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Risk Prediction of Coronary Artery Disease among Naval Forces

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Abstract: Background: Coronary artery disease (CAD) risk factors seem to cluster in some occupational groups. **Objective:** The present study was designed to investigate CAD risk factors among naval forces as an example of a high risk sector and to construct a risk prediction model for the disease. **Methods:** A case control study was carried out at the general naval hospital (GNH) in Alexandria. The study included 250 male consecutive naval CAD cases with a control group of 250 males matches for age, occupational level, sociodemographic characteristics and, free from CAD. All participants were subjected to a questionnaire about personal data, occupational history and exposures, occupational and leisure physical activity, dietary habits, smoking, and medical history. Anthropometric measurements, sitting blood pressure, and lipid profile were determined by the standard methods. **Results:** revealed that occupational sedentary activity and perceived occupational noise were the significantly reported special occupational characteristics together with other conventional risk factors among CAD naval cases verses controls ($p<0.0001$ & <0.009 respectively). Logistic regression analysis with the dependent variable as being a CAD case showed independently significant effects for family history of premature CAD, history of hypertension, smoking, history of diabetes mellitus, body mass index (BMI), leisure physical activity, fish consumption, and HDL-cholesterol. A risk prediction model utilizing these variables was constructed with an overall correct percent of 74.6%. **Conclusions:** Application of the model expresses the risk of having CAD in an individual eligible with criteria of the study population. These results are of special importance for design of preventive programs for CAD in similar high risk occupational groups.

INTRODUCTION

Coronary artery disease (CAD) is the principal cause of premature disability and mortality in most economically advanced countries. Also, developing countries are now subjected to the same risk factors showing increase in their incidence.[1,2] In Egypt, cardiovascular diseases mortality showed a sharp rise since 1998 when it

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represented 47% of total deaths; meanwhile, it represented only 12.4% in 1970. Urbanization may be a contributing mechanism for the increased prevalence of coronary risk factors namely; hypertension, hypercholesterolemia, low HDL-cholesterol, elevated LDL-cholesterol, hypertriglyceridemia, obesity, increased fasting and post-prandial blood glucose and smoking as reported in the Egyptian National Hypertension Project (NHP 1991 – 1994).(3)

On the other hand, physical activity and dietary factors greatly influence the risk of CAD. Also, occupational environment may pose an increased risk for CAD through the different physical, chemical, and psychosocial exposures. Shift work, psychosocial stress, noise, carbon monoxide, organic solvents and heavy metals are important exposures influencing coronary risk either independently or through other conventional risk factors.(4-7)

Such exposures seem to cluster in some special occupational groups such as military and naval forces. The present study was designed to investigate CAD risk factors among naval forces as an example of a high risk occupational group and to construct a model for risk prediction of the disease.

MATERIAL AND METHODS

Study design and setting:

A case control study was carried out at the general naval hospital "GNH" in Alexandria.

Study population, sample size:

The sample size required to accomplish the aim of the present work was determined using EPI-INFO version 6 and considering a level of confidence at 95%, an expected frequency in not ill group of 5%, a power of 90% and an odds ratio (OR) of 3.09.(8) The minimum sample size was estimated as 243 CAD cases.

Accordingly, the study comprised 250 male consecutive naval cases admitted to the GNH and finally diagnosed as CAD. For each case a control matched for age and occupational level was chosen from males attending or admitted to the GNH for any reason other than chest pain and free from CAD as evidenced by history and electorcardiographic examination.

Methods:

All participants were subjected to a questionnaire about personal and occupational data including occupational level, and history of exposure to carbon monoxide, perceived noise or high atmospheric pressure according to their specific job criteria. Occupational and leisure physical activity were inquired as the long-term habits according to the recommendations of the American Heart Association.(9) Smoking, long-term dietary habits, medical history of hypertension and diabetes mellitus, and family history of premature CAD before the age of 55 years according to the WHO guidelines.(10) Weight (Kg), height (cm), body mass index (BMI = kg/m^2), waist circumference (cm), and sitting blood pressure (mmHg) were measured by the standard methods. Fasting venous blood samples were collected by veni-puncture to determine total cholesterol, HDL-cholesterol, and triglycerides by the standard enzymatic methods. The LDL-cholesterol was computed using the Fried Weldi equation. (11)

Statistical analysis:

Data were analyzed using SPSS (Statistical Package for Social Sciences) version 11.(12) Continuous variables were expressed as means and standard deviations, meanwhile, qualitative data were defined as number and percentage. Comparison between cases and controls regarding the different risk factors was done using the appropriate test of significance (t-test, Pearson's χ^2, and multilinear χ^2).

