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# The Prevalence of Hypertension and Its Relation to Age, Body Mass Index, and Physical Activity Among High School Girls in Daniel Susa, Iran 2014

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**Abstract**

**Background:** Hypertension is the most common public health problem that its prevalence increases along with the prevalence of obesity among children and adolescents. It also has a direct relationship with cardiovascular diseases in adults.

**Objectives:** This study was performed to determine the prevalence of hypertension among high school girls in Susa, Iran and its relation to age, body mass index, and physical activity.

**Patients and Methods:** In this cross sectional study, 400 female students aged 15 - 19 years were selected using multistage cluster random sampling method. Their height, weight, and blood pressure (blood pressure was measured twice while in sitting position) were measured by standard methods. The international physical activity questionnaire (IPAQ) was used to score their physical activity. The individual questionnaire was completed by essential question toward hypertension. Data were analyzed with SPSS version 22 using descriptive indexes and the Chi-square and Pearson tests while $P < 0.05$ was considered as significant.

**Results:** The prevalence of hypertension and prehypertension is 5% and 40.3% in the high school girls, respectively. The frequency of age ranges between 14 and 18 years, with the highest frequency belonged to the age of 16 years. Also, there was a significant relationship between age and increase in blood pressure ($P = 0.022$). Direct significant linear relationship and difference were reported between hypertension and exercise ($P = 0.025$), as well as body mass index ($P = 0.036$).

**Conclusions:** The results showed a high prevalence of hypertension in girls with little difference with regard to ethnic groups, indicating that the use of training programs to adjust and modify lifestyle attitudes not only is effective in reducing hypertension, but also can prevent the adolescents' susceptibility to the diseases that cause disability, increased living costs and weakened family ties.

*Keywords:* Prevalence, Blood Pressure, BMI, Adolescent Girls, Physical Activity

## 1. Background

Hypertension is a health problem, a top global disease, and known as a serious risk factor for cardiovascular diseases (1). Prevalence of high blood pressure is increasing in the pediatric population in accordance with the childhood obesity epidemic and lifestyle changes (2). The worldwide rising prevalence of overweight has led to an increased rate of essential hypertension among younger population (3). According to WHO reports, in our country, 41.3% of all deaths in 2005 have been due to cardiovascular diseases and it is anticipated that this number will reach 44.8% by 2030 (4). Also, 54% of myocardial infarctions and 47% of ischemic heart diseases have been linked to hypertension. The prevalence of hypertension in Iran has been reported as 40%, while among people aged 16 - 65 years, this figure is 17.6%. Hypertension has affected 39.5% of the world population (5). The action plan of WHO for prevention and control of non-communicable diseases in 2013 - 2020 has aimed at a 25% relative reduction in the prevalence of hypertension (HTN) (6). The increase in the prevalence of HTN in older women causes higher mortality rate than in men, and 60% of the deaths, which are directly associated with hypertension occur in women (7).

Modifications of lifestyle risk factors, such as increase in exercise levels and reduction in body weight, have been shown to significantly decrease blood pressure levels and hypertension rates (8, 9). Study on the prevalence and early diagnosis of hypertension in adolescence is an important strategy for the general control and prevention of cardiovascular diseases (10).

Although many studies have suggested that age, body mass index, and physical activity can affect the prevalence of hypertension (4, 11, 12), some contradictorily reports denied its effect (13). Blood pressure is affected by changes in lifestyle, including weight loss, reduced sodium intake, and increased physical activity and tuning body mass index (14). Several studies have shown that the prevalence of obesity in people aged 2 to 19 years has increased from 5.5% to 16.9% by 2010 (15). So studies demonstrate that BP values increase progressively until the age of 17 - 18 years when it reaches to adult values. This

increase in blood pressure is most rapid during the first few weeks of life and then during puberty (16).

