Is Cardiopulmonary Fitness Level a Risk Factor in Young Saudi Females?

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Abstract
Low physical fitness is one of the all-cause mortality risk factors. This study aims to estimate cardiopulmonary fitness (VO2 max) in young Saudi females and correlate it to anthropometric and hemodynamic parameters. Forty-eight young Saudi females completed an exercise stress test until exhaustion. Basal and maximum pulse rate, arterial blood pressure, VO2 max and other anthropometric data were measured. The population was divided into low and high VO2 max groups and a comparison was run using student t-test. Correlation was tested between VO2 max and other measured parameters. The mean VO2 max of the sample population was low (33.6 ± 8.2 mL/(kg·min)) with 37.5% exhibiting fair to very poor VO2 max value. The low VO2 max group was characterized by higher body mass index, exercise diastolic and mean arterial blood pressure when compared to normal VO2 max group, indicating a strong negative correlation. This study revealed a low cardiopulmonary fitness in young Saudi females and showed a strong association between VO2 max and increased body fat and maximum exercise diastolic blood pressure. These findings provide reliable indicators of increased all-cause mortality risk in young Saudi females and increase the urgency of prompt action.

Keywords
Cardiopulmonary fitness; VO2 max; Bruce protocol; Exercise stress test; Young female

Introduction
Physical inactivity is one of the major risk factors that threaten the public health. Recent epidemiological studies demonstrated a significant impact of moderate physical activity on lowering the incidence of all vascular diseases including coronary vascular, cerebrovascular and thromboembolic diseases.

Few studies were performed in Saudi Arabia aimed at estimating the extent of physical inactivity in our population. Most of these studies utilized a physical activity questionnaire for the assessment of physical fitness. In a study performed on 1064 subjects of both sexes across a wide range of age (15-78 years), there was a high incidence of physical inactivity that is more obvious in females than males. It is also found that the engagement in frequent exercise activities about three times per week diminishes early in life more commonly in females compared to males (45.6% male engagement versus 33.7% female engagement).

Most of the studies performed in our country focused on males, specifically young teenagers
and children, whether sedentary or athletic\(^5,6\). Concurrently, we believe that females in Saudi Arabia are more prone to an extreme reduction of physical activity due to cultural beliefs, city structure, and family responsibilities.

Although using a standardized physical activity assessment questionnaire helps in providing an insight to the extent of the physical inactivity, some studies revealed an overestimate of physical fitness using the questionnaire, and hence an amelioration of the encountered health hazard\(^5\). The most accurate and reliable method for estimating physical fitness is using the standard cardiopulmonary exercise testing\(^6\). Data collected from different populations revealed differences in the standard values and showed consistently lower female parameters\(^9,10\).

Therefore, in the current study we aim to evaluate cardiopulmonary fitness in young Saudi females by estimating VO\(_2\) max using exercise stress test, compare the finding with other population fitness values, and find the possible correlation of cardiopulmonary fitness represented by VO\(_2\) max with anthropometric and hemodynamic parameters.

**Anthropometric Measurement**

Weight was determined for each subject using a portable platform scale with an accuracy within 0.1 kg. Height was assessed using a cm scale with an accuracy to the nearest 0.25 cm. Body mass index (BMI) was calculated using the formula (weight kg/height m\(^2\)). Determinants of central obesity were also assessed, including waist (at the level of umbilicus using non-stretchable measuring tape while wearing light clothes) and hip circumference (determined as the largest diameter of the hip) and the ratios waist/hip and waist/height were calculated. These measurements were performed before the subject performed the cardiopulmonary exercise testing (CPET).

**Cardiopulmonary Exercise Testing**

A clear explanation of the procedure of CPET was introduced to the subject before starting the test. The subjects were encouraged to perform at maximum effort, however the participant had the right to stop the test when fatigued.

Baseline pulse rate, oxyhemoglobin (HbO\(_2\)) saturation, arterial blood pressure (systolic and diastolic) and electrocardiograph (ECG) were recorded. Continuous monitoring of pulse rate, HbO\(_2\) saturation, arterial blood pressure and ECG was performed during the exercise procedure and carefully observed by an expert.

