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Cardiovascular Diseases in Relation to Anthropometric, Biochemical and Dietary Intake in Women: A Case Control Study

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ABSTRACT

Background: Cardiovascular diseases in women are increasing at an alarming rate but very little attention has been given due to economic and socio-cultural reasons. A study was undertaken to examine the relationship between cardiovascular diseases and nutritional status in Pakistani women.
Methods: A case-control study was carried out in the Outpatients department (OPD) of the Cardiology Unit, Rehman Medical Institute (RMI), Peshawar, Khyber Pakhtunkhwa, Pakistan. The inclusion criteria for selection of cases were females having complaints of myocardial infarction and free from all other infectious and chronic diseases. Forty three cases and 43 controls were selected for the study. Subjects were interviewed for their medical history, dietary intake demographic and socio-economic characteristics. Weight, height measurements and blood samples from both the cases and controls were taken for assessing their nutritional status. Data were analyzed using Student's t-test, Chi-square test, univariate and multivariate unconditional logistic regression to study the relationship between different variables.
Results: The results revealed that the cases had a significantly ($p<0.05$) higher median age than the controls but there were no significant ($p>0.05$) differences in the mean weight, height, BMI, serum ferritin and haemoglobin concentrations between the cases and controls. High prevalence of overweight and obesity was found in both cases (67.4%) and controls (81.4%). Cases had a significantly lower mean dietary energy, protein, carbohydrates, and fat intake than the controls but there was no significant difference ($p>0.05$) in the mean iron intake between the cases and controls. Results of logistic regression showed no significant association between the dependent (CVD) and independent variables (age, diastolic blood pressure, BMI, exercise, family history, family type, family size, haemoglobin, ferritin, carbohydrates and protein).
Conclusions: The study does not reveal significant relationship between the CVDs and nutritional status. The prevalence of overweight and obesity in women was found to be alarmingly high and needs to be addressed by appropriate interventions to prevent the incidence of metabolic syndromes and chronic diseases in population.

KEYWORDS: Cardiovascular diseases; Nutritional status; Overweight and obesity; Pakistani women.

ABBREVIATIONS: CVD: Cardiovascular disease; DALY: Disability Adjusted Life Year; OPD: Outpatients department; OR: Odds Ratio; CAD: Coronary Artery Disease; MI: Myocardial Infarction; CI: Confidence Interval; RMI: Rehman Medical Institute; IQR: Inter-quartile range; IDA: Iron Deficiency Anaemia.

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INTRODUCTION

Cardiovascular diseases (CVDs) are one of the leading causes of disability and premature deaths in adults worldwide, low income to middle income countries bear the brunt by accounting for over 80% of the global disease burden and overwhelming health expenditures amounting to billions of dollars annually.[1,2] The prevalence of CVDs increases with advancing age and varies among racial, ethnic, geographic, and socio-demographic groups. It has been estimated that by the year 2020, the prevalence of CVDs will increase by 75% with predominance in developing counties. CVDs account for 17.3 million deaths per year that are likely to reach 23.6 million deaths per year by 2030.[3] The social and economic implications of CVDs in terms of increased burden on the healthcare system, family sufferings, Disability Adjusted Life Years (DALYs) lost, reduced productivity and economic outputs are enormous and well documented.[4,5,6]

Pakistan has been confronted with an increasing risk of cardiovascular diseases due to non-implementation of food safety laws, unhealthy dietary practices, poor sanitation and hygiene practices, population explosion, rapid urbanization, limited resources, lack of physical activity and unhealthy lifestyles.[7,8] Women share a greater burden of CVDs than men due to sedentary lifestyles, reproductive stress and poor dietary intake.[9] CVDs shorten the life expectancy of women by about 5 years as compared to non-CVDs women.[10] In Pakistan, CVDs account for 19% of all the deaths occurring among adults aged 30-70 years.[11]

Since very limited work has been done on the risk factors associated with cardiovascular diseases in women in this part of the world, a case-control study was undertaken to assess the relationship between CVDs in women and their nutritional status by taking their anthropometric, biochemical, dietary and demographic and socio-economic characteristics.