## 2. Objectives

The changes in lifestyle and dramatic rise in adolescents' obesity in developing countries are considered a major driving force behind the high prevalence of hypertension. Therefore, the present study was performed to determine the prevalence of hypertension and related factors among high school girls in the city of Susa, Iran.

## 3. Patients and Methods

This study was performed on high school girls aged 15 to 18 years in the city of Susa, Iran in 2014. After obtaining permission from the relevant authorities, the name and number of girls' high schools were obtained from the Department of Education. Then, 4 high schools were selected by cluster and simple random sampling. A total sample size was determined (17) by the following equation:

(1) $$n = \frac{Z^2_{\frac{1-\alpha}{2}} \times P_{1-p}}{d_2} = 400$$

Where d = 0.04, P = %18.5, and α = 0.05.

Informed consent was obtained from adolescent girls, and data were collected through interviews and questionnaires. Clear explanation of the study aims and methods preceded taking written informed consent from parents and verbal assent from students. Study was approved by the Ethics Committee of Jundishapur University of Medical Sciences.

In this research, the data collection instrument consisted of a questionnaire assessing age, anthropometric indexes, and physical activity of the study population. The validity of the questionnaire was evaluated by 10 members of the faculty, and its reliability was reported 79% by the Cranach α. The international physical activity questionnaire (IPAQ) was also used, whose reliability was reported to be 0.8 (18, 19).

With regard to anthropometric indexes, weight was measured with a dial calibrated scale (Shaghayegh, manufactured in Iran) with the sensitivity of 0.1 kg. The scale was placed on a flat surface and was daily balanced to zero with a standard weight. Weight was measured twice without shoes while the participants were wearing light clothing; and the average was calculated as final weight. Their height was measured with a seca height meter mounted on the wall, with the sensitivity 0.1 cm. The height was measured in standing position next to a wall, without shoes, and feet stuck together, with heels, buttocks, shoulders, and back of head tangent to the wall. In this case, the highest point of the head on the wall was recorded. Height was measured twice, and the average was calculated as the final height. Body mass index is calculated as the ratio of weight in kilograms to height in square meters. According to the US Center for Disease Control and Prevention (CDC, 2000), BMI less than 85th is defined as underweight for one's age and gender, between the 85th and 95th percentile as overweight and above 95th as obese (20-22). Systolic and diastolic blood pressure was measured from the right arm twice at least 5 minutes after rest (during this period, the student's hands were in a suspended state) using a Japanese calibrated aneroid sphygmomanometer with an appropriate cuff size and a Japanese stethoscope. The cuff bladder length should cover 80% to 100% of the circumference of the arm and deflated the bladder. During the study, the sphygmomanometer of the researcher and his assistant was compared 3 times with a normal sphygmomanometer, to ensure its authenticity. To determine hypertension, we used the tables provided by the fourth report on the diagnosis, evaluation and treatment of high blood pressure in children. A percentile less than 90 was considered as normal blood pressure, the percentile higher than 90 as prehypertension, and blood pressure equal to or more than 95 as hypertension (1, 23).

The collected data was analyzed using SPSS V22. We performed descriptive statistics (percentages and frequencies to determine the frequencies) and inferential statistics (the Chi-square test and the Pearson test) to examine the relationship between the variables and the incidence of hypertension. $P < 0.05$ was considered as the level of significance. For quantitative measures, mean and standard deviations (SD) with 95% confidence intervals (CIs) were calculated. Missing data were not included in the analyses.

## 4. Results

In this study, the participants were 400 female students whose data on the relative age distribution are presented in Table 1.

