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An Examination of Factors Effecting Systolic Blood Pressure, Diastolic Blood Pressure, and Total Cholesterol Simultaneously Using Mixed Responses Model

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Abstract

Background: Hypertension is a risk factor that may lead to development of Atherosclerosis (ATS). Recent studies have emphasized on the importance of high blood pressure and cholesterol on cardiovascular diseases.
Objectives: This study aimed to simultaneously examine factors that affect total cholesterol (TC), systolic blood pressure (SBP) and diastolic blood pressure (DBP) using the mixed response model.
Methods: This cross-sectional study comprised of 245 participants, hospitalized at Shahid Madani state hospital, Khorramabad-Iran diagnosed with ATS in fall and winter 2014. The method of sampling was convenience sampling and the participants were selected through census of all the patients hospitalized in different cardiac wards, except for angiography.
Results: Systolic blood pressure was significantly associated with fasting blood glucose (FBG) (P = 0.001), C - reactive protein (CRP) (P = 0.021), erythrocyte sedimentation rate (ESR) (P = 0.004), and low density lipoprotein-cholesterol (LDL-C) (P = 0.002). In addition, FBG (P=0.002), CRP (P = 0.011) and LDL-C (P = 0.027) levels were significantly associated with DBP. It was revealed that age (P = 0.016), smoking (P = 0.010), triglyceride (TG) (P = 0.001) and FBG (P = 0.021) were significantly associated with TC.
Conclusions: Cardiovascular diseases are highly prevalent and there are many risk factors. Therefore, it is necessary to provide proper education on changing life style and preventing the disease.

Keywords: Atherosclerosis, Systolic Pressure, Diastolic Pressure, Cholesterol, Multivariate Analysis

1. Background

Atherosclerosis (ATS) is a cardiovascular disease (CVD) with gradual and progressive course that gradually thickens artery walls and decreases heart perfusion. Clinical studies indicate that traditional cardiovascular risk factors such as age, hypertension, smoking and dyslipidemia contribute to increase in risks of ATS (1). Smoking is strongly associated with ATS and an ischemic heart disease. The close relationship between hyperlipidemia, abnormal lipoprotein and ATS has been appreciated for many years (2). There are several studies on the role of lipid profile in increase of risk of CVDs, which have showed how the elements of lipid profile including triglyceride (TC) (e.g. increase of blood pressure, smocking and poor nutrition) might increase risk of CVDs (3-5). Studies in this field have made a great contribution to gradual promotion of the idea that systolic blood pressure (SBP) and diastolic blood pressure (DBP) are potential prognoses of CVD (6). Nowadays, researchers have recognized the key role of these factors in development and progress of CVDs so that mortality rate caused by cardiac diseases and hypertension is reported around 50% (7, 8).

2. Objectives

Several studies have examined the risk factors of CVDs and the relationship of cholesterol and blood pressure with other risk factors of the diseases. However, no study has examined the risk factors of cholesterol and hypertension in CVD simultaneously, using multivariate methods. In addition, the relationship of SBP and DBP with erythrocyte sedimentation rate (ESR) and C - reactive protein (CRP) in ATS is an untapped subject. The present study was first to study the probable relationship between these indices and hypertension in these diseases. The objective of this study was an examination of factors effecting systolic blood pressure, diastolic blood pressure, and total cholesterol simultaneously, using mixed responses model.

3. Methods

3.1. Study Population

This cross-sectional study comprised of 245 participants, hospitalized at different cardiology wards (except for angiography) of Shahid Madani State hospital, Khorramabad-Iran diagnosed with ATS in fall and winter 2014. The analyses were limited to participants older than 20 years, who attended the medical examination, and the method of sampling was convenience sampling. Complete medical records of the participants were taken into account by the study. Exclusion criteria included taking anti-hypertensive drugs, having diabetes, uncontrolled hypertension, special diseases or hyperlipidemia, being pregnant, and having had angiography.

After a brief introduction and securing a written/oral consent from the participants, the data was collected from medical files, admittance sheet, record sheet, and test results of the patients. For data gathering, 245 medical files with complete information were used. In addition, the protocol of the study was consistent with ethical guidelines of Helsinki Declaration of 1975.

3.2. Blood Chemistry

All the blood samples were analyzed in one laboratory unit located in the laboratory ward of Shahid Madani hospital. TC, HDL-C, and TG of the blood samples were measured and recorded based mg/dL. Total cholesterol (TC) was categorized at two levels, normal cholesterol (200 mg/dL or less is considered normal) and abnormal cholesterol (greater than 200 mg/dL is considered abnormal). Low density lipoprotein-cholesterol (LDL-C) was calculated by the Friedewald formula. The samples were examined using an auto-analyzer (Selectra E-Korea) purchased from Fanavaran Hayan Med Eng. Co., which was calibrated on daily bases, and biochemical kits were supplied by the Pars Azmun Company. The required tools for the laboratory operation were supplied by Negin Teb and Sina Teb companies. Erythrocyte sedimentation rate (ESR) reader, LENA, was used to measure ESR and ENISON kit was used to measure CRP through agglutination test. Triglyceride was measured using lipase glycerol kinase (GPO/PAP) enzymatic kit. The CRP on the basis of laboratory references (Virgo C-reactive protein 150 kit; Hemagen) was categorized at two levels; highly sensitivity-CRP (HS-CRP) and normal CRP (N-CRP).

