

Effect of Body Mass Index and Waist-Hip Ratio on Blood Pressure in Adolescents: A Descriptive and Correlational Study

Adolesanlarda Beden Kitle İndeksi ve Bel-Kalça Oranının Kan Basıncı Üzerine Etkisi: Tanımlayıcı ve İlişki Arayıcı Çalışma

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ABSTRACT Objective: This study was conducted to examine the effect of the body mass index and waist-hip ratio on blood pressure in adolescents. **Material and Methods:** This study, of descriptive and correlational research design, randomly selected the sampling group in the 3 general high schools of Beşiktaş District. The research population included 2769 students in the 9th, 10th, 11th and 12th grades of high school, and the sample included 711 students. Data were obtained using a research question form that was developed in line with the literature as well as body mass index percentile, waist-hip ratio measurement and a blood pressure (BP) percentile. **Results** The average waist-hip ratio was 72 (0.04) in female adolescents and 79 (0.04) in males adolescents. A total of 60.9% of the sampling had normal weight, and 87.3% had normal blood pressure. Both body mass index and waist-hip ratio had an effect on blood pressure ($p<0.00$), but body mass index in particular had a greater effect. **Conclusion:** To determine chronic health problems at an early age, it is necessary to follow up with adolescents at health centres and train them at school about healthy lifestyles. Nursing is one of the professional groups that should assume this responsibility.

Keywords: Adolescent; blood pressure; body mass index; waist-hip ratio; waist circumference; nurse

ÖZET Amaç: Araştırma, adolesanlarda beden kitle indeksi ve bel-kalça oranının kan basıncı üzerine etkisini incelemek amacıyla gerçekleştirildi. **Gereç ve Yöntemler:** Tanımlayıcı ve ilişki arayıcı olarak gerçekleştirilen araştırmanın evrenini, Beşiktaş ilçesinde bulunan 3 düz lisenin 9., 10., 11. ve 12. sınıflarında öğrenim gören 2769 öğrenci, örneklemini ise 711 öğrenci oluşturdu. Veriler literatür doğrultusunda geliştirilen soru formu, beden kitle indeksi persentili, bel kalça oranı ölçümü ve kan basıncı persentili kullanılarak elde edildi. **Bulgular:** Bel-kalça oranının ortalamasının kızlarda $0,72\pm 0,04$, erkeklerde $0,79\pm 0,04$ olduğu bulundu. Örneklemin %60,9'unun normal kiloda ve %87,3'ünün normal kan basıncına sahip olduğu bulundu. Beden kitle indeksi ve bel-kalça oranının kan basıncı üzerine etkili olduğu ($p<0,00$) ama özellikle beden kitle indeksinin daha büyük etkiye sahip olduğu belirlendi. **Sonuç:** Kronik sağlık sorunlarının erken belirlenmesi için gerek okullarda gerekse sağlık merkezlerinde, adolesanların izlenmesi ve sağlıklı yaşam biçimi kazandırılması konusunda eğitilmesi gereklidir. Bunun gerçekleştirilmesinde hemşire, sorumluluk alan önemli meslek gruplarından biridir.

Anahtar Kelimeler: Adölesan; kan basıncı; beden kitle indeksi; bel-kalça oranı; bel çevresi; hemşire

Adolescence is a transition from childhood to adulthood that involves physical, mental, and social changes. According to the World Health Organization, the period between 10 and -19 years of age is defined as the 'adolescent period'.¹

According to 2014 data from the World Health Organization, there are approximately 1.2 billion adolescents in the world.² In Turkey, according to data from the 2008 Turkey Demographic and Health Survey, adolescents constitute 18.5% or one-fifth of the population, and approximately one half (9.1%) are in the middle and late age groups.³

After the neonatal period, adolescence is the second fastest growth period in which changes occur in height and body weight, bone growth and maturation, muscle and fat tissue, and the circulatory and respiratory systems.⁴⁻⁶ During this period of significant changes, emerging patterns of behaviour also affect the adolescent's diet and habits.⁴

Body-mass index (BMI) and waist-hip ratio (WHR) are important criteria in the clinical determination of obesity. WHR indicates fat distribution that is associated with metabolic diseases and is used to assess a the person's nutritional habits.^{7,8} These high-level criteria form a basis for obesity and, as a result, chronic health problems.^{5,7,8}

