		
TC (mg/dl))	Desirable (≤200)	25.00	28.69	14.34	13.522	0.009
	Risk (201–239)	4.10	9.84	6.15		
	High risk (≥240)	0.82	7.38	3.69		
HDL (mg/dl)	Desirable (≥50)	2.87	3.69	2.87	1.848	0.764
	Risk (36–49)	25.41	38.93	18.85		
	High risk (≤35)	1.64	3.28	2.46		
LDL (mg/dl)	Below normal (≤59)	2.05	1.23	0.00	8.353	0.213
	Desirable (60-130)	22.95	36.48	20.90		
	Risk (131–159)	4.51	5.74	2.87		

It also assumed that with increase in duration of diabetes, control of diabetes declines and if the duration of diabetes is >10 years, it is 3.917 times tougher to control than the <2 years of duration. Scientists theorize that the pancreas ages right along with human being and does not pump insulin as efficiently as it did when people are in their young ages. Also, with the increasing cells' age, they become more resistant to insulin [29].

It is also appeared that physical exercise and controlled food habit are two important factors for checking on diabetes. Though diastolic blood pressure shows no important association, but systolic blood pressure discloses that pre-hypertensive and hypertensive patients are more prone to uncontrolled level of diabetes. In case of dyslipidemia, this study detected those patients who had risk TG level are 2.86 times more attached to uncontrolled diabetes than desirable level of TG. Likewise, with increase in LDL cholesterol, risk of diabetes also increases. However, patients who had risk level of HDL cholesterol are 1.5 times much prone to risk of diabetes than who had desirable level of HDL (Table 5). Then it may be said that risk of diabetes increases dyslipidemia of patients, this uncovering also correlates with another study [30].

Table 5. Logistic Regression of the selected variables effecting control of DM of the respondents.

Independent variables	B	S.E.	Sig.	Exp(B)	95% C.I. for Exp(B)	
					Lower	Upper
Sex						
Male	-	-	-	-	-	-
Female	0.132	0.784	0.867	1.141	0.245	5.303
Residence						
Urban	-	-	-	-	-	-
Rural	2.592	1.055	0.014	13.359	1.691	105.562
Age						
<25	-	-	0.735	-	-	-
26-40	0.904	5.051	0.858	2.469	0.000	49158.474
41-55	2.622	2.438	0.282	13.765	0.116	1637.921
56-70	1.880	1.804	0.298	6.550	0.191	224.997
>70	2.409	1.820	0.186	11.119	0.314	393.395
Body Mass Index						
Lean	-	-	0.093	-	-	-
Normal	-0.802	3.992	0.841	0.449	0.000	1122.850
Overweight	-1.009	1.739	0.562	0.365	0.012	11.009
Obese	-2.512	1.806	0.164	0.081	0.002	2.793
Severe obese	2.559	1.931	0.185	12.925	0.294	568.689
Duration of Diabetes Mellitus						
<2years	-	-	0.599	-	-	-
2-5years	0.006	1.340	0.996	1.006	0.073	13.897
5-10years	0.041	1.258	0.974	1.042	0.088	12.270
>10years	1.365	1.351	0.312	3.917	0.277	55.367
Taking Regular Physical Exercise						
Yes	-	-	-	-	-	-
No	5.858	0.980	0.000	350.054	51.303	2388.518
Controlled Food Habit						
Yes	-	-	-	-	-	-
No	4.233	0.853	0.000	68.890	12.937	366.850
Diastolic BP (mm/Hg)						
Normal	-	-	0.060	-	-	-
Pre-hypertension	-2.979	2.624	0.256	0.051	0.000	8.703
Hypertension	-0.035	2.650	0.989	0.965	0.005	173.945
Systolic BP (mm/Hg)						
Normal	-	-	0.299	-	-	-
Pre-hypertension	1.929	2.738	0.481	6.882	0.032	1472.488
Hypertension	3.092	2.618	0.238	22.020	0.130	3726.519

Triglyceride (mg/dl)			0.733			
Desirable	-	-		-	-	-
Risk	1.051	1.334	0.431	2.860	0.209	39.073
High risk	0.600	1.298	0.644	1.822	0.143	23.182
Total Cholesterol (mg/dl)						
Desirable	-	-	0.900	-	-	-
Risk	-0.576	1.762	0.744	0.562	0.018	17.754
High risk	-0.133	1.878	0.943	0.875	0.022	34.758
LDL (mg/dl)						
Below desirable	-	-	0.390	-	-	-
Desirable	1.084	3.751	0.773	2.956	0.002	4608.583
Risk	3.194	2.160	0.139	24.385	0.353	1682.706
High risk	2.737	2.899	0.345	15.435	0.053	4532.772
HDL (mg/dl)						
Desirable	-	-	0.629	-	-	-
Risk	0.423	1.500	0.778	1.527	0.081	28.878
High risk	1.167	1.269	0.358	3.213	0.267	38.645

Likewise, logistic regression uncovers that female are unable to guard on diabetes and rural people are not also capable of controlling diabetes properly. The detection demonstrates also, increase in age, and increase in duration of diabetes mellitus are also associated with risk of uncontrolled diabetes. The study again discloses the significant correlation of obesity with uncontrolled diabetes. Another important unearthing from the study is that uncontrolled diabetes and dyslipidemia of patients are crucially associated.

