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Prevalence of Coronary Artery Disease among Adults in Nepal

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ABSTRACT

Background: Coronary Artery Disease is a leading cause of death and a major disorder affecting the heart and blood vessels. The aim of this study is to estimate the prevalence of Coronary Artery Disease and its associated risk factors in Nepal.

Methods: This population-based descriptive cross-sectional survey involved 12,557 participants aged 20 years and older, selected through a multistage stratified cluster sampling method. Data on demographics and risk factors were collected via face-to-face interviews, physical examinations, and laboratory tests. The association of different variables with Coronary Artery Disease outcomes was assessed using descriptive statistics.

Results: The prevalence of definite Coronary Artery Disease among Nepalese adults aged 20 years and older was found to be 0.5% (95% CI: 0.3-0.7). Possible Coronary Artery Disease had a prevalence of 2.1% (95% CI: 1.6-3.4), and probable Coronary Artery Disease had a prevalence of 0.3% (95% CI: 0.2-0.4). Higher prevalence rates were observed among older individuals, urban residents, those with higher education levels, males, and participants with hypertension, diabetes, and elevated total cholesterol levels.

Conclusion: This study represents the first comprehensive national population-based assessment of Coronary Artery Disease in Nepal. The findings indicate a significant burden of Coronary Artery Disease and its risk factors among the adult population. Addressing the high prevalence of Coronary Artery Disease and its risk factors requires both individual and population-level interventions.

Keyword: Coronary arterial disease; Nepal; prevalence.

INTRODUCTION

Cardiovascular disease (CVD), particularly Coronary Artery Diseases (CAD) and stroke, continues to be the predominant cause of global mortality and a significant contributor to disability, resulting in an estimated 18.6 million deaths in 2019.[1] The burden of CAD is notably higher (80%) in low- and middle-income countries with majority deaths occurring at younger ages.[2-4] Atherosclerosis, a progressive arterial disease, serves as the primary underlying cause of cardiovascular conditions.[5] In Nepal, CVDs contributed 26.9% of total deaths.[6] Multiple risk factors such as hypertension, hypercholesterolemia, high BMI, diabetes mellitus, smoking, physical inactivity, and aging contribute significantly to CAD.[6, 7] In countries like Nepal, the prevalence of these risk factors is high and projected to increase, impacting the healthcare system and resulting in social and economic consequences. [8-14] Timely diagnosis of CAD is a cornerstone of preventive cardiology. This paper aims to provide nationally representative CAD prevalence in Nepal.

METHODS

A comprehensive population-based survey entitled "The population based prevalence of selected non-communicable diseases in Nepal" was conducted from 2016 to 2018 in Nepal. This study aimed to investigate the prevalence of various non-communicable diseases, such as CAD, chronic obstructive pulmonary disease, chronic

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kidney disease, and Diabetes mellitus. The methodology details were already published.[15-17] However, in brief, a multi-staged stratified cluster sampling method was used to obtain a nationally representative sample of the general Nepalese population from all over the seven provinces of Nepal. The target population included residents aged 20 years and above, residing for at least six months in a given district of Nepal. One adult per household was selected using the Kish method, developed by Leslie Kish in 1949. Participants were excluded from the survey if they had serious physical or mental illnesses which was confirmed by the enumerators from head of the household or through the documents given by the doctors. Considering 4% prevalence of raised blood glucose, three ecological belts as domains, the design effect of 1.5, and a 20% non-response rate, sample size came out to be 13,200 individuals,. Of these, 12,557 responded, yielding a 95.1% response rate.

