NDSP 05: Prevalence and pattern of dyslipidemia in urban and rural areas of Pakistan; a sub analysis from second National Diabetes Survey of Pakistan (NDSP) 2016–2017

Abdul Basit¹ · Sobia Sabir² · Musarrat Riaz¹ · Asher Fawwad^{3,4} ·

NDSP members

Mujeeb Ur Rehman Abro,
Khawaja Ishfaq Ahmed,
Khurshid Ahmed,
Ahmed Bilal,
Anam Butt,
Bikha Ram Devrajani,
Ijaz Hayder,
Yasir Humayun,
Rabia Irshad,
Riasat Ali Khan,
Asima Khan,
Aamir Akram Khowaja,
Raheela Khowaja,
Qazi Masroor,
Maqsood Mehmood,
Hassan Moin,
Nida Mustafa,
Wasif Noor,
Huma Qureshi,
Ibrar Rafique,
Tahir Rasool,
Rubina Sabir,
M. Arif N. Saqib,
Pir Alam Said,
Abrar Shaikh,
AS Shera,
Bilal Tahir,
Bilal Bin Younus,
Salma Tanveer,
Jamal Zafar

Received: 4 January 2020 / Accepted: 7 September 2020 /
Published online: 3 October 2020
© Springer Nature Switzerland AG 2020

Abstract

Objectives Dyslipidemia is a major risk issue for the development of cardiovascular disease. The aim of our study was to observe the pattern and prevalence of dyslipidemia in Pakistani population.

Methodology This is a sub analysis of a population based second National Diabetes Survey of Pakistan (NDSP) 2016–2017 in adults aged 20 years or above, carried out from February 2016 to August 2017 across Pakistan. Multi stage sampling technique was used for the stratification of population, based on rural and urban domains. District wise clusters and sub clusters were selected i.e. 27 and 46 in number. Subjects, consented to participate were requested to come after an overnight fast for anthropometric measurements, oral glucose tolerance test and fasting lipid profile (except for subjects with self-reported diabetes). Dyslipidemia was identified using Adult Treatment Panel III guidelines.

Results A total of 10,834 subjects (43.8% male and 56.2% female) having mean age of 43.8 ± 14.0 years, participated in the survey. Of the subjects studied, 39.3% had hypercholesterolemia, 48.9% had hypertriglyceridemia, 39.7% had high LDL-C levels while 83.9% men and 90% women had low HDL levels. High cholesterol and triglyceride levels were highest in 50–59 years age group, while high LDL and low HDL was most common in 40–49 years age group. Diabetes, obesity and hypertension were found to be the significant determinants for dyslipidemia.

Conclusion Prevalence of dyslipidemia seems to be very high in Pakistan, necessitating an urgent call for early screening and effective management through lifestyle intervention and appropriate lipid lowering drugs to prevent this important cardiovascular risk factor.

✉ Abdul Basit
abdulbasit@bide.edu.pk; research@bide.edu.pk

✉ Sobia Sabir
drsobias@hotmail.com

Musarrat Riaz
dmusarratriaz@gmail.com

Asher Fawwad
asherfawwad@bide.edu.pk

¹ Department of Medicine Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan

² Department of Diabetes and Endocrinology, Lady Reading Hospital, Peshawar, Pakistan

³ Department of Biochemistry, Baqai Medical University, Karachi, Pakistan

⁴ Department of Research Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Karachi, Pakistan

Keywords Dyslipidemia · Prevalence · Pakistan · Second NDSP

Introduction

Cardiovascular disease (CVD) is a significant cause of morbidity and mortality throughout the world, Pakistan being no exception [1]. Lipid abnormalities are a modifiable risk factor leading to atherosclerosis CVD, type 2 diabetes and stroke [1]. South East Asians (SEA) are reported to be more prone to develop CVD at an earlier age even in the absence of traditional risk factors [2]. High levels of total cholesterol (TC), triglyceride (TG) and low-density lipoprotein - cholesterol (LDL-C) and low high-density lipoprotein cholesterol (HDL-C) are associated with CVD, hypertension, and Stroke [3, 4]. Dyslipidemia pattern in Western populations is mainly characterized by predominantly as increased levels of LDL-C in comparison to Asian populations specifically SEA having a mixed dyslipidemia pattern with a significant low HDL-C and high TG levels [5]. HDL-C is recognized to have inverse relationship with CVD morbidity and mortality with a proven role in secondary prevention of CVD [6–8].

Rising trend of dyslipidemia has become observed globally and is a major public health concern. The prevalence varies widely across the globe depending on different risk factors, particularly due to rapid socioeconomic development, lifestyle changes, overweight, under nutrition, urbanization, ageing and ethnicity [9–11].

World Health Organization (WHO), estimates that around 2.6 million deaths are caused by dyslipidemia each year representing a global prevalence of 37% and 40 in males and females, respectively [5]. Therefore, early screening and management strategies of dyslipidemia should be a high priority for CVD prevention. Ten percent reduction in serum cholesterol may results in 50% reduction in risk of ischemic heart disease over a period of 5 years [5].

Although dyslipidemia as a CVD risk factor has been studied in many countries but to best of our knowledge, exploring this linkage in Pakistani population at a community level is still missing. Most of the prevalence studies in Pakistan reported regional data having limitations due to heterogeneous blend of ethnicities along with variations in life styles. These factors can affect the metabolic parameters to a variable extent like gender differences, reported in dyslipidemia pattern and associated CVD. The aim of our study was to observe the pattern and prevalence of dyslipidemia in Pakistani population.

