Send Orders for Reprints to reprints@benthamscience.ae

90 *The Open Public Health Journal*, 2017, *10*, 90-97

BENTHAM OPEN

CrossMark

The Open Public Health Journal

Content list available at: www.benthamopen.com/TOPHJ/

DOI: 10.2174/1874944501710010090

RESEARCH ARTICLE

Screening for Risk Factors of Cardiometabolic Disease Among Female University Students in Riyadh, Saudi Arabia

Toriola Oluwatoyin Olabiji*

Prince Sultan University Campus for Women, Riyadh, Saudi Arabia

Received: November 25, 2016 Revised: February 20, 2017 Accepted: February 21, 2017

Abstract:

Background:

Prevalence of cardiometabolic diseases (CMD), especially among the youth, is a growing public health concern in both developed and developing countries.

Objective:

To examine cardiovascular and metabolic disease risk factors among a cohort of female university students in Riyadh, Saudi Arabia.

Method:

Two hundred and twenty-three (223) female students aged 17-25 years participated in the study. Both physical and physiological parameters were assessed using standard procedures and equipment. The study also evaluated the extent to which body mass index (BMI) could predict CMD risk factors among the participants. Alpha level was set at $\alpha = 0.05$.

Results:

The results showed that 22.4%, 8.5% and 11.2% of the women were overweight, obese, and underweight, respectively. Hemodynamic results indicated that of those overweight and obese, 9.4%and 21.1% were pre-hypertensive, respectively, while only 3 (1.3%) were hypertensive. Blood glucose results showed that 30 (13.5%) participants were pre-diabetic. Also, the BMI for overweight (26.9±1.54 kg/m^2)and obese (33.5±3.17 kg/m^2) categories indicated participants at the risk of CMD. Further analysis showed a statistically significant correlation between BMI and the following dependent measures: systolic ($r = 0.352$, $p = 0.001$) and diastolic ($r = 0.136$, $p = 0.043$) BP, waist circumference ($r = 0.791$, $p = 0.001$), and fasting blood glucose ($r = 0.157$, $p = 0.019$). BMI and age yielded a non-significant association ($r = 0.023$, $p = 0.728$). Results of adjusted regression coefficients indicated that BMI accounted for 65.6% of the variance in the women's physiological variables.

Conclusion:

It was concluded that although many of the women screened had healthy CMD risk profiles, a few presented with excessively high levels which require follow-up clinical investigation and intervention. The need to undertake large scale surveillance of CMD risk factors among this relatively less studied population is recommended as it will promote early detection of risk profiles and health enhancing behaviours among the youth.

Keywords: Health screening, CMD risk factors, Metabolic syndrome, Women, University students, Identification and prevention.

1. INTRODUCTION

In the past three decades, there has been an increasing prevalence of obesity and its co-morbidities in many

* Address correspondence to this author at the Prince Sultan University Campus for Women, P.o. Box-66833-Riyadh 11586, Saudi Arabia; Fax: 4948605; Tel: +966114948000; E-mails: toriolaom@yahoo.com, ptoriola@psu.edu.sa

1874-9445/17 2017 Bentham Open

countries around the world [1]. Since the turn of the 21st century, Saudi Arabia has witnessed marked socio-economic developments in health, education, environment, urban migration, and lifestyle. These developments have led to a decrease in communicable diseases, but an increase in chronic diseases of lifestyle, such as obesity, diabetes, hypertension and other risk factors of cardiovascular disease (CVD) [1]. For instance, the prevalence of overweight and obesity among Saudi female population has been reported as 28% and 24%, respectively thus indicating a major health concern [2].

Other studies on Saudi women [3 - 5] have reported increasing trend in the prevalence of non-communicable diseases. A number of studies have also reported the prevalence of metabolic syndrome in many countries in the Middle East [6], specifically in Oman [7] and Gaza, Palestine [8]. In addition to other factors which predispose adolescent girls and women to obesity and CVD risk, high body mass index (BMI) and waist circumference have also been implicated in the prognosis of chronic diseases of lifestyle (CDL).

