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# Evaluation of the Effect of Demographic, Biochemical, and Lifestyle Variables on Incidence of Hypertension in the Last Five Years in Kerman: Findings From KERCADRS Cohort Study

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**Abstract**

**Background:** Hypertension is an important cause of cardiovascular-related morbidity and mortality. This study aimed to evaluate the effect of demographic, biochemical, and lifestyle variables on hypertension in the last five years in Kerman, Iran.

**Methods:** About 2055 adults were randomly selected through single-stage cluster sampling. Demographic characteristics, biochemical variables, tobacco use, opium use, mood, and physical activity were examined. The effect of the studied variables on hypertension was also measured. COPY methods were used to estimate relative risk (RR) and create confidence intervals. All statistical analysis were done in R 4.4.1.

**Results:** Based on the results obtained using the multivariable COPY method for hypertension, the effects of age, education, physical activity, diabetes, obesity, smoking, anxiety, and depression were significant. It was also found that people with a family history of hypertension and a history of diabetes, obesity, and smoking are at higher risk for hypertension.

**Conclusion:** The present study showed that the results of this study can be effective in designing and implementing intervention programs for the control and prevention of hypertension in this area.

**Keywords:** Hypertension, Relative risk, Cohort, Kerman, Iran

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## Introduction

Blood pressure is the force the circulating blood exerts against the blood vessels. Blood pressure is written as two numbers: the first (systolic) number represents the pressure in blood vessels when the heart contracts or beats, and the second (diastolic) number represents the pressure in the vessels when the heart rests between beats. Hypertension is defined as systolic blood pressure equal to or above 140 mm Hg or diastolic blood pressure equal to or above 90 mm Hg (1,2). The global prevalence of hypertension is predicted to be up to 30% by 2025. Hypertension is a risk factor for heart attack, as well as stroke, congestive heart failure, and peripheral vascular disease (3-5). High blood pressure is common, but it is asymptomatic and often undetectable (6). Also, the World Health Organization estimates that 600 million people worldwide are at risk for major cardiovascular events, including heart attack, stroke, and heart failure (7). In addition, high blood pressure accounts for 13% of all deaths, including 7.1 million deaths per year, 62% of total strokes, and 49% of total heart attacks (8). Taking medication has been shown to reduce high blood pressure and reduce the risk of complications of cardiovascular disease, including stroke, coronary heart disease, and kidney failure (9-12). In addition, according to previous reports, hypertension is the second contributor to the global burden of disease. In developing countries, economic growth and associated sociodemographic changes have brought significant changes that may be associated with an increased prevalence of non-communicable diseases, such as hypertension (13). According to a study in Iran, approximately 6.6 million Iranians aged 25 to 64 had have hypertension, and 12 million had have prehypertension in this age group (4). Globally, 17 million deaths per year are caused by cardiovascular disease, i.e., nearly one-third of total deaths. Hypertension is responsible for at least 45% of

deaths due to heart disease and 51% of deaths due to stroke (3). According to a report, approximately 40% of adults aged 25 and above were diagnosed with hypertension worldwide in 2008; the number of people with the condition rose from 600 million in 1980 to 1 billion in 2008, and hypertension was responsible for at least 45% of deaths (14). The highest prevalence of hypertension has been reported in the African region (46% of adults 25 years and older), and the lowest prevalence was found in the United States (35%). In low- and middle-income countries the prevalence of hypertension is higher than high-income countries (40% compared to 35%) (4). In developing countries such as Iran, the prevalence of hypertension is evident (15). The increasing prevalence of hypertension is due to population growth, aging and behavioral risk factors, lack of physical activity, overweight, and constant stress exposure; these risk factors include tobacco use, obesity, high cholesterol, and diabetes mellitus (14). Also, smoking increases the risk of complications among those with hypertension (3). The results of this review may be beneficial for policymaking through the early detection of hypertension in this population.