Methodology

This is a sub analysis of the second National Diabetes survey of Pakistan (NDSP) 2016–2017, which took place from February 2016 to August 2017 pan Pakistan including participants aged 20 years and above. The detailed methodology of the NDSP

2016–2017 has been published separately [12]. Calculated sample size was 10,834 using probability sampling and multistage stratified sampling technique. Population was stratified based on urban and rural areas for all four provinces of Pakistan as per latest available census [13]. Every province consists of districts and tehsils (geographical sub-division of provinces legally described by government) from where sub-clusters were selected for the survey. Using probability proportional to size (PPS) technique, number of clusters were selected from each province using the “Rule of thumb” Number of clusters (k) = (sample size of stratum/ 2) ^{0.5} [14]. Out of 213, twenty-seven clusters and 46 sub-clusters (21 from urban and 25 from rural) were selected from all over Pakistan.

A total of 214 camps were conducted for recruitment of participants in the survey. The identified household members reported to the camp side in the fasting state [at least 8–12 h] [15, 16] after informed consent. Ethical protocol was obtained by the National Bioethics Committee (NBC) of Pakistan [Ref: No.4–87/17/NBC-226/NBC/2664]. Structured questionnaire was used to obtain the demographic information and medical history of the survey participants. Height, weight and waist circumference was recorded by paramedical staff. Weight was taken by a digital scale placed on a flat surface, to the nearest of 0.1 kg with participants in light clothes and without shoes. Height was measured by standing the participants in erect posture vertically touching the occiput, back, hip, and heels on the wall. Height was measured to the nearest of 0.1 cm.

Physical activity includes exercise as well as other activities like playing, house chores, active transportation and recreational activities [17]. Physical activity (leisure) is define as no activity or once a week (Sedentary life style), two to three times per week (Moderate) and more than 3 times/week (heavy life style). Samples of intravenous blood was collected in vials containing EDTA-anticoagulant agent from all the survey participants according to the National Committee guidelines for Clinical Laboratory Standards [18].

Determination of plasma lipid levels

Samples were collected using sterilized disposable vacutainer tubes containing sodium fluoride (for glucose), gel (for lipids) and EDTA K2 (for HbA1c). CHOD-PAP method for total cholesterol (TC), GPO-PAP method for triglycerides, homogeneous enzymatic calorimetric method for high density lipoprotein cholesterol (HDL-C) and CHOD-PAP method (Selectra Pro S instrument) for low-density lipoprotein cholesterol (LDL-C). HbA1c were performed by high-performance liquid chromatography (HPLC) method by D10. Standardized protocol was used for transfer of samples for lipid profile [19, 20] to Pakistan Health

Research Council (PHRC), Jinnah Postgraduate Medical Centre (JPMC), Karachi for analysis.

Dyslipidemia was classified as one or more of the following conditions in fasting state as per Adult Treatment Panel III guidelines; serum cholesterol more than 200 mg/dl, serum LDL-C more than 130 mg/dl, serum HDL-C less than 40 mg/dl and less than 50 mg/dl for male and female respectively and serum TG more than 150 (mg/dl) [21]. People were also considered as dyslipidemia if they were taking any lipid lowering medication.

Isolated Impaired Fasting Glucose (IFG) was defined as fasting plasma glucose level between 100 mg/dL and 125 mg/dL [22].

Isolated impaired glucose tolerance (IGT) was defined as fasting glucose level ≥ 100 mg/dL and 2-h PGL between 141 mg/dL and 199 mg/dL [22].

Hypertension: All those participants who were on antihypertensive medications and/or diagnosed by a physician and/or those who had diastolic blood pressure > 90 mmHg and/or systolic blood pressure > 140 mmHg were labeled as hypertensive [12].

As per WHO criteria, obesity was classified as a body mass index (BMI) of greater and equal to 25 kg/m^2 for both females and males with or without abdominal obesity [23, 24]. Central obesity was classified as waist circumference more than or equal to 80 cm and more than or equal to 90 cm in females and males, respectively [25, 26].

Tobacco

Tobacco like hypertension participants who were chewing tobacco in the form of naswar, paan, gutka, dipping tobacco, cigarette, water pipe (hookah/shisha) and cigars irrespective of duration and/or quantity consumed, were labeled as tobacco users [27].

Statistical analysis

Data was analyzed using SPSS version 20. Estimates were stated as mean $\pm$ SD for continuous variables and frequency (percentages) for categorical variables. Chi-square test was used to compare proportions between the two groups and Student's *t* test was used to compare groups for continuous variables. Association between outcome variables "dyslipidemia" and various exposures were done by using Multiple logistic regression analysis. By using forward LR selection, variables that remained significant were retained in the final model. The weighted prevalence was obtained as per latest available census of Pakistan [13].

Results

A total of 10,834 subjects (43.8% male and 56.2% female) participated in the survey with a mean age of 43.8 ± 14.0 . Table 1

shows the general characteristics of the study participants regarding dyslipidemia in all the four provinces of Pakistan. Waist to hip ratio (WHR) and BMI were significantly associated with any lipid abnormality (*P* value < 0.05). Systolic blood pressure was significantly higher in subjects with dyslipidemia in Punjab and Baluchistan while family history of diabetes was found to be associated with dyslipidemia in the provinces of Sindh, Punjab and Baluchistan. Mean HbA1c and frequency of known diabetes were significantly higher in subjects with dyslipidemia in Punjab.

Weighted prevalence of dyslipidemia was 98.1% in known and newly diagnosed diabetes, 97.3% in pre-diabetes individuals whereas, 95.2% was found in non-diabetic population. Of the participants considered, 39.3% had hypercholesterolemia, 48.9% had hypertriglyceridemia, 39.7% had high LDL-C levels while 83.9% men and 90% women had low values of HDL. The weighted prevalence of lipid abnormalities in all the four provinces of Pakistan is presented in Table 2. Prevalence of Hypercholesterolemia was found to be 39.3%, highest in Punjab (41.6%) and lowest in Baluchistan (22.7%). Prevalence of Hypertriglyceridemia was 48.9%, with highest rates found in KPK (50.1%) and least in Sindh (46.2%). Low HDL was observed in 87.4%, with highest prevalence of 88.2% in Sindh and lowest in KPK (83.2%). High LDL was found in 38.7%, with highest prevalence observed in Punjab (41.2%) and least in Baluchistan (17.8%). Prevalence of Isolated hypercholesterolemia was 11.7%, highest in Sindh (12.7%) while lowest in Baluchistan (4.8%). Prevalence of Isolated hypertriglyceridemia was 20.6%, highest in Baluchistan (29.4%) and lowest in Sindh (17.7%). Prevalence of Isolated Low HDL was 63.3%, highest in Baluchistan (70.9%) and lowest in Punjab (62.2%). Overall prevalence of dyslipidemia was high in urban areas as compared to rural significantly.