Data were collected from 400 clusters spanning over 72 districts and seven provinces of Nepal. Trained health professionals conducted face-to-face interviews at participants' homes over two days. On the first day, they gathered information on participants' demographics, behaviors (such as smoking and drinking), medical history, family medical history, and history of stroke and chronic diseases like diabetes, hypertension, dyslipidemia, and myocardial infarction (MI). On the second day, physical measurements and laboratory tests, including height, weight, blood pressure, fasting blood glucose, lipid profile, and electrocardiogram (ECG), were carried out. The shorter version of the Rose/WHO questionnaire 17 was used to document the past medical history of angina as well as the history and documents related to MI, definite angina, coronary artery bypass grafting (CABG) surgery, noninvasive investigations for CAD, coronary angiography, and coronary angioplasty were collected including the documented use of drugs for CAD and hospitalization due to CAD.

Anthropometric measurements were taken following the WHO standard protocols. The measurements included:

Measured in kilograms using an adult portable digital weighing scale (seca® 874, seca, Germany).

Measured in centimeters using a portable stature meter (Bioplus®, India).

Measured using a constant tension tape (seca, Germany) to the nearest 0.1 centimeter.

After obtaining these measurements, the Body Mass Index (BMI) was calculated as the ratio of weight (in kilograms) to height (in meters) squared. The BMI values were then categorized into three groups

The CAD is outcome variable of the study which is defined as the combination of past history of documented myocardial infarction (MI), an affirmative response to the Rose questionnaire and ECG abnormalities. CAD was classified into three groups: possible, probable, and definite CAD. Definite CAD was defined as having a documented history of chest pain suggestive of angina or infarction, or previously diagnosed CAD including self-reported admission for MI, percutaneous coronary angioplasty (PCI), or coronary artery bypass grafting (CABG). Probable CAD was characterized by the presence of both Rose angina and ECG changes indicative of CAD, such as inferior, anterior septal, anterior lateral, or extensive anterior Q/QS waves, elevated or depressed ST segments, or inverted T waves. Possible CAD was determined by an affirmative response to the Rose questionnaire, after excluding any obvious local causes of pain.

Selected cardiovascular biochemical profiling included assessments of fasting blood glucose levels, total cholesterol, triglycerides (TG), high-density lipoprotein (HDL), low density cholesterol, and serum creatinine, drawn from participants after 10–12 hours of fasting. A postprandial (PP) sample taken two hours after a meal was used to measure PP blood glucose. Blood glucose and lipid profile were carried out using a semi-automatic biochemistry analyzer (biolyzer® 100 Clinical Chemistry Analyzer, Germany).[18]

Elevated total cholesterol was diagnosed when total cholesterol levels were ≥ 190 mg/dL. Diabetes mellitus (DM) was diagnosed with fasting blood glucose levels ≥ 126 mg/dL, postprandial blood glucose levels ≥ 200 mg/dL, or the current use of diabetes medication.

Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using an electronic device (model HEM-8712, Omron Health Care Co., Ltd, Japan) according to a standardized protocol with an appropriately sized cuff as per the participant's arm. Three readings were taken 3 minutes apart, and the average of the two closest readings was calculated as the final blood pressure reading. Hypertension was defined as SBP ≥ 140 mm Hg, DBP ≥ 90 mm Hg, and/or self-reported current treatment for hypertension.

A standard resting 12-lead ECG and a rhythm strip were recorded for all participants by well-trained field researchers using a standardized procedure. First, a 12-lead ECG was taken in a resting supine position, with

respect for the participants' privacy. The electronic ECGs collected in the electrocardiographs were regularly sent over the NHRC server for analysis. ECG recordings were visually inspected for technical errors and poor quality. Subsequently, the ECGs were evaluated and classified using the Minnesota coding system. These evaluations were performed by an experienced consultant cardiologist licensed by the Nepal Medical Council, in accordance with Minnesota criteria.

The following covariates were investigated for their association with CAD in Nepal: socio-demographic variables including age (categorized as 20-39, 40-59, and 60+ years), sex (male, female), education (illiterate/no formal schooling, below secondary school, and secondary school and above), place of residence (rural, urban), ethnicity (self-reported and categorized into six groups: upper caste group, disadvantaged Janajatis, relatively advantaged Janajatis, disadvantaged non-Dalit Terai caste, Dalit, and religious minorities), and province of residence (Koshi, Madhesh, Bagmati, Lumbini, Gandaki, Karnali, Sudurpashchim). Health and lifestyle variables included smoking status (smoker, non-smoker including former smokers), BMI (underweight, normal weight, overweight, and obese), and alcohol consumption (participants who consumed alcohol in the past 30 days were categorized as alcohol consumers).