In view of the health implications of such anthropometric indicators, it is important to periodically evaluate the tendency for young women to become overweight, obese as well as develop CVD and metabolic disease risk. This approach will provide information needed to design exercise and lifestyle modification programs for the youth. It will also strengthen health promotion initiatives targeted at improving the quality of life of those at risk. Based on this need, a health screening for CVD and metabolic disease risk factors was undertaken among students of Prince Sultan University (PSU) College for Women, Riyadh, Saudi Arabia. Therefore, the purpose of the health screening program was to provide information on the students' health status in order to increase their awareness of the importance of preventing high CDL risk profile and promoting health enhancing behaviours.

2. MATERIALS AND METHODOLOGY

2.1. Study Design

In this study, a descriptive survey involving a cross- sectional design was used.

2.2. Population and Sample

The study population comprised the students of PSU Campus for Women, Riyadh, Saudi Arabia who attended a health screening program. Specifically, the study sample consisted of apparently healthy 223 (91%) students (aged 17-25 years) who volunteered to participate in the study. They were recruited during the university's annual health screening program. From the initial total sample of 245 (100%) students measured, 22 (9%) participants had incomplete data. Consequently, their data were excluded from the analysis. Therefore, the data of 223 students were subsequently analyzed.

2.3. Measurements

The following anthropometric and physiological measurements were taken: height, weight, blood pressure, fasting blood glucose, visceral fat and muscle fat. Height, weight and girth (waist and hip) were measured according to the protocol of the International Society for the Advancement of Kinanthropmetry (ISAK) [9]. Height was measured to the nearest 0.1 cm in bare feet with participants standing upright against a mounted stadiometer. A digital weighing scale calibrated regularly to the nearest 0.1 kg was used to measure body weight with participants lightly dressed using a portable digital weighing scale [(Omron body composition monitor (Model no. BF508)]. Body mass index (BMI) were later derived from the value for height and weight using the BMI formula: [weight (kg) / height $(m)^2$]. BMI was used to classify the participants in the following weight categories: underweight (less than 18.5), normal (18.5-24.9), overweight (25-29.9) or obese (30 and above) [10]. Blood pressure was assessed using the German made aneroid Riesterri-vital equipment which is clinically validated [11]. The blood pressure was assessed after participants had rested for 15 minutes in a semi-recumbent position. Duplicate measures were taken with a five-minute rest period between successive measurements. The average of the two measurements was used in the statistical analyses.Blood pressure (BP) (Systolic BP and diastolic BP) were categorized into normal (< 120/80mmHg), pre-hypertension (120-139/80-89mmHg), and hypertension (140mmHg or higher and 90mmHg or higher) [12]. Fasting blood glucose (categorized as below normal: less than 70 mg/dl), (normal: 70-99 mg/dl), (pre-diabetic: 100-125 mg/dl), and (diabetic: 126mg/dl and above) [13], was measured using the Contour Next digital meter and test strips (manufactured by Ascensia Diabetes Care Holdings AG, New Jersey, USA). These equipment and measurement procedures meet the standards of ISO (International Standards Organisation) 9001 and the Saudi Food and Drug Authority (SFDA).

2.4. Ethical Considerations

Permission to conduct this research was obtained from the higher management of Prince Sultan University Campus for women, Riyadh. Before data collection, the participants gave signed informed consent and other relevant regulatory bodies granted ethics approval for the research to be carried out.The study was carried out according to Helsinki Declaration Ethical Rules of 1975 [14].

2.5. Validity and Reliability

The measurements were taken by the author from the Health and Physical Education (HPE) lecturers who were master's degree holders as well as a university physician and a nurse. Before the actual study, a pilot test involving 11 students was conducted to refine test administration procedures and determine the reliability of the measurements. Test-retest measurements yielded strong Pearson's correlations for FBG (r=0.98), BP (Systolic: r=0.89; Diastolic: r=0.86) and WC (r=0.95). Therefore, the measurement techniques used to obtain data from the participants produced relatively stable and consistent results.

