Hyperlipidemia in Saudi Arabia

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ABSTRACT

الأهداف: يعتبر فرط الدهون من العوامل المعروفة لحدوث أمراض شرايين القلب الإكليلية. و من المتوقع ازدياد فرط الدهون في المملكة العربية السعودية. الغرض من تصميم هذه الدراسة هو معرفة مدى انتشار فرط الدهون عند السعوديين من الجنسين, ما بين أعمار ٣٠ – ٧٠ سنة في المجتمع الريفي و الحضري

الطريقة: هذه الدراسة المجتمعية تفحص السعوديين البالغين من أعمار ٣٠ سنة إلى ٧٠ سنة من البيوت المختارة خلال خمس سنوات من عام ١٩٩٥ إلى عام ٢٠٠٠ م في المملكة العربية السعودية. استخلصت البيانات من بداية المرض و عمل فحص سريري كامل و تحليل الدم الصائم للدهون. تم تحليل البيانات لمعرفة مدى انتشار ارتفاع الكولسترول (≤ ٥,٢ م مول/ ل) و مدى انتشار ارتفاع الدهون الثلاثية(≤ ١,٦٩ م مول/ ل) في المملكة العربية السعودية

النتائج: اجمالى عدد السعوديين بالدراسة كان ١٦٨١٩ شخصا, وكان المعدل الكلى لارتفاع الكولسترول في المملكة العربية السعودية هو 54%. و كان معدل نسبة الكولسترول هو 5.4±1.52 م مول/ ل. وكان المعدل للرجال هو 54.9% , بالمقارنة بنسبة 53.2% للنساء. و لوحظ أن المعدل أعلى للسعوديين المقيمين بالمدن بنسبة53.4% مقارنة للسعوديين بالأرياف55.3% . أما المعدل الكلى لارتفاع الدهون الثلاثية هي 40.3% و كان معدل نسبة الدهون الثلاثية هو1.8±1.29 م مول/ ل. وكان المعدل أعلى للرجال 47.6% , بالمقارنة بنسبة 33.7% للنساء.

خاتمة: المعدل الكلي لانتشار فرط الدهون للسعوديين البالغين في المملكة العربية السعودية في ارتفاع متزايد. مما يشير إلى ارتفاع محتمل لمعدل الإصابة بأمراض الشرايين الإكليلية في المستقبل. ننصح بأنه يجب اتخاذ برنامج توعية في المملكة العربية السعودية عند سن مبكر كالرياضة و تخفيف الوزن.

Objectives: To determine the prevalence of hyperlipidemia among Saudis of both genders in rural and urban communities.

Methods: Selected Saudis in the age group of 30-70 years were studied over a 5-year period between 1995 and 2000 in Saudi Arabia. Data were obtained from history, physical examination, and analysis of fasting plasma lipids. The data were analyzed to classify individuals with hypercholesterolemia (HC) (total cholesterol ≥5.2 mmol/l), and hypertriglyceridemia (HT) (total triglycerides ≥1.69 mmol/l). Logistic regression analysis was performed to provide a risk assessment model and correlation with other coronary artery disease (CAD) risk factors.

Results: The number of study samples included in the final analysis was 16,819. The prevalence of HC was 54% with mean cholesterol level of 5.4±1.52 mmol/l. Prevalence of HC among males was 54.9% and 53.2% for females, while 53.4% among urban Saudis and 55.3% for rural Saudis. Hypertriglycemia prevalence was 40.3% with mean triglycerides level of 1.8±1.29 mmol/l. Males had statistically significant higher HT prevalence of 47.6% compared to 33.7% in females (p<0.0001).

Conclusions: Hyperlipedimia is reaching higher prevalence rates in KSA. This finding may suggest that CAD will soon be a major health problem. Reduction in obesity by adopting healthier eating habits, and increasing physical activity are of considerable importance to our community.