3.3. Assessment of Covariates

Subjects were interviewed about their smoking history and classified as nonsmokers and smokers. Age and gender of the participants were also recorded. Blood Pressure (BP) was measured based on the first and fifth Korotkoff phases and recorded as SBP and DBP, respectively.

3.4. Methodology

Medical file of the patients hospitalized at the cardiac ward of Shahid Madani hospital, Khorramabad in fall and winter 2014, were examined to find candidate participants. Finally, 245 medical files with complete data and without any missing value were recorded. It is notable that the sample group included patients from other cities in vicinity of Khorramabad. Sample size was obtained according to Montazeri et al. (9) and assuming prevalence of chronic diseases of 20% (P = 0.2), Z = 1.96 (Z is 1.96 for 95% confidence level), error value (D = 0.05) and sample size (N).

3.5. Statistical Analysis

Descriptive statistics (mean, standard deviation (SD) and percentage) and inferential statistics were used for multivariate analysis using a latent variable model. Total Cholesterol was used as binary response variable and SBP and DBP were taken as continuous response variables.

4. Results

The study was carried out on 245 patients with ATS in Khorramabad SM hospital. In total, 116 males and 129 females participated in this study. As listed in Table 1, 27.8% of subjects were smokers, 20% had HS-CRP and 42% had abnormal cholesterol. Moreover, mean and standard deviation of age was 62.73 ± 13.35. Other baseline values of variables are reported in Table 1.

The results listed in Table 2 were obtained through fitting the latent variable model with three outcomes. The results showed that one unit increase in FBG, ESR and LDL led to 0.11, 0.42 and 0.22 MmHg increase in SBP, respectively.

Table 1. Baseline Values for Various Atherosclerosis Risk Factors in the Study Population[a]

Variable	Value
Gender	
Male	116 (47.3)
Female	129 (52.7)
Smoking	
Nonsmoker	177 (72.2)
Smoker	68 (27.8)
TC	
Normal	142 (58.0)
Abnormal	103 (42.0)
CRP	
N-CRP	195 (80.0)
HS-CRP	50 (20.0)
Age	62.73 ± 13.35
SBP	144.13 ± 30.47
DBP	85.64 ± 18.45
TG	176.7 ± 127.42
FBG	126.34 ± 62.01
ESR	15.88 ± 14.55
LDL-C	88.2 ± 28.59
HDL-C	39.54 ± 10.43

[a] Values are expressed as No. (%) or mean ± SD.

The mean of SBP at HS-CRP level was 12.29 mg/dL more than N-CRP. As listed in Table 2, for continuous outcome (DBP), age, FBG, HS-CRP and LDL were significantly higher.

The results in Table 2 for the binary outcome (TC) showed that the variables of age, TG and FBG increase z-scores of the probability of abnormal cholesterol by 0.51, 0.501 and 0.502 mg/dL, respectively. In other words, abnormal cholesterol levels increases with increase of age. Using the nonsmokers as the reference group, the z-score of the probability of abnormal cholesterol increases by 0.57 mg/dL. Thus, abnormal cholesterol levels increase in smoker subjects was more than that of nonsmokers.

5. Discussion

The results showed that factors effecting SBP were FBG, HS-CRP, ESR, LDL-C; and the factors influencing DBP were age, FBG, CRP and LDL-C. Moreover, the factors affecting TC were age, smoking, TG and FBG.

Hypertension increases risk of CVDs so it is considered as a potential risk factor of many diseases such as CVD, stroke and diabetes (10). In a study conducted in Argentina, 55% and 45% of the patients with FBG > 110 mg/dL had abnormal SBP and DBP, respectively (2). Our findings were consistent with the above findings so that SBP and DBP had a significant relationship with FBG. C - reactive protein (CRP) is one of the most important mediators that indicate level of inflammation in the blood. Despite its role as a prognosis of CVD, there are a few studies on the relationship between hypertension and CRP. In a cross-sectional study, researchers reported that hypertensive subjects had higher levels of circulating inflammatory factors, such as HS-CRP, than normotensive subjects. That is, there was a relationship between CRP and increase of blood pressure (11). In addition, cross-sectional studies on the relationship between hypertension and CRP have reported that patients with hypertension suffered from higher levels of CRP compared with normotensive patients (12). The data from the present study showed that HS-CRP affected factors effective on SBP; while such a significant effect between HS-CRP and DBP was not observed. In our study, a significant association was found between increase of SBP and ESR. In a retrospective study, a positive relationship was found between hypertension and ESR (13). In another study by Blaj et al. (14), ESR was significantly correlated with SBP, but not with DBP. Today, hypertension is known as the potential cause of CVD, liver disease, diabetes, stroke and heart attack. In a cross-sectional study performed in Bangladesh, hypertension was significantly related with LDL and HDL (15). Our findings showed an increase in the level of LDL for both SBP and DBP, while the relationship of SBP and DBP with HDL and TG was not significant. The inconsistency may be due to differences in age and gender distribution of the subjects. Consistently, a significant relationship between increase of LDL-C and blood pressure has been reported by several studies (1, 16). One unavoidable consequence of aging is increase in blood pressure (17). In this study, a positive association was found between age and DBP, which means that DBP increases with age. In addition, DBP is known as the main risk factor of CVD-related BP.

