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ORIGINAL RESEARCH

Exploring the Sociodemographic and Behavioral Status of People Living with Hypercholesterolemia in Saudi Arabia: A Nation-Wide Cross-Sectional Study

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Introduction: Hypercholesterolemia (HC) is a well-known risk factor for cardiovascular diseases, which are the leading cause of death worldwide. Many factors can contribute to HC, including advanced age, chronic diseases (such as diabetes and nephrotic syndrome), and the use of certain medications.

Aim: Our goal was to compare the sociodemographic, behavioral, and other comorbid conditions of adult participants living with HC in Saudi Arabia to the general population.

Methods: This is a secondary data analysis from the Sharik Health Indicators Surveillance System (SHISS). SHISS consists of cross-sectional phone interviews conducted in all administrative regions of Saudi Arabia on a quarterly basis. Participant recruitment was limited to Arabic-speaking Saudi residents who were ≥18 years old.

Results: Out of 20,492 potential participants contacted in 2021, 14,007 completed the interview. Of the total participants, 50.1% were male. The mean age of participants was 36.7 years, with 1673 (11.94%) having HC. A regression model showed that participants with HC had a higher likelihood of being older, living in Tabouk, Riyadh, or Asir regions, being overweight or obese, having diabetes, hypertension, genetic or heart diseases, or having a higher risk of depression. Gender, all types of smoking, physical activity, and education level were eliminated from the model.

Discussion: In this study, participants with HC were identified with some co-existing conditions that may affect the progression of the disease and the participants' quality of life. This information could assist care providers in identifying patients who are at higher risk, improve screening efficiency, and improve disease progression and quality of life.

Keywords: cardiovascular diseases, hypercholesterolemia, Saudi Arabia, chronic disease, epidemiology

Introduction

Cardiovascular diseases (CVDs) are the leading cause of death worldwide. CVDs are heart and blood vessels disorders that include coronary heart disease, cerebrovascular disease, and other conditions.[1] High blood cholesterol level, known as hypercholesterolemia (HC), is a well-known risk factor for CVDs.[2] HC is generally defined as elevated levels of low-density lipoprotein cholesterol (LDL-C) or non-high-density lipoprotein cholesterol (HDL-C), which can occur either because of certain primary (hereditary or familial), or secondary causes (acquired). According to the World Health Organization (WHO), the prevalence of HC is generally high, and high levels of cholesterol are estimated to end the lives

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of approximately 2.6 million people globally. These high levels of cholesterol are considered a major cause of disease burden in both developed and developing countries.[3]

Hydroxymethylglutaryl CoA reductase inhibitors, also known as "statins" are the first line of antihyperlipidemic agents, with others added to improve statins' efficacy.[4] According to a recent study, combining two different classes of antihyperlipidemic agents was significantly more effective than using one agent alone.[5] Despite the availability of pharmacological treatment to lower HC, and thus reduce the risk of cardiovascular diseases, it remains difficult in some cases because cholesterol levels are affected by a variety of factors. Advanced age, the presence of chronic disease (diabetes and nephrotic syndrome), and the use of certain medications such as cyclosporine and thiazide diuretics are among these risk factors. Other significant risk factors for HC include obesity, diet, and stress.[6]

Data on HC levels are found to be limited in the Middle East. Due to the fact that HC is an asymptomatic disorder, and the fact that HC is largely influenced by demographic characteristics, the prevalence of HC in Saudi Arabia, specifically, ranges widely in different regions from 8.5% to 54.9%.[7–9]

The Ministry of Health in Saudi Arabia has introduced new changes as part of the National Transformation Program (NTP) 2020 and Saudi Vision 2030, in which more emphasis will be placed on the advancement of the wellness framework.[10] Thus, the Saudi Arabian government is currently focusing on improving the services related to medical care while enhancing the public awareness and knowledge regarding their health status. In addition, under Vision 2030, the Saudi Public Health Authority will endeavor to improve the framework and manage healthcare facilities.[11] In addition, efforts to understand the status of various patient groups co-existing conditions and risk factors are increasing to achieve better disease management and outcomes. As a result, various community screening programs and surveillance systems for chronic diseases were established in Saudi Arabia.[12–14]

This study aims to explore sociodemographic and behavioral status, and other comorbid conditions in adult participants with HC in Saudi Arabia and to compare it to the general population.