Data were collected electronically using Android phones equipped with a software named Research and monitoring (REMO) software. ECG readings were sent to a consultant cardiologist for CAD confirmation and categorized. These were integrated with the main dataset and checked for completeness and consistency. Data analysis was conducted using STATA version 13, adjusting for unequal selection probability and non-response with sampling weights. Descriptive analyses included relative frequencies of CAD prevalence with 95% confidence intervals. Associations between categorical variables were assessed using the Chi-square or Fisher's exact test as appropriately.

The study adhered to the principles of the Declaration of Helsinki and received ethical approval from the Ethical Review Board of Nepal Health Research Council (Approval No. 110/2016). Written informed consent was obtained from each participant prior to data collection.

RESULTS

A total of 12,557 participants aged 20 and above were enrolled in this study. The majority of participants were female (57.9%), adults aged 20-59 years (41.3%), and belonged to the upper caste group (32.7%). Additionally, 53.1% of the subjects were either illiterate or had no formal schooling. Detailed socio-demographic characteristics of the study population are presented in Table 1.

Table 1. Distribution of the participants as per the socio-demographic characteristics.

Characteristics	n=12557	%
Age in years, mean (SD)		
20-39	4562	35.5
40-59	5186	41.3
60 years and above	2809	23.3
Sex		
Male	4908	42.2
Female	7649	57.9
Ethnicity		
Upper caste group	4263	32.7
Disadvantaged janjati	2656	20.7
Relatively advantaged janjati	2077	17.0
Disadvantaged non-dalitterai caste	1900	17.0
Dalit	1298	9.6
Religious minorities	363	2.9
Education level		
Illiterate/No formal schooling	6820	53.1
Below secondary (<10 years)	2839	22.3
Secondary and above (≥10 years)	2898	24.6
Provinces		
Koshi	2185	17.6
Madesh	2083	18.4
Bagmati	3223	24.7
Gandaki	1337	9.6
Lumbani	2070	15.9
Karnali	601	4.8
Sudurpaschim	1058	9.1
Place of residence		
Rural	6300	48.5
Urban	6257	51.5

The overall prevalence of coronary artery disease (CAD) among Nepalese adults aged 20 years and older, including all categories—possible, probable, and definite—is 2.9%. This breaks down into 2.1% for possible CAD (positive Rose Angina Questionnaire), 0.3% for probable CAD (positive Rose Questionnaire and ECG abnormality), and

0.5% for definite CAD (history of or documented myocardial infarction)

Definite CAD was more common among older adults, males, those with secondary education or higher, residents of Bagmati province, urban dwellers, religious minorities, smokers, individuals with hypertension, those who are overweight or obese, those with high cholesterol, and those with diabetes. Probable CAD was more frequent in older adults, females, Dalits, those who are illiterate or have no formal schooling, residents of Sudurpaschim province, rural dwellers, smokers, those with hypertension, underweight individuals, those with high cholesterol, non-diabetics, and alcohol users. Possible CAD was more common among older adults, females, those who are illiterate or have no formal schooling, residents of Gandaki province, rural dwellers, smokers, underweight individuals, alcohol users, those with high cholesterol, those with increased waist-to-hip ratio, and non-diabetics. (Table 2). In the unadjusted analysis, there were moderately to highly significant differences in CAD status (Table 2 and 3) for age, gender, education, and ethnicity, place of residence, hypertension, raised total cholesterol and DM. However, no significant difference was reported in the prevalence of probable, possible and definite CAD between gender, provinces, BMI, smoking status, WHR and alcohol consumption.

Table 2. Prevalence of Coronary Artery Diseases by category and socio-demographic characteristic among the respondents.