MATERIALS AND METHODS

A case-control study was carried out in the Outpatients department (OPD) of the Cardiology Unit, Rehman Medical Institute (RMI), Peshawar, Pakistan. Permission to undertake the study was taken from ethical committee of the hospital. The inclusion criteria used for selection of cases were female adults having complaints of myocardial infarction confirmed by clinical and laboratory tests including ECG, ETT, ECHO and blood pressure by a Cardiologist. The controls were women accompanying patients without having any disease. The cases and controls were representing a sample from different geographical areas as RMI is a reputable health care centre with a specified cardiac unit which attracts patients from all over the province. Both cases and controls were exposed to similar risk factors and the latter resembled with the cases in all respects except for the presence of disease. Informed consent was obtained from the 43 cases and 43 controls enrolled in the study.

Medical history, general characteristics and weight-height measurements of women were taken by following the recommended procedures.[12] Body mass index of the subjects was computed and prevalence of overweight and obesity was assessed by following the WHO cut-offs.[13] Haemoglobin and serum ferritin concentration of women were determined by digital portable Hemocue and ELISA, respectively.[14,15] A 24-hr dietary recall was used to assess dietary energy, carbohydrate, protein, fat and iron intakes of women.[16]

STATISTICAL ANALYSIS

Anthropometric, biochemical, dietary, demographic and socio-economic data were analysed by using STATA software version 12.0.[17] Descriptive statistics were expressed as mean and standard deviation for discrete and continuous measures, whereas percentages were reported for categorical variables. Median and Inter-quartile range (IQR) was reported for skewed data. An independent sample t test was used to compare the mean differences between the cases and controls in anthropometric measurements (weight, height and body mass index), biochemical indicators (haemoglobin and ferritin concentrations) dietary intake (energy, carbohydrate, protein, fat and iron) and demographic-socioeconomic characteristics (age, family size, number of children) at 5% level of significance. A Chi-square test of independence was performed to measure the extent of association between two categorical variables with continuity correction where appropriate and a Mann-Whitney U test was used to compare the differences in medians.

A multivariate analysis was undertaken using unconditional logistic regression *logit* procedure in STATA Version 12[17] for unmatched case-control design. Univariate logistic regression was first performed variable by variable, without any adjustment. This was done to explore the association between each variable and the risk of myocardial infarction. Multivariate modelling approach was undertaken by putting all variables considered clinically important. This was done to adjust for each variable with all of the other variables listed in the model. The estimates were expressed as unadjusted Odds Ratio (OR) from univariate model and adjusted OR from multivariate model. The ORs were considered statistically significant if their 95% Confidence Interval (CI) did not include unity. The more the OR deviated from 1, the stronger was the association between the exposure variable.

RESULTS AND DISCUSSION

General characteristics of cases and controls presented in Table 1 indicate that cases had significantly ($p<0.05$) higher median age and mean systolic blood pressure than the controls, but no significant differences were observed in the mean weight, height, body mass index and diastolic blood pressure between

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the cases and controls. Lack of a significant difference in the mean BMI between the cases and controls is somewhat contrary to the general perception that obesity is one of the risk factors for cardiovascular diseases. The categorization of women on the basis of BMI revealed that only about 5% of women in CVDs group were under weight, while 35% and 33% were overweight and obese, respectively. In other words 68% of women in CVDs group were overweight and obese in comparison to about 81% overweight and obese women in non CVDs group (control group) indicating a higher prevalence of overweight and obesity in the non CVDs group (Table 1). Similarly, no significant (p>0.05) association between health status (MI yes-no) and body mass index (high and low) negates the established association between the BMI and CVDs.[18-21] No significant association between BMI and CVDs also identifies BMI as a poor predictor of health status and its cut-off values for categorization of individuals into underweight, normal, overweight and obesity and applicability among different races and ethnic groups has been questioned seriously.[22] However, the difference in mean anthropometric results and association between different categorical variables across different countries could be attributed to differences in genetic and environmental factors that influence the relationships between different variables.

Table 2 shows the mean Heaemoglobin (Hb) and Serum Ferritin (SF) concentrations of CVD cases and controls as well as the prevalence of Anaemia (An), Iron Deficiency (ID) and Iron Deficiency Anaemia (IDA) between the cases and controls. As evident from Table 2, there were no significant (p<0.05) differences in the mean Hb and SF levels between the cases and controls. However, mean SF concentration of cases as well as non-iron deficient group tended to show an increase of 30% and 63%, respectively, over the corresponding iron status groups of controls reflecting a trend of weak relationship due to non-significant results between SF and CVDs (Table 2). Similarly, there was no significant association between the iron status groups (anemic and non-anaemic; iron deficient and non-iron deficient; iron deficient anaemic and iron deficient non-anaemic) and CVDs status (Table 2).

