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ORIGINAL ARTICLE

Prevalence of type 2 diabetes–associated complications in Pakistan

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Abstract The prevalence of type 2 diabetes (T2DM) is rapidly increasing in Pakistan. Various micro- and macro-vascular complications are associated with disease progression which increases the economic burden not only on patients but also on country. The aim of the present study was to determine the prevalence of micro- and macro-vascular complications among T2DM patients in Pakistan. A cross-sectional study was carried out on 692 T2DM patients during July 2011 to December 2012. The participants recruited in this study were clinically diagnosed by certified diabetologist and endocrinologists in the Pakistan Institute of Medical Sciences (PIMS) and Kahuta Research Laboratory (KRL) hospital of Islamabad. Demographic and clinical data was collected under supervision of a diabetologist and endocrinologist using a specially designed questionnaire. Clinical variables were statistically analyzed using SPSS version 16.0 and Graphpad prism 5 version 5.01. Of the 678 T2DM patients, 432 (63.62 %) were females with mean age of 51.81±11.43. Out of total patients, 0.56 % were diagnosed with retinopathy, 0.84 % with nephropathy, 0.28 % with neuropathy, 28.17 % with ischemic heart diseases, 8.45 % with stroke, and 5.35 % with peripheral vascular disease. Overall, 55.77 % of T2DM patients were hypertensive and 0.56 % experienced impotence. Significant association of hypertension ($P = 0.0072$), ischemic heart disease (IHD; $P = 0.0001$), and peripheral vascular disease (PVD; $P = 0.014$) was observed at gender level in the study subjects. This study indicates high prevalence of macro-vascular complications along with high triglyceride level and hypertension among T2DM patients. A study with larger sample set is suggested to explore the relation of genetic and environmental factors on disease progression and sub-population variations.

Keywords Type 2 diabetes · Epidemiology · Micro-vascular complications · Macro-vascular complications

Introduction

Type 2 diabetes (T2DM) is a chronic, heterogeneous, and multi-factorial metabolic disorder that involves complex interaction of environmental factors and susceptibility genes [1–4]. It is characterized by defect in insulin secretion by β cells in pancreatic islets and insulin resistance [5–7]. It affects health quality and life expectancy of the patients [8]. The escalating rate of T2DM has made it one of the important global health challenges [9]. It has been estimated that 371 million people worldwide suffer from diabetes with 187 million of undiagnosed cases. Furthermore, it is one of the major causes of mortality worldwide with 4.8 million deaths and $471.6 billion on health care expenditure in 2012 [5, 9–12]. The prevalence of T2DM is rapidly increasing in both developed and underdeveloped countries. More than 60 % of world's population with diabetes is contributed by Asian countries [13–15].

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According to International Diabetes Federation (IDF), Pakistan is among the top ten countries with highest prevalence of diabetes and have 6.6 million people with diabetes [15].

Although many research groups from developed countries are involved in exploring different factors contributing toward the progression and development of T2DM, similar research efforts in developing countries are unsatisfactory. The prevalence and interrelationship of the complications associated with diabetes have not been properly investigated in developing countries including Pakistan [16]. Therefore, this study was conducted to obtain information on the prevalence of various T2DM-associated complications in T2DM patients and their relationship with duration of disease and age of onset.

Study design and methods

Study population

This cross-sectional study was carried out in 692 T2DM patients. The patients were clinically diagnosed by certified diabetologist and endocrinologists at Pakistan Institute of Medical Sciences (PIMS) and Kahuta Research Laboratory (KRL) hospital of Islamabad, Pakistan, from July 2011 to December 2012. All participants were screened for T2DM according to World Health Organization (WHO) and International Diabetes Foundation (IDF) diagnosis criteria [15, 17, 18]. The inclusion criteria for T2DM patients include (1) fasting plasma glucose ≥126 mg/dL (7.0 mmol/l), (2) a random blood sugar level of ≥200 mg/dL (11.1 mmol/L), (3) 2-h values in the 75-g oral glucose tolerance test (OGTT), cutoff value of ≥200 mg/dL (11.1 mmol/L), and (4) HbA1c of 6.5 %.

The patients with prior history of gestational diabetes, type 1 diabetes (differentiated from T2DM by age of onset and ketoacidosis), and other forms of diabetes were excluded from the final analysis ($n=10$). Each patient underwent detailed interview to collect history, demographic, and clinical data, including age, gender, duration of disease, family history, type of treatment, weight, height, body mass index (BMI), blood pressure, general health conditions, and the presence of any micro- and macro-vascular complications and hypertension (patients already taking hypertension medication or with blood pressure >130/80 mm Hg were considered as hypertensive) [19, 20]. BMI was calculated using formula weight (kilograms) divided by square of height in meters. According to duration of T2DM, patients were divided into three groups, i.e., <5, 5–10, and >10 years. Similarly, on the basis of age, the patients were divided into four groups, i.e., 25–40, 41–55, 56–70, and >70 years.

Each patient was interviewed and data was noted/recorded on a specially designed questionnaire. An informed consent form was signed from each patient and the study was approved by Institutional Review Board (IRB) of Atta-ur-Rahman School of Applied Biosciences, NUST.