Figure 1 (a-d), presenting the age and gender specific prevalence of all four lipid abnormalities. Hypercholesterolemia, hypertriglyceridemia and high LDL levels were mainly observed in urban compared to rural population. Hypercholesterolemia was significantly higher in urban males of age 20–29 years and significantly lower in urban males of age 60 and above as compared to rural males. While no significant difference was observed between urban and rural females. Prevalence of hypertriglyceridemia was almost same in urban and rural population of all age groups. Prevalence of high LDL was significantly high in urban males of age 30–39 years as compared to rural males while prevalence of high LDL was same in urban and rural females of all age groups. Prevalence of low HDL was found significantly lower (78.83%) in urban male of age 50–59 years as compared to rural males (87.21%) of the same age. While Prevalence of low HDL was significantly higher in urban females in age between 20 to 49 years than rural females.

To identify factors which were associated with lipid abnormalities, Multiple logistic regression models was used shown in Table 3. Hypercholesterolemia was significantly associated with urban residence, education less than primary (Person

Table 1 General characteristics of the study subjects based on the presence of dyslipidemia in all the four Province studied

Parameters	Punjab			Sindh		
	No lipid abnormality	Any lipid abnormality	Overall	No lipid abnormality	Any lipid abnormality	Overall
n	129	4000	4129	67	2072	2172
Age [years]	41.53 ± 16.78	43.39 ± 13.94	43.34 ± 14.03	47.08 ± 17.44	45.44 ± 14.15	45.49 ± 14.27
Gender						
Male	65[50.4%]	1354[33.8%]**	1419[34.4%]	41[61.2%]	971[46.9%]*	1012[47.3%]
Female	64[49.6%]	2646[66.1%]**	2710[65.6%]	26[38.8%]	1101[53.1%]*	1127[52.7%]
Body Mass Index [kg/m ²]	25.35 ± 4.72	27.72 ± 6.15**	27.65 ± 6.13	23.47 ± 5.21	26.66 ± 5.76**	26.55 ± 5.77
Waist-Hip ratio	0.89 ± 0.07	0.95 ± 0.14*	0.95 ± 0.14	0.91 ± 0.07	0.92 ± 0.11*	0.92 ± 0.11
Systolic blood pressure [mmHg]	118.76 ± 16.69	126.43 ± 19.72**	126.19 ± 19.68	127.06 ± 20.72	126.11 ± 17.99	126.14 ± 18.08
Diastolic blood pressure [mmHg]	80.12 ± 13.79	85.62 ± 16.29*	85.45 ± 16.25	80.96 ± 9.81	82.14 ± 11.51	82.11 ± 11.46
Education						
Less than primary	53[51%]	1619[47.4%]	1672[47.5%]	20[31.2%]	679[36.4%]	699[36.3%]
Primary or more	51[49%]	1798[52.6%]	1849[52.5%]	44[68.8%]	1184[63.6%]	1228[63.7%]
Sedentary life style	87[84.5%]	2793[84.7%]	2880[84.7%]	46[85.2%]	1318[79.8%]	1364[80%]
Moderate to heavy life style	16[15.5%]	503[15.3%]	519[15.3%]	8[14.8%]	333[20.2%]	341[20%]
Tobacco user						
No	90[81.8%]	3129[90.2%]*	3219[89.9%]	53[82.8%]	1467[78.1%]	1520[78.3%]
Yes	20[18.2%]	341[9.8%]*	361[10.1%]	11[17.2%]	411[21.9%]	422[21.7%]
HbA1c [%]	5.47 ± 1.37	6.03 ± 1.75**	6.01 ± 1.74	5.19 ± 0.86	5.87 ± 1.64	5.85 ± 1.62
Known DM						
No	114[88.4%]	2972[74.3%]**	3086[74.7%]	52[77.6%]	1457[70.3%]	1509[70.5%]
Yes	15[11.6%]	1028[25.7%]**	1043[25.3%]	15[22.4%]	615[29.7%]	630[29.5%]
Family history of DM						
No	85[78%]	2409[69.5%]	2494[69.8%]	48[76.2%]	1059[60.3%]*	1107[60.8%]
Yes	24[22%]	1055[30.5%]	1079[30.2%]	15[23.8%]	698[39.7%]*	713[39.2%]
Parameters						
	Khyber Pakhtunkhwa			Baluchistan		
n	38	540	578	23	482	505
Age [years]	38.5 ± 11.36	39.33 ± 12.95	39.27 ± 12.85	41.83 ± 13.35	48.97 ± 12.66*	48.64 ± 12.76
Gender						
Male	35[92.1%]	278[51.5%]**	313[54.2%]	15[65.2%]	225[46.7%]	240[47.5%]
Female	3[7.9%]	262[48.5%]**	265[45.8%]	8[34.8%]	257[53.3%]	265[52.5%]
Body Mass Index [kg/m ²]	24.65 ± 6.5	25.82 ± 5.99	25.71 ± 6.04	26.85 ± 3.84	26.65 ± 5.04	26.66 ± 4.99
Waist-Hip ratio	0.95 ± 0.05	1.05 ± 0.47	1.04 ± 0.45	0.86 ± 0.12	0.89 ± 0.13	0.89 ± 0.13
Systolic blood pressure [mmHg]	121.81 ± 15.45	119.3 ± 13.28	119.46 ± 13.44	128.7 ± 16.04	136.42 ± 17.91*	136.06 ± 17.89