Materials and Methods

Design

This study is a secondary analysis of data from the Sharik Health Indicators Surveillance System (SHISS) (first and second quarters of 2021). SHISS consists of cross-sectional phone interviews conducted in all 13 administrative regions of Saudi Arabia on a continuous quarterly basis.[12] Each interview was approximately 4–6 minutes long and was conducted by a trained data collector. SHISS uses the ZdataCloud research data collection system to record and manage the data,[15] which also integrates eligibility and sampling modules, to control the sample's eligibility, distribution and prevent human-related sampling bias.[15] All questions had to be completed for the response to be successfully submitted to the database. All data were coded and stored in the ZdataCloud database and linked to the data collectors to also monitor their data recording quality.[15]

Sampling and Sample Size

The SHISS proportional quota sampling method was used to obtain an equal distribution of participants, stratified by age and gender, within and across the 13 administrative regions of the Kingdom of Saudi Arabia. SHISS uses two age groups (18–36 and 37+) in its quota sampling based on the Saudi Arabian median age of 36 years, generating 52 strata (4 strata in each region).

The sample size in the SHISS was calculated based on the medium effect size of approximately 0.25 with 80% power and a 95% confidence level to provide sufficient power for comparison between regions and sampling quotas.[16] Thus, each quota required at least 134 participants, and a total sample of 536 per region, to form a total of 6968 participants/quarterly wave. The quota sampling is an automated process with no human interference, as the sampling process is controlled automatically by ZdataCloud.[15] Once the quota sample was reached, participants with similar characteristics were not eligible to participate in the study.

Participants and Recruitment

Participant recruitment was limited to Arabic-speaking Saudi residents who were ≥18 years old. Random phone numbers were generated from Sharik Association for Health Research (SAHR) to identify potential participants.[17] The Sharik database is composed of individuals who are interested in participating in future research projects and provided consent to be contacted for participation in research projects. It contains a growing number of registered participants, having reached more than 160,000 distributed across the 13 regions of Saudi Arabia.[17] Participants were contacted by phone on up to three occasions. If they did not respond, a new number with similar demographics was generated from the database until the quota was completed and closed automatically. After obtaining consent to participate, the interviewer assessed the eligibility of the participants, based on the above-mentioned quota completion criteria. As the ZdataCloud approached the quota after achieving the targeted sample, and as there was a group of phone call attempts happening simultaneously, on some occasions more than one participant could pass the eligibility process, and there may be a sample increase in some of the quotas above the targeted sample which leads to a slightly larger sample size in some quotas.

Questionnaire Design and Validation

After providing verbal consent, participants were asked about their age to determine eligibility. Then, the data collector recorded the participant's age, gender, and region. Next, major chronic diseases and their major behavioral and intermediate risk factors, as suggested by the WHO and the Centers for Disease Control and Prevention (CDC) were collected.[18,19] As shown in the SHISS data model (Figure 1), the dataset includes behavioral risk factors (diet, physical activity, and tobacco use, including cigarettes, water pipes, and e-cigarettes), diagnosed on-treatment intermediate risk factors (hypertension and HC) and obesity measured as a body mass-index (BMI) using height and weight. Finally, diagnosed major chronic diseases, in which the participants were currently receiving treatment for, including diabetes, heart disease, stroke, cancer, and chronic respiratory disease. For the major chronic diseases and intermediate risk factors, the interviewer will ask the participants if they have been diagnosed by a doctor with the condition (eg, HC), if the participant answers Yes, then the interviewer will confirm by asking if they are currently receiving treatment for the disease, if Yes the condition will be recorded. Moreover, the existence of diagnosed genetic diseases was also recorded as a nonmodifiable risk factor. In 2021, SHISS introduced new variables including income and education level and depression screening using Patient Health Questionnaire-2 (PHQ-2).[20]

Participants were asked to provide their height in cm and weight in kg. Then, we calculated participants' body mass indices (BMIs). BMI was calculated using the following formula: BMI = (Weight (kg))/(Height^2 (m^2)).

