Research Article

Body measures according to physical activity, as predictors for elevated blood pressure among male college students, Minia, Upper Egypt

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Abstract
Adolescents have high and increasing rates of excess body weight and hypertension. Social stress and lack of physical activity are involved as risk factors for many cardiovascular diseases as hypertension. The aim of the study is to evaluate the differences of body measures between physical education and medical male students after **6** months of study in Minia University, Upper Egypt, and to know the most predicting measures associated with blood pressure elevation in both groups. A cross sectional study was performed with a sample of 850 male students (50% medical students and 50% physical education students), ranging between 18 and 19 years old. Anthropometric data was collected, including weight, stature, midarm, midchest, waist, and hip circumferences, also skinfold thickness of subscapular, abdominal and suprailiac regions. Body mass index (BMI), waist-hip ratio (WHR) and waist-stature ratio (WSR) were calculated. All anthropometric measurements indicating that overweight were higher in medical than physical education students, including BMI (24.5±5.2 kg/m2 to 23.2±4.2 kg/m2), with significant level ($p<0.05$). Both systolic and diastolic blood pressure were higher in medical students (SBP= 121.9±14 mmHg, DBP= 79.9±8.8 mmHg), than physical education students (SBP= 117.7±8.5mmHg, DBP= 75.4±6.3mmHg). Midarm circumference, midchest circumference, lean mass (LM) and fat mass (FM) in medical students, while the hip circumference and subscapular skinfold in physical education students were the most valuable predictors for elevated blood pressure.
Key words: blood pressure, Anthropometric measurements, physical activity, students.

Introduction
Body composition was described as the percentage of fat, bones and muscle elements in the individual. Individuals with the same gender and body weight would have a different body composition (Wellens et al., 1992). The seventh report of the Joint National Committee on the Prevention, Detection, Evaluation and Treatment of high blood pressure introduced a new category (pre-hypertension), when a systolic pressure of (120 to 139)mmHg and/or diastolic blood pressure of (80 to 89) mmHg (Aounallah-skhiri et al., 2012). Individuals with Pre-hypertension have a risk of developing hypertension than those with lower blood pressure levels (Huxley et al., 2014). Studies suggesting that hypertension in almost half of adults had elevated blood pressure levels during early life (McNiece et al., 2007). An excess in body fat was associated with elevated blood pressure and both are risk factors for increased cardiovascular morbidity (Mushengezi and Chillo, 2014). Despite of the prevalence of elevated blood pressure in adolescents is low, new studies have shown increased risk of hypertension to occur among obese children (Oduwole et al., 2012). In adults, hypertension and obesity are in close association and obese individuals are more likely to be hypertensive patients (Stamler et al., 1978). Moreover, blood pressure could be decreased in a dose-related fashion when weight is reduced (Mokadad et al., 2003). (Andersen et al., 2006) reported that physical activity is necessary for at least one hour per day to decrease the risk of elevated blood pressure and cardiovascular diseases in adolescents. Decreased physical activity was associated with increased body fatness in boys rather than girls (Basterfield et al., 2012). The use of simple anthropometric measures was an easy method for assessment of overweight and prediction of elevated blood pressure (Kang, 2013). Evaluation of anthropometric measures on association with elevated blood pressure can help to understand its pathogenesis and management (Hastuti et al., 2018). The purpose of this

study was to use simple body adiposity measures in prediction of elevated blood pressure among medical and physical education male students.

Subjects and Methods

A cross-sectional study was done, involving 850 male college students (425 physical education and 425 medical students of 2nd -3rd year of study, 18-19 years old) at Minia University, Upper Egypt. All participants provided written informed consent before data collection with negative history of chronic diseases.

Blood pressure was measured using appropriate cuff size by using mercurial sphygmomanometer. Measurements were done in a quiet room by a single observer and the mean of three readings was taken with four minutes apart. Elevated blood pressure was considered as SBP > 120 mmHg and DBP >80 mmHg (Aounallah-skhiri et al., 2012). All participants were asked for taking off external clothes; weight was measured, averaged to the nearest 0.1 kilogram, stature was measured, averaged to the nearest 0.1 centimeter and body mass index (BMI) was calculated. Skin fold thickness was recorded in millimeters, using a skin fold caliper at subscapular, abdominal and suprailiac regions, on the right side of the tested subjects and by the same observer. The caliper was applied about one cm below, perpendicular to the skin pinch and the mean of three readings was taken (Dwyer and Gibbons, 1994). A stretch-resistant tape was used to measure the circumference of the right upper arm at the midpoint between Acromiom, Olecranon and averaged to the nearest 0.1 cm (Yallamraju et al., 2014). Chest circumference was taken at the horizontal level, just above the nipples during quiet breathing (Olweus et al., 1980). The waist circumference was measured at horizontal level of the midpoint between the lower margin of the chest and the top of the hip bone. Hip circumference was measured at horizontal level of maximum convexity of the buttocks, and then waist-hip ratio (WHR) was calculated (Bigaard et al., 2004). WHO clarified that central obesity is defined according to WHR as >0.9 for males and >0.85 for females (WHO, 2011). Waist-stature ratio (WSR) was calculated and considered as another index for the central body fat.

