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RESEARCH ARTICLE

Prevalence and Determinants of Dyslipidemia: Data from a Saudi University Clinic

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Abstract:

Background:

Dyslipidemia is a risk factor for cardiovascular diseases. The relationship between demographic factors and dyslipidemia in Saudi Arabia is not completely explored.

Objectives:

This analytic cross-sectional study was conducted to describe the lipid profile, determine the proportion and identify significant demographic determinants of dyslipidemia among patients who have undergone lipid profile analysis in a university multispecialty clinic.

Methods:

The results of lipid profile examination of 1,541 King Faisal University clinic patients from 1 April, 2014 to 7 March, 2016 were compiled and subjected to descriptive and analytical statistics using STATA MP version 14. Multivariable logistic regression model using Adjusted Odds Ratio (AOR) and 95% Confidence Interval (CI) was fitted to analyze the independent predictors of dyslipidemia.

Results:

The prevalence of hypercholesterolemia, hypertriglyceridemia, hypo-HDL-cholesterolemia, and hyper-LDL-cholesterolemia were 13.8%, 17.0%, 40.0% 12.85%, respectively. Logistic regression revealed that in comparison with those who were 20 years old and below, those who were between the age of 40-49 years were 4.5 times more likely to have hypercholesterolemia and 3.5 times more likely to have hyper-LDL-cholesterolemia. Similarly, those who were 30-39 years old were 4.3 times and 3 times more likely to have hypertriglyceridemia and hypercholesterolemia, respectively. The same stage group was 3 times more likely to develop hyper-LDL-cholesterolemia. Females were 1.4 times more like to have hypercholesterolemia; non-Saudis were nearly twice as likely to develop hypertriglyceridemia than Saudis.

Conclusion:

Hypo-HDL-cholesterolemia was the most prevalent form of dyslipidemia. Age, gender and nationality were significant determinants of specific types of dyslipidemia.

Keywords: Dyslipidemia, Hypercholesterolemia, Hypertriglyceridemia, Hyper-LDL-cholesterolemia, Hypo-HDL-cholesterolemia, Cardiovascular disease.

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1. INTRODUCTION

The impact of non-communicable diseases as a public health problem is well documented. Non-communicable diseases, particularly Cardiovascular Diseases (CVD), are major public health problems ranking as leading causes of mortality around the world [1 - 4]. In 2010, the World Health Organization attributed 30% of global deaths to cardiovascular disease [4].

The number of CVD cases has rapidly increased in the Middle East in recent years. This is believed to result from multiple factors including rapid socioeconomic development, lifestyle changes, urbanization and ageing [5 - 7]. The prevalence of CVD in the Kingdom of Saudi Arabia has been reported to be at 5% [6]. A 2014 National Survey revealed that 15.2% of Saudis are hypertensive and 40% were borderline hypertensive [8].

Hyperlipidemia has been identified as a major risk factor for CVD [9, 10]. Abnormalities in lipid levels have been proven to be linked with various forms of cardiovascular problems. For instance, hypertension, Coronary Heart Disease (CHD) and stroke are associated with elevated Total Cholesterol (TC), Triglyceride (TG) and Low-Density Lipoprotein - Cholesterol (LDL-C) [10 - 14].

Non-High Density Lipoprotein - Cholesterol (non-HDL–C) and Low-Density Lipoprotein - Cholesterol (LDL-C) are atherogenic cholesterol. Among these, non-HDL-C is considered as the major atherogenic cholesterol [15]. Low blood levels of HDL-C and high levels of LDL were found to be independently associated with ischemic heart disease development [16].

On the other hand, HDL-C has been found to inversely affect CVD mortality and is an important factor in secondary prevention of atherosclerotic cardiovascular disease [17 - 19].

A 2012 study revealed that dyslipidemia is highly prevalent among Saudis while a 2013 study reported hypercholesterolemia prevalence to be 8.5% with an alarming 65% of cases undiagnosed [20, 21].

Although CVD risks such as hyperlipidemia have been studied in many countries, studies regarding the link between hyperlipidemia and CVD development among Saudis are still limited. For instance, although CVD is a common problem for both genders, there is insufficient understanding about sex differences in lipid profiles and CVD risks [5, 22 - 25].