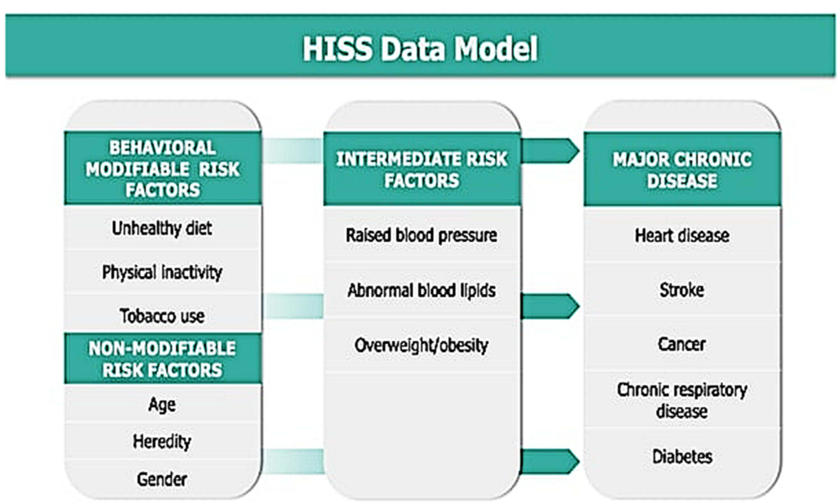

Figure 1 Health Indicators Surveillance System (HISS) data model.
Note: Reproduced with permission from Sharik Health.[21]

We used the (CDC) BMI category status in kg/m^2 (Underweight: <18.5, Normal Weight: 18.5–24.9, Overweight: 25.0–29.9, Obese: ≥30.0).[22] The WHO's global recommendations on physical activity for adults (18–64 years old) were used: (1) Vigorous Intensity Physical Activity (VIPA), 75 min per week, or (2) Moderate Intensity Physical Activity MIPA, 150 min per week.[23] Based on participants' self-reported responses to the interview questionnaire (ie, number of exercise minutes, frequency, and intensity level per week), two categorical outcome variables were created that reflected whether or not guidelines were met. An Acceptable Level of Physical Activity (ALPA) (at least 150 min of MIPA per week and/or at least 75 min of VIPA per week) and a Low Level of Physical Activity (LLPA) (<150 min of MIPA and/or <75 min of VIPA).

For diet, we asked participants about their daily fruit and vegetable intake. If a participant's daily food intake included at least one portion of fruit and one portion of vegetables, they were categorized as having an Acceptable Level of Fruit and Vegetable Intake (AFVI). If not, they were categorized as having a Low Level of Fruit and Vegetable Intake (LFVI). For depression screening using PHQ-2, a cut-off score ≥3 was used.[20]

Statistical Analysis

Descriptive statistics were used to describe prevalence. Quantitative variables are presented herein by mean and SD values if they have a normal distribution, or median and range, as appropriate. Categorical variables are presented as percentages and confidence intervals (CIs) and are compared using the Pearson Chi-squared test. As this study used an electronic data collection with submission completion checks, there were no missing values; the ZdataCloud also includes a data integrity check to prevent users from entering invalid data (eg, the maximum age is between 18 and 99) and improve the data quality.[15] A backward maximum likelihood logistic regression model including all the variables was used to identify variables that are currently associated with HC status. The results have been reported according to the checklist for cross-sectional studies, Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[24]

Ethical Considerations

The ethics committee of the Sharik Association for Health Research approved this research project (Approval no. 2021–2) in accordance with regulations on national research ethics. Participant consent was obtained verbally during phone interviews with the participants and was recorded in the data collection system; no audio recording took place in this study. We confirm that this study complies with the Declaration of Helsinki.

Results

Out of 20,492 potential participants contacted in quarters 1 and 2 of 2021, 14,007 completed the interview from all 13 administrative regions of Saudi Arabia, with a response rate of 68.3% and successful quota sampling. Table 1 shows the demographic distribution by cholesterol status (normal vs hypercholesterolemia).