In youth, the critical value of WSR should be less than (0.5) (Browning et al., 2010). Percent body fat (FP) was calculated by using BMI; = (1.20 × BMI) + (0.23 × age) – (10.8 × gender) – 5.4, using for gender male = 1 (Wang et al., 2007). FP was used for extraction of approximate fat mass (FM), (FM = FP × body weight) and lean mass (LM), (LM =body weight – FM).

Statistical methods

Before the study, the number of subjects required in each group was determined after a power calculation according to data obtained Pilot study (10 college students within each group). In that study the mean SBP was 121.5± 8.83 in medical group and (120±6.59) in physical group. A sample size of (425) Students in each group was determined to provide 80% power for Independent Samples T test at the level of (0.05) significance using G Power (3.1 9.2) software. The collected data were coded, tabulated, and statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 25. Descriptive statistics were done for quantitative data by mean and standard while they were done for categorical data by number and percentage. Analyses were done for parametric quantitative data between the two groups using independent samples T test, Analyses were done for qualitative data using Chi square test. Multiple stepwise binary logistic regression analysis of variables (tested significant in univariate statistics) was done for prediction of elevated blood pressure in medical and physical education students. Receiver operating characteristic (ROC) curve was done for estimation of AUC, optimal cutoff point, sensitivity, Specificity, PPV, NPV and accuracy for variables predicting elevated blood pressure. The level of significance was taken at (P value < 0.05)

Results

All variables were compared between physical education and medical male students. The means of both systolic and diastolic blood pressure were significantly higher in medical students (SBP= 121.9±14, DBP= 79.9±8.8), than physical education students (SBP= 117.7± 8.5, DBP= 75.4±6.3), as shown in table-1. Also, all means of parameters that indicated more body adiposity were significantly higher in medical than physical education students, with significant statistical difference (P value <0.01). The difference between the two groups for midarm circumference and WHR was insignificant.

The percentage of overweight and obesity was higher in medical than physical education student (17.8 to 2.8%). Also, the prevalence of elevated blood pressure was much higher in medical (SBP: 30.5% and DBP: 27.8%), than physical education students (SBP: 12.7% and DBP: 8.9%), with significant p value (<0.05). All taken measurements were significantly associated with elevated blood pressure in both medical and physical education students as shown in tables-2 and -3.

Multiple stepwise binary logistic regression analysis of variables that shown significant difference in univariate analysis between normal and elevated systolic blood pressure in medical students (table-4), revealed that the most predicting variables for blood pressure elevation were midarm, midchest and lean mass (LM). Increase in midarm circumference, mid-chest circumference and lean mass by one unit associated with increase the incidence of blood pressure elevation by 15.8%, 15.6% and 10.8%, respectively. So the most predicting variables are midarm and midchest circumferences followed by LM.

Receiver operating characteristic curve of midarm, midchest circumferences and LM (table-5, figure-1), for prediction of elevated systolic blood pressure in medical student revealed that, for the midarm circumference, AUC = 0.715, optimal cutoff point is >27 cm with sensitivity (81.74%,) specificity (50.49%), midchest circumference AUC = 0.720, optimal cutoff point is (>92)cm with sensitivity (80.32%), specificity (51.94%), while the LM showed AUC = 0.719, optimal cutoff point is (>58.44) Kg with sensitivity (73.97%), specificity (58.74%). The accuracies of all variables were (66.6%).

Multiple stepwise binary logistic regression analysis of variables could be used for prediction of elevated systolic blood pressure in physical education students (table-6), revealed that the most predicting variables for blood pressure elevation were hip circumference and subscapular skinfold. An increase in hip circumference and subscapular skinfold by one unit associated with increased the incidence of blood pressure elevation by 40.8% and by 9.6%, respectively. The most predicting variable was hip circumference.