T2DM-associated complications

Since this was an observational and open label study, data for all the associated complications like hypertension, retinopathy, nephropathy, neuropathy, ischemic heart disease (IHD), stroke, impotency, peripheral vascular disease (PVD), urinary tract infection (UTI), and dental infection were collected from medical records by the help of endocrinologist and no further clinical assessments were performed.

Statistical analysis

Statistical analysis was performed in SPSS version 16.0 (SPSS Inc., USA) and Graphpad Prism version 5.01 (San Diego, California, USA). Frequency of categorical variables was calculated in percentages, while continuous variables were described as mean and median. χ^2 test was used to explore associations in ordinal data at the significance level of <5 % (0.05).

Results

Demographic and clinical characteristics of study subjects

Of the total 692 T2DM recruited patients, 678 met the inclusion criteria for the study. The clinical and demographic profile of study population is shown in Table 1. Of the 678 patients, 246 (36.22 %) were males and 432 (63.62 %) were females with a mean age of 51.81±11.43 (ranges from 27 to 95 years). The mean age of diagnosis was 44.95±10.86 years, and median age of 44 years with 25th and 27th percentiles of 37 and 52 years, respectively. The average duration of disease was 7.23±6.754. Females were diagnosed with T2DM at younger age of 44.50±10.89 ($P=0.0332$; 41.64 %, diagnosis age range 25–50 years) as compared to males with average age of diagnosis at 45.76±10.78 (34.92 %, diagnosis age range 25–50 years) (Fig. 1a and Table 1). Furthermore, on average, newly diagnosed T2DM cases were more prevalent in females (47.56 %; $P=0.05$) than males (39.11 %; Fig. 1b). Obesity, an important risk factor of T2DM, was higher in females ($P<0.0001$; Fig. 1c).

Prevalence of T2DM-associated complications and chronic conditions is presented in Table 2 and Fig. 1d. Of the total patients, 66.6 % were diagnosed with hypertension (more prevalent in females), 0.8 % with retinopathy, 1 % with nephropathy, 7.3 % with neuropathy, 18.1 % with IHD, 5.5 % with stroke, 3.6 % with PVD, and 0.3 % with impotency. These complications were more prevalent in age group 56–

Table 1 Demographic and clinical characteristics of T2D patients

Age (years)	51.85±11.134		
HbA1C	8.7 %		
Fasting glucose level (mg/dL)	184.78±85.62		
Random glucose level (mg/dL)	260.87±99.57		
Systolic BP (mmHg)	135±21.425		
Diastolic BP (mmHg)	86.08±13.4		
Total serum cholesterol (mg/dL)	185.15±47.51		
HDL cholesterol (mg/dL)	43.43±34		
LDL cholesterol (mg/dL)	100.82±39.16		
Triglycerides (mg/dL)	210±129		
	Gender		
	Male *N* (%)	Female *N* (%)	Total N
Duration of T2D			
<5	78 (40.83 %)	166 (48.96 %)	244
5–10	58 (30.36 %)	103 (30.38 %)	161
>10	55 (28.79 %)	70 (20.64 %)	125
Total	191	339	530
BMI			
Underweight (below 18.5)	10 (4.95 %)	7 (2.03 %)	17
Normal (18.5 to 24.9)	81 (40.10 %)	78 (22.67 %)	159
Overweight (25.0 to 29.9)	82 (40.59 %)	138 (40.11 %)	220
Obese (30 or higher)	29 (14.35 %)	121 (35.17 %)	150
Total	202	344	546
Age at diagnosis			
25–40	66 (34.92 %)	142 (41.64 %)	208
40–55	91(48.15 %)	135 (39.59 %)	226
55–70	30 (15.87 %)	60 (17.60 %)	90
>70	2 (1.05 %)	4 (1.17 %)	6
Total	189	341	530
Total serum cholesterol			
Below 200 mg/dL	51 (66.23 %)	66 (61.11 %)	117
200–239 mg/dL	16 (20.78 %)	27 (25 %)	43
240 mg/dL and above	10 (12.98 %)	15 (13.89 %)	25
Total	77	108	185
HDL			
Below 40 mg/dL	30 (44.78 %)	44 (46.80 %)	74
40–59 mg/dL	33 (49.25 %)	47(50 %)	80
60 mg/dL and above	4 (5.97 %)	3 (3.2 %)	7
Total	67	94	167
LDL			
Below 100 mg/dL	39 (54.16 %)	43 (45.26 %)	82
100–129 mg/dL	17 (23.61 %)	31 (32.63 %)	48
130–159 mg/dL	8 (11.11 %)	16 (16.84 %)	24
160–189 mg/dL	8 (11.11 %)	5 (5.26 %)	13
Total	72	95	167
Triglycerides			
Below 150 mg/dL	33 (45.21 %)	33 (29.73 %)	66
150–199 mg/dL	13 (17.81 %)	26 (23.42 %)	39
200 mg/dL and above	27 (36.98 %)	52 (46.84 %)	79
Total	73	111	184

BP blood pressure, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *T2D* type 2 diabetes, *BMI* body mass index

Diabetes Public Health Resource, CDC 2011. http://www.cdc.gov/diabetes/statistics/