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Over the past 3 decades lipids have gained great importance in the medical community, reflected by the large number of publications in the medical literature. Lipids play an integral role in human physiology and excess lipids has been shown to be a risk factor for coronary artery disease (CAD), as well

as cerebrovascular and peripheral vascular disease.[1-6] Hyperlipidemia (HL) may be either primary due to genetically determined disorders or secondary as a result of acquired causes.[7-14] However, several studies have shown beneficial effects of reversing HL by either primary or secondary prevention.[15-20] The prevalence of CAD is increasing in the Kingdom of Saudi Arabia (KSA).[21] Establishing the prevalence of HL, a well-known risk factor for CAD, is an important step in enhancing the awareness of the magnitude of the problem to provide clear management strategy. Previous studies on the prevalence of HL in KSA were able to provide some light on the problem.[22-24] However, the expanding knowledge on what should be considered normal for lipids level has definitely changed our perception of HL. The National Cholesterol Education Program (NCEP) and the Third Adult Treatment Panel (ATP III) provide a definition for hypercholesterolemia (HC) if serum cholesterol is equal to or more than 5.2 mmol/l.[25] We designed and conducted this study to provide an estimate of the overall prevalence of HL among the Saudi population. The outcome of this study will enhance our perception of HL as a current and actively progressing medical problem that can be contained by different measures to prevent its complications.

Methods. A 5-year community-based national epidemiological health survey to study CAD and its risk factors was conducted in Saudi Arabia between 1995 and 2000. Male and female Saudi subjects aged 30-70 years, in rural and urban areas of KSA formed the target population for this study. Most previous studies on HL from other parts of the world focused on a similar population that allows for inter-countries comparison. The study was approved by the ethical committees of the Ministry of Health and King Abdulaziz City for Science and Technology (KACST). Each participant consented prior to inclusion in this survey. A sample size of 20,000 participants was the target of the study to ensure high reliability of our estimates of the prevalence of HL. Subjects were selected using a 2 stage stratified cluster sampling procedure, urban and rural being the strata. Subjects were included in this survey according to the following inclusion criteria: a) between 30 and 70 years of age b) holding valid Saudi identification c) had signed an informed consent. Subjects were excluded if they did not meet the inclusion criteria. Samples were selected from each region of the 14 administrative regions in KSA and the study population was drawn from the 1,623 primary health care centers (PHCCs) uniformly distributed in the Kingdom. Each region was classified into urban and rural communities and a simple random sample of PHCCs were selected. The number of PHCCs to be selected from each community was based on the total number of PHCCs in each rural and urban community. A total of 66 PHCCs were selected from urban, and 58 from rural areas. One hundred households from urban PHCCs and 50 households from rural PHCCs were randomly selected. All subjects from the age group of 30-70 years from selected households were interviewed using a standard questionnaire at their respective houses and examined at PHCCs. The questionnaire was developed, pre-tested, and validated in a pilot study. The questionnaire included basic demographic and socioeconomic data as well as detailed medical history including intake of medications. A clinical examination was conducted, and included height, weight, waist circumference, blood pressure, followed by obtaining 12-hour fasting blood samples (for measurement of fasting plasma cholesterol, fasting high-density lipoprotein (HDL), fasting low-density lipoprotein (LDL) and fasting triglycerides). Well-trained primary care physicians conducted a clinical examination including measurement of blood pressure as well as performing an electrocardiogram (ECG). Weight was measured with ordinary scales (non-electronic portable balance) with indoor clothing on and without shoes on to the nearest 0.1 kg. Height measurement was carried out in the standing position, without footwear, to the nearest millimeter (mm) by using a measuring tape that is part of the weighing scale. Weight and height were measured using standardized techniques and equipment (to be precise, health care workers were trained, for the purpose of this study, to use the same technique of weight and height measurements for all subjects of the study population, using the same type of equipment such as blood pressure apparatus, weighing scale, and ECG machine). Waist circumference was measured using ordinary non-stretchable measuring tape by centimeters (cm). Trained technicians, under the supervision of primary care physicians, collected 20 cc. of blood (12 hour fasting), in 2 tubes of 10 cc. each. Tubes were immediately kept in the refrigerator for at least 30 minutes and no more than 4 hours before centrifugation. Centrifugation was carried out for 30 minutes at 3000 rate per minute (RPM) in a refrigerated centrifuge at 4^0C. Plasma and serum were separated and were frozen at -20^0C immediately. These samples were transported frozen in ice to the coordinating laboratory in the region where they were kept frozen at -20^0C. At the end of the sample collection from all participants in the region, these samples were transferred frozen in ice in incubators to the central laboratory at the College of Science, King Saud University, Riyadh. All biochemical parameters were analyzed on a clinical analysis (Konelab, Intelligent Diagnostics system, Helsinki-Finland). The instrument was calibrated prior to analysis using quality control samples provided with the solutions. Standard International Units (mmol/L) were used to record the results.