Logistic regression analysis, forward stepwise method, was used to obtain the best predictive model for CAD cases utilizing the independently significant factors. The level of significance for p value was considered at < 0.05.

RESULTS

The occupational characteristics of CAD cases and controls showed no significant differences between both groups regarding occupational level, history of exposure to carbon monoxide, and high atmospheric pressure. However, perceived occupational noise was more significantly reported among CAD cases in comparison to controls (19.2% versus 6%, respectively, $p < 0.05$) (Table 1).

There were no significant differences for age and height between CAD cases and controls. Comparison of risk factors for the study population demonstrated significant differences with higher mean values among CAD cases versus controls for weight (93.2 vs 91.1 Kg), BMI (28.8 vs 28.1 kg/m^2), waist circumference (105.3 vs 100.6 cm), SBP (133.4 vs 123.7 mmHg), DBP (87.6 vs 79.4 mmHg), total cholesterol (232.3 vs 200.4 mg/dl), LDL-cholesterol (150.2 vs 108.9 mg/dl), triglycerides (146.6 vs 132.4 mg/dl), and smoking index (319.7 vs 207.4 daily cigarettes years) ($p < 0.001$ for all). On the other hand, the mean value of HDL-cholesterol was significantly lower for CAD cases than controls (52.8 vs 65.0 mg/dl) ($p < 0.001$) (table 2).

The rates for diabetes mellitus, hypertension, family history of pre-mature CAD, smoking and occupational sedentary activity were significantly higher among CAD cases in comparison to controls ($p < 0.01$ for all). Meanwhile, regular leisure physical activity was less significantly reported by CAD cases than controls ($p = 0.014$) (table 3).

Dietary habits were investigated in the study population to reveal higher significant rates of excessive frank fat intake, excessive salt intake and regular full cream milk consumption, and higher mean weekly egg intake for CAD cases than controls ($p < 0.005$ for all). On the contrary, the rate of regular raw stuff consumption and mean monthly fish intake were significantly lower for CAD cases than controls (p< 0.005 for all). There were no significant differences for daily intake of both tea and coffee by CAD cases and controls (table 4).

Logistic regression analysis with the dependent variable as being CAD case or control was performed by the forward stepwise method. The final best model included family history of premature CAD, history of hypertension, smoking, history of diabetes mellitus, BMI, leisure physical activity, fish consumption and HDL-cholesterol as significant independent variables (P < 0.05 for all) (table 5). The overall correct predictive percentage of the model was 74.6% (table 6).

Table (1): Occupational characteristics of CAD cases and controls.

	Cases		Controls		X^2	p
	no.	**%**	**no.**	**%**		
Retired officer	223	89.2	221	88.4		
Working officer	27	10.8	29	11.6	0.008	0.928
History of exposure to CO	14	5.6	12	4.8	<5	>0.05
History of exposure to high atmosphere pressure	5	2.0	9	3.6	<5	>0.05
Perceived occupational noise	48	19.2	15	6.0	19.78*	0.000

*Significant at level 0.05

Table (2): Continuous risk factors among CAD cases and controls.

