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Identification of Significant Risk Factors Causing Coronary Heart Disease

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Abstract: Coronary heart disease is a major cause of increasing death rate in developing as well as developed countries in the world. In industrial countries it has more serious impact on human lives. Faisalabad is the third biggest city of Pakistan. It is an industrial city. This paper attempted to identify the significant risk factors associated with coronary heart disease in Faisalabad. A hospital-based, case-control study was conducted in Faisalabad Institute of Cardiology in 2012. A total of 129 cases of coronary artery disease along with 221 controls were studied. Hyperlipidemia (OR=3.55; p<0.001), cold sweating (OR=3.41; p=0.01), Orthopnea (OR=20.56; p<0.001), use of cooking oil instead of ghee (OR=2.55; p<0.05) and angina (OR=196.37; p<0.001) were found significant risk factors for the prevalence of CAD using Wald's statistic and with the help of odds ratios. The risk factors gender (OR=0.79; p = 0.64), family history of CAD (OR=1.86; p = 0.15), hypertension (OR=0.92; p=0.86), diabetes (OR=2.05; p=0.18), smoking (OR=0.73, p=0.50) and age (30-45 years OR=0.76, p=0.66; >45 years OR=0.46, p=0.21) were found insignificant in the studied sample.

Key words: Angina · Coronary Artery Disease · Hyperlipidemia · Hypertension · Orthopnea

INTRODUCTION

The term Atherosclerotic heart disease or coronary artery disease (CAD) is generally related to a pathologic process that affects the coronary arteries. Atherosclerotic heart disease occurs as a result of plague that builds up within the walls of coronary arteries. This plague leads to blockage of blood flow to the heart because arteries become narrow and rigid. As a result there is a deficiency of oxygen and vital nutrients that are required to pump the heart properly [1, 2].

Coronary artery disease (CAD) is a major cause of increasing death rate in industrial countries. The disease is more common in developing countries [1, 3, 4]. United States is at the top of the list of developed countries with higher rate of patients regarding heart diseases. Webber *et al.* [5] has recently investigated the prevalence of coronary and aortic atherosclerosis in the US armed forces [5]. The risk of stroke or heart attack raises up several times, when a person is suffering from high blood pressure along with smoking, obesity and high blood cholesterol or diabetes [6].

Cardiovascular diseases account for a large proportion of all deaths and disability worldwide. Global Burden of Disease (GBD) Study reported that in 1990 there were 5.2 million deaths from cardiovascular diseases in economically developed countries and 9.1 million deaths from the same causes in developing countries [6]. However, whereas about one-quarter of all cardiovascular disease deaths occurred in persons who were less than 70 years of age in the developed world, more than about half of these deaths occurred in those less than 70 years in the developing world [7, 8]. It has been predicted that by the year 2020 there will be an increase by almost 75% in the global cardiovascular disease burden. World Health Organization (WHO) has made recommendations to prevent the people from recurrent heart attacks and strokes in developing and under developed countries [9].

The current article used the logistic regression model to identify the potential risk factors for CAD among a large number of possible risk factors. Also, it explored the odds ratios of different categories of risk factors that can possibly cause coronary artery disease (CAD).

MATERIALS AND METHODS

If X is an explanatory variable, Y is the binary response and π_i denotes the probability of success for a given level of $X=X_i$, then the logistic regression model is given by

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$$E(Y_i \mid X_i) = \pi_i = \frac{\exp(\beta_0 + \beta_1 X_i)}{1 + \exp(\beta_0 + \beta_1 X_i)}$$

$$\ln\left(\frac{\pi_i}{1-\pi_i}\right) = \beta_0 + \beta_1 X_i$$

The potential risk factors among a detailed list were identified using logistic regression analysis. At first stage, a series of univariate logistic regression was performed by taking each risk factor individually and independently to observe its effect on the prevalence of CAD. At second stage all the risk factors made a part of multiple logistic regression model. The significance of risk factors was identified on the basis of Wald statistic and odds ratios. In case of categorical predictors, first category was taken as the reference category and rest of the categories were compared with this baseline category. The two predictors age and income were observed as metric variables which were later categorized each with three categories for analysis purpose.