Each subject performed the treadmill Bruce protocol\(^12\) using exercise physiology laboratory (ADInstruments, Bella Vista NSW, Australia). In the Bruce protocol, the subject starts with speed of 1.7 mph at a 10% grade. Consequently, both speed and inclination are increased every three minutes until exhaustion.

Simultaneously the increment in pulse rate was observed and compared to the calculated maximal heart rate of the subject as predicted by age, using the formula:

\[
\text{Predicted maximum heart rate} = 208 - 0.7 \times \text{age}^{13}\]

An achievement of 85% of the predicted maximum heart rate or above was set as the criterion of reaching maximum effort.

Maximal oxygen consumption (V - volume, O\(_2\) - oxygen, max - maximum (VO\(_2\) max)) was estimated...
from the total time until exhaustion $T$ (min) using the following formula (Pollock Formula)

$$VO_2 \text{ max} = 4.38 \times T - 3.9^{[14]}$$

Mean arterial blood pressure was determined using the following formula:

$$MAP = \text{Diastolic blood pressure} + \frac{1}{3} (\text{systolic blood pressure} - \text{diastolic blood pressure})^{[15]}$$

Statistical Analysis

IBM SPSS Statistics for Windows, Version 20 (IBM Corp., Armonk, NY USA) was used to analyze the data. Maximum oxygen consumption values were normally distributed based on the results of Shapiro-Wilk and Kolmogorov-Smirnov tests, therefore, parametric tests were used for comparison. All data were expressed as Mean ± SD.

The Bivariate (Pearson) Correlation was used to find out the possible correlation of $VO_2$ max, anthropometric and hemodynamic data. Linear regression models were generated when a significant correlation was found. The level of significance was set at $P$-value < 0.05.

Results

Descriptive data for all participants, including age, anthropometric, exercise and hemodynamic parameters, are shown in Tables 1 and 2. All CPETs ran uneventfully, no signs of ischemia or arrhythmias were detected in ECG at baseline or during the exercise test. A comparison of hemodynamic data including heart rate, blood pressure and $HbO_2$ saturation percentage revealed significantly higher maximum exercise heart rate, systolic and mean arterial blood pressure vs the corresponding resting values (Table 2).

The participants were classified based on their $VO_2$ max value into six categories according to the specification of the physical fitness specialist certification manual$^{[16]}$ (Table 3): 17% very poor ($VO_2$ max < 23.6 mL/(kg-min); 17% poor ($VO_2$ max = 23.6-28.9 mL/(kg-min); 4% fair ($VO_2$ max = 29.0-32.9 mL/(kg-min); 17% good ($VO_2$ max = 33.0-36.9 mL/(kg-min); 27% excellent ($VO_2$ max = 37.0-41.0 mL/(kg-min); 19% superior ($VO_2$ max > 41.0 mL/(kg-min).

The participants were then divided into two main groups to simplify comparison. The first group includes very poor to fair categories, considered the low $VO_2$ max group, and accounts for 37.5% of the sample. The second group includes good to superior categories, considered the high $VO_2$ max group, and accounts for 62.5% of the sample. Using independent samples “student’s” $t$ test, the anthropometric and hemodynamic data were compared and revealed significantly higher values for weight, BMI, waist/height ratio (Table 4), last diastolic blood pressure, and mean arterial blood pressure (Table 5) in the low $VO_2$ max group compared to the high $VO_2$ max group. Conversely, $VO_2$ max, and time until exhaustion were lower in the low $VO_2$ max group (Table 5).