Receiver operating characteristic curve of hip circumference and subscapular skinfold (table-7, figure-2) for prediction of elevated systolic blood pressure in physical education students revealed that AUC of hip circumference = 0.767, optimal cutoff point is (>93.5) cm with sensitivity (80.7%), specificity(64.63%), and accuracy of (68.9%), while subscapular skinfold showed AUC = 0.645, optimal cutoff point is (>21) mm with sensitivity (34.21%), specificity (91.32%), and accuracy of (76%).

Multiple stepwise binary logistic regression analysis of variables between normal and elevated diastolic blood pressure in medical students (table-8), declared that the most predicting variable for diastolic blood pressure elevation were midarm and fat mass (FM). Increase in midarm circumference one unit associated with increase the incidence of blood pressure elevation by 16.6%, and increase in (FM) by one unit associated with increase the incidence of blood pressure elevation by 8.2%. So the most predicting variable was midarm circumference for elevation of diastolic blood pressure in medical students.

Receiver operating characteristic curve of midarm circumference and fat mass (FM) (table-9, figure-3), for prediction of elevation of diastolic blood pressure in medical student revealed that AUC= 0.743 for midarm circumference with optimal cutoff point is (>31) cm with sensitivity (49.68%), specificity (86.3%), and accuracy of (72.9%), while (FM) showed AUC = 0.736, optimal cutoff point is (>17.2) Kg with sensitivity (71.61%), specificity (65.19%), and accuracy of (67.5%).

Multiple stepwise binary logistic regression analysis of variables between normal and elevated diastolic blood pressure in physical education students (table-10), declared that the most predicting variable for blood pressure elevation was hip circumference. Increase in hip circumference by one unit associated with increase the incidence of diastolic blood pressure elevation by 42.7%.

Receiver operating characteristic curve of hip circumference (table-11, figure-4), for prediction of elevation of diastolic blood pressure in physical education students revealed that AUC = 0.810 and optimal cutoff point is (>95) cm with sensitivity (80.77%), specificity (69.16%), and accuracy of (71.3%).

Table 1: Descriptive statistics for blood pressure, different body measures, classification of obesity and elevated blood pressure in all subjects:

	Medical students N=425	Physical education N=425	P value
SBP	121.9±14	117.7±8.5	***<0.001****
DBP	79.9±8.8	75.4±6.3	***<0.001****
Abdominal	26.3±11.9	18.9±7.5	***<0.001****
Subscapular	21.7±10.1	17.1±5.7	***<0.001****
Suprailiac	27.7±12.9	21.4±8.2	***<0.001****
Midarm	29.2±3.6	29±2.7	*0.273*
Midchest	96.3±8.5	94.9±5.3	***0.005****
Waist	84.2±11.4	80.9±6.3	***<0.001****
Hip	97.8±9.7	93.9±6.1	***<0.001****
WHR	0.86±0.04	0.85±0.03	*0.113*
WSR	0.48±0.07	0.46±0.05	***<0.001****
BMI	24.5±5.2	23.2±4.2	***<0.001****
FM	13.8±6.9	11.1±4.1	***<0.001****
FP	17.5±5.3	15.2±3.1	***<0.001****
LM	57.5±8	59.3±4.3	***<0.001****
Obesity FP			
Lean	215(50.6%)	310(72.9%)	
Normal	134(31.5%)	103(24.2%)	***<0.001****
Overweight	61(14.4%)	12(2.8%)	
Obese	15(3.5%)	0(0%)	

SBP: Systolic blood pressure (mmHg), **DBP**: Diastolic blood pressure (mmHg), **Abdomen**: abdominal skinfold (mm), **Subscpular**: subscapular skinfold (mm), **Suprailiac**: suprailiac skinfold (mm), **Midarm**: midarm circumference (cm), **Midchest**: midchest circumference (cm), **Waist**: waist circumference (cm), **Hip**: hip circumference (cm), **WHR**: waist-hip ratio, **WSR:** waist-stature ratio, **BMI**: body mass index (Kg/m^2), **FM:** Fat mass by (Kg), **FP**: Fat percentage (%), **LM**: Lean mass by (Kg), **Obesity FP:** level of obesity according to fat percentage.