Table 1 shows the prevalence of HC and the sociodemographic characteristics of adults' Saudi residence with either normal cholesterol levels or HC. The prevalence of HC was 11.9%.

Table 2 shows crosstab results between behavioral risk factors, intermediate risk factors and other chronic diseases with HC.

As shown in Table 2, some of the bivariate associations were statistically significant, and some subgroups had very high estimates of HC prevalence. However, a multi-variate analysis to account for multiple factors is presented in Table 3.

Table 1 Comparison of Sociodemographic Characteristics of Adults' Saudi Residence with and without Hypercholesterolemia

Variables	Hypercholesterolemia Status, n (%)		Total, n (%)	*P* value, Chi Square
	Yes	No		
Gender				<0.001
Male	907 (12.92)	6112 (87.08)	7019 (50.1)	
Female	766 (10.96)	6222 (89.04)	6988 (49.9)	

(*Continued*)

Table 1 (Continued).

Variables	Hypercholesterolemia Status, n (%)		Total, n (%)	*P* value, Chi Square
	Yes	No		
Age Groups (Years)				<0.001
18–19	11 (1.55)	698 (98.45)	709 (5.1)	
20–29	150 (3.21)	4522 (96.79)	4672 (33.4)	
30–39	180 (6.41)	2629 (93.59)	2809 (20.1)	
40–49	500 (15.87)	2650 (84.13)	3150 (22.5)	
50–59	445 (25.68)	1288 (74.32)	1733 (12.4)	
60+	387 (41.43)	547 (58.57)	934 (6.7)	
Regions				0.030
Asir	156 (14.44)	924 (85.56)	1080 (7.7)	
Baha	120 (11.09)	962 (88.91)	1082 (7.7)	
Eastern region	102 (9.43)	980 (90.57)	1082 (7.7)	
Hail	119 (10.99)	964 (89.01)	1083 (7.7)	
Jazan	102 (9.41)	982 (90.59)	1084 (7.7)	
Al Jouf	130 (12.03)	951 (87.97)	1081 (7.7)	
Madinah	137 (13.09)	910 (86.91)	1047 (7.5)	
Makkah	148 (13.68)	934 (86.32)	1082 (7.7)	
Najran	109 (10.41)	938 (89.59)	1047 (7.5)	
Northern borders	98 (9.04)	986 (90.96)	1084 (7.7)	
Qassim	139 (12.82)	945 (87.18)	1084 (7.7)	
Riyadh	183 (16.80)	906 (83.20)	1089 (7.8)	
Tabuk	130 (12.01)	952 (87.99)	1082 (7.7)	
Education				<0.001
Less than a bachelor's degree	1011 (14.35)	6032 (85.65)	7043 (50.3)	
Bachelor's degree or above	662 (9.51)	6302 (90.49)	6964 (49.7)	
Monthly Income (SAR)				<0.001
No stable monthly Income	129 (8.89)	1322 (91.11)	1451 (10.4)	
Less than 5000	481 (8.59)	5121 (91.41)	5602 (40.0)	
5001–11,000	482 (13.16)	3181 (86.84)	3663 (26.2)	
More than 11,000	581 (17.65)	2710 (82.35)	3291 (23.4)	
Grand Total	**1633**	**12,374**	**14,007**	

Notes: Data are presented as number (percent); Chi^2 test. *P*-value ≤0.05 is considered statistically significant.
Abbreviation: SAR, Saudi Arabian riyal.

Table 2 Behavioral, Intermediate Risk Factors and Chronic Diseases by Cholesterol Status (n = 14,007)