2.6. Data Analysis

Data analyses were carried out using SPSS software version 23.0. Descriptive statistics, such as mean, standard deviation, and percentages were used to examine the prevalence of cardiovascular risk factors among the participants. One-way analysis of variance (ANOVA) was used to test for any substantial differences in the participants' dependent measures according BMI categories and risk factor profiles. In order to determine the relationship between the participants' BMI and their blood sugar, blood pressure, age, and waist circumference, Pearson's correlation analysis was performed. The correlations were interpreted using the categorization of Dancey and Reidy [15], where *r*-value of ± 1 is interpreted as a perfect correlation, *r*-values between ± 0.7 to ± 0.9 are interpreted as strong correlations, *r*-values in the range ± 0.4 to ± 0.6 are categorized as moderate correlations, *r*-values between ± 0.1 to ± 0.3 are weak correlations and an *r*-value of 0 is zero correlation, implying there is no correlation. Backward multiple regression modeling was used to determine the relative influence of dependent measures (waist circumference, systolic and diastolic BP, and blood sugar) in predicting BMI among the women.For all statistical tests a probability level of *0.05* or less was considered significant.

3. RESULTS

A total of 223 apparently healthy women were tested for CMD risk factors. Presented in Table **1** are the physical characteristics of the participants. The mean age value of the participants was 19.2±1.05 years. The mean values for body weight and height among the participants were 60.7±12.5 kg and 161±6.13cm, respectively. In general, their BP readings were: SBP (109.6±11.7mmHg) and DBP (69.0±8.62 mmHg). Overall, the participants' mean BMI was 23.4±4.54 kg/m^2. The mean value for blood glucose was 91.1±8.76 mg/dl.

Table 1. Physical characteristics of the participants (N=223).

Variables	n	Mean	SD	Min	Max	Range
Age (years)	223	19.2	1.05	17	25	8
Weight (kg)	223	60.6	12.4	36.6	114.7	78.1
Height (cm)	223	160.9	6.07	146	179	33
BMI (kg/m^2)	223	23.4	4.55	14.3	40.4	26.1
Systolic(mmHg)	223	109.5	11.7	80	157	77
Diastolic(mmHg)	223	69.0	8.64	27	92	65
FBG (mmol)	223	91.1	8.77	60	125	65
Waist Circ (cm)	223	77.4	9.46	60	113	53

SD, standard deviation; Min, minimum; Max, maximum; n, number; FBG, fasting blood glucose; Circ., circumference.

The prevalence of risk factor categories by age are presented in Table **2**. The results of the BMI category by age revealed that, in total, 50 (22.4%), 19 (8.5%), and 25 (11.2%) were overweight, obese, and underweight, respectively. For systolic and diastolic BP measurements, 47 (21.1%) and 21 (9.4%) were pre-hypertensive, respectively, while 3 (1.3%) were systolically hypertensive. The blood glucose readings showed that 30 (13.5%) were pre-diabetic. Provided in Table **3** are data on the women's CMD risk profiles.

Table 2. Prevalence of risk factors category by participants' age category[#].