Early diagnosis and prompt initiation of treatment is important for people who are at risk for CVDs and could reduce morbidity and mortality for cardiovascular death [22, 26 - 28].

This study sought to describe the lipid profile, determine the proportion and identify significant demographic determinants of dyslipidemia among patients who have undergone lipid profile analysis in a university multispecialty clinic.

2. METHODS

An analytical cross-sectional study design was used to determine the patterns of lipid levels and the prevalence and demographic determinants of dyslipidemia among King Faisal University (KFU) Polyclinic patients. This research was conducted with an approval from the King Faisal University Deanship of Scientific Research – Research Ethics Committee.

This study utilized secondary data consisting of lipid profile (TC, TG, LDL-C, and HDL-C) results of King Faisal University Polyclinic patients who were subjected to lipid analysis from April 1, 2014, to March 7, 2016. A total of 2,732 lipid profile results were extracted from the polyclinic records. After the exclusion of incomplete lipid profile data, 1,541 (56.4%) results were included in the final analysis.

The lipid values were classified according to the *Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III)* guidelines of the National Institutes for Health. For the purposes of this research, hypercholesterolemia was defined as serum TC $\geq$ 240 mg/dL (6.21 mmol/L); hypertriglyceridemia as serum TG $\geq$ 200 mg/dL (2.26 mmol/L); hypo-HDL-cholesterolemia as serum HDL-C $<$ 40 mg/dL (1.03 mmol/L); and hyper-LDL-cholesterolemia as serum LDL-C $\geq$ 160 mg/dL (4.14 mmol/L) [29].

Independent t-test was used to determine gender and nationality differences in the means of TC, TG, HDL-C and LDL-C. The prevalence of dyslipidemia was estimated. Finally, logistic regression was used to determine the association between the demographic factors and the lipid abnormalities.

3. RESULTS

The study sample consisted of 1,541 KFU Polyclinic patients with ages ranging from 17 to 89 (median age = 48). There were 864 (55.1%) males (median age = 47.0 years) and 677 (43.9%) females (median age = 48 years). The patients included faculty members, administrative staff and their dependents, as well as university students. The Saudi patients comprised 62.45% of the population while the remaining 37.55% were of different nationalities.

3.1. Lipid Profile and Dyslipidemia Prevalence

3.1.1. Total Cholesterol

The mean total cholesterol of the study population was 5.14 ± 1.05 mmol/L. More than half (51.1%) of the samples tested fell in the desirable category for total cholesterol. The other half was classified as borderline high (35.1%) and high (13.8%). The highest proportion of cholesterol tested fell in the desirable category for both gender groups, both nationality groups and all age groups.

The prevalence of hypercholesterolemia level was 13.8% with a 95% CI of 12.1% - 15.55% (Table **1**). However, the combined prevalence of borderline hypercholesterolemia and hypercholesterolemia was 48.9% with a 95% CI of 46.4% - 51.4%.

Table 1. Age distribution of dyslipidemia among university clinic patients.

Age group	*n*	Hypercholesterolemia		Hypertriglyceridemia		Hypo-HDL-cholesterolemia		Hyper-LDL-cholesterolemia	
		Freq	%	Freq	%	Freq	%	Freq	%
<20	40	4	10.0	3	7.5	13	32.5	2	5.0
20-29	139	17	12.2	10	7.2	45	32.4	17	12.2
30-39	219	30	13.7	46	21.0	90	41.1	36	16.4
40-49	468	57	12.2	88	18.8	212	45.3	61	13.0
50-59	414	71	17.15	59	14.25	153	37.0	55	13.3
60-69	211	27	12.8	26	12.3	84	39.8	21	9.95
≥70	50	7	14.0	4	8.0	20	40.0	6	12.0
Total	**1541**	**213**	**13.8**	**236**	**15.3**	**617**	**40.0**	**198**	**12.85**

3.1.2. Triglyceride

The mean serum triglyceride value of the population was 1.90 ± 0.97 mmol/L. Nearly three-quarters (73.1%) of the patients had desirable triglyceride levels. Only 17.0% had high triglyceride while the remaining 9.9% had borderline triglyceride levels. The highest proportion of triglyceride tested fell in the desirable category for both genders, both nationality groups and all age groups.