## Methods

### *Study population*

This study is part of a larger study on coronary artery disease risk factors (the KERCADR study) in Kerman, the largest province in southeast Iran. KERCADRS Phase 1 was a population-based cohort study conducted from 2009 to 2012 on 5900 individuals aged between 15 and 75. The study sample was recruited using a non-proportional one-stage cluster sampling household survey. Briefly, 250 postal codes (as clusters) were selected randomly among an up-to-date roster in the provincial post office. The research coordinating team approached households, and all the eligible members (15–75 years old) of the household were recruited for the study in clusters. The recruitment was continued until 24 subjects were allotted to each cluster. In this study, the necessary information from the studied samples, including age, level of education, occupation, mental state (anxiety and depression), physical activity, smoking and opium use, and blood pressure, were collected using a standard questionnaire (Beck Anxiety and Depression Inventory, WHO Physical Activity Questionnaire, GPAQ 2013).

Blood samples were taken for fasting blood glucose, cholesterol, and triglyceride tests. Body mass index (BMI) above 25 and above 30 were considered overweight and obese, respectively. Individuals who reported smoking and using opium at the time of the interview were considered smokers and opium users, respectively. People who said they used opium regularly and had withdrawal symptoms when they stopped using it were considered opium dependent. More details on the sampling and sample size calculation have already been published (16). All participants signed a written informed consent. The second phase of this study was repeated five years later, between 2014 and 2018, on 10000 subjects, of whom 2813 participants were among the participants of the first phase. The rest of the participants were lost to follow up because their address had changed, they had left the city of Kerman, or they had died between the two phases. From the data of 2813 subjects, those whose hypertension status was unknown (missing data) and people who had hypertension in the first phase of the study were excluded, so the sample size was reduced to 2055 people (17).

### *Statistical analysis*

Data entry and analysis were performed using IBM SPSS version 23. In order to analyse the obtained data, frequency, and percentage were calculated.. We conducted the statistical analysis using R software to evaluate the effect of the studied variables and the relative risk (RR) index. As our response variable was binary, logistic regression had to be used. In logistic regression, the results are reported as odds ratio, but our goal was RR, so we used the log-binomial regression model. This model yields RR. However, this method also has the problem of non-convergence, so we used the COPY method to solve this problem. In the univariate COPY method, variables whose *P* value is less than 0.2 are entered into the multivariable model. Finally, *P* values less than 0.05 were used to identify significant variables in the model with the backward approach. The results were expressed as RR with 95% confidence interval (CI).

## Results

Among the 2055 participants in the study, the average age was 41.4 ± 14.1, the lowest age was 15 years, and the highest age was 75 years.

Table 1 describes the status of qualitative variables in the study based on their frequency and percent. Table 1 shows that hypertension is directly related to the variables of education level, level of physical activity, history of hypertension in the family, diabetes, hyperlipidemia, obesity, anxiety, and depression. In addition, hypertension is inversely related to gender, smoking, and opium consumption.

Table 2 shows the RR, *P* value, and 95% Ci estimation of the univariate and multivariable COPY method.

In the univariate COPY method, variables whose *P* value is less than 0.2 are entered into the multivariable model. According to Table 2, the *P*-values related to age, education level, physical activity, family history of hypertension, diabetes, obesity, hyperlipidemia, smoking, opium use, anxiety, and depression were less than 0.2. Our multivariable model was then determined using the backward method. The model obtained by the multivariable COPY method analysis revealed that for every year of aging, the risk of hypertension increased