Variables						Years				
Age		17 yr	18 yr	19 yr	20 yr	21 yr	22 yr	23 yr	25 yr	Total
BMI										
	Under W	1 (100)	6 (10.7)	12 (12.6)	6 (12.8)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	25 (11.2)
	Normal W	0 (0.0)	34 (60.7)	52 (54.7)	26 (55.3)	16 (80.0)	0 (0.0)	1 (100)	0 (0.0)	129 (57.8)
	Over W	0 (0.0)	10 (17.9)	23 (24.2)	10 (21.3)	4 (20.0)	2 (100.0)	0 (0.0)	1 (100.0)	50 (22.4)
	Obese	0 (0.0)	6 (10.7)	8 (8.4)	5 (10.6)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	19 (8.5)
Systolic BP										
	Normal	1 (100.0)	49 (87.5)	70 (73.7)	35 (74.5)	17 (85.0)	1 (50.0)	1 (100.0)	1 (100.0)	175 (78.5)
	Pre-hypertension	0 (0.0)	7 (12.5)	24 (25.3)	12 (25.5)	3 (15.0)	1 (50.0)	0 (0.0)	0 (0.0)	47 (21.1)
	Hypertension	0 (0.0)	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.4)
Diastolic BP										
	Normal	1 (100.0)	51 (91.1)	85 (89.5)	42 (89.4)	16 (80.0)	2 (100.0)	1 (100.0)	1 (100.0)	199 (89.2)
	Pre-hypertension	0 (0.0)	5 (8.9)	9 (9.5)	3 (6.4)	4 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)	21 (9.4)
	Hypertension	0 (0.0)	0 (0.0)	1 (1.1)	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (1.3)
Blood Glucose										
	Below normal	0 (0.0)	0 (0.0)	1 (1.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.4)
	normal	1 (100.0)	55 (98.2)	77 (81.1)	36 (76.6)	19 (95.0)	2 (100.0)	1 (100.0)	1 (100.0)	192 (86.1)
	Pre-diabetes	0 (0.0)	1 (1.8)	17 (17.9)	11 (23.4)	1 (5.0)	0 (0.0)	0 (0.0)	0 (0.0)	30 (13.5)
	Diabetes	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)

BP, blood pressure; BMI, body mass index; yr., year; [#] results are presented as no (%).

Table 3. Cardiovascular and metabolic disease risk profile according to BMI categories.

Variables		BMI groups				
	Total (n=223)	Under Weight (n=25)	Normal weight (n=129)	Over weight (n=50)	Obese (n=19)	p-value
Age (yr.)	19.2±1.05	18.9±0.81	19.2±1.02	19.4±1.29	18.9±0.77	0.198
BMI (Kg/m^2)	23.4±4.55	17.2±1.01	21.7±1.69	26.9±1.54	33.5±3.17	0.000*
SBP (mmHg)	109.5±11.8	104.0±7.76	107.8±11.2	112.0±12.6	121.8±7.91	0.000*
DBP (mmHg)	69.0±8.64	67.2±6.28	68.7±8.59	68.6±9.75	73.7±7.42	0.072
FBG (mmol/l)	91.1±8.77	90.2±7.65	90.4±9.15	91.7±7.63	95.7±9.40	0.079
WC (cm)	77.4±9.46	68.4±6.37	74.5±6.24	82.7±6.25	95.3±8.83	0.000

Differences between BMI groups compared using one way ANOVA. BMI = body mass index; SBP = systolic blood pressure; DBP=diastolic blood pressure; cm = centimeter; yr. = year; WC, waist circumference.*= significant difference at 0.05 level.

When the cardiovascular and metabolic disease risk factors were analyzed according to BMI categories results showed that the obese group had significantly highest CMD risk profiles (BMI: 33.5±3.17 kg/m^2, fasting glucose: 95.7±9.40 mg/dL, and waist circumference: 95.3±8.83 cm), among the weight categories ($p<0.05$) (Tables **3** and **4**). provides the correlation matrix of the relationship between BMI and cardiovascular risk factors among the women.

Table 4. Correlation matrix of the relationship between BMI and cardiovascular risk factors (n=223).

Variables	Age (yr.)	BMI (Kg/m^2)	SBP (mmHg)	DBP (mmHg)	FBG (mmol/l)	WC (cm)
Age (yr.)	1					
BMI (Kg/m^2)	0.023	1				
SBP(mmHg)	0.019	0.352*	1			
DBP(mmHg)	-0.005	0.136	0.577*	1		
FBG(mmol/l)	-0.013	0.157	0.163	0.070	1	
WC (cm)	-0.004	0.791*	0.235*	0.077	0.139	1

**Significant at 0.01; *Significant at 0.05- Pearson moment correlation coefficient; WC, waist circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index; yr., year.