A significant relationship was found between age and cholesterol. Cholesterol level increases with age, however, there are evidences of very low cholesterol in the elderly, and in some cases a decrease in cholesterol has been reported. In a clinical study that was performed in 2002, subjects were divided to three groups: non-smokers, those who smoked 1 - 10 cigarettes, and subjects smoking 11 - 20 cigarettes per day. There was a significant relationship between TC and smoking habits only in the group with the highest rate of smoking (18). Our findings are consistent with the above findings, which means that there is a significant relationship between smoking and cholesterol. Triglyceride was an independent risk factor for CVD.

Table 2. Estimates, Standard Errors and P Values of the Association Between Risk Factors of Atherosclerosis and Systolic Blood Pressure, Diastolic Blood Pressure and Total Cholesterol From Mixed Responses Model

Variable	SBP			DBP			TC[a]			
	Estimate	SE[b]	P Value	Estimate	SE	P Value	Estimate	SE	Z Value	P Value
Age	0.21	0.15	0.168	0.24	0.09	0.032	0.12	0.05	0.51	0.016
Sex										
Male	.[c]									
Female	5.94	4.14	0.152	1.41	2. 57	0.581	0.09	0.18	0.54	0.612
Smoking										
Nonsmoker	-									
Smoker	4.14	4.37	0.345	1.87	2.72	0.491	0.18	0.07	0.57	0.01
TG	0.02	0.04	0.193	0.02	0.03	0.86	0.003	0.001	0.501	0.001
FBG	0.11	0.03	0.001	0.06	0.02	0.002	0.004	0.002	0.502	0.021
CRP										
N-CRP	-									
HS-CRP	12.29	5.21	0.021	8.28	3.24	0.011	0.28	0.24	0.39	0.243
ESR	0.42	0.15	0.004	0.01	1.09	0.884	0.02	0.01	0.51	0.133
LDL	0.22	0.07	0.002	0.1	0.04	0.027				
HDL	0.02	0.18	0.933	0.11	0.13	0.322				

[a] Normal cholesterol was reference group.
[b] Standard error.
[c] Comparator Group.

In this cross-sectional study, subjects who had higher levels of TG showed four times more increase in heart attacks compared to normal TG levels (19). Moreover, a significant relationship was found between cholesterol and TG. These results provide a population-based support for the hypotheses about biological relationships between blood pressure and TC, and indicated that pathophysiological factors underlying these relationships may influence the mechanisms, whereby, increase of blood pressure is associated with increase of risk of ATS. The advantages of the present study were using multivariate model and reliance on correlation between the response variables to achieve a more reliable estimate of the variables. Another advantage of the study was examination of the relationship of SBP and DBP with ESR and CRP, which makes the study unique.

5.1. Conclusion

Given the results obtained in this study and those of similar studies on different populations, the role of blood lipids, including cholesterol and hypertension on increase of ATS- and CVD-caused death was supported. In addition, joint effects of these factors intensified risk of the diseases. Individuals with high risk of CVDs are recommended to prevent the diseases and ATS by controlling their blood pressure and blood lipids. Considering the importance of cardiovascular disease and its associated risk factors, it is essential to perform further studies in this field.

5.2. Study Limitations

As to limitations, lack of information about any other disease and variables such as inflammatory indices, anthropometric variables and demographics of the patients (e.g. education, number of family members, chronic and diseases background) are notable.

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Footnote

Authors' Contribution: Study concept and design: Fereshteh Mazhariazad, Zahra Salehi, Sahar Dalvand and Reza Ghanei Gheshlagh; statistical analysis and interpretation of data: Sahar Dalvand; data collection: Hossein Zahednezhad, Nazli Ebrahimi, Vahid Rahmani and Mahboubeh Nazari; manuscript drafting: Fereshteh Mazhariazad, Masoud Taheri-Asl and Reza Ghanei Gheshlagh; critical revision of the manuscript as for important intellectual content: Fereshteh Mazhariazad, Mahboubeh Nazari, Nazli Ebrahimi, Reza Ghanei Gheshlagh and Hossein Zahednezhad; technical and material support: Reza Ghanei Gheshlagh, Sahar Dalvand, Hossein Zahednezhad and Mahboubeh Nazari.

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