The results related to non-significant association between the CVDs, SF and other iron status indicators are in fair agreement with findings of the earlier researchers[23] who also reported no significant association between the increasing risk of CVD and SF. Similarly, no significant association was found between the mortality of CVDs' patients and SF.[24] Conversely, a U-shaped relationship was found between CVD, IHD and SF levels in women and no significant association between CVD and SF in men.[25] Another study[26] revealed that SF ≥200 ng/ml was associated with four fold higher risk of coronary heart disease in Iranian men. Likewise, other researchers[27-30] also reported a significant association between CVDs and SF. The conflicting results in establishing an association between CVDs and SF may be attributed to differences in ethnicity, ages, gender, socioeconomic characteristics, study designs and type and severity of CVDs. No significant association (p>0.05) between the health status (MI yes-no) and iron status indicators also suggests that Hb and SF do not share any relationship with CVDs.

Dietary energy, carbohydrates, protein, fat and iron intakes of the cases and controls shown in Table 3 revealed that the cases had significantly lower mean dietary energy, carbohydrates, protein and fat intakes than the controls but there was no significant difference in the mean dietary iron intake between the cases and controls. The lower nutrients intake of cases may have been partly attributed to patients' stress and illness and partly to confounding variables such as BMI. The lower energy and carbohydrates intake have been reported[31] to have protective affects against cardiovascular diseases but in our study the lower nutrients intake by cases could not prevent the occurrence of MI. The differences in results amongst the various studies could be attributed to the differences in intensity of CVDs, study designs, dietary and environmental variations. The present results suggest that hospitalized CVD patients are at a greater risk of malnutrition. The nutrients intake of controls also appeared to be lower when compared with the mean nutrients intake of corresponding age non-hospitalized adult normal women as well with those of recommended dietary allowances.[32-34] Thus, one day 24-hr dietary recall of hospitalized patients (cases) and non-patients

Variable	Total (n=86)	Cases(n=43)	Control (n=43)	p-value
Age (yrs), Median (IQR)	46.5 (40.0-50.0)	50.0 (45.0-56.0)	42.0 (40.0-50.0)	<0.01
Weight (kg), Mean ± SD	66.9±13.4	65.8±16.0	68.1±10.8	0.43
Height (kg), Mean ± SD	152.5±4.3	153.30±4.30	152.44±4.4	0.37
Body mass index, Mean ± SD	28.3±5.5	27.3± 6.0	29.3± 4.7	0.10
Systolic, mm/Hg, Mean ± SD	128.0±17.13	132.47±20.94	123.02±11.45	0.01
Diastolic, mm/Hg, Mean ± SD	84.98±12.75	86.16±14.68	83.79±10.51	0.39
Under weight (BMI <18.5) n (%)	2 (2.3)	2 (4.7)	-	-
Normal weight (18.5 ≤ BMI <25) n (%)	20 (23.3)	12 (27.9)	8 (18.6)	0.44
Overweight (25 ≤ BMI <30) n (%)	31 (36.0)	15 (34.8)	16 (37.2)	0.99
Obese ≥30 n (%)	33 (38.4)	14 (32.6)	19 (44.2)	0.38

SD=Standard deviation; IQR=Inter quartile range (25th-75th Percentile); p values are based on Mann Whitney U test for age (skewed distribution); Independent sample t-test for systolic, diastolic and BMI variables (symmetric distribution) and Chi-square test for a categorical variable body mass index

Table 1: General characteristics of subjects.

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Variable	Cases (n=43)	Controls (n=43)	p-value
Hemoglobin (Hb), Mean ± SD	13.52±2.18 (n=43)	13.14±1.18 (n=43)	0.3828
Anaemic (Hb< 12 g/dl), Mean ± SD	10.20±1.66 (n=8)	10.62±0.65 (n=9)	0.5166
Non-anaemic (Hb≥ 12 g/dl), Mean ± SD	14.28±1.45 (n= 35)	13.81±1.37 (n=34)	0.1699
Serum Ferritin (SF), Mean ± SD	53.75±76.93 (n=43)	41.39 ± 69.79 (n=43)	0.4374
Iron deficient (SF<12 ng/ml), Mean ± SD	2.39±3.41 (n=18)	4.55±3.49 (n=12)	0.1062
Non-iron deficient (SF ≥ 12 ng/ml) Mean ± SD	90.74±83.34 (n=25)	55.65±77.86 (n=31)	0.1132
Anaemic (Hb<12 g/dl) n (%)	8 (18.60)	9 (20.93)	0.787
Non-anaemic (Hb≥ 12 g/dl) n (%)	35 (81.40)	34 (79.07)	
Iron deficient (SF<12 ng/ml) n (%)	18 (41.86)	12 (27.91)	0.175
Non-iron deficient (SF ≥ 12 ng/ml)n (%)	25(58.14)	31 (72.09)	
Iron deficient anaemic (SF<12 ng/ml and Hb<12 g/dl) n (%)	5 (11.63)	2 (4.65)	0.339
Non-iron deficient anaemic (SF ≥12 ng/ml (Hb<12 g/dl) n (%)	13 (30.23)	10 (23.26)	
Iron deficient non-anaemic (SF<12 ng/ml) (Hb ≥ 12 g/dl) n (%)	3 (6.98)	7 (16.28)	
Non-iron deficient non-anaemic (SF ≥12 ng/ml) (Hb ≥12 g/dl) n (%)	22 (51.16)	24 (55.18)	