The prevalence of hypertriglyceridemia was 15.3% with a 95% CI of 13.5% - 17.1%. The combined prevalence of borderline high and high triglyceride level was 26.9% with a 95% CI of 24.7% - 29.1%.

3.1.3. HDL-Cholesterol

The mean HDL-C value of the study population was 1.14 ± 0.32 mmol/L. Of the 1541 samples, only 9.5% fell in the high HDL-C category. Half (50.5%) of the patients had borderline HDL-C while 40.0% had low HDL-C.

The prevalence of hypo-HDL-cholesterolemia level was 40.0% with a 95% CI of 37.6% - 42.5%. However, the prevalence of borderline low HDL level is 50.48% with a 95% CI of 48.0% - 53.0%. The combined prevalence of borderline hypo-HDL-cholesterolemia and hypo-HDL-cholesterolemia was 90.5% with a 95% CI of 89.1% - 92.0%.

3.1.4. LDL-Cholesterol

The mean LDL-C value of the study population was 3.11 ± 0.92 mmol/L. Majority of the patients had near optimal or optimal LDL-C levels at 32.7% and 29.2%, respectively. Among the patients, 9.3% fell in the high LDL-C category while 3.5% were in the very high LDL-C category. The remaining 25.2% fell in the borderline category for LDL-C.

The prevalence of hyper-LDL-cholesterolemia is 12.85% with a 95% CI of 11.2% - 14.5%. The combined prevalence of borderline hyper-LDL-cholesterolemia and hyper-LDL-cholesterolemia was 38.1% with a 95% CI of 35.7% - 40.5%.

3.2. Determinants of Dyslipidemia

Multiple logistic regression was used to identify possible associations between age, gender and nationality of the clinic patients and the result of their lipid analysis. Four types of dyslipidemia were examined, namely hypercholesterolemia, hypertriglyceridemia, hypo-HDL- cholesterolemia, and hyper- LDL- cholesterolemia.

3.2.1. Hypercholesterolemia

Patients who are 30 - 39 years and those who are 60 - 69 years were 3 times more likely to have borderline to high levels of cholesterol compared to those who were below 20 years old after controlling for gender and nationality (Table **2**).

Table 2. Determinants of dyslipidemia among university clinic patients.

-	Odds Ratio	p	95% Confidence interval	
Hypercholesterolemia				
Gender: Male Female	1.000 1.418	0.001	1.153	1.743
Nationality: Saudi Non-Saudi	1.000 1.097	0.402	0.883	1.364
Age: <20 20-29 30-39 40-49 50-59 60-69 ≥70	1.000 1.868 3.359 4.513 4.013 3.004 2.711	 0.092 0.000 0.000 0.000 0.001 0.019	 0.904 1.708 2.355 2.098 1.527 1.174	 3.861 6.609 8.649 7.677 5.907 6.257
Hypertriglyceridemia				
Gender: Male Female	1.000 0.661	0.001	0.521	0.839
Nationality: Saudi Non-Saudi	1.000 1.855	0.000	1.459	2.358
Age: <20 20-29 30-39 40-49 50-59 60-69 ≥70	1.000 1.304 4.372 2.864 2.546 2.403 2.347	 0.603 0.001 0.019 0.037 0.058 0.123	 0.480 1.785 1.192 1.057 0.970 0.793	 3.542 10.707 6.882 6.133 5.956 6.948
Hypo-HDL-cholesterolemia				
Gender: Male Female	1.000 0.134	0.000	0.086	0.209
Nationality: Saudi Non-Saudi	1.000 1.144	0.506	0.770	1.699
Age: <20 20-29 30-39 40-49 50-59 60-69 ≥70	1.000 0.835 1.840 1.360 1.714 1.599 1.312	 0.701 0.184 0.464 0.197 0.303 0.661	 0.333 0.748 0.597 0.756 0.655 0.390	 2.092 4.522 3.096 3.887 3.907 4.421
Hyper-LDL-cholesterolemia				
Gender: Male Female	1.000 0.811	0.052	0.656	1.002

(Table 2) contd.....