The bivariate correlation showing the relationship between BMI and cardiovascular risk factors variables revealed that there was a statistically significant relationship between the women's BMI and the following variables: systolic (r =

0.352, *p* = 0.001) and diastolic (r = 0.136, *p* = 0.043) BP, waist circumference (r = 0.791, *p* = 0.001), and fasting glucose (r = 0.157, *p* = 0.019). Conversely, non-significant correlation was found between BMI and participants' age (r = 0.023, *p* = 0.728) (Table **4**).

4. REGRESSION OF BMI AS PREDICTOR VARIABLE

Univariate analysis showed that BMI significantly predicted systolic and diastolic BP, blood sugar, and waist circumference among the Saudi women (β = 0.067; p = 0.000, β = 0.071; p = 0.043, β = 0.082; p = 0.019, and β = 0.360; p = 0.000, respectively). It was also of interest in this study to examine the variable which most significantly predicted BMI using a backward regression model. The results revealed that the regression model including systolic BP and waist circumference was the best predictor of BMI of all possible models, since it had the highest value of adjusted R^2 which represents the amount of variance (65.2%) in BMI predicted by the model (Table **5**).

Table 5. Summary of stepwise backward regression analysis.

Variables in the model	Unstandardized coefficient	*P*-value	R^2	Adjusted R^2
(Constant)	-11.886	0.000	0.655	0.652
WC	0.360	0.000		
Systolic BP	0.067	0.000		

WC, waist circumference; BP, blood pressure.

Specifically, when waist circumference was held constant, systolic BP was independently associated with increase in BMI. Therefore, every one kilogram per meter squared (kg/m^2) change in BMI was independently associated with a significant increase in systolic BP by 0.067 mmHg. However, holding systolic BP constant, the waist circumference was autonomously associated with increase in BMI, meaning that for every one kilogram per meter squared (kg/m^2) change in BMI there was a significant increase in waist circumference by 0.360 cm.

5. DISCUSSION

A major finding of this study was the high prevalence of unfavorable body weight values among the Saudi women in terms of underweight (11.2%), overweight, (22.4%) and obesity (8.5%), which are considered abnormal by international definitions. However, it should be noted that majority (57.8%) of the participants fall within the normal BMI range. Previous research has reported a growing prevalence of obesity among Saudi women [2], with Al Kadi and Alissa [16] reporting a high prevalence of overweight and obesity (20%). Another important finding of this study is that across all ages, in total, 21.1% of the participants were found to be pre-hypertensive, while 13.5% were pre-diabetic. The high incidence of CMD risk found in this study was observed among the 19 year-old participants. This age category is important for girls in terms of biological changes in growth, development, and maturation.

The BMI mean value of the participants of this study was 23.4±4.55 kg/m^2. The World Health Organization [17] proposed a BMI between 18.5 kg/m^2 and 24.9 kg/m^2 to be normal for average men and women. Therefore, the BMI of an average participant in this study was within the normal range. The mean value of the students' waist circumference (77.4±9.46 cm) was also within normal limits. Waist circumferences of 88 and 100 centimetres are generally recommended as cut-off points for women and men, respectively [18], as they are an indication of a strong metabolic disease risk [19]. Whilst it can be argued that some of the participants in this study were adolescents, studies have shown that for children and adolescents from different ethnicities no uniform definition of WC cut-offs exists because of the influence of physiological growth and development [20]. For example in the BIG Study, Schwandt *et al.* [21] reported that the relatively homogeneous WC mean values in adolescents of the three different ethnicities in the BIG Study were far lower than those obtained for American adolescents, *i.e.* 79.6±12.5 cm (males) and 78.8±11.7 cm (females) [22].