Characteristics		Normal		Possible		Probable		Definite		p- value
	n	%	95% CI	%	95% CI	%	95% CI	%	95% CI	
Age categories										
20-39	4562	97.9	97.4-98.4	1.7	1.3-2.2	0.2	0.1-0.4	0.2	0.1-0.4	0.001
40-59	5186	97.3	96.7-97.8	2.1	1.7-2.7	0.2	0.1-0.4	0.3	0.2-0.6	
60 years and above	2809	95.6	94.6-96.5	2.8	2.1-3.7	0.4	0.2-0.8	1.2	0.8-1.8	
Gender										
Male	4908	97.6	97.0-98.1	1.6	1.2-2.1	0.2	0.1-0.4	0.6	0.4-0.9	0.009
Female	7649	96.8	96.1-97.4	2.5	2.0-3.1	0.3	0.2-0.5	0.4	0.2-0.7	
Ethnicity										
Dalit	1298	96.5	94.9-97.6	2.6	1.7-3.8	0.7	0.3-1.5	0.2	0.1-0.8	0.007
Disadvantaged Janajati	2656	96.4	95.5-97.2	2.7	2.0-3.6	0.4	0.3-0.8	0.5	0.3-0.9	
Disadvantaged non Dalit Terai	1900	97.3	95.0-98.5	2.7	1.4-5.0	-	-	0.1	0.0-0.5	
Religious minorities	363	96.1	92.4-98.0	2.3	1.0-5.1	0.4	0.1-1.8	1.2	0.3-4.5	
Relatively advanтaged janajati	2077	97.6	96.6-98.3	1.7	1.1-2.5	-	-	0.7	0.4-1.3	
Upper caste	4263	97.6	96.9-98.1	1.6	1.2-2.1	0.3	0.1-0.5	0.6	0.4-1.0	
Education level										
Illiterate/no formal schooling	6820	96.3	95.4-97.0	2.9	2.3-3.7	0.4	0.2-0.6	0.5	0.3-0.7	0.001
Below secondary (<10 years)	2839	97.7	97.1-98.3	1.6	1.1-2.2	0.3	0.1-0.6	0.4	0.2-0.8	
Secondary and above (≥10 years)	2898	98.5	97.8-99.0	1.0	0.6-1.5	-	-	0.6	0.3-1.0	
Province										
Koshi Province	2185	97.0	95.9-97.8	2.3	1.6-3.4	0.1	0.0-0.4	0.6	0.3-1.1	0.272

Table 2. Prevalence of Coronary Artery Diseases by category and socio-demographic characteristic among the respondents.										
Characteristics		**Normal**		**Possible**		**Probable**		**Definite**		**p- value**
Madhesh province	2083	97.2	95.2-98.4	2.4	1.3-4.5	0.2	0.1-0.4	0.2	0.1-0.7	
Bagmati province	3223	97.0	96.1-97.6	1.9	1.4-2.6	0.3	0.1-0.5	0.9	0.5-1.5	
Gandaki Province	1337	96.4	94.3-97.8	2.6	1.6-4.3	0.4	0.1-1.2	0.6	0.3-1.2	
Lumbini province	2070	97.7	96.7-98.4	1.8	1.2-2.8	0.4	0.2-0.8	0.1	0.0-0.4	
Karnali Province	601	99.2	94.9-99.9	0.8	0.1-5.1	-	-	-	-	
Sudurpaschim Province	1058	96.4	93.9-97.9	2.4	1.5-3.9	0.6	0.3-1.4	0.6	0.2-1.9	
Region type										
Rural	6300	97.2	96.5-97.9	2.3	1.8-3.1	0.3	0.2-0.5	0.1	0.1-0.2	0.001
Urban	6257	97.1	96.3-97.6	2.0	1.5-2.6	0.2	0.1-0.3	0.8	0.6-1.2	
Total	**12557**	**97.1**	**96.6-97.6**	**2.1**	**1.8-2.6**	**0.3**	**0.2-0.4**	**0.5**	**0.3-0.7**	