Because of the increased prevalence of obesity in children, the prevalence of essential hypertension is expected to increase in the future.⁹ Studies in Turkey have reported hypertension prevalence rates of 3.5% and 7.9%.^{10,11} Prehypertensive children are at higher risk of developing hypertension in adulthood than normotensive children are.^{9,12} Therefore, nurses must perform follow-up of the children and adolescents in both health centres and schools and must contribute to the identification and resolution of health problems at an early age.^{5,13} Nursing is one of the professional groups that should assume this responsibility.

Within this scope, children at risk should be designated and they should be directed to proper centers by nurse by evaluating growth and development of children and adolescent with constant monitoring.⁴ The nurse should guide children/adolescents and their families for planning of physical activities that are proper for their age and level of development.^{10,13} The nurse should participate in determination of adolescents at risk by attending school health medical screening (hyperlipidemia, vision, hearing, blood pressure, weight and length,

scoliosis, mouth and dental health etc).^{4,10,13} The nurse should measure the blood pressure of adolescents once a year and evaluate it for early detection of hypertension which is one of the chronic health problems.^{12,13} In addition to these, the nurse should participate in researches about maintaining and developing of adolescent health, share the problems and recent developments and contribute to development of adolescent health.

This research was performed as a descriptive and correlational study to determine the BMI and WHR in adolescents and examine their effects on blood pressure (BP).

The research questions that needed to be answered are as follows:

1. What is the effect of BMI of adolescents on BP?
2. What is the effect of WHR of adolescents on BP?
3. Which has a greater effect on BP in adolescents; BMI or WHR?

MATERIAL AND METHODS

PARTICIPANTS

There are 23 formal high schools in Istanbul Province under the Beşiktaş District National Education Directorate of the Ministry of National Education of the Republic of Turkey. The 2769 students in the 9th, 10th, 11th, and 12th grades in the 3 general high schools in Beşiktaş District constituted the research population.

The sample size of the research was determined to be 750 students, with a probability of 95% and deviation as $d = 0.05$. Because the number of students differed among the schools, a stratified sampling method was used to select students on an equal basis. In the stratified sampling method, first the stratification weight and the number of students from each school to be included in the sample were calculated. In the stratified sampling method, firstly the layer weight for each school and the number of students who will be sampling from each school was calculated. Then, the number of students number from each class (9th, -10th, -11th, -

12th grade) to be included in the sample was determined. The sampling group was established with the randomized method by starting the selection with the first student, skipping the next 2 students, choosing another student, and moving ahead in this manner for the list of students in each class until the desired number was obtained. Because of the thirty-nine students of the total sampling group of 750 did not fill in the data collection forms completely, data obtained from 711 students were assessed. All students wished to participate in the research. Adolescents with chronic health problems (cardiovascular disease, renal disease, diabetes, cancer, and so on) were excluded from the study.

The power of the test was 99.9% in the analysis of power performed according to this sample number.

INSTRUMENTS

A research question form, BMI percentile, BP percentile, waist -hip raito measurement and were used as data collection tools.

RESEARCH QUESTION FORM

In the form developed in line with the literature, body weight, height, waist and hip circumference, and BP were measured by the researcher, who also asked questions about the adolescent's demographic characteristics.^{5,6}

BMI PERCENTILE

The BMI percentile was calculated as the body weight in kilograms divided by the height in meters squared ($BMI = \text{kg}/\text{m}^2$).^{5,14} BMI percentile curves that were created by Bundak et al. in 2006 and adapted to healthy Turkish children between 6 and -18 years of age have been used in Turkey.¹⁵

BP PERCENTILE

BP percentile curves, which were determined according to age, gender, and height and published by the Study Group on Children and Adolescents under the National High Blood Pressure Education Program in 2004, were determined.¹⁶ Because this percentile curve is valid for adolescents 17 years of age and younger BP of adolescents, 18 years of age

and older was assessed in the same manner as for adults. A systolic and diastolic BP of 120-129/80-84 mm Hg was considered normal, 130-139/85-89 mmHg as prehypertension, and greater than 140/90 mmHg as hypertension.¹⁷ BP was measured 3 times with an interval of 5 minutes, and then the average was assessed.¹⁶

PROCEDURE

Students were randomly selected before data collection and were informed about the research. "Consent forms" were completed by the students who are willing to participate in the research.