Table 2: Means of all variables among *medical* students in association to elevated blood pressure:

Medical students	Systolic blood pressure		Diastolic blood pressure	
	Normal 295(69.4%)	**Elevated** 172(30.6%)	**Normal** 307(72.2%)	**Elevated** 118(27.8%)
Abdominal	23±10.4	29.3±12.5*	23.1±10.4	31.7±12.5*
Subscapular	18.9±8.1	24.4±11*	18.9±8.1	26.7±11.3*
Suprailiac	24.1±10.7	31±13.9*	24.2±11.1	33.7±13.7*
Midarm	27.8±3.4	30.5±3.3*	28.1±3.3	31.2±3.4*
Midchest	93±7.6	99.4±8.1*	93.7±7.5	100.8±8.2*
Waist	80.9±9.7	87.4±12*	81±9.5	89.8±12.3*
Hip	94.7±8.6	100.7±9.8*	95±8.3	102.8±9.9*
WHR	0.85±0.04	0.86±0.04*	0.85±0.04	0.87±0.04*
WSR	0.47±0.06	0.50±0.07*	0.47±0.06	0.51±0.07*
BMI	23.2±3.8	25.9±4.5*	23.3±3.6	27±4.6*
FM	11.4±5.3	16±7.6*	11.6±5.1	17.6±8*
FP	15.8±4.6	19.1±5.4*	15.9±4.3	20.3±5.6*
LM	57.8±6.8	64±7.8*	58.5±6.9	65.2±8*

***: Significant level at P value <0.05**

Table 3: The means of all variables among *physical* education students in association to elevated blood pressure:

Physical education students	Systolic blood pressure		Diastolic blood pressure	
	Normal 371(87.3%)	**Elevated** 54(12.7%)	**Normal** 387(91.1%)	**Elevated** 38(8.9%)
Abdominal	18.6±6.4	22.8±9.2*	18.4±6.5	25.6±8.9*
Subscapular	15.3±4.6	18.8±6.9*	15.3±4.5	20.8±7*
Suprailiac	18.9±6.9	24.5±9.7*	18.9±6.8	26.9±9.8*
Midarm	28.6±2.5	30.1±2.9*	28.7±2.5	30.4±2.9*
Midchest	93.9±4.7	97.7±5.4*	94.1±4.7	98.5±5.5*
Waist	79.2±5.1	84.7±7.5*	79.3±5.2	86.5±7.6*
Hip	92.9±4.7	98.2±5.6*	93.1±4.7	99.6±5.5*
WHR	0.85±0.02	0.86±0.04*	0.85±0.02	0.87±0.04*
WSR	0.45±0.03	0.48±0.05*	0.45±0.03	0.49±0.05*
BMI	22.6±1.9	24.2±2.7*	22.7±2	24.7±2.8*
FM	10.7±2.4	13.1±3.8*	10.8±2.5	13.8±4*
FP	15.3±2.3	17.2±3.3*	15.4±2.4	17.8±3.4*
LM	58.5±3.8	61.6±4.7*	58.7±3.9	62.4±4.8*

***: Significant level at P value <0.05**

Table 4: Multiple stepwise logistic regression analysis for prediction of elevated Systolic blood pressure in *medical* students

	AOR	95% CI	P value
Midarm	1.158	1.012-1.325	0.033*
Midchest	1.156	1.058-1.263	0.001*
LM	1.108	1.049-1.17	<0.001*

AOR: Adjusted Odds Ratio
CI: Confidence Interval
***: Significant level at P value <0.05**

Table 5: Receiver operating characteristic curve analysis of midarm, midchest circumferences and LM for prediction of systolic blood pressure elevation in *medical* student

	Midarm	Midchest	LM
Optimal cutoff point	>27	>92	>58.44
AUC	0.715	0.720	0.719
95% CI	0.670-0.757	0.675-0.762	0.674-0.761
P value	***<0.001****	***<0.001****	***<0.001****
Sensitivity	81.74	80.32	73.97
Specificity	50.49	51.94	58.74
PPV	63.7	64	65.6
NPV	72.2	71.3	68
Accuracy	66.6	66.6	66.6

AUC: Area Under Curve
CI: Confidence interval
PPV: Positive predictive Value
NPV: Negative Predictive Value

Table 6: Multiple stepwise logistic regression analysis for prediction of elevated Systolic blood pressure in *physical education* students:

	AOR	95% CI	P value
Hip	1.408	1.261-1.572	<0.001*
Subscapular	1.096	1.002-1.199	0.045*

AOR: Adjusted Odds Ratio
CI: Confidence Interval
***: Significant level at P value <0.05**

Table 7: Receiver operating characteristic curve analysis of hip circumference and subscapular skinfold for prediction of systolic blood pressure elevation in *physical education* students:

	Subscapular	Hip
Optimal cutoff point	>21	>93.5
AUC	0.645	0.767
95% CI	0.597-0.690	0.724-0.806
P value	***<0.001****	***<0.001****
Sensitivity	34.21	80.7
Specificity	91.32	64.63
PPV	59.1	45.5
NPV	79.1	90.1
Accuracy	76	68.9

AUC: Area Under Curve
CI: Confidence interval
PPV: Positive predictive Value
NPV: Negative Predictive Value

Table 8: Multiple stepwise logistic regression analysis for prediction of elevated diastolic blood pressure in *medical* students:

	AOR	95% CI	P value
Midarm	1.166	1.026-1.324	0.018*
FM	1.082	1.012-1.156	0.021*

AOR: Adjusted Odds Ratio
CI: Confidence Interval
***: Significant level at P value <0.05**

Table 9: Receiver operating characteristic curve analysis of Midarm circumference and fat mass for prediction of diastolic blood pressure elevation in *medical* students:

	Midarm	FM
Optimal cutoff point	>31	>17.2
AUC	0.743	0.736
95% CI	0.699-0.784	0.691-0.777
P value	***<0.001****	***<0.001****
Sensitivity	49.68	71.61
Specificity	86.3	65.19
PPV	67.5	54.1
NPV	74.9	80
Accuracy	72.9	67.5

AUC: Area Under Curve **CI: Confidence interval**
PPV: Positive predictive Value **NPV: Negative Predictive Value**

Table 10: Multiple stepwise logistic regression analysis for prediction of elevated diastolic blood pressure in *physical education* students:

	AOR	95% CI	P value
Hip	1.427	1.283-1.587	<0.001*

AOR: Adjusted Odds Ratio
CI: Confidence Interval
***: Significant level at P value <0.05**

Table 11: Receiver operating characteristic curve analysis of hip circumference for prediction of diastolic blood pressure elevation in *physical education* students:

	Hip
Optimal cutoff point	>95
AUC	0.810
95% CI	0.769-0.846
P value	***<0.001****
Sensitivity	80.77
Specificity	69.16
PPV	37.1
NPV	94.1
Accuracy	71.3

AUC: Area Under Curve
CI: Confidence interval
PPV: Positive predictive Value
NPV: Negative Predictive Value