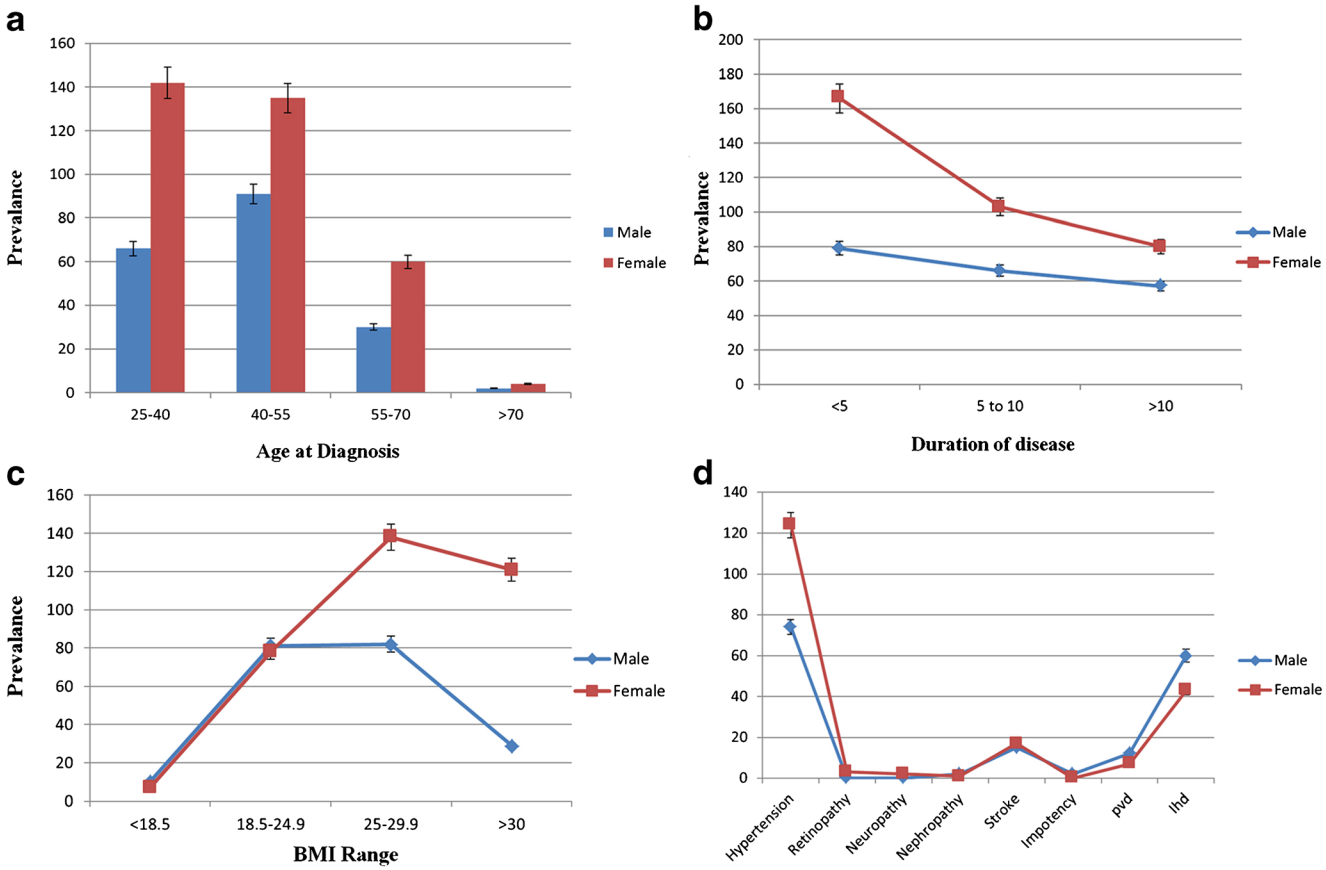

Fig. 1 **a** Comparison of age of diagnosis of T2DM among male and female T2DM patients. **b** Comparison of duration of T2DM among male and female T2DM patients. **c** Comparison of BMI among male and female T2DM patients. **d** Prevalence of diabetes-associated complications among male and female T2DM patients

70 years (41.97 %). The most common complication was IHD along with hypertension. Association analysis of T2DM-associated complications with duration of disease indicated the same trend of high hypertension (in groups with disease duration of less than 5 and more than 10 years). Furthermore, an increase in prevalence of IHD and PVD with duration of disease was found, while stroke was more prevalent with 5–10 years of duration of disease. On the other hand, in males, these complications showed different trends and there was gradual increase in prevalence of IHD and stroke with duration, but PVD was more prevalent with duration of 5–10 years. These results show that prevalence of IHD with duration of disease has the same trend in both males and females. High prevalence of nephropathy was observed in females; however, an increase in prevalence with duration of disease in both males and females was found. Neuropathy, on the other hand, showed a decrease in prevalence with increase in duration of disease in females, but there was no significant change in neuropathy with duration in males. Retinopathy also showed a similar trend as neuropathy in both males and females with duration of disease.

Prevalence of infections among T2DM patients

Three common infections associated with T2DM were selected for analysis, including urinary tract infection (UTI), ear and dental infections. T2DM-associated infection was higher in female (76.11 %) than in male (23.89 %) patients. UTI was observed in 35.84 %, ear infections in 3.53 %, and dental infections in 60.62 % of the total T2DM patients. Of the three T2DM-associated infection considered in this study, the gender-based distribution/difference of only UTI was found statistically significant (OR 0.244 (0.126–0.471); $P<0.0001$) (Table 3).