-	Odds Ratio	p	95% Confidence interval	
Nationality: Saudi Non-Saudi	1.000 1.071	0.542	0.859	1.337
Age: <20 20-29 30-39 40-49 50-59 60-69 ≥70	1.000 2.210 3.005 3.512 3.303 2.150 2.453	 0.047 0.003 0.001 0.001 0.043 0.050	 1.010 1.437 1.726 1.624 1.024 0.999	 4.832 6.281 7.149 6.717 4.514 6.025

On the other hand, the odds of having borderline high to high levels of cholesterol were 4.5 times for patients who were 40 - 49 and 4 times higher for those who were 50 - 59 years compared to those who were below 20 years old after controlling for gender and nationality.

When age and nationality were held constant, females were 1.4 times more likely to be having borderline to high levels of cholesterol compared to males. The risk for hypercholesterolemia was unaffected by nationality when other variables were held constant.

3.2.2. Hypertriglyceridemia

When nationality and gender were held constant, patients who were between the age of 30 to 39 were at higher risk for having borderline high to high levels of triglyceride (OR = 4.4, p = 0.001) compared to patients who were below 20. Two other age groups had significantly higher risks for hypertriglyceridemia, namely those in the 40 - 49 age group (OR = 2.86, p = 0.019) and patients who were in 50 - 59 group (OR = 2.55, p = 0.037).

Females had a 34% lower risk of having borderline high to high triglyceride compared to males when age and nationality were held constant (p = 0.001). On the other hand, when age and gender were held constant, non-Saudis were 1.8 times more likely of having borderline and high triglyceride compared to Saudis (p < 0.001).

3.2.3. Hypo-HDL-Cholesterolemia.

There was no significant increased risk for low HDL found among any age groups compared to those below 20 years old when gender and nationality were held constant. Females were 87% less likely to have borderline-low to low HDL compared to males when age and nationality were held constant. However, nationality was not significantly associated with increased risk for this type of dyslipidemia when the other variables were held constant.

3.2.4. Hyper-LDL-Cholesterolemia

The likelihood of having elevated LDL-C was the highest for 40 - 49 age group, and decreased among 50 - 59, 30 - 39, 20 - 29 years of age, and finally 60 - 69 age groups.

Patients who were between the age of 40 - 49 years were 3.5 times more likely to have borderline high, high and very high levels of LDL-C compared to those who were below 20 years after controlling for gender and nationality (p = 0.001).

The odds for elevated LDL was 3.3 times higher for the 50 - 59 and 3 times higher for the 30 - 39 group compared to those below 20 when gender and nationality were held constant. Those who were between the age of 60 - 69 years were 2.1 times more likely to be having borderline high, high and very high levels of LDL-C compared to those who were below 20 years after controlling for gender and nationality. The odds was also doubled for the 20 - 29 and the 60 - 69-year-old patients.

The odds for hyper-LDL-cholesterolemia did not appear to be significantly associated with gender and nationality when other variables were held constant.

4. DISCUSSION

The mean total serum cholesterol of men (5.07 ± 1.03 mmol/L) and women (5.24 ± 1.07 mmol/L) differed significantly (p = 0.001). A higher proportion of females had total cholesterol levels that fell in the borderline high and high categories.

Age by gender analysis showed that for men, the prevalence of hypercholesterolemia increased with age and peaks at 30 - 39 then decreased after this age group. For women, the prevalence increased until age 50 - 59 before declining (Table **3**).

Table 3. Distribution of dyslipidemia stratified by age and gender.