Students were placed in an empty classroom or in an empty room in groups of 5; they were informed about the research procedure and their questions were answered to decrease their anxieties and fears. All data collection was carried out between at 09:00-13:00. The research question form was then completed by the students.

After a 5-minute rest, the first BP measurement was performed using the right arm. Following the resting periods, the second and third BP measurements were performed respectively and recorded.

Physical measurements (weight, height, and waist and hip circumference) were then taken using with weighing scale which has 100-g sensitivity, a sphygmomanometer, a stethoscope, an age-appropriate cuff, and a non-elastic tape measure.

Before performing body weight measure, the adolescent was requested to take off his/her heavy clothes like jacket, cardigan, jumper and shoes. The weight was initialized as it is located on a flat ground. It was ensured that the adolescent measurements his/her shoulders and keeps his/her hands away without bending his/her knees during the measurement. Moreover, it was ensured that the adolescent distributes his/her weight on his/her both feet. The result observed on the indicator was immediately recorded in kg.

The tape measure which will be used for length measurement was immobilized on a wall. It was ensured that head, back, hip and heel of adolescent touch to back of the device and it was en-

sured that feet of adolescent are naked and united. The length from the head of adolescent to the ground was recorded after measurement.

Waist and hip circumferences were measured when the balance on the both legs were equal and when the feet were next to each other. This measurement was performed while arms of adolescent were located on both sides over the thinnest cloth. Waist circumference was measured from the middle point between the ribs and crista ilyaka. Hip circumference was recorded by measuring the maximum circumference passing through buttocks.

All measurements were performed by one of the researchers (D.M.), who was a master student in the paediatric nursing department during the study.

DATA ANALYSIS

Number, percentage, average, and standard deviation were used for descriptive statistics, and multiple regression analysis (backward method) was used in the examination of the effect of variables on BP. Statistical significance was accepted as $p < 0.05$.

RESULTS

PARTICIPANT CHARACTERISTICS

In total, 50.2% of the adolescents were girls and 49.8% were boys. The average age was 16.00 (1.18) years, and 30.5% were in 9th grade, 21.7% in 10th grade, 25.4% in 11th grade, and 22.4% in 12th grade.

VALUES AND COMPARISONS OF BP, BMI, AND WHR IN ADOLESCENTS

In total, 71.3% of adolescents had normal weight, 12.8% were thin, 8.3% were overweight, and 7.6% were obese (Table 1).

The systolic BP of 93.1% and the diastolic BP of 91.3% (<90th percentile) of the adolescents were determined to be normal. When systolic and diastolic BP were assessed together, 87.3% of the adolescents had normal BP values (<90th percentile) (Table 2).

As shown in Table 3, the average waist circumference was 69.82 (6.81) cm for girls and 77.78 (9.30) cm for boys, the average hip circumference was 95.68 (7.47) cm for girls and 97.77 (8.85) cm for boys, and the average WHR was 72 (0.04) for girls and 79 (0.04) for boys.

The results of the regression analysis performed to assess the effects of BMI and WHR on the BP (systolic/diastolic) of adolescents are presented in Table 4.

According to the standardized regression coefficient (b), the order of importance of predicting (affecting) variables on systolic BP was BMI and then WHR. According to the t-test results with regard to the significance of regression coefficients, both variables are effective in predicting systolic BP ($p=0.000$). A 1-unit increase in BMI leads to a 1.34-unit increase in systolic BP, and a 1-unit increase in WHR leads to a 42.63-unit increase in systolic BP.

According to the standardized regression coefficient (b), the order of importance of predicting (affecting) variables on diastolic BP was BMI and then WHR. According to the t-test results with regard to the significance of regression coefficients, both variables are effective predicting diastolic BP ($p=0.000$, $p=0.003$). A 1-unit increase in BMI leads to a 0.63-unit increase in diastolic BP, and a 1-unit increase in WHR leads to a 20.37-unit increase in diastolic BP.