The data were analyzed using the Statistical Package for Social Sciences (SPSS Version 10) on personal

Table 1 - Prevalence of hypercholesterolemia and hypertriglyceridemia categorized by gender, age, and residence of Saudi Arabia.

Factor	n (%)	TC ≥ 5.2 mmol/l n (%)	*P*-value	Trig ≥ 1.69 mmol/l n (%)	*P*-value
Gender					
Male	8010 (47.6)	4399 (54.9)	0.026	3810 (47.6)	<0.0001
Female	8809 (52.4)	4687 (53.2)		2968 (33.7)	
Age group					
30-39	5787 (34.4)	3095 (53.5)		2015 (34.8)	
40- 49	4771 (28.4)	2590 (54.3)	0.152	1983 (41.6)	0.380
50-59	3403 (20.2)	1889 (55.5)		1568 (46.2)	
60-70	2858 (17.0)	1512 (52.9)		1212 (42.5)	
Residence					
Urban	11542 (68.6)	6168 (53.4)	0.025	4990 (43.2)	<0.0001
Rural	5277 (31.4)	2918 (55.3)		1788 (34.1)	
Total	**16819**	**9086 (54.0)**		**6778 (40.3)**	

TC - total cholesterol, Trig - triglycerides

Table 2 - Prevalence of hypercholesterolemia and hypertriglyceridemia categorized by income, marital status, housing, and educational level.

Factor	n (%)	TC ≥ 5.2 mmol/l n (%)	*P*-value	Trig ≥ 1.69 mmol/l n (%)	*P*-value
Monthly income					
<2,500	4663 (28.1)	2510 (53.8)		1681 (36.0)	
2500–4999	5535 (33.3)	2963 (53.5)		2299 (41.5)	
5000–7499	3420 (20.6)	1819 (53.2)	0.149	1423 (41.7)	<0.0001
7500–9999	1449 (8.7)	803 (55.4)		601 (41.7)	
10000–14999	1169 (7.0)	669 (57.2)		513 (44.0)	
≥ 15000	364 (2.2)	204 (56.0)		175 (47.9)	
Marital status					
Single	387 (2.3)	216 (55.8)		127 (32.9)	
Married	15359 (91.3)	8317 (54.2)	0.083	6204 (40.4)	0.013
Divorced	219 (1.3)	125 (57.1)		87 (39.4)	
Widowed	854 (5.1)	428 (50.1)		360 (42.6)	
Housing					
Villa/palace	4861 (28.9)	2609 (53.7)		2197 (45.6)	
Small house	6009 (35.8)	3253 (54.1)		2253 (37.4)	
Flat	4535 (27.0)	2473 (54.5)	0.944	1873 (40.9)	<0.0001
Wooden house/tent	365 (2.2)	195 (53.4)		116 (32.0)	
Mud house	470 (2.8)	247 (52.6)		132 (28.3)	
Others	557 (3.3)	302 (54.2)		199 (36.2)	
Education					
Illiterate	8654 (51.6)	4602 (53.2)		3151(36.4)	
Read and write only	1957 (11.7)	1057 (54.0)		827 (42.5)	
Primary	3141 (18.7)	1676 (53.4)	0.004	1434 (45.6)	<0.0001
Secondary	1676 (10.0)	955 (57.0)		744 (44.5)	
College and above	1342 (8.0)	772 (57.5)		599 (44.8)	

TC - total cholesterol, Trig - triglycerides

computers. *P*-value of <0.05 was considered significant. The estimate prevalence rate of HL (hypercholesterolemia [HC] and hypertriglyceridemia [HT]) was calculated for the total sample and sub-groups of gender, marital status, area of residence, income, educational level, occupation, age groups, regions of Saudi Arabia, obesity groups, and abnormal waist circumference. The prevalence of CAD, hypertension, and metabolic syndrome were also determined for patients with HL. The correlation of hyperlipidemic patients with height, weight and waist circumference was also calculated.

Results. The total number of studied population was 17,209 Saudi subjects from selected households. Sixteen thousand eight hundred nineteen subjects completed the study, and 48% of them were males. **Table 1** shows

Table 3 - Prevalence of hypercholesterolemia and hypertriglyceridemia by regions of Saudi Arabia.