**Table 1.** Distribution of the studied variables according to hypertension status ($N=2055$)

| Variable | | Hypertension | | *P* value |
|---|---|---|---|---|
| | | Yes n (%)8 | No n (%) | |
| Sex | Female | 143 (14.9) | 816 (85.1) | 0.62 |
| | Male | 155 (14.1) | 941 (85.9) | |
| Level of education | Illiterate | 50 (34.0) | 97 (66.0) | <0.001 |
| | Under diploma | 122 (17.3) | 584 (82.7) | |
| | Diploma | 74 (9.4) | 711 (90.6) | |
| | Associate & Bachelor | 46 (12.0) | 338 (88.0) | |
| | MSc and higher | 6 (18.2) | 27 (81.8) | |
| Physical activity | Low | 136 (15.6) | 737 (84.4) | 0.03 |
| | Moderate | 145 (14.8) | 836 (85.2) | |
| | Severe | 17 (8.5) | 184 (91.5) | |
| History of hypertension in the family | Yes | 161 (17.0) | 786 (83.0) | 0.003 |
| | NO | 137 (12.4) | 971 (87.6) | |
| Diabetes | Yes | 58 (34.1) | 112 (65.9) | <0.001 |
| | NO | 240 (12.7) | 1645 (87.3) | |
| Hyperlipidemia | Yes | 32 (11.1) | 256 (88.9) | 0.08 |
| | NO | 266 (15.1) | 1501 (84.9) | |
| Obesity | Yes | 211 (19.5) | 871 (80.5) | <0.001 |
| | NO | 87 (8.9) | 886 (91.1) | |
| Smoking | Yes | 38 (17.4) | 181 (82.6) | 0.20 |
| | NO | 260 (14.2) | 1576 (85.8) | |
| Opium consumption | Dependent | 44 (17.0) | 215 (83.0) | 0.48 |
| | Occasional | 9 (14.1) | 55 (85.9) | |
| | No | 245 (14.1) | 1487 (85.9) | |
| Anxiety | No | 75 (14.2) | 454 (85.8) | 0.01 |
| | Mild | 65 (10.9) | 533 (89.1) | |
| | Moderate | 88 (17.2) | 423 (82.8) | |
| | Severe | 70 (16.8) | 347 (83.2) | |
| Depression | No | 182 (13.2) | 1194 (86.8) | 0.04 |
| | Mild | 97 (16.7) | 485 (83.3) | |
| | Moderate | 19 (19.6) | 78 (80.4) | |

(RR = 1.05; 95 % CI: 1.04–1.05; $P<0.001$). The risk of hypertension was higher for those with a history of hypertension in the family (RR = 1.60; 95 % CI: 1.53–1.66; $P<0.001$) and for those who had diabetes (RR = 1.44; 95 % CI: 1.27–1.64; $P<0.001$) and obesity (RR = 1.61; 95 % CI: 1.39–1.86; $P<0.001$). Also, the risk of hypertension was higher for those who smoked (RR = 1.21; 95 % CI: 1.00–1.47; $P=0.049$).

## Discussion

Hypertension is one of the major factors threatening human health, and it is one of the most common chronic diseases, particularly in developing countries, including Iran; it is essential to evaluate risk factors for hypertension in order to identify groups of patients that could benefit from preventive measures (18). This study investigated the effect of the study variables on incidence of hypertension in the last five years in Kerman. According to the results of this study, the prevalence of hypertension in women (14.14%) and in men (14.91%) was not significantly different. The variables of age, level of education, family history of hypertension, diabetes, obesity, smoking, anxiety, and depression were risk factors associated with hypertension.

The results of this study showed that there was a relationship between obesity and hypertension. The study's conclusions follow those of the studies by Leggio et al (19), who also found a relationship between obesity and hypertension. The results of this study found that the average BMI of the respondents with hypertension was higher than that of the respondents without hypertension. The nature of the correlation between hypertension and body weight remained uncertain until the mid-1980s when basic clinical and population-based research explained the significance of the association between several factors and these two common and complex regulatory disturbances. Over the same time, the clinical importance of hypertension caused by obesity increased dramatically, to the degree that obesity is now recognized as a major cause of hypertension, and the combination of obesity and hypertension is recognized as a major cardiovascular risk (19).

The results of this study are in line with those of the study of Najafipour et al, who studied the effect of opium addiction and six other risk factors on hypertension using a population study on 5900 people in Kerman (20). They found that the prevalence of hypertension in adults in Kerman was about 18.5% and had a positive correlation with opium use, age, hyperlipidemia, diabetes, low level of education, physical activity, and obesity. However, in our study, the effects of opium consumption and hyperlipidemia were not significant. In addition, the findings of Keshvari et al. showed that there is a significant relationship between hypertension, diabetes, and hyperlipidemia (6).