DATA: The sample used in the study consisted of the patients who visited Faisalabad Institute of Cardiology, Faisalabad, Pakistan during 2012. It was a case-control study. Our sample consisted of 350 patients out of which 254 male and 96 female patients. A total of 129 patients with significant coronary artery disease were regarded as cases whereas 221 patients without significant coronary artery disease were taken as controls.

The risk factors measured for coronary artery disease were: gender (male=1, female=0), area (urban=1, rural=0), family history of CAD (yes=1, no=0), hypertension (1=yes, no=0), diabetes (1=yes, no=0), cold sweating (yes=1, no=0), orthopnea (yes=1, no=0), education (literate=1, illiterate=0), awareness about CAD (yes=1, no=0), exercise (no=0, regular=1, irregular=2), use of cooking oil (cooking oil=1, ghee=0), heart attack (yes=1, no=0), angina (yes=1, no=0), smoking (yes=1, no=0) and age (<30=0, 30-45=1, >45=2).

The criteria for the measurements of diagnosis risk factors were taken using standard procedures. Exercise test and electrocardiography (ECG) were conducted if indicated [10]. A general physician who was unaware of the study hypothesis performed all measurements. At the screening examination, blood pressure was measured after five minutes of rest with the subjects seated. Measurements were performed on the right arm using a standard mercury manometer. Hypertension was defined as systolic blood pressure greater than 140 mmHg, diastolic blood pressure greater than 90 mmHg or current use of antihypertensive medication [11].

Cholesterolemia and hypertriglyceridemia were defined as e"200 mg/dl and e"200 mg/dl, respectively, according to standard laboratory procedures [11, 12]. Education should focus on modification of the risk factors for changing the lifestyle of the patients [12]. Smoking history was recorded as either smokers or non-smokers. Income of the respondents was also asked and further it was categorized as low (below 6000 PKR), middle (6000 to 16000 PKR) and high (above 16000 PKR). Aerobic exercise training on treadmill can improve physical fitness in patients with ischemic heart disease [13, 14]. The patients were asked whether they do exercise or not. Childhood obesity leads to a higher risk of adult cardiovascular morbidity and mortality [15]. High blood sugar was defined as a fasting blood sugar greater than 126 mg/dl [16-18]. Education of patient was recorded as literate and illiterate. Heredity is a major independent risk factor of CAD. So each subject was investigated about having any family history regarding CAD [19].

RESULTS AND DISCUSSION

A logistic regression analysis was carried out to analyze the significance of risk factors. The statistical programming environment R was used to carry out the analyses.

The frequencies and percentages for each risk factor among case and control groups were given in Table 1. Further, p-values for Wald's test statistic were given to check the significance of each risk factor in a univariate context. The results of parameter estimates, when entered as a whole in a logistic regression model, were given in Table 2. Each estimated coefficient of the risk factors is the expected change in the log odds of having CAD problem for a unit increase in the corresponding risk factor/predictor variable holding the other predictor variables/risk factors constant at certain value. Each exponentiated coefficient is the ratio of two odds, or the change in odds in the multiplicative scale for a unit increase in the corresponding risk factor holding other risk factors at certain value. In the complete logistic regression model, hyperlipidemia ($p<0.001$), cold sweating ($p=0.01$), orthopnea ($p<0.001$), use of cooking oil instead of ghee ($p<0.05$) and angina ($p<0.001$) were found significant risk factors for the prevalence of CAD.

Table 1: Distribution of the coronary artery disease according to selected risk factors