Table 1 (continued)

Diastolic blood pressure [mmHg]	81.22 ± 10.63	76.77 ± 10.48*	77.07 ± 10.54	84.78 ± 8.98	89.38 ± 11.29	89.17 ± 11.23
Education						
Less than primary	6[15.8%]	256[48.5%]**	262[46.3%]	8[34.8%]	206[45.8%]	214[45.2%]
Primary or more	32[84.2%]	272[51.5%]**	304[53.7%]	15[65.2%]	244[54.2%]	259[54.8%]
Sedentary life style	31[81.6%]	489[92.8%]*	520[92%]	3[60%]	102[73.9%]	105[73.4%]
Moderate to heavy life style	7[18.4%]	38[7.2%]*	45[8%]	2[40%]	36[26.1%]	38[26.6%]
Tobacco user						
No	30[78.9%]	477[91%]*	507[90.2%]	15[68.2%]	331[70.9%]	346[70.8%]
Yes	8[21.1%]	47[9%]*	55[9.8%]	7[31.8%]	136[29.1%]	143[29.2%]
HbA1c [%]	5.28 ± 0.85	5.67 ± 1.72	5.64 ± 1.68	5.55 ± 1.16	6.3 ± 2.05	6.26 ± 2.03
Known DM						
No	38[100%]	515[95.4%]	553[95.7%]	20[87%]	362[75.1%]	382[75.6%]
Yes	0[0%]	25[4.6%]	25[4.3%]	3[13%]	120[24.9%]	123[24.4%]
Family history of DM						
No	27[73%]	389[77.3%]	416[77%]	15[65.2%]	277[57.5%]	292[57.8%]
Yes	10[27%]	114[22.7%]	124[23%]	8[34.8%]	205[42.5%]	213[42.2%]

Data presented as mean ± SD or n(%)

*P value<0.05 and **P value<0.001 compared to subjects with no lipid abnormality

Table 2 Prevalence of dyslipidemia in all the four province of Pakistan

Parameters	Pakistan			Punjab			Sindh			KPK			Baluchistan		
	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall	Urban	Rural	Overall
Hypercholesterolemia	39.1	39.4	39.3	40.2	42.4	41.6	42.4	39.4*	41.2	29.8	33.3	27.2	17	24.5*	22.7
Hypertriglyceridemia	49.1	47.7*	48.9	53	47.1**	49.3	45.3	47.5	46.2	45.9	52.4*	50.1	47	47.6	47.3
Low HDL	88.3	85.8	87.4	92.5	83.4**	86.7	86.4	90.8*	88.2	70.8	90.6**	83.2	86.2	86.6	86.4
High LDL	40.6	37.5*	38.7	47.5	37.4**	41.2	38.3	41.6*	39.6	22.3	47.9**	40.2	21.4	15.9	17.8
Isolated hypercholesterolemia	11.8	11.6	11.7	9.8	14.2*	12.6	14.6	10*	12.7	14.9	4.9**	8.3	5.6	4.5*	4.8
Isolated hypertriglyceridemia	21.7	19.8	20.6	22.6	18.9	20.3	17.5	18.1	17.7	30.1	23.5	25.7	35.1	26.5*	29.4
Isolated Low HDL	64.9	62.1	63.3	66.2	59.7	62.2	62.9	65.3	63.8	59.4	65	63.1	75.6	68.5	70.9
Dyslipidemia	97	95.3*	96	99.2	95**	96.5	96.2	97.3	96.6	89.8	95.9**	93.8	93.5	92.3	92.7

*P value<0.05 and **P value<0.001 compared to Urban participants

who have not been to school/just know to read-write/illiterate), central obesity, prediabetes, diabetes and hypertension. Hypertriglyceridemia was significantly associated with female gender, urban residence, education less than primary, overweight, obesity, central obesity, prediabetes, diabetes and hypertension. High LDL cholesterol was significantly associated with female gender, overweight, obesity, prediabetes, diabetes and hypertension. Low HDL cholesterol was significantly associated with female gender, overweight, obesity, prediabetes and diabetes.

Discussion

In this community based national survey a total of 10,834 participants were recruited. The total prevalence of dyslipidemia was found to be 96%, which was higher significantly in urban areas in comparison to rural. Findings of our study are in accordance with another local study [28]. In contrast the prevalence figures from Venezuelan study was found to be 24%, and National Surveillance data from Iran reported a prevalence of dyslipidemia as 42.9% leading to raise concerns for such an alarmingly high prevalence in Pakistan in contrast to other developing countries [29, 30]. Showing almost a similar trend, an Indian survey reported prevalence of dyslipidemia as high as 75% [31].

There is a growing epidemic of CVD across the globe with dyslipidemia being one of its major yet modifiable risk factor. Some of the earlier studies suggested that the increased burden of CVD among SEA is primarily due to the pattern of dyslipidemia [32]. Population surveillance is crucial in monitoring the risk factors for CVD; however, in Pakistan there is a lack of community-based data.

In the provinces of Punjab and Baluchistan, a higher age group stratum correlated positively with dyslipidemia, although no similarities were found between the two ethnic areas. Similar findings were reported in a Punjab based study by Zahid N et al., observing a rise in lipid levels with advancing age of the population [33]. However, in another study it has been specifically narrated that there is greater trend of dyslipidemia in Urban areas of Pakistan, possibly due to higher socioeconomic status, sedentary life style, unhealthy dietary patterns and low level of physical activity [32]. In Punjab there had been a rapid urbanization with improved economic status progressively over time. Since we do not have population-based registry data for dyslipidemia, all these may be worth considered as the confounding factors in Pakistan. The same has been elaborated in an Iranian study where they found association between dyslipidemia and urbanization leading to the unhealthy lifestyle of the population [34].