**Table 1.** The Frequency of Age Distribution and Diastolic Blood Pressure

| | Diastolic Blood Pressure, mmHg | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 50 | 60 | 70 | 80 | 90 | 100 | |
| **Age, y** | | | | | | | |
| 15 | 8 | 34 | 19 | 25 | 11 | 2 | 99 |
| 16 | 6 | 52 | 29 | 36 | 24 | 0 | 147 |
| 17 | 1 | 42 | 26 | 31 | 14 | 1 | 115 |
| 18 | 1 | 7 | 10 | 13 | 7 | 1 | 39 |
| **Total** | 16 | 135 | 84 | 105 | 56 | 4 | 400 |
| **Prehypertension stage** | | | | | | | 14% |
| **Hypertension** | | | | | | | 0.05% |

Tables 1 - 5 show the physical, BMI, systolic and diastolic blood pressure, and physical activity of the participants indicating that blood pressure increased with age and BMI. The prevalence of prehypertension and hypertension state in students are shown too.

According to Tables 1 - 3, the highest frequency in this study was belonged to the age of 16 years (36.75%), with a 95% confidence interval (69.43% - 73.29%) and (107% - 110.27%) for the mean diastolic and systolic blood pressures. According to the statistical values, a significant difference is observed between the age and blood pressure (P = 0.022).

**Table 2.** The Frequency of Age Distribution and Systolic Blood Pressure

| | Systolic Blood Pressure, mm Hg | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 80 | 90 | 100 | 110 | 120 | 130 | |
| **Age, y** | | | | | | | |
| 15 | 2 | 13 | 32 | 28 | 19 | 5 | 99 |
| 16 | 1 | 13 | 40 | 46 | 41 | 6 | 147 |
| 17 | 2 | 10 | 40 | 29 | 29 | 5 | 115 |
| 18 | 3 | 3 | 3 | 12 | 16 | 2 | 39 |
| **Total** | 8 | 39 | 115 | 115 | 105 | 18 | 400 |
| **Prehypertension stage** | | | | | | | 4.5% |
| **Hypertension** | | | | | | | - |

**Table 3.** The Frequency Distribution and Percentage of Blood Pressure With Respect to Age

| Age, y | Frequency [a] | Mean DBP, mm Hg | Mean SBP, mm Hg | Systolic Confidence Interval | 95% Diastolic Confidence Interval |
|---|---|---|---|---|---|
| **14** | 4 (2.5) | 67 | 108 | (60.21 and 73.79) | (115.39 and 100.61) |
| **15** | 89 (22.25) | 70.67 | 105.73 | (73.37 and 67.98) | (107.97 and 103.49) |
| **16** | 147 (36.75) | 71.36 | 108.63 | (73.29 and 69.43) | (110.27 and 107) |
| **17** | 115 (28.75) | 71.56 | 109.2 | (73.61 and 69.52) | (111.2 and 105.3) |
| **18** | 36 (9) | 75 | 109.72 | (78.92 and 71.8) | (114.04 and 105.4) |
| **19** | 3 (0.75) | 80 | 113.33 | (104.48 and 55.16) | (120.2 and 100.4) |

[a] The frequency are presented as No. (%).

**Table 4.** The Relationship Between Blood Pressure and Physical Activity in Adolescents [a]

| Hypertension | Physical Activity | | P Value | Chi-Square |
|---|---|---|---|---|
| | Do exercise During the Week | Don't Exercise During the Week | | |
| **Frequency** | 63.75 | 36.25 | | |
| **Diastolic prehypertension** | 26.20 | 26.27 | | |
| **Diastolic hypertension stage 1** | 14.48 | 13.72 | 0.029 | 6.143 |
| **Diastolic hypertension stage 2** | 0.68 | 1.17 | | |
| **Systolic prehypertension** | 31.72 | 30.58 | 0.025 | 1.74 |

[a] The values are presented as percent.