Gender	Age group	*n*	Hypercholesterolemia		Hypertriglyceridemia		Hypo-HDL-cholesterolemia		Hyper-LDL-cholesterolemia	
			Freq	%	Freq	%	Freq	%	Freq	%
Male	<20	17	2	11.8	2	11.8	8	47.1	1	5.9
	20-29	82	11	13.4	8	9.8	33	40.2	10	12.2
	30-39	112	19	17.0	36	32.1	60	53.6	21	18.75
	40-49	288	38	13.2	72	25.0	159	55.2	38	13.2
	50-59	212	26	12.3	36	17.0	110	51.9	24	11.3
	60-69	123	10	8.1	18	14.6	68	55.3	10	8.1
	≥70	30	3	10.0	2	6.7	14	46.7	4	13.3
	Total	**864**	**109**	**12.6**	**174**	**20.1**	**452**	**52.3**	**108**	**12.5**
Female	<20	23	2	8.7	1	4.35	5	21.7	1	4.35
	20-29	57	6	10.5	4	7.0	12	21.1	7	12.3
	30-39	107	11	10.3	20	18.7	30	28.0	15	14.0
	40-49	180	19	10.6	28	15.6	53	29.4	23	12.8
	50-59	202	45	22.3	23	11.4	43	21.3	31	15.35
	60-69	88	17	19.3	6	6.8	16	18.2	11	12.5
	≥70	20	4	20.0	6	30.0	6	30.0	2	10.0
	Total	**677**	**104**	**15.4**	**88**	**13.0**	**165**	**24.4**	**90**	**13.3**

Wide variations in prevalence rates and gender-specific prevalence rates of hypercholesterolemia and hyper-LDL-cholesterolemia in the Middle East have been reported [30]. A Saudi study showed that males were found to consistently have higher mean scores for CHD risk factors compared to females [24].

Gender difference in hypercholesterolemia prevalence was similarly observed in the community-based national epidemiological survey in KSA [31]. In contrast, a 2012 study conducted in Riyadh showed that hypercholesterolemia was more prevalent among women [32]. A recent study in a university setting revealed that both hypercholesterolemia and hypertriglyceridemia were common among male patients [33].

Hypercholesterolemia was highest among the 50 - 59-year-old patients. Additionally, nationality by age analysis showed that the highest proportion of patients with hypercholesterolemia was in the 70 and over group among Saudis but was in the 20 and below group among the non-Saudis (Table **4**).

Table 4. Distribution of dyslipidemia stratified by age and nationality.

Nationality	Age group	*n*	Hypercholesterolemia		Hypertriglyceridemia		Hypo-HDL-cholesterolemia		Hyper-LDL-cholesterolemia	
			Freq	%	Freq	%	Freq	%	Freq	%
Saudi	<20	33	2	6.1	1	3.0	10	30.3	2	6.1
	20-29	123	13	10.6	10	8.1	39	31.7	13	10.6
	30-39	110	7	6.4	23	20.9	48	43.6	16	14.55
	40-49	218	22	10.1	39	17.9	101	46.3	30	13.8
	50-59	273	44	16.1	26	9.5	91	33.3	34	12.45
	60-69	147	21	14.3	16	10.9	53	36.05	18	12.2
	≥70	43	7	16.3	8	18.6	18	41.9	6	14.0
	Total	**947**	**116**	**12.25**	**123**	**13.0**	**360**	**38.0**	**119**	**12.6**
Non-Saudi	<20	7	2	28.6	2	28.6	3	42.9	0	0.0
	20-29	16	4	25.0	2	12.5	6	37.5	4	25.0
	30-39	109	23	21.1	33	30.3	42	38.5	20	18.35
	40-49	250	35	14.0	61	24.4	111	44.4	31	12.4
	50-59	141	27	19.15	33	23.4	62	44.0	21	14.9
	60-69	64	6	9.4	8	12.5	31	48.4	3	4.7
	≥70	7	0	0.00	0	0.0	2	28.6	0	0.0
	Total	**594**	**97**	**16.3**	**139**	**23.4**	**257**	**43.3**	**79**	**13.3**

The mean serum triglyceride of men (2.01 ± 1.02 mmol/L) and women (1.76 ± 0.87 mmol/L) differed significantly ($p = 0.001$). A higher proportion of male patients had hypertriglyceridemia was higher for men (20.1%) than for women (13.0%). The gender difference in hypertriglyceridemia observed in this study was similarly reported in previous studies [31, 32].