Findings of this survey suggest that younger men had a greater tendency for dyslipidemia as compared to young females. Similar findings were documented in another study

Fig. 1 a-d Age and sex-specific prevalence of dyslipidemia in the study population

Table 3 Multiple logistic regression predicting risk factors associated with dyslipidemia

Hypercholesterolemia				
Parameters	Univariable logistic regression		Multiple logistic regression	
	OR [95% C.I.]	P value	OR [95% C.I.]	P value
Age ≥ 43 years \$	1.34[1.22–1.47]	<0.0001	–	–
Female	1.19[1.08–1.31]	<0.0001	–	–
Urban	1.06[0.97–1.17]	0.163	1.20[1.05–1.36]	0.004
Education less than primary	1.27[1.15–1.41]	<0.0001	1.27[1.12–1.45]	<0.0001
Overweight [BMI 23–24.9 kg/m ²]	1.27[1.07–1.52]	0.005	–	–
Obesity [BMI ≥ 25 kg/m ²]	1.48[1.31–1.68]	<0.0001	–	–
Central obesity	1.47[1.28–1.68]	<0.0001	1.32[1.14–1.54]	<0.0001
Tobacco users	0.88[0.77–1.01]	0.089	–	–
Prediabetes	1.18[1.03–1.35]	0.015	1.13[0.95–1.35]	0.014
Diabetes	1.47[1.33–1.63]	<0.0001	1.43[1.24–1.64]	<0.0001
Hypertension	1.33[1.21–1.47]	<0.0001	1.22[1.07–1.38]	0.002
Hypertriglyceridemia				
Parameters	Univariable logistic regression		Multiple logistic regression	
	OR [95% C.I.]	P value	OR [95% C.I.]	P value
Age ≥ 43 years \$	1.69[1.54–1.86]	<0.0001	–	–
Female	0.93[0.85–1.02]	0.157	0.74[0.65–0.85]	<0.0001
Urban	1.11[1.01–1.21]	0.027	1.17[1.03–1.34]	0.016
Education less than primary	1.16[1.05–1.29]	0.002	1.22[1.06–1.39]	0.004
Overweight [BMI 23–24.9 kg/m ²]	1.58[1.33–1.88]	<0.0001	1.30[1.05–1.61]	0.012
Obesity [BMI ≥ 25 kg/m ²]	2.21[1.95–2.51]	<0.0001	1.64[1.38–1.93]	<0.0001
Central obesity	2.38[2.08–2.72]	<0.0001	1.71[1.44–2.02]	<0.0001
Tobacco users	1.01[0.88–1.15]	0.883	–	–
Prediabetes	1.44[1.26–1.65]	<0.0001	1.36[1.14–1.61]	<0.0001
Diabetes	2.65[2.38–2.94]	<0.0001	2.66[2.30–3.07]	<0.0001
Hypertension	1.69[1.53–1.87]	<0.0001	1.37[1.20–1.56]	<0.0001
High LDL cholesterol				
Parameters	Univariable logistic regression		Multiple logistic regression	
	OR [95% C.I.]	P value	OR [95% C.I.]	P value
Age ≥ 43 years \$	1.19[1.08–1.31]	<0.0001	–	–
Female	1.24[1.13–1.37]	<0.0001	1.21[1.07–1.37]	0.002
Urban	1.13[1.02–1.24]	0.011	–	–
Education less than primary	1.06[0.96–1.18]	0.193	–	–
Overweight [BMI 23–24.9 kg/m ²]	1.38[1.15–1.64]	<0.0001	1.45[1.18–1.79]	<0.0001
Obesity [BMI ≥ 25 kg/m ²]	1.58[1.39–1.80]	<0.0001	1.56[1.33–1.83]	<0.0001
Central obesity	1.34[1.16–1.53]	<0.0001	–	–
Tobacco users	0.90[0.78–1.03]	0.137	–	–
Prediabetes	1.28[1.12–1.47]	<0.0001	1.27[1.07–1.51]	0.005
Diabetes	1.32[1.19–1.46]	<0.0001	1.13[0.98–1.30]	0.007
Hypertension	1.24[1.13–1.37]	<0.0001	1.19[1.04–1.35]	0.007
Low HDL Cholesterol				
Parameters	Univariable logistic regression		Multiple logistic regression	
	OR [95% C.I.]	P value	OR [95% C.I.]	P value
Age ≥ 43 years \$	0.98[0.85–1.13]	0.83	–	–
Female	2.21[1.92–2.54]	<0.0001	2.38[1.99–2.83]	<0.0001
Urban	1.09[0.95–1.25]	0.213	–	–
Education less than primary	1.03[0.89–1.19]	0.654	–	–
Overweight [BMI 23–24.9 kg/m ²]	1.21[0.95–1.55]	0.115	1.27[0.97–1.67]	0.04

Table 3 (continued)

Obesity [BMI $\geq 25\text{kg/m}^2$]	1.40[1.18–1.67]	<0.0001	1.37[1.12–1.69]	0.002
Central obesity	1.66[1.39–1.98]	<0.0001	—	—
Tobacco users	0.72[0.60–0.87]	0.001	—	—
Prediabetes	1.18[0.97–1.45]	0.09	1.16[0.91–1.48]	0.02
Diabetes	1.57[1.34–1.85]	<0.0001	1.64[1.34–2.02]	<0.0001
Hypertension	1.14[0.99–1.32]	0.068	—	—

Variables significant at p value ≤ 0.25 in an initial univariable regression analysis were entered in a multiple regression model

§ The reason of taking 43 years as cutoff is due to the mean and median age of the analyzed sample

conducted in the Punjab province of Pakistan [33]. Amongst females there was a greater prevalence of low HDL and a higher triglyceride level. Similar findings were reported in another Pakistani study [35] while in contrast to the study done by Zaid M et al. stated that males demonstrated significantly higher prevalence of high TG and low HDL-C levels than females [32].