Association between complications and age at diagnosis

Patients were divided into various age groups according to age at diagnosis, i.e., 25–40, 41–55, 56–70, and >70 years. T2DM-associated complications were common among patients with late onset of disease (74.44 %), especially in the age group of 55–70 years. IHD, being a most prevalent complication, was found in 20 % of the patients diagnosed at age of 55–70 years, while 7.77 % patients of the same age at

Table 2 Prevalence of type 2 diabetes–associated complications in different age groups and at different age of diagnosis of diabetic patients

Age	Hypertension *N* (%)	Retinopathy *N* (%)	Nephropathy *N* (%)	Neuropathy *N* (%)	IHD *N* (%)	Stroke *N* (%)	Impotency *N* (%)	PVD *N* (%)	Total[a]
25–40	31 (15.66 %)	0	0	0	6 (6 %)	2 (6.67 %)	0	3 (15.79 %)	42 (11.83 %)
41–55	88 (44.44 %)	1 (50 %)	0	0	40 (40 %)	12 (40 %)	0	4 (21.05 %)	145 (40.84 %)
56–70	73 (36.87 %)	1(50 %)	3 (100 %)	1(100 %)	46(46 %)	12 (40 %)	1(50 %)	12 (63.15 %)	149 (41.97 %)
>70	6 (3.03 %)	0	0	0	8 (8 %)	4 (13.33 %)	1(50 %)	0	19 (5.35 %)
*Total	198 (55.77 %)	2 (0.56 %)	3 (0.84 %)	1 (0.28 %)	100 (28.17 %)	30 (8.45 %)	2 (0.56 %)	19 (5.35 %)	355
Age at diagnosis (years) (*n*)	Hypertension *N* (%)	Retinopathy *N* (%)	Nephropathy *N* (%)	Neuropathy *N* (%)	IHD *N* (%)	Stroke *N* (%)	Impotency *N* (%)	PVD *N* (%)	Overall *N* (%)
25–40 (208)	64 (30.76 %)	0	1 (0.48 %)	0	21 (10.09 %)	7 (3.36 %)	1 (0.48 %)	4 (1.92 %)	98 (47.11 %)
40–55 (226)	73 (32.30 %)	1 (0.44 %)	2 (0.88 %)	1 (0.44 %)	26 (11.50 %)	8 (3.53 %)	1 (0.44 %)	11 (0.85 %)	126 (54.42 %)
55–70 (90)	39 (43.33 %)	1 (1.11 %)	0	0	18 (20 %)	7 (7.77 %)	0	2 (2.22 %)	67 (74.44 %)
>70 (6)	0	0	0	0	1 (16.67 %)	0	0	0	1 (16.67 %)

IHD ischemic heart disease, *PVD* peripheral vascular disease

[a] Total number represents total number of individuals/participants with above mentioned complications

Table 3 Prevalence of type 2 diabetes–associated infections in males and females and association statistics of clinical variables at gender level

T2D-associated infection		Frequency of males and females patients (%)		Statistical significance (alpha <0.05)					
				Odd ration (OR) (95 % confidence interval)			P-Value		
Urinary tract infection (UTI)		Male: 11 (20.37) Female: 70 (40.69)		0.244 (0.126–0.471)			<0.0001		
Ear infection		Male: 1 (1.85) Female: 7 (4.07)		0.2524 (0.0308–2.066)			0.269		
Dental infection		Male: 42 (77.7) Female: 95 (55.23)		0.7426 (0.493–1.117)			0.158		
Variables	*n**	Hypertension *N* (%)	Retinopathy *N* (%)	Nephropathy *N* (%)	Neuropathy *N* (%)	IHD *N* (%)	Stroke *N* (%)	Impotency *N* (%)	PVD *N* (%)
Gender	246	74 (30.08)	0	2 (0.81)	0	60 (24.39)	15 (6.09)	2 (0.81)	12 (4.87)
Male Female	432	124 (28.70)	3 (0.069)	1 (0.23)	2 (0.46)	43 (9.95)	17 (3.93)	0	7 (1.62)
		χ^2=7.224 *P*=0.0072	χ^2=1.721 *P*=0.19	χ^2=1.196 *P*=0.274	χ^2=1.148 *P*=0.284	χ^2=29.87 *P*=<0.0001	χ^2=0.204 *P*=0.652	χ^2=3.51 *P*=0.61	χ^2=6.09 *P*=0.014

**n*=number of males and females with type 2 diabetes–associated complications with reference to total number of participating male and female patients

IHD ischemic heart disease, *PVD* peripheral vascular disease

diagnosis suffered from stroke. Furthermore, hypertension was observed in 43.33 % patients diagnosed at older age (later than 55 years) (Table 2).

Association analysis of clinical variables at gender level

Association of T2DM-associated complications at gender level is shown in Table 3. Significant association of hypertension ($P = 0.0072$), IHD ($P = 0.0001$), and PVD ($P = 0.014$) was observed at gender level in the study subjects, IHD being the most significant (Fig. 2).