Table 3. Prevalence of Coronary Artery Diseases by category and bio-behavioral characteristics of the participants.										
Characteristics		**Normal**		**Possible**		**Probable**		**Definite**		**p- value**
	% (95% CI)	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	**%**	**95% CI**	
Smoking habit(n=12557)										
Non smoker	68.1(66.5-69.7)	97.25	96.6-7.79	2.1	1.6-2.7	0.2	0.2-0.4	0.4	0.3-0.6	0.600
Smokers	31.9(30.3-33.5)	96.9	96.2-97.5	2.2	1.7-2.8	0.3	0.2-0.5	0.6	0.4-1.0	
Alcohol consumption(n=12557)										
No	75.4(73.7-77.02)	97.2	96.6-97.7	2.1	1.6-2.6	0.2	0.2-0.4	0.5	0.4-0.8	0.385
Yes	24.6(22.98-26.3)	97.0	96.2-97.7	2.3	1.8-3.1	0.3	0.2-0.6	0.3	0.1-0.7	
Blood pressure(n= 12557)										
Normal	63.1(61.6-64.6)	97.3	96.7-97.9	2.1	1.7-2.7	0.2	0.1-0.4	0.3	0.2-0.6	0.038
Raised*	36.9(35.4-38.5)	96.8	96.1-97.4	2.1	1.7-2.7	0.3	0.2-0.5	0.7	0.5-1.1	
Body mass index (n=12556)										
Normal	57.0(55.6-58.5)	97.1	96.4-97.7	2.2	1.7-2.8	0.2	0.1-0.4	0.4	0.3-0.7	0.215
Underweight	12.3(11.3-13.4)	97.3	96.3-98.0	2.4	1.7-3.2	0.3	0.1-0.8	0.1	0.0-.7	
Overweight and obese	30.7(28.9-32.5)	97.1	96.4-97.7	1.9	1.5-2.5	0.2	0.1-0.5	0.7	0.4-1.1	
Total cholesterol (n=10861)										
Normal	71.2(69.6-72.7)	97.6	97.0-98.0	1.8	1.4-2.2	0.2	0.1-0.4	0.4	0.3-0.7	0.033
Raised	28.8(27.3-30.4)	96.3	95.1-97.2	2.7	1.9-3.9	0.4	0.2-0.7	0.6	0.4-1.1	
Waist hip ratio(n= 11997)										
Normal	44.4(43.3-46.1)	97.6	97.0-98.1	1.8	1.4-2.3	0.2	0.1-0.4	0.5	0.3-0.8	0.068
Increased	55.3 (53.9-56.7)	96.7	96.0-97.3	2.5	2.0-3.1	0.3	0.2-.5	0.5	0.3-.8	
Diabetes Mellitus (n=11277)										
No	91.5(90.7-92.2)	97.2	96.7-97.7	2.1	1.7-2.7	0.3	0.2-0.4	0.4	0.2-0.5	0.001
Yes	8.5(7.8-9.3)	96.3	94.4-97.6	1.9	1.1-3.3	0.1	0.0-0.9	1.7	1.0-2.9	

*Raised blood pressure is defined as sytolic≥140 and or Diasystolic≥90mmhg

Table 3 shows the CAD according to risk factors among the study participants. A higher number of participants had these risk factors: 31.9% of participants smoked, with 2.2% having possible CAD, 0.3% having probable CAD, and 0.6% having definite CAD. Additionally, 24.6% of participants had a history of alcohol consumption, with 2.3% having possible CAD, 0.3% having probable CAD, and 0.3% having definite CAD. Furthermore, 36.9% of participants had high blood pressure, with 2.1% having possible CAD, 0.3% having probable CAD, and 0.7% having definite CAD. Participants who were overweight or obese had a 1.9% of possible CAD, a 0.2% of probable CAD, and a 0.7% of definite CAD. Among participants with diabetes, 1.9% had possible CAD, 0.1% had probable CAD, and 1.7% had definite CAD. Finally, participants with high total cholesterol had a 2.7% of possible CAD, a 0.4% of probable CAD, and a 0.6% of definite CAD.