We compare our results with previous studies for the physical exercise and food habit as a key factor for controlling diabetes. Ashis et al. reported significant association for physical exercise and food habit to control diabetes mellitus, where $p<0.001$ [22]. The importance of food habit and physical exercise for controlling DM was clarified by another work in which statistical value $p<0.001$ was found [26]. Additionally, Karin et al. reported the significant association ($p<0.005$) for physical exercise and food habit with DM [31]. After all, our study extends that regular physical exercise and controlled food habits are prime determinants for controlling diabetes which is consistent with the previous reports.

CONCLUSIONS

Prevalence of diabetes mellitus (DM) is growing in a rapid pace in both urban and rural communities of Bangladesh. The study attempts to uncover the impact of regular physical exercise and controlled food habit on type II DM and examine a few social demographic factors influencing control of diabetes, though there may be some other factors that have not been considered here. Furthermore, due to resource constraints, the study included limited urban and rural communities as a result the study findings may not represent the real picture. Besides, recall bias and respondent's bias may be found due to influence of other respondents during interview method.

Conflict of interest

Author declares that there is no conflict of interest.

REFERENCES

1. Srilakshmi B., Dietetics, Revised Fifth ed., Chapter-Diet in Diabetes Mellitus. pp. 244-266.

2. World Health Organization (WHO). Diabetes definition. Geneva. at: http:// www. who.int/ topics/diabetes_ mellitus/en/; 2011. [Accessed on 29.12.2013].

3. World Health Organization. Report of a WHO Consultations, Definitions, Diagnosis and Classification of Diabetes Mellitus and its Complications, Part I. Geneva 1999; WHO/NCD/NCS/ 99.2.

4. Ramachandran A., Snehalatha C., Kapur A., Vijay V., Mohan V., Das A.K., Rao P.V., Yajnik C.S., Prasanna K.K.M., Jyotsna D.N., 2001. High prevalence of diabetes and impaired glucose tolerance in India: National Urban Diabetes Survey. Diabetologia. 44, 1094–1101.

5. Shera A.S., Jawad F., Maqsood A., 2007. Prevalence of diabetes in Pakistan. Diabetes Research and Clinical Practice. 76(2), 219-222.

6. Gu D., Reynolds K., Duan X., Xin X., Chen J., Wu X., Mo J., Whelton P.K., He J., 2003.. Prevalence of diabetes and impaired fasting glucose in the Chinese adult population: International Collaborative Study of Cardiovascular Disease in Asia (Inter ASIA). Diabetologia. 46(9), 1190-1198.

7. Sekikawa A., Tominaga M., Takahashi K., Eguchi H., Igarashi M., Ohnuma H., Sugiyama K., Manaka H., Sasaki H., Fukuyama H., Miyazawa K., 1993. Prevalence of diabetes and impaired glucose tolerance in Funagata area, Japan. Diabetes Care. 16(4), 570-574.

8. Mooradian A.D., 2003. Cardiovascular disease in type 2 diabetes mellitus: current management guidelines. Arch Intern Med. 163, 33–40.

9. International Diabetes Federation (IDF). Morbidity and mortality due to diabetes. Brussels. 2011. http://www.diabetesatlas.org/content/diabetes-mortality. [Accessed on 15.03.2013].

10. Sadikot S.M., Nigam A., Das S., Bajaj S., Zargar A.H., Prasannakumar K.M., Sosale A., Munichoodappa C., Seshiah V., Singh S.K., Jamal A., Sai K., Sadasivrao Y., Murthy S.S., Hazra D.K., Jain S., Mukherjee S., Bandyopadhay S., Sinha N.K., Mishra R., Dora M., Jena B., Patra P., Goenka K., 2004. The burden of diabetes and impaired glucose tolerance in India using the WHO 1999 criteria: prevalence of diabetes in India study (PODIS). Diabetes Res Clin Pract. 66(3), 301-307.

11. Magliano D.J., Shaw J.E., Shortreed S.M., Nusselder W.J., Liew D., Barr E.L., Zimmet P.Z., Peeters A., 2008. Lifetime risk and projected population prevalence of diabetes. Diabetologia. 51(12), 2179-86.

12. Sue R.W., Essentials of Nutrition and Diet Therapy, Fifth ed., Chapter-21. pp. 504-528.

13. José L., Palma G., Antonio H.M., Vicente B.M., José R. González J., Víctor L.G.A., Alberto C.M., Eduardo A.E., Moisés C.C., 2004. Diabetes mellitus in clinical cardiology in Spain. Survey by the working group on the heart and diabetes regarding the importance of diabetes mellitus in relation with other cardiovascular diseases. Rev Esp Cardiol. 57(7), 661-6.