Similarly, we found a trend towards greater adiposity in terms of raised BMI and waist to hip ratio in females with dyslipidemia. The similar findings was also noted in study by Zahid N et al., group [33]. A strong correlation was observed between dyslipidemia and adiposity by Souza et al., [36]. In a study from Northern China increased WC has been described as a predictor of dyslipidemia [37].

In our study we found Blood Pressure to be slightly elevated in persons with dyslipidemia supported in the work done by Brown et al., and Souza et al., [36, 38]. Furthermore, it is observed that increased TC, Low LDL-C and high TG levels were associated with raised blood pressure. However, in contrary low HDL as not found to be associated with high blood pressure. Brown et al. group (38) noticed that the rise in blood pressure was associated with rising age as well as increased BMI, however no ethnic variations were seen in their study.

We observed that dyslipidemia was negatively associated with physical activity and education levels. Study conducted in Hispanic population also supported the findings of our study [39].

Multiple logistic regression revealed that dyslipidemia was associated significantly with female gender, BMI, waist circumference (WC) (for TC and TG), FBG (only for TG and LDL-C), hypertension (only for TG and LDL-C), education level (for TC and TG), pre-diabetes (for LDL-C and TG), diabetes, hypertension (except for low HDL-C).

An appreciable number of study participants were found to have prediabetes and a quarter of the persons had known diabetes. In the study conducted by Souza et al., diabetes was found in 16.2% of the individuals with any type of dyslipidemia [36]. Insulin resistance plays a key role as a pathophysiological reason leading to dyslipidemia specifically low HDL-C and hypertriglyceridemia levels [36, 40]. the findings of this survey are also suggestive of this underlying pathogenic mechanism.

Strengths and limitation

The key strength of our study is that it shows the weighted prevalence of dyslipidemia pan Pakistan both rural and urban thus truly representing the extent of problem. This study is a large population based and representative with a good response rate of the general population. Information regarding the medication use for the treatment of dyslipidemia was beyond the scope of our survey. Similarly analyses on genetic polymorphisms and lipoproteins were not done as it was not the aim of the survey.

Conclusion

The weighted prevalence of dyslipidemia seems to be very high in Pakistan, necessitating an urgent call for early screening and effective management through lifestyle intervention and appropriate lipid lowering drugs to prevent this important cardiovascular risk factor. The findings of this study can sensitize the policy makers for initiating preventive measures at public health measures for prevention of dyslipidemia and hence of CVD in Pakistan.

Acknowledgements We acknowledge the support of clinical research laboratory and department of research from Baqai Institute of Diabetology and Endocrinology (BIDE), Baqai Medical University, for the data management. NDSP team would also grateful to Mr. Muhammad Sohail and Mr. Abdul Rashid from PHRC, Karachi. We are thankful to all survey participants for their contribution in the second NDSP (2016–2017).

NDSP members (with surnames in alphabetical order);

1. **Dr. Mujeeb Ur Rehman Abro**, Assistant Professor of Medicine, Chandka Medical College, Shaheed Mohtarma Benazir Bhutto Medical University, **Larkana – Sindh**.
2. **Dr. Khawaja Ishfaq Ahmed**, Ex-PGR, Pakistan Institute of Medical Sciences, **Islamabad – Punjab**.
3. **Dr. Khurshid Ahmed**, Consultant Physician, Zahid Medical Centre, **Hub - Baluchistan**.
4. **Prof. Ahmed Bilal**, Professor and Head of Medical Department Faisalabad Medical College, **Faisalabad – Punjab**.
5. **Dr. Anam Butt**, Research Officer, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.

6. **Prof. Bikha Ram Devrajani**, Chairman, Department of Medicine and Director Sindh Institute of Endocrinology and Diabetes, Liaquat University of Medical and Health Sciences, **Jamshoro - Sindh**.
7. **Mr. Ijaz Hayder**, Research Officer, **Pakistan Health Research Council, Karachi - Sindh**.
8. **Dr. Yasir Humayun**, EPI coordinator, DHO Office, **Mansehra - Khyber Pakhtunkhwa**.
9. **Mrs. Rabia Irshad**, Research Officer, **Pakistan Health Research Council, Karachi - Sindh**.
10. **Dr. Riasat Ali Khan**, Diabetologist, Canada Medical Group Hospital, Defence, **Karachi - Sindh**.
11. **Dr. Asima Khan**, Head of Diabetes Department, Sindh Government Hospital, New Karachi, **Karachi - Sindh**.
12. **Dr. Aamir Akram Khowaja**, Postgraduate Resident, Sindh Government Qatar Hospital - **Karachi - Sindh**.
13. **Dr. Raheela Khowaja**, Postgraduate Resident, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.
14. **Prof. Qazi Masroor**, Professor of Medicine and Head of Department, Quaid-e-Azam Medical College, **Bahawalpur - Punjab**.
15. **Dr. Maqsood Mehmood**, Head of Department, Fatma tu Zahra Hospital, **Gujranwala - Punjab**.
16. **Mr. Hassan Moin**, Statistician, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.
17. **Ms. Nida Mustafa**, Statistician, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.
18. **Dr. Wasif Noor**, Diabetologist, Akhuwat Health Services Diabetes Centre, **Lahore - Punjab**.
19. **Dr. Huma Qureshi**, Ex-Director, Pakistan Health Research Council, **Islamabad, Punjab**.
20. **Mr. Ibrar Rafique**, Research Officer, Pakistan Health Research Council, **Islamabad, Punjab**.
21. **Dr. Tahir Rasool**, Diabetologist, Akhuwat Health Services Diabetes Centre, **Lahore - Punjab**.
22. **Mrs. Rubina Sabir**, Laboratory Manager, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.
23. **Dr. M. Arif N. Saqib**, Senior Research Officer, Pakistan Health Research Council, **Islamabad, Punjab**.
24. **Dr. Pir Alam Said**, Medical Specialist DHQ, **Sawabi - Khyber Pakhtunkhwa**.
25. **Prof. Abrar Shaikh**, Head Department of Medicine, Ghulam Muhammad Mahar Medical College, **Sukkur - Sindh**.
26. **Prof. AS Shera**, Secretary General, Diabetic Association of Pakistan and WHO Collaborating Centre, **Karachi - Sindh**.
27. **Mr. Bilal Tahir**, NDSP Coordinator, Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, **Karachi - Sindh**.
28. **Prof. Bilal Bin Younus**, Head of Sakeena Institute of Diabetes & Endocrine Research, **Lahore - Punjab**.
29. **Prof. Salma Tanveer**, Professor of Medicine, In-charge Diabetes and Endocrinology, Nishtar Medical University, **Multan - Punjab**.
30. **Prof. Jamal Zafar**, Professor of Medicine, Pakistan Institute of Medical Sciences, **Islamabad - Punjab**.