Maximum oxygen consumption showed a significant negative correlation with anthropometric data including body weight ($r = -0.554, P = 0.001$), BMI ($r = -0.535, P = 0.001$), waist ($r = -0.497, P = 0.001$), and hip circumference ($r = -0.519, P = 0.001$) (Fig. 1). Similarly, a negative correlation was found between $VO_2$ max and last diastolic blood pressure ($r = -0.304, P = 0.036$) and mean arterial blood pressure ($r = -0.325, P = 0.024$) (Fig. 2). Correlation of $VO_2$ max with age was insignificant ($r = -0.009, P = 0.950$).

| Parameters                                | Mean ± SD          | Min-Max          |
|-------------------------------------------|--------------------|------------------|
| Age (years)                               | 20.58 ± 1.90       | 19.00-27.00      |
| Body weight (kg)                          | 59.26 ± 16.36      | 37.20-115.80     |
| Height (cm)                               | 158.65 ± 7.50      | 143.50-176.50    |
| Body mass index (kg/m²)                   | 23.34 ± 5.15       | 16.81-38.91      |
| Waist circumference (cm)                  | 71.90 ± 11.23      | 59.00-116.00     |
| Hip circumference (cm)                    | 97.77 ± 12.12      | 78.00-133.00     |
| Waist/hip ratio (W/H)                     | 0.73 ± 0.05        | 0.63-0.89        |
| Waist/height ratio (W/S)                  | 0.45 ± 0.06        | 0.36-0.67        |
| $VO_2$ max (mL/(kg·min))                  | 32.00 ± 8.12       | 13.38-44.01      |
| Time of exercise till exhaustion (min)    | 8.40 ± 1.87        | 4.23-11.14       |

$VO_2$ max: Maximum oxygen consumption
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Table 2. Hemodynamic parameters of young Saudi female college students (n= 48).

| Hemodynamic Parameter                          | Resting        | Last            | Significance |
|-----------------------------------------------|----------------|-----------------|--------------|
| Systolic blood pressure (mmHg)                | 120.10 ± 12.27 | 144.96 ± 31.47  | 0.0001       |
| Diastolic blood pressure (mmHg)               | 78.70 ± 7.29   | 76.81 ± 7.30    | 0.054        |
| Mean arterial blood pressure (mmHg)           | 92.51 ± 8.13   | 99.54 ± 12.27   | 0.0001       |
| HbO2 saturation (%)                           | 97.70% ± 2.93% | 95.79% ± 6.85%  | 0.091        |
| Heart rate (beats/min)                        | 103.60 ± 13.86 | 178.44 ± 8.89   | 0.0001       |

Data expressed as mean ± standard deviation. Comparison between each pair of variables was made using paired “student’s” t test.

Table 3. Classification of VO2 max[16]

| VO2 max Category | Number (%) of Participants |
|------------------|---------------------------|
| Very Poor (VO2 max< 23.6 mL/(kg·min)) | 8 (17.00%) |
| Poor (VO2 max = 23.6-28.9 mL/(kg·min)) | 8 (17.00%) |
| Fair (VO2 max = 29.0-32.9 mL/(kg·min)) | 2 (4.00%) |
| Good (VO2 max = 33.0-36.9 mL/(kg·min)) | 8 (17.00%) |
| Excellent (VO2 max = 37.0-41.0 mL/(kg·min)) | 13 (27.00%) |
| Superior (VO2 max > 41.0 mL/(kg·min)) | 9 (19.00%) |

VO2 max: Maximal oxygen consumption

Table 4. Comparison of anthropometric data between subjects with low and high VO2 max.

| Parameters      | Low VO2 max (n = 18) | High VO2 max (n = 30) | P-value |
|-----------------|----------------------|-----------------------|---------|
| Age (years)     | 20.39 ± 1.69         | 20.70 ± 2.04          | 0.588   |
| Weight (Kg)     | 69.04 ± 20.28        | 53.39 ± 9.87          | 0.006   |
| Height (cm)     | 161.00 ± 6.26        | 157.24 ± 7.91         | 0.093   |
| BMI (kg.m²)     | 26.33 ± 6.08         | 21.55 ± 3.52          | 0.006   |
| Waist Circumference (cm) | 78.11 ± 14.14 | 68.17 ± 6.98 | 0.011   |
| Hip Circumference (cm) | 104.39 ± 14.12 | 93.80 ± 8.81 | 0.002   |
| Waist/Hip circumference | 0.74 ± 0.05      | 0.72 ± 0.06          | 0.288   |
| Waist/Height ratio | 0.46 ± 0.08      | 0.43 ± 0.05          | 0.018   |

Data expressed as mean ± standard deviation. Comparison between the two groups was made using unpaired “student’s” t test.