Age by gender analysis showed that the proportion of patients with hypertriglyceridemia was highest for the 30 – 39 age group and decreased gradually in the older age groups for males while among female patients, the highest proportion was seen in the 70 and above age group. The same trend was observed among Saudi and non-Saudi patients across the age groups. A similar age-related increase was seen in a population-based cohort study conducted in Japan. However, whereas the rates decreased after the 40 - 49 age group in the current study for both genders, a linear increase in serum triglyceride was seen among Japanese women [34].

The mean serum HDL-C of men (1.04 ± 0.24 mmol/L) and women (1.27 ± 0.36 mmol/L) differed significantly ($p < 0.001$). Hypo-HDL-cholesterolemia was more common among in men (52.3%) than among women (24.4%).

The proportion of patients with hypo-HDL-cholesterolemia was highest at age group 60 - 69 for males, age group 70 and over for females, age group 40 - 49 among Saudis, and age group 60 - 69 among non-Saudis. Age-related changes were also seen in a Japanese study but were found to be significantly correlated only to women [34].

Hypo-HDL-cholesterolemia was found to be associated with ischemic heart disease development independent of hyper-LDL-cholesterolemia [17]. On the other hand, HDL cholesterol levels have been proven as strong inverse predictors of cardiovascular disease and cardiovascular mortality for both men and women [17, 18].

The mean serum LDL-C of men (3.18 ± 0.91 mmol/L) and women (3.10 ± 0.95 mmol/L) did not differ significantly ($p = 0.660$). The prevalence of hyper-LDL-cholesterolemia was slightly higher for women (13.3%) than for men (12.5%).

Age by gender analysis showed that the proportion of patients with hyper-LDL-cholesterolemia increased with age for men and peaked at 30 - 39 then decreased after this group. For women, the prevalence was highest in the age group 50 - 59.

Among the Saudis, the proportion of cases of hyper-LDL-cholesterolemia increased with age, and peaked in the 50 - 59 group before declining. Among the non-Saudis, an earlier peak at age group 40 - 49 was observed.

The prevalence of elevated Low-Density Lipoprotein (LDL) in the Middle East varied between men and in women [30]. Increases in the prevalence rate of hyper-LDL-cholesterolemia has been shown to be age-dependent [35]. A Japanese study on age-related clinical parameters showed that hyper-LDL-cholesterolemia increased up to age 50 - 59 for men and up to 60 - 69 for women [34].

This study had several limitations. The study utilized secondary data therefore the investigators did not have control over the quality of the laboratory test results. There was a minimal tendency for misclassification bias transpiring. Furthermore, the prevalence of specific types of dyslipidemia obtained did not completely manifest dyslipidemia in the university community, much less the residents of the community where the clinic is located. Determinants examined in the study were limited to those available in the patients' records specifically: age, gender, and nationality. Other factors such as dietary intake of fats, comorbidities, family history of dyslipidemia, smoking status, alcohol consumption, *etc.*, which might be plausible contributory causes of the various forms of dyslipidemia were not considered. The results of the study are only validly applicable to the sampled population and not the overall Saudi population due to the inherent restrictions of the sampling scheme applied.

CONCLUSION

The study found that the different forms of dyslipidemia were prevalent among patients of the university clinic, with hypo-HDL-cholesterolemia as the most common among its clients. This study showed that gender was a significant determinant for hypercholesterolemia, hypertriglyceridemia, hypo-HDL-cholesterolemia; age was a significant determinant for hypercholesterolemia, hypertriglyceridemia, and hyper-LDL-cholesterolemia; and finally, nationality was a significant determinant for hypertriglyceridemia.

ETHICAL APPROVAL AND CONSENT for PARTICIPATETION

This research was conducted with an approval from the King Faisal University Deanship of Scientific Research - Research Ethics Committee.

HUMAN AND ANIMAL RIGHTS

No animals/humans were used for the studies that are bases of this research.

CONSENT FOR PUBLICATION

Not applicable

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest, financial or otherwise.

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Declared none.

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