Region	n (%)	5.2 ≤ TC < 6.2 mmol/l n (%)	TC ≥ 6.2 mmol/l n (%)	*P*-value	1.69 ≤Trig <2.3 mmol/l n (%)	Trig. ≥ 2.3 mmol/l n (%)	*P*-value
Central	3912 (23.3)	1163 (30.0)	886 (22.9)		689 (17.8)	879 (22.7)	
Northern	1445 (8.6)	422 (28.9)	438 (30.0)		306 (21.0)	364 (24.9)	
Southern	3391 (20.2)	1054 (30.7)	656 (19.1)	<0.0001	614 (17.9)	632 (18.4)	<0.0001
Western	5434 (32.3)	1712 (31.7)	1322 (24.4)		924 (17.1)	1027 (19.0)	
Eastern	2637 (15.7)	746 (28.3)	676 (25.7)		453 (17.2)	890 (23.5)	
Total	**16819**	**5097 (30.3)**	**3978 (23.7)**		**2986 (17.8)**	**3792 (22.6)**	

Table 4 - Hyperlipidemia with BMI and waist circumference.

Factor	n (%)	TC≥ 5.2 mmol/l n (%)	*P*-value	TG≥ 1.69 mmol/L n (%)	*P*-value
BMI					
Underweight (<18.5)	198 (1.2)	110 (55.6)	0.892	42 (21.3)	<0.0001
Normal (18.5-25)	4360 (26.1)	2369 (54.3)		1374 (31.3)	
Overweight (>25-<30)	6009 (36.0)	3255 (54.2)		2607 (43.3)	
Obese (≥30)	6124 (36.7)	3290 (53.7)		2724 (44.5)	
Waist circumference					
Male					
(< 102 cm)	5805 (74.7)	3210 (55.3)	0.495	2559 (44.1)	<0.0001
(≥102 cm)	1961 (25.3)	1067 (54.4)		1140 (57.4)	
Female					
(<88 cm)	3850 (44.5)	2016 (52.4)	0.224	1035 (26.8)	<0.0001
(≥88 cm)	4801 (55.5)	2577 (53.7)		1876 (39.0)	

BMI - body mass index, TC - total cholesterol, TG - triglycerides

the prevalence of HC and HT categorized by gender, age-groups, residence (urban/rural), and regions of Saudi Arabia. The prevalence of HC (total cholesterol [TC] ≥5.2 mmol/L) among male subjects was 54.9%, while HT (total trigycerides [TG] ≥1.69 mmol/L) prevalence was 47.6%. The prevalence of HC (p=0.008) and HT (p<0.0001) among female subjects was significantly lower compared to males. Prevalence of HC increased progressively up to the age of 50 years, then stabilized after the age of 60 years. There was no significant difference for HC among urban and rural residents. The urban population showed significantly higher prevalence of HT than the rural population (p<0.0001). Subjects living in Northern and Eastern regions showed the highest prevalence of HC and HT, while the Southern region showed the lowest prevalence for lipids and this difference was statistically significant (p<0.0001). Single subjects showed statistically non-significant (p=0.083) higher prevalence of HC (55.8%) and significant (p=0.013) lower prevalence of HT (32.9%), compared to widows with a prevalence of HC (50.1%) and HT (42.6%) **(Table 2)**. Businessmen showed higher prevalence of HC (59.4%) and HT (52%), while housewives (34.2%) showed statistically significant lower prevalence of HT. There was no significant difference among different income groups for HC (p=0.149), while it was directly proportional with the prevalence of HT as shown in **Table 2,** with the lowest prevalence of 36% for the lowest income group (SR <2,500) and the highest prevalence of 47.9% for the highest income group (SR >15,000). The people living in villas/palaces, small houses or flats showed higher prevalence of HC and HT than the people living in mud-houses, wooden houses or some other types of houses. The difference of prevalence of HC was statistically non-significant (p=0.944) and HT was statistically significant among these housing types (p<0.0001). **Table 3** shows the relationship of HC and HT with respect to different regions of Saudi Arabia. The cut-off points for HC is ≥5.2 mmol/l and HT ≥1.69 mmol/l. Subjects living in the Northern region showed the highest prevalence of HC and HT, while subjects living in the Southern region showed the lowest prevalence of HC and HT. The difference among different regions was statistically significant (p<0.0001). The prevalence of HT was increased with increasing BMI (**Table 4**). The prevalence of HT is higher with abnormal waist size both in males and females. These increments were statistically significant (p<0.0001). Furthermore, the increments for HT were 13.3% for males and 12.2% females with abnormal waist sizes compared to subjects with normal waist size (p<0.0001).