Table 5. Comparison of exercise test and hemodynamic parameters between subjects with low and high VO2 max.

| Parameters                  | Low VO2 max (n = 18) | High VO2 max (n = 30) | P-value |
|-----------------------------|----------------------|-----------------------|---------|
| VO2 max mL/(kg·min)         | 24.10 ± 4.40         | 39.30 ± 2.80          | 0.001   |
| Time of exercise till exhaustion (min) | 6.24 ± 1.00     | 9.69 ± 0.67          | 0.001   |
| Resting systolic blood pressure (mmHg) | 123.78 ± 11.85 | 117.90 ± 12.18       | 0.108   |
| Last systolic blood pressure (mmHg) | 155.94 ± 37.53 | 138.37 ± 25.68       | 0.060   |
| Resting diastolic blood pressure (mmHg) | 80.56 ± 7.16     | 77.60 ± 7.26         | 0.177   |
| Last diastolic blood pressure (mmHg) | 79.72 ± 6.70     | 75.07 ± 7.20         | 0.031   |
| Baseline mean arterial blood pressure | 94.96 ± 7.23   | 91.03 ± 8.40         | 0.106   |
| Last mean arterial blood pressure | 105.17 ± 13.02 | 96.17 ± 10.64        | 0.012   |
| Resting HbO2 saturation%     | 97.72% ± 2.99%     | 97.89% ± 3.92%       | 0.437   |
| Last HbO2 saturation%        | 96.93% ± 7.29%     | 95.43% ± 6.67%       | 0.645   |
| Resting heart rate (beats/min) | 107.39 ± 12.62   | 101.37 ± 14.28       | 0.147   |
| Last heart rate (beats/min)  | 179.11 ± 8.20     | 178.03 ± 9.39        | 0.689   |

Data expressed as mean ± standard deviation. Comparison between the two groups was made using unpaired “student’s” t test.

HbO2 = Oxyhemoglobin; VO2 max: Maximal oxygen consumption
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Figure 1. Bivariate correlation and linear regression relationship of VO2 max and anthropometric data: (a) Body weight, (b) BMI, (c) Waist circumference, (d) Hip circumference.

- R = -0.554, P < 0.001
- R = -0.535, P < 0.001
- R = -0.519, P < 0.001
- R = -0.497, P < 0.001
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Discussion

The main finding of the current study is the low VO$_2$ max and time until exhaustion obtained from young Saudi females. 37.50% of the currently recruited Saudi females were at the category of fair or below based on the classification of the physical fitness specialist certification manual [16]. To our knowledge, this is the first Saudi study that determines VO$_2$ max in young females.

The current findings indicate first, an objective and reliable estimate of the cardiopulmonary fitness status of young Saudi females, since these data were obtained by standard exercise stress test [8]. When the value of VO$_2$ max of our studied group was compared to the international value obtained from a large European study, it displays a generalized reduction in the indicator of cardiopulmonary fitness in young Saudi females, 33.6 ± 8.2 mL/(kg·min) compared to 42.8 ± 7.6 mL/(kg·min) from 92 females age 20-29 of HUNT fitness study [9]. Similarly, in a study performed on college female students in Spain, VO$_2$ max of the studied sample was 41.25 ± 8.5 mL/(kg·min) for non-health colleges and 35.7 ± 7.4 mL/(kg·min) for nursing students [17]. A small study of the aerobic capacity of Mexican-American individuals revealed VO$_2$ max of females equal to 44.69 mL/(kg·min) [18]. Furthermore, VO$_2$ max determination of Indian college females revealed a value of 35.9 ± 3.46 mL/(kg·min) [19]. Variations in the values of physical fitness among different studies might be attributed to the variation in the methodology and techniques used for the determination of VO$_2$ max. However, other important factors might be involved including differences in body mass [20,21], age groups, environmental, and genetic factors [10].