	Cases		Controls		t-test	p
	Mean	S.D.	Mean	S.D.		
Age (years)	58.33	7.64	58.32	7.41	0.006	0.995
Height (cm)	180.02	3.51	180.12	3.29	0.30	0.763
Weight (kg)	93.24	6.31	91.09	6.05	3.89*	0.000
BMI (kg/m^2)	28.81	2.28	28.10	2.06	3.62*	0.000
Waist circumference (cm)	105.2	6.15	100.56	5.35	9.20*	0.000
SBP (mmHg)	133.38	16.96	123.72	15.6	6.63*	0.000
DBP (mmHg)	87.56	10.27	79.4	8.83	9.53*	0.000
TC (mg/dl)	232.26	37.55	200.37	30.81	10.38*	0.000
HDL-C (mg/dl)	52.75	24.35	65.01	27.15	5.31*	0.000
LDL-C (mg/dl)	150.21	29.86	108.88	36.34	13.89*	0.000
Tg (mg/dl)	146.55	30.87	132.42	35.27	4.77*	0.000
Smoking index (daily cigarettes x years)	319.65	181.35	207.36	115.80	4.92*	0.000

*Significant at level 0.05

Table (3): Categoric risk factors among CAD cases and controls.

	Cases		Controls		X^2	p
	no.	%	no.	%		
History of D.M	79	31.6	38	15.2	18.76*	0.000
History of hypertension	103	41.2	37	14.8	43.21*	0.000
Family history of premature CAD	55	13.0	21	8.4	17.94*	0.000
Smoking	108	43.2	63	25.2	17.99*	0.000
Occupational sedentary activity	214	85.6	187	74.8	9.49*	0.009
Regular leisure physical activity	30	12.0	60	24.0	6.09*	0.014

* Significant at level 0.05

Table (4): Dietary habits among CAD cases and controls.

	Cases		Controls		X^2	p
	no.	**%**	**no.**	**%**		
Excessive frank fat intake	148	59.2	51	20.4	78.38*	0.000
Excessive salt intake	95	38.0	65	26.0	8.73*	0.003
Regular full-cream milk consumption	66	26.4	24	9.60	27.34*	0.000
Regular raw stuff consumption	90	36.0	122	48.8	8.37*	0.005
	Mean	**S.D.**	**Mean**	**S.D.**	**t-test**	**p**
Fish/month	2.75	2.56	4.24	3.00	5.99*	0.000
Eggs/week	6.07	3.85	4.88	3.66	3.65*	0.000
Tea/day	2.82	1.38	2.66	1.20	1.35	0.178
Coffee/day	2.30	1.17	2.21	1.64	0.75	0.452

* Significant at level 0.05

Table (5): Logistic regression analysis with CAD cases as the dependent variable: The best model for the independently significant factors.

Variables	β	Adjusted OR	95% confidence interval		p
			Lower	**Upper**	
Constant	-2.358				
Family history of premature CAD	1.325	3.762	2.00	7.07	0.000
History of hypertension	1.307	3.696	2.249	6.072	0.000
Smoking	0.827	2.287	1.078	1.321	0.000
History of D.M.	0.529	1.697	1.019	2.826	0.042
BMI	0.177	1.194	1.078	1.321	0.001
Leisure physical activity	-0.810	0.445	0.284	0.697	0.000
Fish consumption	-0.193	0.825	0.765	0.890	0.000
HDL-cholesterol	-0.025	0.976	0.976	0.984	0.000

Table (6): The classification table for the model.

Observed	Predicted		Percent correct
	Case	Control	
Case	188	62	75.2
Control	65	185	74.0
Overall %			74.6

The risk of CAD could be predicted as follows:

$1/1+e^{-Z}$

Where

e = 2.718

$z = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots \beta_P X_P$

z = -2.358 + 1.33 * family history of premature CAD
+ 1.31 * history of hypertension
+ 0.83 * smoking
+ 0.53 * history of D.M.
+ 0.18 * BMI
- 0.8 * Leisure physical activity
- 0.19 * fish consumption
- 0.03 * HDL-cholesterol

(X_1) Family history of premature CAD = No = 1, Yes = 2.
(X_2) History of hypertension: No = 1, Yes = 2.
(X_3) Smoking: No = 1, Yes = 2
(X_4) History of D.M: No = 1, Yes = 2
(X_5) BMI: Absolute value (kg/m^2)
(X_6) Leisure physical activity: No = 1, Yes = 2.
(X_7) Fish consumption: Monthly number
(X_8) HDL-cholesterol: Absolute value (mg/dl).