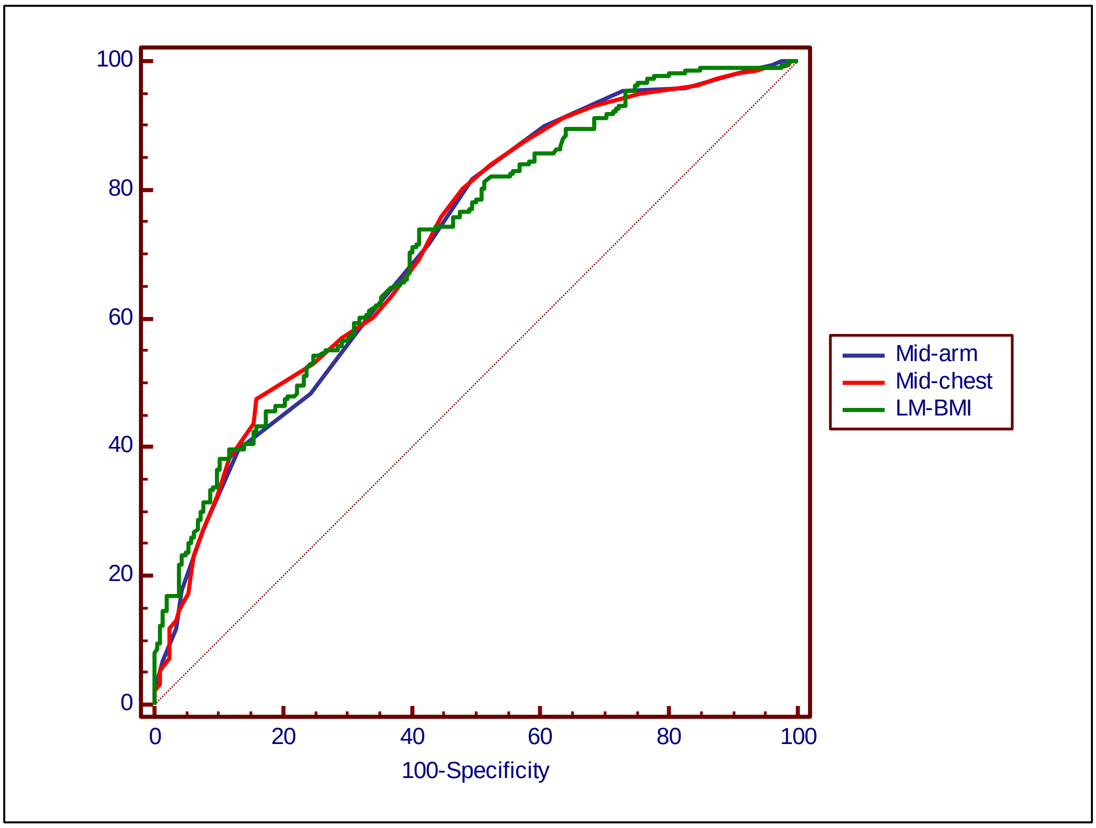

Figure 1: Receiver operating characteristic curve of midarm, midchest circumferences and LM for prediction of systolic blood pressure elevation in *medical* student.

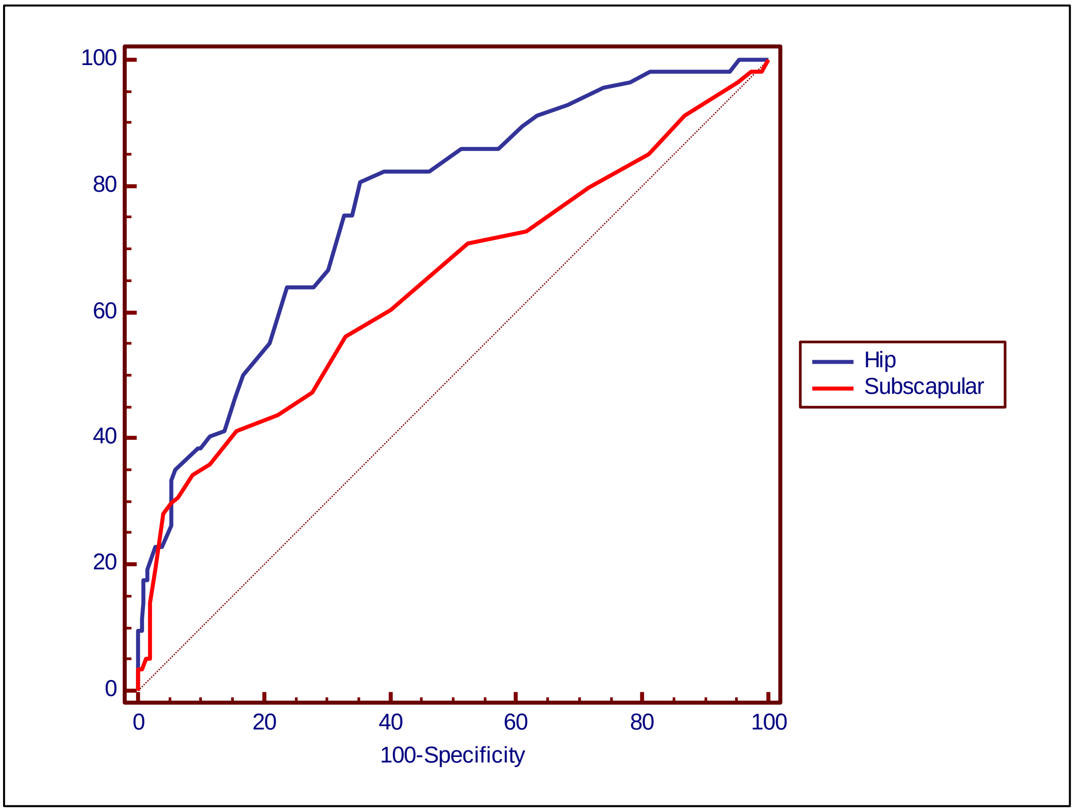

Figure 2: Receiver operating characteristic curve of hip circumference and subscapular skinfold for prediction of systolic blood pressure elevation in *physical education* students.