Classification of cardiovascular and metabolic disease risk factors according to BMI categories shows that the obese group in the present cohort of women had the highest CMD risk factors. It is well known that higher BMI values, increase predisposition to higher the CMD risk factors such as developing type 2 diabetes and hypertension [23]. Furthermore, the participants' waist circumference according to BMI categories indicated higher values than the cut-off point recommended for women. This finding is worrisome as it has been reported that intra-abdominal fat has deleterious impact on metabolism [23]. Al Kadi and Alissa [16] stated that studies conducted in East Asian countries have regularly emphasized the necessity to decrease BMI and waist circumference cut-off points for assessing the risk of metabolic disorders. Therefore, follow-up evaluations of such participants in the present study including referral to their physicians should be considered. In a recent comprehensive review of non-communicable diseases and their risk factors in Saudi Arabia, Al Quaiz, *et al*. [4] concluded that Saudi women have experienced a significant trend in obesity which is likely to make them more susceptible to developing CVD and diabetes than their male counterparts. This calls for implementation of regular health screening programs at PSU College for Women as part of its strategic wellness promotion initiative.

This study revealed that systolic BP, diastolic BP, blood glucose, and waist circumference were positively correlated with BMI. This result is consistent with those of Hatemi *et al*. [24] study which indicated that BMI was positively and significantly associated with systolic and diastolic BP. The results of the present study also showed a positive correlation between the women's BMI and blood glucose. This finding agrees with those of Panagiotakos, *et al*. [25] which revealed a positive association between BMI and blood pressure, total cholesterol, triglycerides, and glucose levels.

Based on the univariate analysis performed for the independent variables that were significant in the bivariate correlation analysis, it was found that all the variables significantly predicted BMI. However, to determine which of the variables could best predict BMI among the Saudi women, dependent variables were entered into multiple linear (backward) regression analysis. In the regression model, waist circumference, and systolic BP significantly predicted BMI. Similar findings were reported by Clark, *et al*. [26] who found that BMI and waist circumference examined independently were significant predictors of stroke volume, cardiac output, and systolic blood pressure among their participants. Furthermore, consistent with the literature, these direct associations indicate that heavier individuals are at risk of elevated BP compared to their slimmer counterparts [27]. It has also been reported that waist circumference and BMI can be used in monitoring the development of obesity in young adults [27]. Midha, *et al*. [28] also confirmed that BMI and waist circumference can be used to screen individuals at great risk of high BP so as to increase their health awareness and recommend appropriate diagnostic assessment.

6. LIMITATIONS AND STRENGTHS OF THE STUDY

The findings of this study should be interpreted in the light of the following constraints: First, only a few students participated in the 2015 health screening program relative to the entire population of the university students. Therefore, the results do not reflect the status of CMD profile of the entire population of PSU students; thus limiting the generalizability of the findings. Second, it was not feasible to measure the students' smoking, alcohol consumption, diet and physical activity habits. Probably, such information would have clarified some of the present results. Third, it was not feasible to analyze the data based on the students' age groups in view of the relatively small sample. This analysis would have permitted further data interpretation based on age-related trend and the participants' occupational roles. However, the strength of the study lies in the fact that it has provided baseline information on the CMD risk profile of PSU students who have hardly been previously studied. Also, information presented on the women's risk profiles opens a window of opportunity for periodic health assessments of the university community which could potentially promote healthy lifestyles among the students.

CONCLUSION

Although many of the students in the health screening exercise had healthy metabolic disease risk profiles, a few presented with excessively high levels which require follow-up clinical investigations.

RECOMMENDATIONS

There is a dire need to encourage students to participate in the health screening program in view of its importance to personal wellbeing. Health outcomes of such screening exercise could be compared from year to year for effective monitoring and diagnostic interventions. Healthy profiles among students can be promoted through a combination of interventions targeted at nutrition, physical activity and overall wellness lifestyle. Implementation of regular health awareness programs among students is therefore necessary in order to achieve this goal.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Permission to conduct this research was obtained from the higher management of Prince Sultan University Campus for women, Riyadh.