14. Hashemi M., Gholampour A.I., Rezai Z., Rouhi S., 2012. Mycological Survey and Total Aflatoxin Analyze in Silage from Qaemshahr City (Northern Iran). Journal of Chemical Health Risks. 2(2), 51-56.

15. Lorestani B., Kolahchi N., Ghasemi M., Cheraghi M., Yousefi N., 2012. Survey the Effect of Oil Pollution on Morphological Characteristics in Faba Vulgaris and Vicia Ervilia. Journal of Chemical Health Risks. 2(3), 5- 8.

16. Javad F., Hamed R. B., Zeynab E., Mahnaz Z., 2014. Survey of Mycotoxins in Wheat from Iran by HPLC Using Immunoaffinity Column Cleanup. Journal of Chemical Health Risks. 4(1), 23-28.

17. Naresh K.P, Ragavendrasamy B., Vibhas K., 2020. A pilot cross-sectional survey on awareness and practice regarding Type 2 Diabetes mellitus and its management with Yoga. Journal of Ayurveda and Integrative Medicine. 11, 106-109.

18. Kyung H.L., Hea S.L., 2020. Hypertension and diabetes mellitus as risk factors for asthma in Korean adults: The Sixth Korea National Health and Nutrition Examination Survey. International Health. 12, 246–252.

19. Isabel P.T., Magaly F.F., Marlon Y.A., Claudia G.O., Paolo Z.L., Claudio I.E., Cristian M.M., Carlos A.D., Kevin P.B., 2020. Prevalence of Diabetes Mellitus and Its Associated Unfavorable Outcomes in Patients with Acute Respiratory Syndromes Due to Coronaviruses Infection: A Systematic Review and Meta-Analysis. Clinical Medicine Insights: Endocrinology and Diabetes. 13, 1–16.

20. Purwo S.N., Niken A.T., Sri S., Ainur R., Denny S.F., Ridwan A., 2020. Predictor Risk of Diabetes Mellitus in Indonesia based on National Health Survey. Mal J Med Health Sci. 16(1), 126-130.

21. Ahmed O.A., Safaa B., Wadie M.E., Hanan T., Mohamed H.A., 2020. The prevalence and risk factors of stroke among Sudanese individuals with diabetes: Cross-sectional survey. Brain Circ. 6, 26-30.

22. Talukder A., Hossain M.Z., 2019. Prevalence of Diabetes Mellitus and Its Associated Factors in Bangladesh: Application of Two-level Logistic Regression Model. Scientific Reports. 10(1), 10237.

23. Jessica Y.I., Mohammad M.Z., Mahfuz R.B., Syed A.H., Shamim A., Ahmad Z.A.Q., 2019. Prevalence and determinants of hyperglycaemia among adults in Bangladesh: results from a population based national survey. BMJ Open. 9, 029674.

24. Carlton J., Elliott J., Rowen D., Stevens K., Basarir H., Meadows K., Brazier J., 2017. Developing a questionnaire to determine the impact of self-management in diabetes: giving people with diabetes a voice. Carlton et al. Health and Quality of Life Outcomes. 15, 146.

25. World Health Organization. Definition and diagnosis of diabetes mellitus and intermediate hyperglycemia. Report of a WHO/IDF Consultation, Geneva, Switzerland, 2006, 3.

26. Pan X.R., Li G.W., Hu Y.H., Wang J.X., Yang W.Y., An Z.X., Hu Z.X., Lin J., Xiao J.Z., Cao H.B., Liu P.A., Jiang X.G., Jiang Y.Y., Wang J.P., Zheng H., Zhang H., Bennett P.H., Howard B.V., 1997. Effects of Diet and Exercise in Preventing NIDDM in People with Impaired Glucose Tolerance, Epidemiology/Health Services/ Psychosocial Research. Diabetes Care. 20(4), 537-44.

27. Tasneem I., 2012. Diabetic Prevalence in Bangladesh: The Role of Some Associated Demographic and Socio-economic Characteristics. International Journal of Advancements in Research & Technology. 1(7), 95-105.

28. Sayeed M.A., Mahtab H., Khanam P.A., Latif Z.A., Ali S.M.K., Banu A., 2003. Diabetes and Impaired Fasting Glycemia in a rural population of Bangladesh. Diabetes Care. 26, 1034 -1039.

29. Ahasan H., Islam M., Alam M., Miah M., Nur Z., Mohammed F., Imran Khan M., Hossain H., Mahbub M., 2011. Prevalence and Risk Factors of Type 2 Diabetes Mellitus among Secretariat Employees of Bangladesh. J Medicine. 12, 125-130.

30. Agrawal Y., Goyal V., Chugh K., Shanker V., Singh A.A., 2014. Types of Dyslipidemia in Type 2 Diabetic Patients of Haryana Region. Sch J App Med Sci. 4, 1385-1392.

31. Karin M.N., Md M., Gayle R., Phd M., Edward J.B., Md M., 2002. Diet and Exercise Among Adults with Type 2 Diabetes. Diabetes Care. 25,10, 1722-1728.