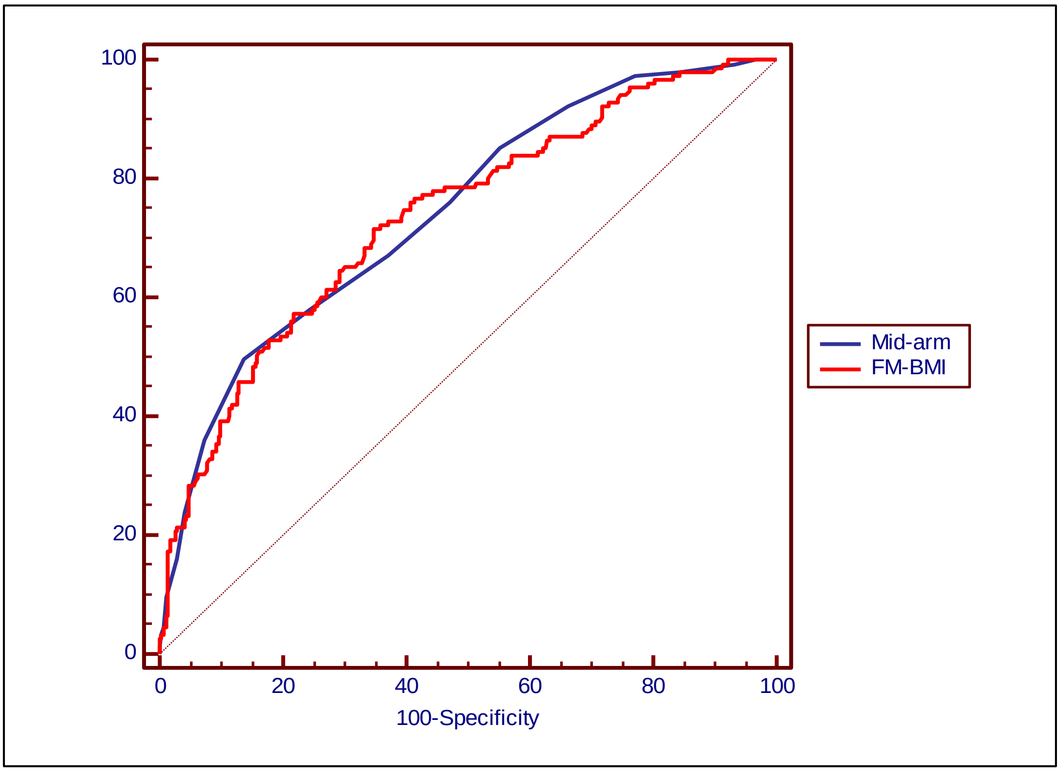

Figure 3: Receiver operating characteristic curve of Midarm circumference and fat mass for prediction of diastolic blood pressure elevation in *medical* students.