In this study the low VO$_2$ max group was found to be characterized by higher BMI, waist and hip circumference, when compared to the high VO$_2$ max group. In addition, significant negative correlations were found between VO$_2$ max and body weight, BMI, waist and hip circumference. Adiposity is reported in the literature as one of the factors that lead to a deterioration of physical fitness. In an observational study in South Korea of young healthy individuals, BMI was negatively correlated with cardiorespiratory fitness [22]. Similarly, VO$_2$ max of young healthy Iranian children was adversely correlated with BMI, waist to height ratio, waist circumference and fat mass [23]. Besides being a causative factor of reduced physical fitness, increased body adiposity is believed to work adversely with the low physical fitness to cumulatively increase the health burden upon the cardiovascular and metabolic systems [24].

Hemodynamic parameter comparison between resting and maximum exercise values revealed significantly higher maximum exercise systolic, mean blood pressure and heart rate vs. the corresponding resting values. Laukkanen et al. [24] studied the potential risk of exercise blood pressure, heart rate and VO$_2$ max...
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...to sudden cardiac death in a prospective study and their data revealed weak correlation of the exercise hemodynamic values including SBP at 2 min recovery to cardiac mortality but strong correlation of low VO\textsubscript{2}\text{max} with sudden cardiac death\cite{24}. Studies that reported reference values and normal ranges of exercise heart rate and blood pressure are few. One large-scale community-based study in Germany revealed reference values of exercise hemodynamic parameters for 88 young females with normal BMI as maximum SBP 173 ± 21, maximum DBP 88 ± 12, and maximum HR 171 ± 13\cite{25}. Our reported exercise hemodynamic data were slightly lower than the corresponding German reference data, particularly the systolic blood pressure.

Furthermore, the current study revealed higher last mean and diastolic blood pressure in the group of low VO\textsubscript{2}\text{max}, and negative correlation between VO\textsubscript{2} max and last mean and diastolic blood pressure. The increased diastolic and mean arterial blood pressure induced by exercise stress test in the low fitness group might be an early sign of a future risk of developing hypertension\cite{26}. Therefore, we might conclude that the stress test is a useful tool to elucidate the risk for future cardiovascular disorders\cite{27}. In addition, the strong negative association between VO\textsubscript{2} max and diastolic and mean arterial blood pressure might indicate the importance of physical fitness in regard to cardiovascular risk\cite{28}. In this study systolic blood pressure was not elevated or correlated with VO\textsubscript{2} max. It might be explained by the structure of the recruited sample i.e., young age group and female only, where the association of high systolic blood pressure and reduced fitness is less frequently developed\cite{29,30}.

One proposed mechanism of the relationship of reduced physical fitness, increased fat and increased arterial blood pressure is a claimed increase in sympathetic stimulation and improper balance between sympathetic and parasympathetic discharge whether at rest or during exercise\cite{31,32}. Improvement in physical fitness is found to be associated with enhancement and a reversing of sympathetic parasympathetic imbalance\cite{33,34}.

Last but not least, there was no significant correlation between VO\textsubscript{2} max and age. The reason might be due to the relatively small sample size and the narrow age range of the involved sample.

**Conclusion**

In conclusion, our cross-sectional study revealed low cardiopulmonary fitness level in young Saudi females indicated by low VO\textsubscript{2} max. We assume that increased body fat might be one of the main causative factors for the currently discovered low VO\textsubscript{2} max. However, we recommend future studies to reveal other possible underlying mechanisms. Moreover, the currently demonstrated reduced fitness was also associated with high exercise diastolic blood pressure, which might be an initial sign for potential risk of future cardiovascular morbidity. A large national plan is urgently needed to study the physical fitness of different age groups of our population, to increase the awareness of the need for better physical fitness among females in Saudi Arabia and to provide opportunities to enhance the fitness in schools, educational institutes, community and recreational centers.