Discussion

T2DM is an extremely heterogeneous, multifactorial metabolic disorder characterized by combination of deficiency of insulin secretion and insulin resistance that involves complex

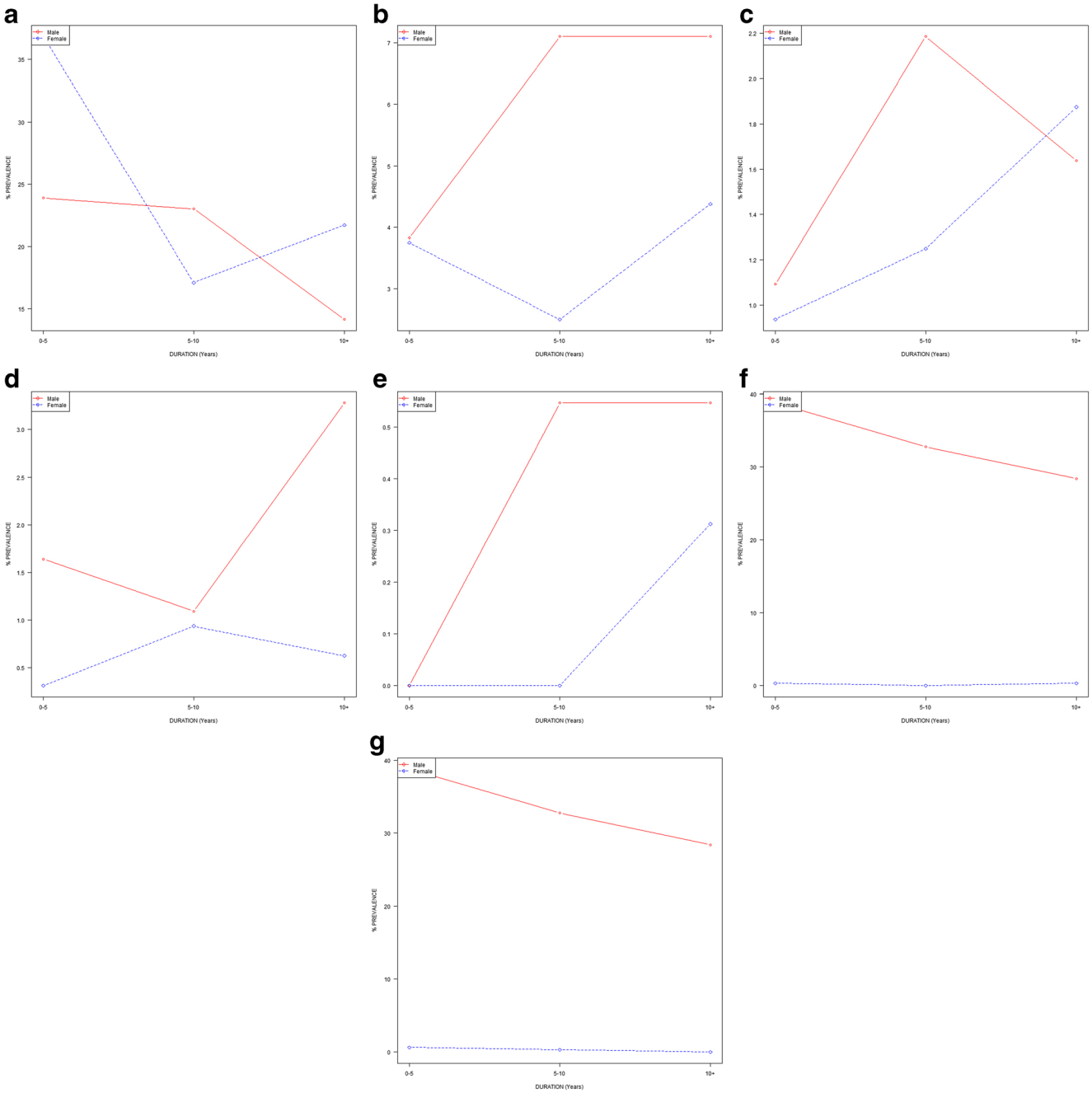

Fig. 2 Prevalence of T2DM complications with duration of disease among male and female diabetic patients. Association of **a** hypertension, **b** IHD, **c** stroke, **d** PVD, **e** nephropathy, **f** neuropathy, and **g** retinopathy with duration of disease

interaction of environmental factors and susceptibility genes [5]. The etiology of diabetes is very complex involving various pathogenic processes ranging from autoimmune destruction of pancreatic beta cells to insulin deficiency and insulin resistance that may be a consequence of various environmental and genetic factors [21]. Diabetes mellitus has become one of the leading and important health problems worldwide [9, 15]. T2DM is one of the common diseases in Pakistan. Prevalence of T2DM has also increased in Pakistan in the past few years placing it at the tenth position in the countdown with 6.6 million people with diabetes that was 5.2 million in year 2000 [14, 15, 22].