Variables	HC status		Total, n (%)	*P* value, Chi Square
	Yes	No		
Fruit and Vegetable Intake				<0.001
AFVI	134 (21.24)	497 (78.76)	631 (4.5)	
LFVI	1539 (11.51)	11,837 (88.49)	13,376 (95.5)	
Physical Activity				0.205
ALPA	299 (11.23)	2364 (88.77)	2663 (19.0)	
LLPA	1374 (12.11)	9970 (87.89)	11,344 (81.0)	
Cigarette Smoking				0.015
Never	1330 (11.57)	10,163 (88.43)	11,493 (82.1)	
Yes, daily	226 (13.61)	1435 (86.39)	1661 (11.9)	
Yes, occasionally	117 (13.72)	736 (86.28)	853 (6.1)	
Water-Pipe Smoking				0.032
Never	1442 (11.81)	10,765 (88.19)	12,207 (87.1)	
Yes, daily	96 (15.24)	534 (84.76)	630 (4.5)	
Yes, occasionally	135 (11.54)	1035 (88.46)	1170 (8.4)	
E-Cigarette Smoking				0.535
Never	1536 (12.00)	11,265 (88.00)	12,801 (91.4)	
Yes, daily	53 (10.37)	458 (89.63)	511 (3.6)	
Yes, occasionally	84 (12.09)	611 (87.91)	695 (5.0)	
Hypertension				<0.001
Yes	824 (47.9)	898 (52.1)	1722 (12.3)	
No	849 (6.9)	11,436 (93.1)	12,285 (87.7)	
Diabetes				<0.001
Yes	733 (44.9)	900 (55.1	1673 (11.9)	
No	940 (7.6)	11,434 (92.4)	12,334 (88.1)	
BMI Category				<0.001
Underweight	20 (2.65)	736 (97.35)	756 (5.4)	
Normal	378 (6.66)	5301 (93.34)	5679 (40.5)	
Overweight	648 (14.35)	3868 (85.65)	4516 (32.2)	
Obese	627 (20.52)	2429 (79.48)	3056 (21.8)	
Heart Disease				<0.001
Yes	309 (51.85)	287 (48.15)	596 (4.3)	
No	1364 (10.17)	12,047 (89.83)	13,411 (95.7)	

(*Continued*)

Table 2 (Continued).

Variables	HC status		Total, n (%)	*P* value, Chi Square
	Yes	No		
Stroke				<0.001
Yes	71 (42.01)	98 (57.99)	169 (1.2)	
No	1602 (11.58)	12,236 (88.42)	13,838 (98.8)	
Cancer				<0.001
Yes	57 (31.49)	124 (68.51)	181 (1.3)	
No	1616 (11.69)	12,210 (88.31)	13,826 (98.7)	
Chronic Respiratory Disease				<0.001
Yes	183 (19.2)	772 (80.8)	955 (6.8)	
No	1490 (11.4)	11,562 (88.6)	13,052 (93.2)	
Genetic Diseases				<0.001
Yes	212 (30.0)	495 (70.0)	707 (5.0)	
No	1461 (11.0)	11,839 (89.0)	13,300 (95.0)	
Risk of Depression				<0.001
Yes	378 (14.34)	2258 (85.66)	2636 (18.8)	
No	1295 (11.39)	10,076 (88.61)	11,371 (81.2)	

Notes: Data are presented as number (percent); Chi^2 test. *P*-value ≤0.05 is considered statistically significant.

Table 3 Odds Ratio (OR) and 95% Confidence Interval (CI) for Hypercholesterolemia According to Behavioral, Intermediate Risk Factors and Chronic Diseases

Variable	OR	95% CI for Exp(B)		Sig.
		Lower	Upper	
Age	1.037	1.032	1.041	0.001
Region (Northern Borders)				
Al Jouf	1.296	0.938	1.791	0.116
Tabuk	1.438	1.042	1.984	0.027
Hail	1.182	0.852	1.639	0.316
Madinah	1.363	0.989	1.879	0.059
Qassim	1.319	0.958	1.815	0.090
Makkah	1.364	0.991	1.877	0.057
Riyadh	2.051	1.510	2.786	<0.0001
Eastern Region	0.951	0.678	1.334	0.771
Baha	1.324	0.956	1.833	0.092

(*Continued*)

Table 3 (Continued).