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All research procedures followed were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008 (http://www.wma.net/en/20activities/10ethics/10helsinki/).

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

Profound appreciation is extended to the higher management of PSU Campus for Women for granting the permission to conduct the health screening program. The roles of the staff and students, health professionals and colleagues who participated in the screening exercise are gratefully acknowledged. The support of the university statistician in preliminary data analysis is gratefully acknowledged.

REFERENCES

[1] World Health Organization. Regional office for Eastern Mediterranean Cairo, Egypt country cooperation strategy for Saudi Arabia (2006-2011). Geneva, Switzerland: WHO 2006.

[2] Al-Othaimeen AI, Al-Nozha M, Osman AK. Obesity: an emerging problem in Saudi Arabia. Analysis of data from the National Nutrition Survey. East Mediterr Health J 2007; 13(2): 441-8. [PMID: 17684864].
[PMID: 17684864]

[3] Al-Daghri NM, Khan N, Alkharfy KM, *et al.* Selected dietary nutrients and the prevalence of metabolic syndrome in adult males and females in Saudi Arabia: a pilot study. Nutrients 2013; 5(11): 4587-604. [http://dx. doi: 10.3390/nu5114587]. [PMCID: PMC3847750].
[http://dx.doi.org/10.3390/nu5114587] [PMID: 24284611]

[4] M Alquaiz A, R Siddiqui A, H Qureshi R, *et al.* Women Health in Saudi Arabia: A review of non-communicable diseases and their risk factors. Pak J Med Sci 2014; 30(2): 422-31. [PMCID: PMC3999023].
[PMID: 24772156]

[5] Al-Daghri NM, Alkharfy KM, Al-Attas OS, *et al.* Gender-dependent associations between socioeconomic status and metabolic syndrome: a cross-sectional study in the adult Saudi population. BMC Cardiovasc Disord 2014; 14: 51.
[http://dx.doi.org/10.1186/1471-2261-14-51] [PMID: 24735007]

[6] Deniz N. Ethnicity and cardiovascular disease in the Middle East. the University of Gavle: Department of Occupational and Public Health 2013.

[7] Al-Lawati JA, Mohammed AJ, Al-Hinai HQ, Jousilahti P. Prevalence of the metabolic syndrome among Omani adults. Diabetes Care 2003; 26(6): 1781-5.
[http://dx.doi.org/10.2337/diacare.26.6.1781] [PMID: 12766109]

[8] Jamee A, Abed Y, Abutawila H. Risk factors of metabolic syndrome among clinic patients in Gaza – Palestine. Am J Cardiovasc Dis 2013; 1: 20-4. [http://dx.DOI: 10.12691/ajcdr-1-1-5].

[9] Marfell-Jones M, Olds T, Stew A, Carter L. International standards for anthropometric assessment. Australia: The International Society for the Advancement of Kinanthropometry 2006.

[10] Cole TJ, Flegal KM, Nicholls D, Jackson AA. Body mass index cut offs to define thinness in children and adolescents: international survey. BMJ 2007; 335(7612): 194-201.
[http://dx.doi.org/10.1136/bmj.39238.399444.55] [PMID: 17591624]

[11] Sandham J. Risks of poorly managed technology. EMBE seminar review. The clinical services journal 2015; 71-3.

[12] Stage H. Understanding blood pressure readings. Heart, 17. Available at: http://www.heart.org/HEARTORG/Conditions/ HighBloodPressure/ AboutHighBloodPressure/ Understanding-Blood-Pressure-readings_UCM_301764_Article.jsp#.WACjxeh97IU

[13] American Association for Clinical Chemistry. Lab Tests Online: Empower Your Health, Understand Your Tests. Available at: https://labtestsonline.org/understanding/analytes/glucose/tab/test/; 2016 [accessed 04.11.2016].