TABLE 1: Distribution of body mass index percentile values of adolescents according to sex (N=711).

Blood Pressure (%) Percentile	Girl		Boy		Total	
	n	%	n	%	n	%
Thin (<5 th percentile)	48	13.4	43	12.1	91	12.8
Normal weight (5 th to <-85 th percentile)	256	71.7	251	70.9	507	71.3
Overweight (85 th to -95 th percentile)	22	6.2	37	10.5	59	8.3
Obese (>95 th percentile)	31	8.7	23	6.5	54	7.6
Total	357	100	354	100	711	100

TABLE 2: Distribution of blood pressure values of adolescents according to the blood pressure percentile values (N=711).

Blood Pressure (%) Percentile	Systolic Blood Pressure		Diastolic Blood Pressure		Systolic and Diastolic Blood Pressure*	
	n	%	n	%	n	%
Normal (<90 th percentile)	662	93.1	649	91.3	621	87.3
Prehypertension (90 th to < - 95 th percentile)	18	2.5	44	6.2	51	7.2
Hypertension stage -I (95 th to <-99 th percentile + 5 mmHg)	27	3.8	18	2.5	35	4.9
Hypertension stage b-II (>99 th percentile + 5 mmHg)	4	0.6	-	-	4	0.6
Total	711	100	711	100	711	100

*Assessed together.

TABLE 3: Distribution of, adolescents' mean waist circumference, hip circumference, and waist-hip ratio according to the sex (N=711).

	Girl			Boy		
	Minimum	Maximum	Mean (SD)	Minimum	Maximum	Mean (SD)
Waist circumference (cm)	55	98	69.82 (6.81)	57	121	77.78 (9.30)
Hip circumference (cm)	69	132	95.68 (7.47)	76	125	97.77 (8.85)
Waist-hip ratio	0.61	0.90	0.72 (0.04)	0.65	0.98	0.79 (0.04)

TABLE 4: Results of regression analysis of the effect of body mass index and waist-hip ratio on blood pressure in adolescents (N=711).

	Variables	B	Standard Error	Beta (β)	t	p	95% Confidence Interval
Systolic blood pressure*	Stable	49.346	6.079		8.118	0.000	37.41 61.28
	Body mass Index	1.338	0.130	0.366	10.259	0.000	1.08 1.59
	Waist-hip ratio	42.627	8.501	.179	5.014	0.000	25.94 59.32
Diastolic blood pressure **	Stable	38.108	4.804		7.932	0.000	28.68 47.54
	Body mass Index	0.633	0.103	0.236	6.136	0.000	0.43 0.84
	Waist-hip ratio	20.368	6.719	0.117	3.031	0.003	7.18 33.56

*R=0.46, adjusted R2=0.21, F=96.132, p=0.000, Durbin Watson=1.985.

**R=0.30, adjusted R2=0.09, F=34.580, p=0.000, Durbin Watson=2.002.

DISCUSSION

Childhood obesity is one of the most important public health problems of the 21st century and has increased at an alarming rate,² more than 10% of children and adolescents between 5 and -17 years of age are overweight or obese.¹⁸ Studies conducted

in Turkey have reported the frequency of obesity in adolescents to be 3.4-5.9%.^{8,10,19-21} Even though these rates may be lower than those in other countries, the fact that the rate of obesity has been determined to be higher in this study (7.6%) than in other studies conducted in Turkey indicates that this problem is increasing.

Furthermore, as a result of assessment of BMI, 12.8% of the adolescents in this study were thin (Table 1), compared with findings in other studies of 24%, 18.7% and 3.6% of adolescents who were thin.²¹⁻²³ The results indicate that the rate of thin adolescents should not be underestimated in comparison with that of obese adolescents.