DISCUSSION

It is recognized that the epidemic of cardiovascular disease has shifted to middle-income and low-income countries, so that about 80% of the global burden of CVD currently occur in these countries.(13) Unless the interacting risk factors for high-risk groups are defined and preventive measures are taken, most developing countries will not be able to afford the considerable costs for control strategy and treatment.(14)

The current study involved CAD in a special occupational group demonstrating the possible influence of some occupational exposures. Naval cases of CAD reported significantly more frequently perceived occupational noise than naval controls. However, this significance disappeared in multivariate analysis after consideration of other CAD risk factors. This finding may enforce the assumption that a neurohormonal activation mediated by noise possibly imposes an indirect effect through other risk factors such as hypertension and dyslipidemia.[5]

Conventional CAD risk factors by quantitative or qualitative measures were more significantly observed among CAD cases versus controls including high levels of BMI, waist circumference, SBP, DBP, total cholesterol, LDL-cholesterol, triglycerides and smoking index, and low HDL level. Also, significant high rates of diabetes mellitus (31.6%), hypertension (41.2%), family history of premature CAD (13%), smoking (43.2%), occupational sedentary activity (85.6%), and absence of regular leisure physical activity (88%) were reported among CAD cases. The existence of these interacting risk factors have been documented in many studies to be the key mechanism in induction of endothelial damage and the inflammatory process of atherogenesis even in young aged patients. [15-18]

All coronary risk factors that were prevalent in this study among CAD naval cases are modifiable except the genetic factor that was reported in 13% of cases only. Hypertension, blood lipids, diabetes mellitus, smoking, obesity, and physical activity are the most important modifiable CAD risk factors.[14]

The negative dietary habits that were significantly reported in this study among CAD cases were excessive fat intake, including frank fat, full-cream milk and/or high weekly egg intake, and excessive salt intake. On the other hand, the positive dietary habits that were less significantly observed among CAD cases were regular raw stuff consumption and monthly times of fish intake. Dietary intervention is an essential tool in cardio-prevention to reduce body weight and to contribute in control of other risk factors such as dyslipidemia, hypertension and diabetes.[19] Food availability and occupation may influence type of diet of the individual. Fish is a particularly common diet among naval population that should be encouraged along with other healthy food as a part of a balanced diet.[20]

Data of the current occupational group were utilized to construct a CAD risk model to be used in the future for prediction of CAD in any individual eligible with the criteria of study population. The independently significant risk factors in the best model were hypertension, smoking, diabetes mellitus and HDL-cholesterol. These are common risk predictors in this model, as well as in Framingham Heart Study prediction score [21] and others.[22] However, BMI, leisure physical activity and fish consumption in our model have replaced total or LDL- Cholesterol in the traditional models.

Body weight reduction and physical activity both occupational and at leisure time were previously reported to reduce total and LDL-cholesterol and to increase the good HDL- cholesterol.[23-24] This was observed to reduce CAD events. [25] Moreover, the favorable effect of fish consumption on CAD risk was previously reported.[26] This is possibly explained by the high concentration of omega 3 fatty acids that may have an antiprostaglandin like action aborting the inflammatory process of atherogenesis. Also, it has a favorable effect on blood lipids particularly triglycerides.[27]

These findings draw the attention for the special needs of this occupational group to optimize CAD risk profile through controlling risk factors and promoting favorable factors, in community-based preventive programs. Application of the CAD risk prediction model is the novel aspect in this study to define high risk subjects in similar situations, in order to provide them with intensified risk control measures in individual-based preventive programs.

CONCLUSION AND RECOMMENDATIONS

The suggested model may be used to predict CAD risk in individuals having similar demographic and occupational characteristics without CAD in primary prevention or with CAD in secondary prevention. Also, more studies are needed for other occupational groups.

Global CAD risk management is needed to get the best preventive outcome. Particular emphasis on controlling hypertension, smoking and diabetes mellitus with increasing HDL-cholesterol is needed. Also, promoting the favorable triad of weight reduction, physical activity and fish consumption is a fruitful option for CAD prevention in general and among naval forces in particular.

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