Various T2DM-associated micro- and macro-vascular complications develop through the natural progression of the disease. To our knowledge, this is the first cross-sectional epidemiological study to collectively report prevalence of various macro- and micro-vascular complications among T2DM patients in Pakistan although individual studies of microvascular complications and stroke have been conducted in different regions of Pakistan. The present study was conducted on 692 T2DM patients including 36.22 % males and 63.62 % females. Various studies have shown that diabetes is more prevalent in middle-aged males than in females [23–26], and our results are consistent with the previous studies as we observed 48.15 % males and 39.59 % females in age group of 40–55 years. On the other hand, newly diagnosed T2DM cases were common in females diagnosed at age of 24–40 years than males.

Lipid profiling of patients showed normal serum cholesterol (185.15±47.51 mg/dL; n=185), normal HDL cholesterol (43.43±34 mg/dL; n=167), near-normal LDL cholesterol (100.82±39.16 mg/dL; n=167), and elevated triglyceride (210±129 mg/dL; n=184) levels. High triglyceride level was prevalent in females (46.84 %) than in males (36.98 %). High triglyceride level is a risk factor not only for T2DM but also for cardiovascular diseases. Cardiovascular diseases are one of the important complications associated with T2DM. This indicates high risk of developing cardiovascular diseases in these patients [27]. That may be the reason why we found higher prevalence of heart-related complications like IHD (18.1 %), stroke (5.5 %), and PVD (3.6 %) in our study sample group.

Prevalence of hypertension (30.08 % in male and 28.70 % in female) among T2DM patients was consistent with Crawford et al. (22.8 % male and 20.1 % female) [28]. They also showed high prevalence of hypertension among patients within age group of 20–39 years that is inconsistent with our results where the highest prevalence was found in patients with in age group of 56–70 years. Newly diagnosed T2DM patients are more hypertensive than patients with 5–10 years of disease duration. In case of females, we observed that newly diagnosed and those with longer duration of disease (>10) have more hypertension as compared to those with 5–10 years of disease duration. This may be because hypertension increases with age [29].

Prevalence of retinopathy was only 0.8 % that is less than in a previously reported study conducted in Abbottabad, Pakistan, by Hayat et al. [30] in which they reported 17 % of cases with retinopathy. Similarly, Ali et al. reported 31.4 % prevalence of retinopathy in T2DM patients of Lahore, Pakistan [31]. Overall, all studies carried out on prevalence of retinopathy in Pakistani T2DM patients reported variable results. This shows that a large study is needed in order to reach a consensus of prevalence [32–35]. Studies conducted on Indian population observed 28.9 % prevalence of retinopathy in Northwest India and 23.7 % in Chennai region. This shows that the Indian population although considered similar to our population has more prevalence of retinopathy [36–38].

A study conducted in Lahore region of Pakistan observed 56.2 % T2DM patients with nephropathy[31]. Another study conducted in Karachi reported 20.2 % prevalence [32] while a study from Peshawar region has shown 67 % prevalence of nephropathy in T2DM patients [39]. In the current study, we observed nephropathy in 1 % T2DM patients that is much lesser than observed by others. Study on Indian patients showed prevalence of 32.5 % which is not consistent with any of the studies conducted in Pakistan. Similarly, all these studies also reported higher prevalence of neuropathy, which is one of the most common long-time complication associated with T2DM, while in this study, we observed 7.3 % T2DM patients diagnosed with neuropathy. The huge difference in data might be difference in environmental and socio-economic and lifestyle factors. Another possible reason might be genetic composition of people living in these regions belonging to different sub-populations that have different ethnic backgrounds that contribute toward increased risk of developing T2DM-associated complications.

Prevalence of macro-vascular complications like IHD, stroke, and PVD was 18.1, 5.5, and 3.6 %, respectively, in the study population. One of the two studies that reported macro-vascular complications in Pakistani T2DM patients observed 2.6 % prevalence of stroke and the other study observed 26.4 % IHD. But, no other study is conducted so far for prevalence of PVD in Pakistani population except for the present study. Our results show more prevalence of stroke than reported previously. But, prevalence of IHD was observed to be less than in previous studies [32, 40]. As our results show, higher level of triglycerides in T2DM patients may be the reason why we observed higher percentage of heart-related complications in T2DM patients [37]. Although a study in South Asian population observed 23.3 % prevalence of macro-vascular complication, they did not describe the prevalence of different macro-vascular complications separately [41].

Impotency was prevalent among 0.3 % of patients only and no female was reported with any sexual dysfunction. A study

in northern area of Pakistan observed 17.1 % with mild, 37.8 % with mild to moderate, 21.7 % with moderate, and 20.7 % with severe erectile dysfunction [42]. Another study in Karachi region of Pakistan reported prevalence of different types of impotence. In this study, Shaikh et al. reported that the most common type of impotence was erectile dysfunction that was prevalent in 55 % patients, while retrograde ejaculation was the least prevalent (10 % patients) dysfunction in study population [43].

Complications were most prevalent in patients of middle age. The most common complications associated with T2DM were heart-related including IHD, PVD, and stroke. Various environmental and genetic factors might contribute toward elevated triglyceride levels thus resulting in high prevalence of macro-vascular complications. Our study also shows high prevalence of hypertension in females than in males that might be due to various lifestyle and environmental factors as Pakistan is a developing country and the majority of the masses live below the poverty levels and cannot afford good treatment, medicines, and healthy food. There is also high illiteracy rate so they are unable to well manage the disease [44, 45].