Table 2: Biochemical status of cases and controls (n=86).

Variable	Cases (n=43)	Control (n=43)	p-value
Energy (kcal), Mean± SD	699.09±269.77	949.23±275.86	0.0001
CHO (g), Mean± SD	107.17±51.72	141.77±50.51	0.0023
Protein (g), Mean± SD	31.86±10.86	41.76±17.34	0.0022
Fat (g), Mean± SD	23.84±21.18	33.35±12.00	0.0127
Iron (mg), Mean± SD	8.63±5.44	10.11±4.44	0.4374

Table 3: Dietary nutrients intake per day of cases and control.

(controls) selected from attendants and accompanied persons of cases may not be suitable to capture their usual dietary intake and therefore, dietary results may be used with caution.

The demographic and socio-economic characteristics of cases and controls presented in Table 4 show that 95% of the women from cases and 86% of the women from the controls had education up to secondary school level and there was no significant association between education and health status groups. Similarly, 93% of cases were housewives in comparison to 84% of women in the control group and no significant association was found between the subjects' profession and health status groups (Table 4). Likewise, no significant association was found between the economic and health status categorical variables (Table 4). These findings differ from the generally established perception that individuals with lower socio-economic status have increased morbidity and shorter life expectancy than those of higher socio-economic status. Lack of association between the socio-demographic and health status variables suggests that causes of CVDs in women are beyond the socio-demographic domain. The results are in line with those of others[35] who studied an association between the socio-demographic characteristics and cardiovascular risk factors in patients with severe mental disorders and reported that increased cardiovascular profile in young adults could not be explained by socio-demographic variables alone. Conversely, there was a compelling body of evidence that populations from lower socio-economic status had higher incidence CVDs and premature deaths as compared to those of the higher socio-economic status.[36]

Results of logistic regression presented in Table 5 showed no significant association between the dependent (CVD) and independent variables (age, diastolic blood pressure, BMI, exercise, family history, family type, family size, haemoglobin, ferritin, carbohydrates and protein). Non-significant association between CVDs and independent variables suggest the complex nature of the disease that may result from a variety of factors not included in this study, in other words, to establish an association between CVDs and risk factors, a more thorough and comprehensive investigation is required by taking into consideration genetic, environmental (anthropometric, dietary, biochemical, clinical), lifestyle factors, socio-economic characteristics, a larger sample size and robust study design. These arguments are substantiated by other researchers[37] who reported a significant association between Coronary Artery Disease (CAD) and smoking (OR=1.89; 95% CI=1.74-2.05); CAD and hypertension (OR=1.56; 95%

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CI=1.48-1.65); CAD and alcohol (OR=1.37; 95% CI=1.30-1.46); CAD and diabetes (OR=1.37; 95% CI=1.25-1.50); CAD and high fat diet (OR=1.35; 95% CI=1.28-1.43); CAD and BMI>24 kg/m^2 (OR=1.09; 95% CI=1.03-1.17). Similarly, others investigators[2] have also reported a significant association between Myocardial Infarction (MI) and smoking (OR=2.87, CI=2.58-3.19); MI and diabetes (OR=2.37, CI=2·07-2·7); MI and hypertension (OR=1.91, CI=1.74-2·1); MI and abdominal obesity (OR=1.62,CI=1.45-1.80); MI and psychosocial factors (OR=2.67; CI=2.21-3.22); MI and Apoβ/ApoA1 ratio (3 *vs.* 1) (OR=1.84; CI=1.58-2.13).