Studies of BP of adolescents in Turkey have reported rates of hypertension of are 3.5%, 7.9% and 4.4%.^{10,11,24} The prevalence of hypertension in childhood, which is one of the most important causes of mortality and morbidity is 1% -3% in childhood and is lower than the prevalence of hypertension in adulthood, but in recent years the prevalence of hypertension in childhood has gradually increased.¹² Although the prevalence of hypertension in this study (5.5%) was similar to the findings of other studies, it was higher than the rate in the literature.^{11,12,22,24}

In this study, the average waist circumference was 77.78 (9.30) cm for boys and 69.82 (6.81) cm for girls and the average hip circumference was 97.77 (8.85) cm for boys and 95.68 (7.47) cm for girls (Table 3). These results are similar to the findings of other studies.^{25,26} Waist circumference percentile values for children and adolescents in Turkey could not be found, only the waist circumference percentile curves developed by Hatipoğlu et al.²⁷ According to this curve, waist circumference values in the 50th percentile for those between the ages of 14 and -17 years of age were 64.7-66.5 cm for girls and 68.9-73 cm for boys. Waist circumference is an important determinant of accumulation of abdominal fat, which, particularly in the abdominal area is a risk in terms of insulin resistance and the development of cardiovascular diseases.²⁷ When the results of this study are compared with the percentile values developed by Hatipoğlu et al., the waist circumference values in adolescents are greater than the 50th percentile.²⁷

In this study, the WHR was 0.79 (0.04) cm in boys and 0.72 (0.04) cm in girls (Table 3). There are no percentiles or criteria for evaluating WHR in children in Turkey. Thus, in other studies conducted with regards to children evaluation has

been performed using adult WHRs.^{7,8} In this evaluation, a WHR greater than .8 in female individuals and greater than 1.0 in male individuals indicates a risk of abdominal obesity and chronic illness.⁵ When the results of this study are assessed according to these criteria, the WHR in girls is close to the risk value, the boys had values below the risk value.

In this research, there was a strong relationship between BMI and WHR and systolic and diastolic BP (Table 4). The literature and studies evaluating the relationship between BMI and BP in adolescents.^{4,28-32} have shown that BMI has an effect on BP, similar to the results of our study. In studies performed in Turkey, there was a positive relationship between BMI and systolic and diastolic BP; these results support the accuracy of the relationship between BMI and BP.^{10,24,33,34}

Studies evaluating the effect of WHR on BP in adolescents were not found in the literature, and generally the effect of waist circumference on BP was assessed. Janssen et al., Huerta et al., and Mazicioğlu et al. found a strong relationship between waist circumference and BP.^{25,31,34} The reason for evaluating the effect of WHR instead of waist circumference on BP is because WHR is an important criterion that shows the fat distribution associated with metabolic diseases and is used to evaluate nutritional habits.^{7,8} In addition, studies in which WHR was assessed in children and adolescents were not encountered, and these results are important in terms of creating a data source for this type of research. Finally, as BMI and WHR increased, BP rate also increased, but BMI had a greater effect on BP

LIMITATIONS

This research is limited to the students in 9th through 12th grades in the fall term of the 2010-2011 school year at 3 general high schools in the Beşiktaş District in Istanbul and the questions listed on the research question form. Because the research period was limited, this was an applied research study, and transportation was easier, students from general high schools with the lowest number of students were selected.

CONCLUSION

Both BMI and WHR had an effect on BP, but BMI in particular had greater effect.

IMPLICATIONS FOR SCHOOL HEALTH

As a result of this study, the following may be recommended;

- In schools, health screenings should be performed (BP, height, -body weight, WHR) and risk groups should be determined.

- Percentile curves of BP, waist circumference, and WHR should be created for Turkish children.

HUMAN SUBJECTS APPROVAL STATEMENT

Before data collection, permission letters from the

Istanbul Medical Faculty Ethic Committee and Provincial National Education Directorate and written approvals from the students to be included in the research and their families were obtained.

Conflict of Interest

Authors declared no conflict of interest or financial support.

Authorship Contributions

Idea/Concept: Dilek Menekşe, Serap Balcı; **Design:** Dilek Menekşe, Serap Balcı; **Control/Supervision:** Dilek Menekşe, Serap Balcı; **Data Collection and/or Processing:** Dilek Menekşe; **Analysis and/or Interpretation:** Dilek Menekşe, Serap Balcı; **Literature Review:** Dilek Menekşe, Serap Balcı; **Writing the Article:** Dilek Menekşe, Serap Balcı; **Critical Review:** Dilek Menekşe, Serap Balcı; **References and Fundings:** Dilek Menekşe; **Materials:** Dilek Menekşe.

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