DISCUSSION

This study is the first to provide nationally representative estimates of CAD status and to identify associated risk factors in the general adult population aged 20 years and older in Nepal. Our findings indicate that 0.5% of Nepalese adults aged 20 years or older have definite CAD, with the prevalence of probable CAD at 0.3% and possible CAD at 2.1%. The analysis revealed that age, gender, education, ethnicity, place of residence, hypertension, elevated total cholesterol, and DM were significant factors influencing CAD. Additionally, the study highlighted a high prevalence of CAD risk factors in this population, including DM, hypertension, elevated total cholesterol, overweight/obesity, alcohol consumption, and smoking.

The prevalence of definite CAD in Nepal (0.5% for individuals aged 20 years and older) is lower than in other Asian countries, such as India (3.5% for ages 20-59),[19] Pakistan (5.1% for ages over 40),[20] and Iran (15.7% for ages 35 and older).[21] However, data indicates that the prevalence of CAD in Nepal also increases with age.

Cross-country comparisons of CAD prevalence may be challenging due to the limited number of studies, differences in study settings, sample characteristics, diagnostic methods for CAD, and the tendency to report only overall prevalence without further classification. Previous studies on CAD in Nepal have all been conducted on a small scale, within specific settings, and among subpopulations. One earlier study showed that the prevalence of definite CAD among the urban residents was 2.1%, ≥35 years[22] which was higher than our study, probably due to the urban set up and a higher cut-off of age at 35.

CAD is strongly associated with traditional cardiovascular disease risk factors such as hypertension, diabetes, hypercholesterolemia, and current smoking.[23] In the present study, selected cardio-metabolic risk factors, including elevated blood pressure, high total cholesterol, and DM, were associated with the presence of CAD.[24]

Population ageing is the well-established risk factor of an increasing CAD epidemic. As expected, our study showed an association between age and sex with the prevalence of CAD in unadjusted analysis, and subjects over age 60 had the highest prevalence of CAD and were more prevalent in men. This pattern is consistent with the previous population based research worldwide.[20,25,26] Our study observed a higher prevalence of definite CAD among urban residents compared to rural residents. These findings align with previous reports, suggesting that a sedentary lifestyle, physical inactivity, unhealthy diet, and ambient air pollution may contribute to the increased prevalence of CAD in urban settings.[27,28] Additionally, our unadjusted analysis revealed a positive association between higher educational levels and the prevalence of CAD. However, the associations between smoking, BMI, WHR, and alcohol consumption with CAD were not statistically significant in this study.

This study is the most comprehensive, largest community-based national study to investigate risk factors and CAD, incorporating echocardiographic findings in this region. We utilized various modalities and criteria to detect all possible cases of CAD.

However, there are limitations to our study. Firstly, the cross-sectional nature of the study does not allow for determining causal relationships between CAD and its related factors, necessitating future studies with a prospective design. Secondly, due to the small number of definite CAD cases in our dataset, we could not quantify the independent risk factors of CAD in our final model. Additionally, we did not measure diet and physical activity-related factors, which are known risk factors for CAD.

CONCLUSIONS

This national population-based study highlights the concerning prevalence of CAD and its associated risk factors, such as hypertension and diabetes, which are on the rise. The prevalence of CAD varies by socio-demographic and cardio-metabolic risk factors. Our unadjusted analysis found that older age, male gender, higher education, urban residency, hypertension, diabetes, and elevated total cholesterol were significantly associated with an increased risk of CAD. Given the high prevalence of hypertension, obesity, diabetes, and smoking observed in this study, CAD is likely to continue increasing in the coming years. Therefore, local health systems need to be strengthened, and immediate targeted interventions should be implemented to reduce these traditional risk factors and decrease the overall burden of CAD in Nepal.

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