**Table 5.** The Relationship Between Blood Pressure and Weight Status in Adolescents [a]

| Blood Pressure | Body Mass Index | | | | P Value | Chi-Square |
|---|---|---|---|---|---|---|
| | Normal | Underweight | Overweight | Obese | | |
| **Frequency** | 290 (72.5) | 79 (19.75) | 21 (5.25) | 10 (2.5) | | |
| **Diastolic prehypertension** | 74 (18.5) | 4 (16) | 21 (2.75) | 4 (1) | | |
| **Diastolic hypertension stage 1** | 41 (10.25) | 6 (1.5) | 9 (2.25) | 0 | < 0.0001 | 75.295 |
| **Diastolic hypertension stage 2** | 2 (5) | 0 | 0 | 2 (0.5) | | |
| **Normal diastolic blood pressure** | 173 (43.25) | 57 (14.25) | 1 (0.25) | 2 (0.5) | < 0.0001 | 66.48 |
| **Systolic prehypertension** | 93 (23.25) | 20 (5) | 10 (2.5) | 1 (0.25) | | |
| **Normal systolic blood pressure** | 197 (49.25) | 59 (14.75) | 11 (12.75) | 9 (2.25) | | |

[a] The values are presented as No. (%).

Table 4 shows that 36.25% of the students do not exercise during the week, while 63.75% gave positive answer. About 26.20% and 14.48% of those who did exercise during the week were in diastolic prehypertension stage and stage 1 diastolic blood pressure, respectively, and 30.58% of the girls who did not do exercise during the week had systolic prehypertension. The statistical values show a significant difference (P = 0.025), but it should be noted that there is no significant difference in physical activity and inactivity patterns and the prevalence of diastolic and systolic hypertension.

Table 5 shows the positive relationship between BP levels and weight status (underweight, normal weight, overweight/obese). A total of 79 persons (19.75%) were underweight. The girls who were underweight had almost close percentage between normal diastolic (14.25%) and systolic blood pressure (14.75%). One of the overweight girls (0.25%) had normal diastolic blood pressure, and 11 overweight girls (2.75%) had normal systolic blood pressure. Two (0.5%) and 9 (2.25%) obese girls had normal diastolic and systolic blood pressure, respectively. For both systolic and diastolic blood pressures, the statistical values showed a direct linear relationship according to the correlation test (diastolic blood pressure, P < 0.001; and systolic blood pressure, P = 0.036).

## 5. Discussion

The results of this study showed high prevalence of hypertension (5%) and prehypertension (40.3%) among female students of Susa, which would be a risk factor for cardiovascular and kidney diseases. In particular, 14% and 0.5% of the students were in diastolic prehypertension stage and diastolic hypertension stage, respectively. About 26.3% of female students had systolic prehypertension and 4.5% of them had systolic hypertension. The results are comparable to the findings of other studies. In a study that was performed on 7 - 14 years old students to determine the risk factors in France, Monteg showed that 5.7% of girls had hypertension (24). An epidemiological study by Falkner showed that the prevalence of hypertension is less than 3% in children and adolescents (25). In addition, Taheri et al. (26) showed that the prevalences of high systolic and diastolic blood pressure were 8.5% and 6.5, respectively. However, in this study, 0.12% of the people at the age of 17 had prehypertension, and there was also high prevalence of hypertension (8.6%) in the girls aged 16 years old. In a study that was performed by Abdulle et al. (2014) to determine hypertension and its relation to body weight among 1600 students (47% female and 53% male) in Abu Dhabi (United Arab Emirates), the prevalence of prehypertension was 10.5% in males and 11.4% in females, and the prevalence of hypertension was calculated to be 15.4% in males and 17.8% in females (27). In America, Lo et al. (28) reported the prevalence of prehypertension as 12.7% and the prevalence of hypertension as 5.4% among young people. In a large Caspian study with 13486 participants (49.2% girls and 75.6% boys), the prevalence of hypertension was reported to be higher in girls. About 17.4% and 4.33% of them had systolic and diastolic hypertension, respectively (5). Another study in India in 2010 reported that 5.9% of children had hypertension, and 12.3% of them were in prehypertension stage (29).