LIMITATIONS OF THE STUDY

The sample size of the study was relatively small which may limit its scope and applications to be generalized. Ideally, controls should have been selected from the general population but controls were selected from accompanying patients who may not necessarily be relatives of the patients. It is customary in this part of the world that friends and relatives from distant places visit hospitals for inquiring about patients' health but still the selection of controls from the attendants could have introduced a selection bias and distorted some results. Due to funding con-

Health and socio-demographic characteristics	Total (n=86)	Cases (n=43)	Controls (n=43)	p-value
Education				
Lower secondary	78 (90.7)	41 (95.4)	37 (86.1)	0.14
Higher secondary	8 (9.3)	2 (4.6)	6 (13.9)	
Profession				
Unemployed (Housewife)	76 (88.4)	40 (93.0)	36 (83.7)	0.18
Employed	10 (11.6)	3 (7.0)	7 (16.3)	
Family Type				
Nuclear	49 (57.0)	26 (60.5)	23 (53.5)	0.51
Joint	37 (43.0)	17 (39.5)	20 (46.5)	
Family History				
No	59 (68.6)	33 (76.7)	26 (60.5)	0.10
Yes	27 (31.4)	10 (23.3)	17 (39.5)	
Socio-economic Status				
Moderate rich	58 (67.4)	31 (72.1)	27 (62.8)	0.36
Rich	28 (32.6)	12 (27.9)	16 (37.2)	
Exercise				
No	50 (58.1)	28 (65.1)	22 (51.2)	0.19
Yes	36 (41.9)	15 (34.9)	21 (48.8)	

Percentages are in parentheses. p values are based on Chi-square test

Table 4: Health and demographic-socioeconomic characteristics of cases and controls.

Variable (Categorical)	Unadjusted		Adjusted[a]	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age, y (≤ 40 *vs.* > 40)	2.59 (0.97-6.95)	0.06	3.08 (0.87-10.86)	0.08
SBP, mmHg (≤ 140 *vs.* > 140)	9.60 (1.14-80.52)	0.04	24.00 (2.00-288.52)	0.01
DBP, mmHg (≤ 90 *vs.* > 90)	2.30 (0.71-7.42)	0.16	1.36 (0.25-7.41)	0.72
BMI (≤ 30 *vs.* > 30)	0.55 (0.23-1.33)	0.18	0.33 (0.10-1.06)	0.06
Exercise (No *vs.* Yes)	0.56 (0.24-1.33)	0.19	0.41 (0.13-1.26)	0.12
Family History (No *vs.* Yes)	0.46 (0.18-1.18)	0.11	0.41 (0.12-1.38)	0.15
Family Type (Nuclear *vs.* joint)	0.75 (0.32-1.77)	0.51	0.95 (0.31-2.93)	0.94
Family Size (≤ 5 *vs.* > 5)	0.71 (0.22-2.25)	0.56	1.41 (0.28-7.12)	0.68
Haemoglobin (≤ 10 *vs.* > 10)	1.00 (0.19-5.26)	0.99	0.88 (0.11-7.16)	0.91
Ferritin (≤100 *vs.* > 100)	3.53 (0.88-14.09)	0.07	2.42 (0.41-14.32)	0.33
Carbohydrates (≤ 100 *vs.* > 100)	0.32 (0.12-0.84)	0.02	0.35 (0.10-1.23)	0.10
Protein (≤ 50 *vs.* > 50)	0.21 (0.04-1.07)	0.06	0.40 (0.06-40.53)	0.76

SBP=Systolic blood pressure; DBP=diastolic blood pressure; BMI=Body mass index; OR=Odds ratio; CI=Confidence interval
A= Each risk variable was adjusted for with all of the other risk variable listed in the table.

Table 5: Unconditional logistic regression model of socio-demographic and nutritional factors associated with CVD cases over control.

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straints, the control sample size (n=43) was kept equal to cases (n=43) that could have limited the statistical power of the study. In addition, all variables of interest could not be included in the study and that could be one of the reasons for not establishing any association between the dependent and independent variables. Keeping in view the above stated limitations, the results may be used with caution further studies are needed in the area to augment the study findings.

CONFLICTS OF INTEREST

This is to declare that none of the authors have any conflict of interests.

INDIVIDUAL CONTRIBUTION

PIP conceptualized, designed and supervised the study; HW conducted field and laboratory work; SIP assisted PIP in manuscript drafting and critically reviewing the paper; SU did the statistical analysis of the data; SSB facilitated HW during data collection and management.

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