Discussion. The data obtained from the current study shows that HC and HT are prevalent medical problems affecting nearly one half of the adult Saudi population, putting them at increased risk for the development of CAD as well as other disorders related to excess lipids. Clearly, the prevalence is increasing with age and income. The higher prevalence of HT among urban subjects compared to those living in rural regions may be explained by the lifestyle and type of feeding habits, particularly, now that fast food chains have increased in prevalence in the cities of KSA. The prevalence of HC may have been lower if we considered a cutoff value of ≥ 6.2 mmol/l for TC. As the current recommendation is adopting "the lower, the better" for cholesterol level, therefore we chose a cut-off of ≥5.2 mmol/l for TC to define HC. Taking a cut-off value of serum concentrations above the 19th percentile for general population may be misleading with the current evidence of unequivocal harmful effect of HL in the development of atherosclerosis and premature CAD. We found a large percentage of our population with levels of TC ≥6.2 mmol/l in all regions of Saudi Arabia indicating true higher levels for HC. Similarly, the majority of subjects in the present study were found to have higher levels of HT ≥2.3 mmol/l. From the analysis of our data presented here, HL prevalence varies among our population, and we can clearly see the effect of factors such as obesity and waist circumference in increasing the prevalence of HC and HT. The common denominator would be lack of physical activity associated with unhealthy eating habits. This was demonstrated in Saudi Arabia by looking at the prevalence of physical inactivity among Saudis that was found to be strikingly affecting up to 99.5% of the studied population.[26,27] Recent evidence has demonstrated the relationship between the TC concentration and the risk of developing CAD.[28] The data showed a similar relationship between HC and CAD, as a significant number of patients with CAD have higher cholesterol level compared to subjects without CAD.[21] Furthermore, it has been shown by meta-analysis of many trials that reducing TC translates into reduction in the morbidity of CAD.[20] We have seen a modest increase in the prevalence of HC compared to previous studies conducted in KSA, as one study reported a prevalence of 48.8% of HC (TC ≥5.2 mmol/l).[29] Additionally, the prevalence of HC varies according to the population studied, as we have seen it as low as 1.2% among studied population (2520 over 30 years of age) in Yon chon County, Korea (TC ≥6.2 mmol/l).[30] Alternatively, the overall prevalence rate of HC was 62.5% among adult Nigerians with systemic hypertension.[31] One study reported an overall prevalence of HC (TC ≥5.2 mmol/l) of 66.4% among 3782 subjects from Poland.[32] Another study from India[33] reported a prevalence of HC (TC ≥5.2 mmol/l) as 33.2% for males and 28.9% for females.

It is clear that HL is prevalent in Saudi Arabia and the question now is what should we do about it? Learning from interventions made in other populations who identified this problem earlier, may answer this question. A group of researchers from the United States of America (USA) examined 40-year trends in CAD risk factors among US adults aged 20-74 years, and they found 21% lower prevalence of high cholesterol level (39% in 1960-1962 versus 18% in 1999-2000).[34] Therefore, implementation of healthy eating habits, and promotion of physical activity may actually halt the problem if we start at younger age groups to prevent the damaging effects of HL. We also recommend screening of adult Saudi subjects for serum cholesterol, particularly those at risk of developing CAD.

One limitation of the study is the lack of universal agreement of what is to be considered a normal or abnormal value for lipid profile; as currently the terms used are either optimal or desired values. The recommended cutoff values are determined by the presence of other risk factors for CAD or previous CAD events (secondary prevention). In addition, despite clear instructions for 12 hour fasting prior to obtaining the blood samples, one cannot be 100% certain of adherence to this instruction from all participants.

In summary, HC and HT (collectively known as HL) are prevalent medical problems among adult Saudis that need to be addressed by the health care providers. This piece of information, considered along with higher prevalence of other CAD risk factors in Saudi Arabia, including diabetes mellitus, smoking, obesity and the metabolic syndrome, suggest that CAD will be a future major health problem. Therefore, a national campaign promoting healthy eating habits and encouraging physical activity is a health care priority. Finally, screening for fasting serum lipids in adult Saudis to identify those who need intervention is recommended.

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