The present study shows a high prevalence of prehypertension, compared to other studies, which predicts high prevalence of hypertension in the near future. In line with other studies, hypertension has a significant relationship with increasing age. A comparison between the results of the present study and these studies shows the prevalence of hypertension since childhood (30). However, the differences in the prevalence of prehypertension and hypertension can be due to many reasons, such as sample size, gender, number of blood pressure readings, and different methodologies. Most studies have focused on childhood and adolescence ages, and the criteria of fourth Task Force were used to determine hypertension status (1, 23). We also used these criteria in this study, where the rate of prevalence of hypertension is slightly different from those in previous studies. This indicates an increase in the prehypertension in recent years. It is a wake-up call that the progression to heart disease and hypertension can be prevented with the right and logical planning.

Table of physical activity shows that, although in the present study, more than half of the students do exercise during the week, the statistical values show that the percentage of diastolic and systolic hypertension is very close together in the two groups, and a statistically significant difference was found between physical activity and diastolic hypertension (P = 0.029). A study on Nepali adult men and women by Vaidya and Krettek (31) showed that the prevalence of hypertension is equal to 43.3%, indicating a significant relationship (P < 0.05) with low physical activity. In this study, 35 people who did not exercise had diastolic prehypertension, and 2 people were prone to diastolic hypertension, showing that there was a significant relationship between them according to the Chi-square test (P = 0.025). Different factors are involved in the reduction of physical activity, including physical inactivity pattern of the family because of the modern life, the reduced number of group games, higher prevalence of video games, and watching TV. A study in Bushehr showed that more than half of obese patients (58.3%) had less than 30 minutes of physical activity per day (32). A study by Jackson et al. (33) in Australia showed that physical activity has relationship with the risk of increased blood pressure. There was a weak positive relationship between physical activity and the variables of obesity and hypertension. The risk of hypertension was 3.4 times higher in obese women with high physical activity and was 4.9 times higher in inactive sedentary obese women. Given the importance of physical activity and exercise to lower blood pressure, which has been demonstrated in the literature, a program should be designed to encour-

age high school girls who expressed the importance of exercise throughout the day. Physical activities can promote a healthy lifestyle and reduce the complications of inactivity.

In the present study, a direct linear relationship was observed between hypertension and the variables of weight gain and obesity. A study by Lu et al. (34) in Shanghai, China showed that the prevalence of diastolic and systolic hypertension is higher among overweight and obese children. In an Indian study by Rao et al. (35) 9.7% of school girls had high systolic blood pressure, and blood pressure increased with obesity. Peymani et al. (36) showed that the prevalence of hypertension in obese women was significantly higher than that in women with normal weight ($P < 0.001$). Also they showed that BMI was a stronger predictor of hypertension in girls. Our results are in line with the above studies, but there is a difference among the sample size reported in the studies. Since the data in Salem's study (17) is 3 times greater than that in the present study, greater percentage of hypertension was reported. In Rao et al. (35) study, the subjects included adolescent girls and boys; but screening in the present study was performed on adolescent girls whose gender is naturally effective in determining the hypertension. The low sample size can be considered a limitation of this study, and for a closer look at the prevalence and factors associated with the hypertension, it was better to examine the food consumption pattern, education level of the family, and socioeconomic status, so that with the needs assessment and lifestyle awareness of the subjects, some solutions can be implemented to prevent hypertension.

Generally, women are considered the main pillar of social development and the foundation for family health (37). According to the results of this study, although the problem of obesity and overweight among adolescents in the city of Susa was reported less than other parts of the country, the prevalence of prehypertension needs more attention and precise control. Given the role of socioeconomic and cultural factors underlying obesity, as well as decreased mobility and increased blood pressure in adolescents, it is necessary to provide knowledge for the students and their families. Many undesirable consequences and complications of hypertension can be reduced by early diagnosis of obesity and hypertension in adolescent girls, and measures can be taken at schools to control and prevent problems related to adulthood.

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