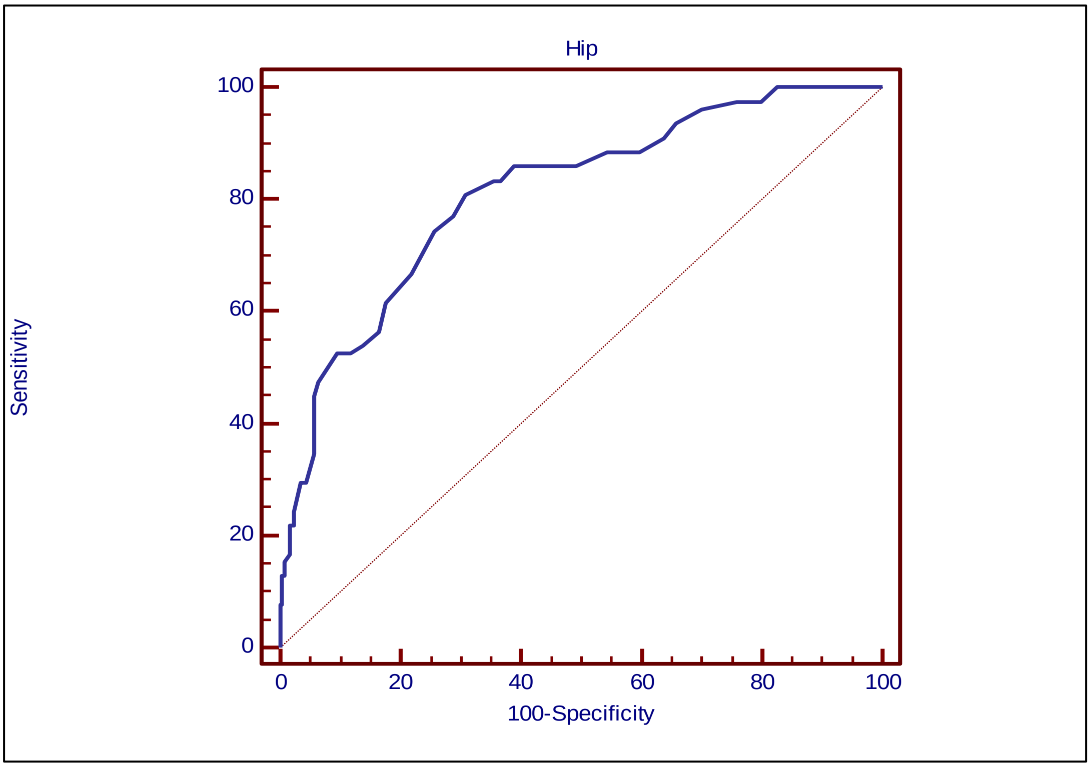

Figure 4: Receiver operating characteristic curve of hip circumference for prediction of diastolic blood pressure elevation in *physical education* students.

Discussion

The present study was done for comparing between the effect of physical activity and sedentary life on the body fat measures and to know the most useful body measures that could be used to predict elevated blood pressure. Means of both systolic and diastolic blood pressure were higher in medical students than physical education students, this finding was in agreement with the study of (Arazi et al., 2012) which done in Iran, they reported that, in non athletic students (mean of SBP= 126.3±14 mm Hg, DBP= 86.1±6 mm Hg), while in physical education students (SBP= 117.3±7 mm Hg, DBP= 76.1±7.3 mm Hg),. Also our finding was in line with (Leffelholc and Bodzsar, 1997) in Hungary, who found that the mean blood pressure for medical students was (SBP= 122.3 ±13.8 mm Hg, DBP= 80.6±7.8 mm Hg).

In the current study, means of all body measurements of increased body adiposity - BMI, skinfold thickness, circumferences, waist-hip ratio (WHR), and waist-stature ratio (WSR) – were higher in medical group than physical education one. (Arazi et al., 2012) described similar results between athletic and non athletic students. Also with (Zin et al., 2014), in Malaysia, who found that medical students have high measurements of body adiposity.

It was reported that the regular physical activity had a great effect of reduction of body fat and subsequently development of hypertension. Sedentary life and stress are strongly correlated with high blood pressure, (Bouchard, 1996). A higher level of physical activity was associated with a higher percentage of fat-free mass, muscle mass (Stachoń and Pietraszewska, 2013). Researchers have found that the combination of dietary control and regular exercise was effective in reduction of elevated blood pressure in pre-hypertensive individuals, with improvement similar to those who are receiving drug therapy for control of mild hypertension (Bacon et al., 2004). Physical activity was associated with lower body mass index (β = 0.017, 95%CI) (Joensuu et al., 2018). Scientific evidences denoting that physical activity was recommended to promote and maintain health (Haskell et al., 2007). However, other researchers studied the effect of physical activity on body composition and blood pressure and they found no précised support for this idea (Vianna et al., 2012), while in adolescents, physical fitness exhibit a minor effect on blood pressure and a high BMI was associated with elevated systolic blood pressure, especially in ages 14 to 18 years old (Sousa et al., 2014).

Medical students have been reported to suffer more stressful life style due to difficult study, the prevalence of high systolic pressure was (25.9%) and high diastolic pressure was (24.2%) among male medical students (Leffelholc and Bodzsar, 1997). When the results were compared with current study, a higher prevalence for both elevated systolic (30.5%) and diastolic (27.8%) blood pressure was found. Reduction of the time dedicated to do physical activity among medical students can worsen the body composition during the years of university, (López et al., 2019).

In the present work, the midarm circumference was the most predictable variable for elevated blood pressure in medical students. This measurement was used for searching about growth retardation in developing countries; outlines the main health consequences of impaired growth and adult life consequences (De Onis, 2017). Hip circumference is the most predictable variable for blood pressure elevation in physical education students. The mortality rate ratio adjusted hip circumference was 0.70 (95% CI), with higher effect of large hip circumference in men than women (Bigaard et al., 2004). Abnormal distribution of fat in medical students might be a result of psychosocial and study challenges or stress that stimulate sympathetic activity and adrenal axis, and when these occur on a chronic basis, they were associated with an increased visceral obesity, abnormal fat distribution to develop the metabolic disorders (Kyrou et al., 2006).

Recommendation

Prospective studies should be done to investigate and clarify the role of physical exercise on body composition and development of elevated blood pressure especially for youth, recommendation is necessary for educational and preventive programs to promote more active life style that would be helpful to decrease body adiposity and blood pressure levels among university students.

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