Macro-vascular complications show variable trends with duration of disease in males and females. Males show a trend toward increase in prevalence of IHD and stroke with increase in duration of disease as reported in various studies conducted in an Indian population [32, 38]. But, the trend was variable in females as IHD prevalence increases with duration of disease; stroke is more prevalent in female patients with 5–10 years of duration of T2DM. We did not find any study that shows similar trend. One of the reasons for this variability can be improved knowledge about disease and better management with passage of time. But, PVD prevalence increases with duration of disease among females and is more prevalent with duration of 5–10 years among males. Prevalence of micro-vascular complications like nephropathy increases with duration of disease in females and males but is more prevalent in females. But, neuropathy and retinopathy on the other hand show decreasing trend with increase in duration of disease in females, but there is no significant change with duration in males.

We also calculated prevalence of various infections and found that the most common infection is dental infection. Our results indicate that ear infections are rare among the T2DM patients. We observed that females have more prevalence of infections than males. This is the first study to report the prevalence of infections among Pakistani T2DM patients. The chi-square test was applied to check the significance of the data and we found significant association of macro-vascular complications confirming the higher prevalence of these in our population. We also find out that prevalence of complication is higher among hypertensive patients. This is consistent with the previous studies [25, 28, 31, 38].

Our study was a preliminary observational study of Rawalpindi, Islamabad region of Pakistan, and we found variability in different studies carried out so far out in Pakistani population from different regions of Pakistan. The limitation of our study was that it was an open-label observational study and we had a problem of missing data as we did not perform any additional clinical assessments to cope with missing clinical history and due to non-cooperation of many patients as well. We need a larger study to verify the results and for a more comprehensive epidemiological data to better understand and manage the T2DM and associated complications. We also need to associate genetic and environmental factors with epidemiological data in order to better understand ethnic variations among sub-populations and their effect on disease progression and management.

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Conflict of interest All authors declare that they have no conflict of interest.

Statement of animal and human rights Written informed consent (consent form explaining the purpose of study and the rights of participants approved by respective Institutional Review Board) was obtained from all participants in this study.

References

1. Morris AP, Voight BF, Teslovich TM, Ferreira T, Segre AV, et al. Large-scale association analysis provides insights into the genetic architecture and pathophysiology of type 2 diabetes. Nature genetics. 2012;44:981–90.
2. Ahlqvist E, Ahluwalia TS, Groop L. Genetics of type 2 diabetes. Clinical chemistry. 2011;57:241–54.
3. Billings LK, Florez JC. The genetics of type 2 diabetes: what have we learned from GWAS? Annals of the New York Academy of Sciences. 2010;1212:59–77.
4. Cervin C, Lyssenko V, Bakhtadze E, Lindholm E, Nilsson P, et al. Genetic similarities between latent autoimmune diabetes in adults, type 1 diabetes, and type 2 diabetes. Diabetes. 2008;57:1433–7.
5. Stumvoll M, Goldstein BJ, van Haeften TW. Type 2 diabetes: principles of pathogenesis and therapy. Lancet. 2005;365:1333–46.
6. Alonso-Magdalena P, Quesada I, Nadal A. Endocrine disruptors in the etiology of type 2 diabetes mellitus. Nature reviews Endocrinology. 2011;7:346–53.
7. DeFronzo RA. Pathogenesis of type 2 diabetes mellitus. The Medical clinics of North America. 2004;88:787–835. ix.
8. Dey L, Attele AS, Yuan CS. Alternative therapies for type 2 diabetes. Altern Med Rev. 2002;7:45–58.
9. Chen L, Magliano DJ, Zimmet PZ. The worldwide epidemiology of type 2 diabetes mellitus–present and future perspectives. Nature reviews Endocrinology. 2012;8:228–36.