Variable	OR	95% CI for Exp(B)		Sig.
		Lower	Upper	
Asir	1.507	1.096	2.071	0.012
Jazan	0.865	0.614	1.218	0.406
Najran	1.157	0.829	1.614	0.391
Monthly Income (SAR) No stable monthly income				
Less than 5000	0.960	0.758	1.216	0.738
5001–11,000	1.137	0.896	1.443	0.291
More than 11,000	1.253	0.989	1.586	0.062
AFVI (Yes)	1.265	0.990	1.616	0.060
Depression (yes)	1.242	1.068	1.445	0.005
Diabetes (yes)	3.393	2.945	3.908	<0.0001
Hypertension (Yes)	4.138	3.599	4.757	<0.0001
Genetic diseases (Yes)	1.684	1.359	2.087	<0.0001
Heart disease (Yes)	2.757	2.227	3.414	<0.0001
BMI Category (Underweight)				
Normal	1.470	0.907	2.383	0.118
Overweight	2.378	1.471	3.845	<0.0001
Obese	2.891	1.784	4.687	<0.0001

Abbreviation: SAR, Saudi Arabian riyal.

The backward maximum likelihood logistic regression model including all the variables eliminated the education, smoking (all types), physical activities, and gender from the model. In addition, income level and AFVI were not significant.

However, the model showed that participants living with HC in Saudi Arabia were associated with more likelihood of being older, living in Tabouk, Riyadh, or Asir regions, being overweight or obese, having diabetes, hypertension, genetic or heart diseases, or a risk of depression.

Discussion

This study aims to explore sociodemographic and behavioral status, and other comorbid conditions in adult participants with HC in Saudi Arabia and to compare it to the general population. The current research work was done using secondary data obtained from the Sharik Health Indicators Surveillance System (SHISS), which was carried out in a nation-wide cross-sectional survey study. SHISS is similar to the Behavioral Risk Factor Surveillance System (BRFSS) in the United States, which collected self-reported health indicators using phone-interviews carried out by the CDC.[25,26] The results of this study revealed the current situation of participants living with HC and on-treatment. Unlike previous studies that sought HC risk factors, the findings of this study focused on the factors associated with HC diagnosis and treatment. It may aid practitioners in screening for and managing associated factors in order to improve HC treatment outcomes.

This nation-wide study found that 11.9% of Saudi residents were diagnosed and on-treatment for HC. Other self-reported studies in various cities in Saudi Arabia found almost similar prevalence of people who are aware of having HC. For example, in the Al-Kharj city 12.5%,[27] and Hofuf city 13.8%.[28] However, for such a silent condition, the real prevalence might be higher while many people are not aware of having HC and not yet diagnosed. In the Saudi World Health Survey 2019, which screened people for raised cholesterol levels via lab test, the prevalence of raised cholesterol levels was 43%.[13] In addition, not all people who have raised cholesterol levels need treatment. Thus, it is important to differentiate between these three groups in reporting the results of studies related to raised cholesterol levels. Nevertheless, due to high prevalence of raised cholesterol levels, screening for HC in Saudi Arabia in routine health checkup needs to be evaluated for cost-effectiveness and the outcomes of early diagnoses.

Some of the known risk factors for HC such as smoking and physical activity were eliminated from the regression model in this study, potential explanations are Unlike, individuals who are not yet diagnosed the risk factors are existing and contributing to the development of the disease, people who are diagnosed and on-treatment are likely have changed their lifestyle and might also tried different behavioral interventions to improve their healthy lifestyle. Similarly, healthy diet was not significant in the regression model and might go under the previous explanation.

This study has both strengths and limitations. Some primary strengths include that it is a population-based, nation-wide study design with a large sample and data quality. However, because it is cross-sectional in nature, causation cannot be determined. It is not possible to determine trends from this study, so it is not apparent whether HC is increasing or decreasing. The main limitation was that hypercholesterolemia was self-reported. Unfortunately, this may have resulted in bias in the study.

Conclusions

This study explored the status of HC and its associated factors in Saudi Arabia. The study reported that 11.9% of the participants had HC and on-treatment. This study described the status of participants living with HC in Saudi Arabia and identified some co-existing conditions that may affect the progression of the disease and participants quality of life. This information could assist care providers in identifying patients who are at higher risk, improve screening efficiency, improve disease progression and quality of life.

Data Sharing Statement

Data are available from the Sharik Association for Research and Studies upon request.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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