Risk factor	categories	Cases (percent)		Control (percent)		Total (percent)		p-value
Gender	Male	85	(33.46)	169	(66.54)	254	(72.57)	0.03
	Female	44	(45.83)	52	(54.17)	96	(27.43)	
Area	Rural	64	(30.77)	144	(69.23)	208	(59.43)	
	Urban	65	(45.77)	77	(54.23)	142	(40.57)	0.004
Family history	Yes	69	(47.26)	77	(52.74)	146	(41.71)	<0.001
	No	60	(29.41)	144	(70.59)	204	(58.29)	
Hypertension	Yes	57	(50.00)	57	(50.00)	114	(32.57)	<0.001
	No	72	(30.51)	164	(69.49)	236	(67.43)	
Hyperlipidemia	Yes	69	(63.30)	40	(36.70)	109	(31.14)	<0.001
	No	60	(24.90)	181	(75.10)	241	(68.86)	
Diabetes	Yes	36	(54.55)	30	(45.45)	66	(18.86)	<0.001
	No	93	(32.75)	191	(67.25)	284	(81.14)	
Cold sweating	Yes	78	(75.00)	26	(25.00)	104	(29.71)	<0.001
	No	51	(20.73)	195	(79.27)	246	(70.29)	
Orthopnea	Yes	78	(74.29)	27	(25.71)	105	(30)	<0.001
	No	51	(20.82)	194	(79.18)	245	(70)	
Obesity	Yes	48	(36.92)	82	(63.08)	130	(37.14)	0.984
	No	81	(36.82)	139	(63.18)	220	(62.86)	
Exercise	No	66	(30.28)	152	(69.72)	218	(62.29)	
	Regular	36	(53.73)	31	(46.27)	67	(19.14)	<0.001
	Irregular	27	(41.54)	38	(58.46)	65	(18.57)	0.091
Use of cooking oil	Yes	70	(30.43)	160	(69.57)	230	(65.71)	
	No	59	(49.17)	61	(50.83)	120	(34.29)	<0.001
Angina	Yes	127	(69.02)	57	(30.98)	184	(52.57)	
	No	2	(1.20)	164	(98.80)	166	(47.43)	<0.001
Occupation	No	39	(36.79)	67	(63.21)	106	(30.29)	
	Job	26	(48.15)	28	(51.85)	54	(15.43)	0.167
	Business	20	(27.03)	54	(72.97)	74	(21.14)	0.171
	Farmer	16	(42.11)	22	(57.89)	38	(10.86)	0.563
	Labour	28	(35.90)	50	(64.10)	78	(22.29)	0.900
Smoking	No	87	(36.71)	150	(63.29)	237	(67.71)	
	Ever	42	(37.17)	71	(62.83)	113	(32.29)	0.934
Use of Fast food	No	27	(39.71)	41	(60.29)	68	(19.43)	
	Often	31	(22.63)	106	(77.37)	137	(39.14)	0.011
	Sometime	53	(52.48)	48	(47.52)	101	(28.86)	0.104
	Ex-fastfood	18	(40.91)	26	(59.09)	44	(12.57)	0.899
Use of meat	No	77	(33.19)	155	(66.81)	232	(66.29)	
	Often	24	(43.64)	31	(56.36)	55	(15.71)	0.146
	Sometime	28	(44.44)	35	(55.56)	63	(18.00)	0.099
Income	Low	65	(32.83)	133	(67.17)	198	(56.57)	0.02
	Medium	47	(38.84)	74	(61.16)	121	(34.57)	0.475
	High	17	(54.84)	14	(45.16)	31	(8.86)	
Age	Low	21	(24.71)	64	(75.29)	85	(24.29)	
	Middle	59	(39.07)	92	(60.93)	151	(43.14)	0.069
	Old	49	(42.98)	65	(57.02)	114	(32.57)	0.004