Authors' contribution AB: Concept, design, data interpretation, edited and approved the final manuscript.

SS: Concept, design, Literature search, wrote the manuscript.

MR: Concept, design, Literature search, interpretation of data, wrote the manuscript.

AF: Concept, design, interpretation of data, edited and approved the final manuscript.

NDSP members: Members were responsible for the supervision of the survey, concept, design, involved in the quality control and data

management in their respective areas. All members approved the final submitted version.

Funding The funding source for the study remained same as in the second NDSP [2016–2017].³

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

References

1. Lee JS, Chang PY, Zhang Y, Kizer JR, Best LG, Howard BV. Triglyceride and HDL-C dyslipidemia and risks of coronary heart disease and ischemic stroke by glycemic dysregulation status: the strong heart study. *Diabetes Care*. 2017;40(4):529–37.
2. Enas EA, Yusuf S, Mehta JL. Prevalence of coronary artery disease in asian Indians. *Am J Cardiol*. 1992;70:945–9.
3. Nishiyama Y, Otsuka T, Ueda M, Kimura K. Dyslipidemia should be associated with an increased risk of hypertension in a working-age Japanese male population. *Stroke*. 2016;47:ATP197.
4. Cicero AF, Rosticci M, Baronio C, Morbini M, Parini A, Grandi E, et al. Serum LDL cholesterol levels and new onset of arterial hypertension: an 8-year follow-up. *Eur J Clin Invest*. 2014;44(10):926–32.
5. Alshamiri M, Ghanaim MMA, Barter P, Chang KC, Li JJ, Matawaran BJ, et al. Expert opinion on the applicability of dyslipidemia guidelines in Asia and the Middle East. *Int J Gen Med*. 2018;11:313–22.
6. Jacobs DR Jr, Mebane IL, Bangdiwala SI, Criqui MH, Tyroler HA. High density lipoprotein cholesterol as a predictor of cardiovascular disease mortality in men and women: the follow-up study of the lipid research clinics prevalence study. *Am J Epidemiol*. 1990;131(1):32–47.
7. Barter P, Gotto AM, LaRosa JC, Maroni J, Szarek M, Grundy SM, et al. HDL cholesterol, very low levels of LDL cholesterol, and cardiovascular events. *N Engl J Med*. 2007;357(13):1301–10.
8. Chang WT, Yin WH, Lin FJ, Tseng WK, Wu YW, Li YH, et al. Non-high-density-lipoprotein cholesterol is an important residual risk factor in the secondary prevention for patients with established atherosclerotic cardiovascular diseases. *Circulation*. 2016;134:A16414.
9. Al-Nozha MM, Abdullah M, Arafah MR, Khalil MZ, Khan NB, Al-Mazrou YY, et al. Hypertension in saudi arabia. *Saudi Med J*. 2007;28(1):77–84.
10. Al-Dahi S, Al-Khashan H, Al Madeer MA, Al-Saif K, Al-Amri MD, Al-Ghamdi O, et al. Assessment of framingham cardiovascular disease risk among militaries in the Kingdom of Saudi Arabia. *Mil Med*. 2013;178(3):299–305.
11. Alwan AA (1993) Cardiovascular diseases in the eastern Mediterranean region. *World health statistics quarterly Rapport trimestriel de statistiques sanitaires mondiales* 46[2]: 97–100.
12. Basit A, Fawwad A, Qureshi H, Shera AS (2018) NDSP Members. Prevalence of diabetes, pre-diabetes and associated risk factors: second National Diabetes Survey of Pakistan [NDSP], 2016–2017. *BMJ Open* 8:e020961.
13. Pakistan Bureau of Statistics. Population Census 2017. Available at: http://www.pbscensus.gov.pk/sites/default/files/Population_Results.pdf [last assessed on October 10, 2019].
14. Multiple indicator cluster survey manual. Chapter 4: Designing and selecting the sample. <http://mics.unicef.org/files?job=W1siZiIsIjIwMTUvMDQvMDIvMDgvMDAvMTkvODEwL01JQ1MzX0NoYXB0ZXJfNF9fX0Rlc2lnbmluZ19hbmRfu2VzZWNoaW5>