10. Jain S, Saraf S. Type 2 diabetes mellitus—Its global prevalence and therapeutic strategies. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2010;4:48–56.
11. Gadsby R. Epidemiology of diabetes. Advanced drug delivery reviews. 2002;54:1165–72.
12. Hu FB, Manson JE, Stampfer MJ, Colditz G, Liu S, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. The New England journal of medicine. 2001;345:790–7.
13. Ramachandran A, Snehalatha C, Shetty AS, Nanditha A. Trends in prevalence of diabetes in Asian countries. World journal of diabetes. 2012;3:110–7.
14. (2011) National diabetes fact sheet. 2011 ed: National estimates and general information on diabetes and prediabetes in the United States. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2011.
15. (2012) International Diabetes Federation. 2012 ed: Brussels, Belgium: International Diabetes Federation.
16. Orchard TJ, Dorman JS, Maser RE, Becker DJ, Drash AL, et al. Prevalence of Complications in IDDM by Sex and Duration: Pittsburgh Epidemiology of Diabetes Complications Study II. Diabetes. 1990;39:1116–24.
17. Information ND (2011) Diagnosis of Diabetes and Prediabetes.
18. WHO (2003) Screening for Type 2 Diabetes. Report of a World Health Organization and International Diabetes Federation meeting.
19. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, et al. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. JAMA : the journal of the American Medical Association. 2003;289:2560–71.
20. Krause T, Lovibond K, Caulfield M, McCormack T, Williams B (2011) Management of hypertension: summary of NICE guidance.
21. Groop L, Pociot F (2013) Genetics of diabetes - Are we missing the genes or the disease? Mol Cell Endocrinol.
22. Shera AS, Jawad F, Maqsood A. Prevalence of diabetes in Pakistan. Diabetes research and clinical practice. 2007;76:219–22.
23. Lipscombe LL, Hux JE. Trends in diabetes prevalence, incidence, and mortality in Ontario, Canada 1995-2005: a population-based study. Lancet. 2007;369:750–6.
24. Sarwar N, Gao P, Seshasai SR, Gobin R, Kaptoge S, et al. Diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta-analysis of 102 prospective studies. Lancet. 2010;375:2215–22.
25. Logue J, Walker JJ, Colhoun HM, Leese GP, Lindsay RS, et al. Do men develop type 2 diabetes at lower body mass indices than women? Diabetologia. 2011;54:3003–6.
26. Choi YJ, Kim HC, Kim HM, Park SW, Kim J, et al. Prevalence and management of diabetes in Korean adults: Korea National Health and Nutrition Examination Surveys 1998-2005. Diabetes Care. 2009;32:2016–20.
27. Tirosh A, Shai I, Bitzur R, Kochba I, Tekes-Manova D, et al. Changes in triglyceride levels over time and risk of type 2 diabetes in young men. Diabetes Care. 2008;31:2032–7.
28. Crawford AG, Cote C, Couto J, Daskiran M, Gunnarsson C, et al. Prevalence of obesity, type II diabetes mellitus, hyperlipidemia, and hypertension in the United States: findings from the GE Centricity Electronic Medical Record database. Population health management. 2010;13:151–61.
29. Messerli F, Ventura HO, Glade LB, Sundgaard-Riise K, Dunn FG, Frohlich ED. Essential hypertension in the elderly: haemodynamics, intravascular volume, plasma renin activity, and circulating catecholamine levels. The Lancet. 1983;322.
30. Hayat AS, Khan AH, Baloch GH, Shaikh N. Frequency and pattern of retinopathy in newly diagnosed type 2 diabetic patients at tertiary care settings in Abbottabad. Journal of Ayub Medical College, Abbottabad : JAMC. 2012;24:87–9.
31. Ali A, Iqbal F, Taj A, Iqbal Z, Amin MJ, et al. Prevalence of microvascular complications in newly diagnosed patients with type 2 diabetes. Pakistan journal of medical sciences. 2013;29:899–902.
32. Shera AS, Jawad F, Maqsood A, Jamal S, Azfar M, et al. Prevalence of chronic complications and associated factors in type 2 diabetes. JPMA The Journal of the Pakistan Medical Association. 2004;54:54–9.
33. Wahab S, Mahmood N, Shaikh Z, Kazmi WH. Frequency of retinopathy in newly diagnosed type 2 diabetes patients. JPMA The Journal of the Pakistan Medical Association. 2008;58:557–61.
34. Iqbal T. Frequency of Retinopathy in newly diagnosed Type 2 Diabetes Mellitus. RMJ. 2009;34:167–9.
35. Hussain FA, Mohammad; Ahmad, Munir (2011) The prevalence of diabetic retinopathy in Faisalabad, Pakistan: a population-based study. Turk J Med Sci 41.
36. Knuiman MW, Welborn TA, McCann VJ, Stanton KG, Constable IJ. Prevalence of diabetic complications in relation to risk factors. Diabetes. 1986;35:1332–9.
37. Ramchandran ASC, Satyavani K, Latha E, Sasikala R, Vijay V. Prevalence of vascular complications and their risk factors in type 2 diabetes. Journal of Assoc Physicians India. 1999;47.
38. Agrawal RPRM, Beniwal R, Sharma S, Purohit VP, Kochar DK, Kothari RP. Prevalence of micro and macro vascular complications in type 2 diabetes and their risk factors. INT J DIAB DEV COUNTRIES. 2004;24:6.
39. Shafiqur-Rahman IZ. Prevalence of microvascular complications among diabetic patients. Pakistan journal of medical Research. 2004;43:3.
40. Khuwaja AK, Rafique G, White F, Azam SI. Macrovascular complications and their associated factors among persons with type 2 diabetes in Karachi, Pakistan–a multi-center study. JPMA The Journal of the Pakistan Medical Association. 2004;54:60–6.
41. Litwak L, Goh SY, Hussein Z, Malek R, Prusty V, et al. Prevalence of diabetes complications in people with type 2 diabetes mellitus and its association with baseline characteristics in the multinational A1chieve study. Diabetology & metabolic syndrome. 2013;5:57.
42. Ahmed I, Aamir A, Anwar E, Ali SS, Ali A. Erectile dysfunction and type 2 diabetes mellitus in northern Pakistan. JPMA The Journal of the Pakistan Medical Association. 2013;63:1486–90.
43. Shaikh IAKS, Ujjan ID, Shaikh S. Frequency of Sexual Dysfunctions in Type 2 Diabetic Males. Journal of Liaquat University of Medical and Health Sciences. 2010;9:3.
44. Haq R (2014) Pakistan Education Atlas 2013: Education survey reveals mixed bag of results. The Express Tribune. Pakistan: Express News.
45. UNICEF (2013) Pakistan Statistics. December, 2013 ed: UN.