Table 2: Parameter estimates and odds ratios for multiple logistic regression

		Estimate	Std. Error	Wald statistic	P value	C.I.	Odds Ratio	C.I. for OR
(Intercept)		-1.37	0.81	-1.69	0.09	(-2.96, 0.22)	0.25	(0.05, 1.24)
Gender		-0.23	0.49	-0.47	0.64	(-1.19, 0.73)	0.79	(0.30, 2.07)
Area		-0.15	0.45	-0.32	0.75	(-1.03, 0.74)	0.86	(0.36, 2.09)
Family history		0.62	0.44	1.43	0.15	(-0.23, 1.48)	1.86	(0.79, 4.38)
Hypertension		-0.08	0.45	-0.18	0.86	(-0.96, 0.79)	0.92	(0.38, 2.21)
Hyperlipidemia		1.27	0.44	2.86	<0.001	(0.40, 2.13)	3.55	(1.49, 8.43)
Diabetes		0.72	0.54	1.33	0.18	(-0.34, 1.77)	2.05	(0.71, 5.88)
Cold sweating		1.23	0.45	2.75	0.01	(0.35, 2.10)	3.41	(1.42, 8.17)
Orthopnea		3.02	0.53	5.75	<0.001	(1.99, 4.05)	20.56	(7.34, 57.58)
Education		-0.18	0.5	-0.36	0.72	(-1.17, 0.81)	0.83	(0.31, 2.24)
Awareness		-0.08	0.51	-0.15	0.88	(-1.08, 0.92)	0.93	(0.34, 2.52)
Exercise	Regular	1.5	0.6	2.49	0.01	(0.32, 2.67)	4.46	(1.37, 14.5)
	Irregular	0.66	0.6	1.1	0.27	(-0.51, 1.84)	1.94	(0.60, 6.30)
Cooking oil		0.94	0.47	2	<0.05	(0.02, 1.86)	2.55	(1.02, 6.40)
Angina		5.28	0.91	5.79	<0.001	(3.50, 7.06)	196.37	(33.12, 1164.44)
Smoking		-0.32	0.48	-0.67	0.5	(-1.25, 0.61)	0.73	(0.29, 1.84)
Age	Middle	-0.27	0.63	-0.44	0.66	(-1.51, 0.96)	0.76	(0.22, 2.61)
	High	-0.77	0.62	-1.25	0.21	(-1.98, 0.44)	0.46	(0.14, 1.55)

The most of the other risk factors which were insignificant like gender (p = 0.64), family history of CAD (p = 0.15), hypertension (p=0.86), diabetes (p=0.18), smoking (p=0.50) and age (30-45, p=0.66; >45, p=0.21) in the complete model were found significant when they were used as the only risk factors for the coronary artery disease.

The results of table 2 show that the odds of having CAD with family history of CAD over the odds of having CAD without family history of CAD were 1.86. In percentages, we could say that odds of suffering from CAD with CAD family history were 86% higher than the odds for a patient who did not have family history of CAD. The problem of hyperlipidemia in a person increases the odds of CAD by 255%. Similarly a diabetic patient has 105% more odds of CAD than a non-diabetic person. The cold sweating increases the odds of CAD by 241%. Orthopnea i.e. short breathing is also another important risk factor with odds ratio 20.56. The use of ghee instead of cooking oil in daily life foods increases the odds of CAD by 155%.

The odds ratios are computed by exponentiating the corresponding parameter estimate value. For confidence interval of odds ratios, similarly the upper and lower limits of the C.I. of parameters were exponentiated. The entire C.I. for odds ratio above 1 is indicating a positive association between the risk factor and the presence of CAD e.g. hyperlipidemia, cold sweating, orthopnea, regular exercise, use of cooking oil instead of ghee and angina in our logistic regression model. All of these risk factors are having positive association with the response variable. If the entire C.I. is less than 1, means a negative association between the predictor and response and we could not find any risk factor in our model with such negative association. However, if the interval covers a value of 1, we can't conclude about the association between risk factor and response.

In our model, the confidence limits for the odds ratios corresponding to the risk factors; gender, area of residence, family history of CAD, hypertension, diabetes, literacy, awareness about the coronary artery disease, smoking and age were covering the value of 1 in the interval. So we cannot be sure about the association of these risk factors with the CAD.

CONCLUSION

The significant risk factors of CAD among the patients studied in Faisalabad Institute of Cardiology were Hyperlipidemea, cold sweating, orthopnea, use of cooking oil and angina. The other risk factors mentioned as potential cause of CAD in literature like gender, family history of CAD, diabetes, smoking, age, were found insignificant in the data at hand. However gender, location of residence, family history, hypertension and age were found significant when treated independently in a logistic regression model.

Recommendations: The increasing prevalence of Coronary heart disease can be avoided by using the preventive programs about weight loss in case of obesity, smoking cessation and diabetes nutritional education.

The use of red meat should be avoided and use of fish, olive oil and nuts should be increased. From clinical point of view aspirin can benefit with increasing cardiovascular risk.

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