- nX3RoZV9TYW1wbGVfMDYwMjE5LnBkZiJdXQ&sha=3d97a05358bb0e37 (Last assessed on May 18, 2020).
15. Joshi SR, Anjana RM, Deepa M, Pradeepa R, Bhansali A, Dhandania VK, et al. Prevalence of dyslipidemia in urban and rural India: the ICMR-INDIAB study. *PLoS One*. 2014;9(5):e96808.
 16. Anjana RM, Pradeepa R, Deepa M, Datta M, Sudha V, Unnikrishnan R, et al. The Indian Council of Medical Research-India diabetes (ICMR-INDIAB) study: methodological details. *J Diabetes Sci Technol*. 2011;5(4):906–14.
 17. Global Strategy on Diet, Physical Activity and Health by World Health Organization (WHO). Available from: <https://www.who.int/dietphysicalactivity/pa/en/> (Last assessed on July 6, 2020).
 18. Kawamoto R, Tabara Y, Kohara K, Miki T, Kusunoki T, Takayama S, et al. Relationships between lipid profiles and metabolic syndrome, insulin resistance and serum high molecular adiponectin in Japanese community-dwelling adults. *Lipids Health Dis*. 2011;10:79–85.
 19. Fawwad A, Sabir R, Riaz M, Moin H, Basit A. Measured versus calculated LDL-cholesterol in subjects with type 2 diabetes. *Pak J Med Sci*. 2016;32(4):955–60.
 20. Fawwad A, Sabir R, Riaz M, Moin H, Basit A. Measured versus calculated LDL-cholesterol in subjects with type 2 diabetes. *Pak J Med Sci*. 2016;32(4):955–60.
 21. Executive Summary of The Third Report of The National Cholesterol Education Program [NCEP] Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults [Adult Treatment Panel III]. *JAMA*. 2001; 285[19]: 2486–97.
 22. American Diabetes Association [ADA]. Standards of medical care in diabetes - 2018. *Diabetes Care*. 2016; 41 [1]: 1–106.
 23. WHO Western Pacific Region, International Association for the Study of obesity, international obesity task force. The Asia Pacific perspective: redefining obesity and its treatment. Health Communications Australia Pty Limited: St Leonards, 2000.
 24. Lim JU, Lee JH, Kim JS, Hwang YI, Kim TH, Lim SY, et al. Comparison of World Health Organization and Asia-Pacific body mass index classifications in COPD patients. *Int J Chron Obstruct Pulmon Dis*. 2017;12:2465–75.
 25. Shera AS, Rafique G, Khwaja IA, Ara J, Baqai S, King H. Pakistan national diabetes survey: prevalence of glucose intolerance and associated factors in Shikarpur. *Sindh Province Diabet Med*. 1995;12(12):1116–21.
 26. Shera AS, Basit A, Fawwad A, Hakeem R, Ahmedani MY, Hydrie MZI, et al. Pakistan National Diabetes Survey: prevalence of glucose intolerance and associated factors in the Punjab Province of Pakistan. *Prim Care Diabetes*. 2010;4:79–83.
 27. Basit A, Tanveer S, Fawwad A, Naeem N. NDSP members. Prevalence and contributing risk factors for hypertension in urban and rural areas of Pakistan; a study from second National Diabetes Survey of Pakistan (NDSP) 2016–2017. *Clin Exp Hypertens*. 2020;42(3):218–24.
 28. Sarfraz M, Sajid S, Ashraf MA. Prevalence and pattern of dyslipidemia in hyperglycemic patients and its associated factors among Pakistani population. *Saudi J Biol Sci*. 2016;23(6):761–6.
 29. Florez H, Silva E, Fernandez V, Ryder E. Prevalence and risk factors associated with the metabolic syndrome and dyslipidemia in white, black, Amerindian and mixed Hispanics in Zulia state, Venezuela. *Diabetes Res Clin Pract*. 2005;69(1):63–77.
 30. Tabatabaei-Malazy O, Qorbani M, Samavat T, Sharifi F, Larijani B, Fakhrzadeh H. Prevalence of dyslipidemia in Iran: a systematic review and meta-analysis study. *Int J Prev Med*. 2014;5(4):373–93.
 31. Ajay Raj S, Sivakumar K, Sujatha K. Prevalence of dyslipidemia in south Indian adults: an urban-rural comparison. *Int J Community Med Public Health*. 2016;3(8):2201–10.
 32. Zaid M, Hasnain S. Plasma lipid abnormalities in Pakistani population: trends, associated factors, and clinical implications. *Braz J Med Biol Res*. 2018;51(9):e7239.
 33. Zahid N, Claussen B, Hussain A. High prevalence of obesity, dyslipidemia and metabolic syndrome in a rural area in Pakistan. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*. 2008;2:13–9.
 34. Mohammadbeigi A, Moshiri E, Mohammad-salehi N, Ansari H, Ahmadi A. Dyslipidemia prevalence in Iranian adult men: the impact of population-based screening on the detection of undiagnosed patients. *World J Mens Health*. 2015;33(3):167–73.
 35. Gilani SYH, Bibi S, Ahmed N, Shah SRA. Gender differences of dyslipidemia in type 2 diabetics. *J Ayub Med Coll Abbottabad*. 2010;22(3):146–8.
 36. Souza LJ, Souto Filho JT, Souza TF, Reis AF, Gicovate Neto C, Bastos DA, et al. Prevalence of dyslipidemia and risk factors in Campos dos Goytacazes, in the Brazilian state of Rio de Janeiro. *Arq Bras Cardiol*. 2003;81(3):257–64.
 37. Feng RN, Zhao C, Wang C, Niu YC, Li K, Guo FC, et al. BMI is strongly associated with hypertension, and waist circumference is strongly associated with type 2 diabetes and dyslipidemia, in northern Chinese. *J Epidemiol*. 2012;22(4):317–23.
 38. Brown CD, Higgins M, Donato KA, Rohde FC, Garrison R, Obarzanek E, et al. Body mass index and the prevalence of hypertension and dyslipidemia. *Obes Res*. 2000;8(9):605–19.
 39. Rodriguez CJ, Daviglus ML, Swett K, et al. Dyslipidemia patterns among Hispanics/Latinos of diverse background in the United States. *Am J Med*. 2014;127(12):1186–94.e1.
 40. Tangvarasittichai S. Oxidative stress, insulin resistance, dyslipidemia and type 2 diabetes mellitus. *World J Diabetes*. 2015;6(3):456–80.

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.