As one grows older, their risk of developing hypertension also increases as the blood vessels become more stiff (21). Also, the heavier one is, the more blood flow is needed to supply oxygen and nutrients to cells and tissues; as blood flow increases, so does the pressure inside the arteries (22). High blood pressure and diabetes often occur together, and the two seem to share some risk factors. Lifestyle changes can help control blood pressure and blood sugar (23). Past studies indicate that performing moderate-to-vigorous physical activity, particularly aerobic exercise, and improving cardiorespiratory fitness lowers blood pressure. Although evidence is limited, performing resistance exercises increase muscular strength and appears to be associated with and accompanied by a decrease in high

**Table 2.** Effect of the studied variables on the incidence of hypertension

| Variable | | Univariate model | | | Multivariable model | | |
|---|---|---|---|---|---|---|---|
| | | RR | 95% CI | *P* value | RR | 95% CI | *P* value |
| Age | | 1.05 | (1.04–1.05) | <0.001 | 1.05 | (1.04–1.05) | <0.001 |
| Sex | Women | 1.05 | (0.91–1.22) | 0.48 | | | |
| | Men | 1 | | | | | |
| Level of education | Illiterate | 0.51 | (0.42–0.62) | <0.001 | | | |
| | Under diploma | 0.53 | (0.31–0.91) | 0.02 | | | |
| | Diploma | 1 | | | | | |
| | Associate Bachelor | 0.24 | (0.17–0.34) | <0.001 | | | |
| | MSc and higher | 0.52 | (0.39–0.70) | 0.009 | | | |
| Physical activity | Low | 0.54 | (0.38–0.76) | <0.001 | | | |
| | Moderate | 1 | | | | | |
| | Severe | 0.95 | (0.81–1.10) | 0.50 | | | |
| History of hypertension in the family | Yes | 1.37 | (1.18–1.60) | <0.001 | 1.60 | (1.53–1.66) | <0.001 |
| | No | 1 | | | 1 | | |
| Diabetes | Yes | 2.68 | (2.26–3.17) | <0.001 | 1.44 | (1.27–1.64) | <0.001 |
| | No | 1 | | | 1 | | |
| Obesity | Yes | 2.18 | (1.85–2.57) | <0.001 | 1.61 | (1.39–1.86) | <0.001 |
| | No | 1 | | | 1 | | |
| Hyperlipidemia | Yes | 0.74 | (0.58–0.94) | 0.01 | | | |
| | No | 1 | | | | | |
| Smoking | Yes | 1.22 | (0.98–1.53) | 0.07 | 1.21 | (1.00–1.47) | 0.049 |
| | No | 1 | | | 1 | | |
| Opium consumption | Dependent | 1.20 | (0.98–1.48) | 0.08 | | | |
| | Occasional | 0.98 | (0.63–1.95) | 0.88 | | | |
| | No | 1 | | | | | |
| Anxiety | Very light | 1.30 | (1.05–1.62) | 0.02 | | | |
| | Mild | 1 | | | | | |
| | Moderate | 1.58 | (1.28–1.95) | 0.01 | | | |
| | Severe | 1.54 | (1.24–1.93) | <0.001 | | | |
| Depression | No | 1 | | | | | |
| | Mild | 1.26 | (1.07–1.09) | 0.004 | | | |
| | Moderate | 1.48 | (1.48–2.00) | 0.01 | | | |

blood pressure. Furthermore, replacing sedentary time with physical activity might lower hypertension (24).

Another study reported that hypertension is significantly related to smoking habits, diabetes mellitus, cardiovascular disease, chronic kidney disease, BMI, waist circumference, and education level (25). Another study found that there was a relationship between the number of cigarettes and the incidence of hypertension in people with high blood pressure. Cigarette smoke contains nicotine and carbon dioxide, which damage the vascular artery endothelial layer by reducing the elasticity of the blood vessels, leading to hypertension (26).

The results of the present research are in line with those of the study by Rutledge and Hogan, who showed that anxiety and depression could be part of the maladaptive responses to stressors, causing high blood pressure and other diseases (27).

## Conclusion

In conclusion, the incidence of hypertension among Iranians is concerning. Therefore, future strategies should focus on hypertension prevention and early detection of hypertension in these patients. Routine screening, appropriate education of patients' families and their caregivers, and integration of health services into medical services available for these patients may reduce the burden of hypertension in this population.

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**Authors' Contribution**

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**Competing Interests**

The authors hereby state that the present study has no conflict of interest.

**Ethical Approval**

The Ethics Committee of Kerman University of Medical Sciences approved the study protocol (IR.KMU.REC.1398.503).

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