[14] Shephard DA. The 1975 Declaration of Helsinki and consent. Can Med Assoc J 1976; 115(12): 1191-2.
[PMID: 1000449]

[15] Dancey C, Reidy J. Statistics without Maths for Psychology: Using SPSS for Windows. London, UK: Prentice Hall 2004.

[16] Al Kadi HA, Alissa EM. Prevalence of hyperlipidemia and associated risk factors among healthy young Saudi females: Relationship with waist circumference and body mass index. Endocrinol Metab Syndr 2011; S2: 1-5. [http://dx.doi.org/10.4172/2161-1017.S2-001].

[17] WHO expert consultation. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363: 57-63.

[18] Aronne LJ. Classification of obesity and assessment of obesity-related health risks. Obes Res 2002; 10(Suppl. 2): 105S-15S. [http://dx.DOI: 10.1038/oby.2002.203]. [PMID: 12490659].
[http://dx.doi.org/10.1038/oby.2002.203] [PMID: 12490659]

[19] Ojoawo AO, Adeniran SA, Olubayo F, Onagbiye SO, Bamiwuye S. Relationship between body circumferences and lung function tests among undergraduate students of a Nigerian university. Pak J Physiol 2013; 9: 3-6.

[20] Schwandt P, Haas GM. Waist circumference in children and adolescents from different ethnicities. NTECH Open Access Publisher 2012.

[21] Schwandt P, Kelishadi R, Ribeiro RQ, Haas GM, Poursafa P. A three-country study on the components of the metabolic syndrome in youths: the BIG Study. Int J Pediatr Obes 2010; 5(4): 334-41. [http://dx.DOI: 10.3109/17477160903497043]. [PMID: 20233158].
[http://dx.doi.org/10.3109/17477160903497043] [PMID: 20233158]

[22] Jolliffe CJ, Janssen I. Vascular risks and management of obesity in children and adolescents. Vasc Health Risk Manag 2006; 2(2): 171-87. [PMCID: PMC1994001].
[http://dx.doi.org/10.2147/vhrm.2006.2.2.171] [PMID: 17319462]

[23] World Heart Federation. Obesity. Available at: http://www.world-heart-federation.org/ cardiovascular-health/ cardiovascular-disease-risk-factors/obesity/ [accessed 04.11.2016]

[24] Hatemi H, Yumuk VD, Turan N, Arik N. Prevalence of overweight and obesity in Turkey. Metab Syndr Relat Disord 2003; 1(4): 285-90.
[http://dx.doi.org/10.1089/1540419031361363] [PMID: 18370653]

[25] Panagiotakos DB, Pitsavos C, Chrysohoou C, *et al.* Epidemiology of overweight and obesity in a Greek adult population: the ATTICA Study. Obes Res 2004; 12(12): 1914-20.
[http://dx.doi.org/10.1038/oby.2004.239] [PMID: 15687390]

[26] Clark VR, Greenberg B, Harris TS, Carson BL. Body mass index and waist circumference predictors of cardiovascular risk in African Americans. Ethn Dis 2012; 22(2): 162-7.
[PMID: 22764637]

[27] Lara M, Bustos P, Amigo H, Silva C, Rona RJ. Is waist circumference a better predictor of blood pressure, insulin resistance and blood lipids than body mass index in young Chilean adults? BMC Public Health 2012; 12: 638.
[http://dx.doi.org/10.1186/1471-2458-12-638] [PMID: 22882972]

[28] Midha T, Krishna V, Nath B, *et al.* Cut-off of body mass index and waist circumference to predict hypertension in Indian adults. World J Clin Cases 2014; 2(7): 272-8. [http//:dx.doi: 10.12998/wjcc.v2.i7.272]. [PMCID: PMC4097154].
[http://dx.doi.org/10.12998/wjcc.v2.i7.272] [PMID: 25032202]