**Limitations**

The current study might be limited by the relatively small sample size and the narrow age group. Based on the obtained data from young educated Saudi females, we believe large national studies of the female population of different age and cultural groups are highly recommended. However, the current obtained data would serve as a good reference and baseline data for future studies.

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**Conflict of Interest**

The author has no conflict of interest.

**Disclosure**

The author did not received any type of commercial support either in forms of compensation or financial for this study. The author has no financial interest in any of the products or devices, or drugs mentioned in this article.

**Ethical Approval**

Obtained.

**References**

\[1\] Barry VW, Baruth M, Beets MW, Durstine JL, Liu J, Blair SN. Fitness vs. fatness on all-cause mortality: a meta-analysis. Prog Cardiovasc Dis 2014; 56(4): 382-390.
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[2] Twisk JW, Kemper HC, van Mechelen W. Tracking of activity and fitness and the relationship with cardiovascular disease risk factors. Med Sci Sports Exerc 2000; 32(8): 1455-1461.

[3] Al-Hazzaa HM. Health-enhancing physical activity among Saudi adults using the International Physical Activity Questionnaire (IPAQ). Public Health Nutr 2007; 10(1): 59-64.

[4] Taha AZ. Self-reported knowledge and pattern of physical activity among school students in Al Khober, Saudi Arabia. East Mediterr Health J 2008; 14(2): 344-355.

[5] Al-Hazzaa HM, Alahmadi MA, Al-Sobayel HI, Abahussain Taha AZ. Self-reported knowledge and pattern of physical activity among Saudi adolescents. J Phys Act Health 2014; 11(6): 1202-1211.

[6] Al-Rafaee SA, Al-Hazzaa HM. Physical activity profile of adult males in Riyadh City. Saudi Med J 2001; 22(9): 784-789.

[7] Bermúdez VJ, Rojas JJ, Córdova EB, Añez R, Toledo A, Al-Rafaee SA, Al-Hazzaa HM. Measures of cardiorespiratory fitness in relation to measures of body size and composition among children. Clin Physiol Funct Imaging 2015; 35(6): 469-477.

[8] Ross RM. ATS/ACCP statement on cardiopulmonary exercise testing. Am J Respir Crit Care Med 2003; 167(10): 1451.

[9] Loe H, Steinsshamn S, Wilsøff U. Cardio-respiratory reference data in 4631 healthy men and women 20-90 years: the HUNT 3 fitness study. PLoS One 2014; 9(11): e113884.

[10] Koch B, Schäper C, Ittermann T, Spielhagen T, Dörr M, Völzke H, Opitz CF, Ewert R, Gläser S. Reference values for cardiopulmonary exercise testing in healthy volunteers: the SHIP study. Eur Respir J 2009; 33(2): 389-397.

[11] Association WM. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013; 310(20): 2191-2194.

[12] Froelicher VF, Thompson AJ, Davis G, Stewart AJ, Triebwasser PT. Exercise systolic blood pressure >/=190 mmhg at moderate workload predicts coronary heart disease in healthy, middle-aged men. J Hypertens 2015; 33 Suppl 1: e28.

[13] Irazusta A, Gil S, Ruiz F, Gondra J, Jauregi A, Irazusta J, Gil J. Exercise, physical fitness, and dietary habits of first-year female nursing students. Biol Res Nurs 2006, 7(3): 175-186.

[14] Pennathur A, Lopes A, Contreras LR. Aerobic capacity of young Mexican American adults. Int J Industrial Ergonomics 2004; 35(1): 105-117.

[15] Palaniappan L, Simons LA, Simons J, Friedlander Y, McCallum J. Comparison of usefulness of systolic, diastolic, and mean blood pressure and pulse pressure as predictors of cardiovascular death in patients >/=60 years of age (The Dubbo Study). Am J Cardiol 2002; 90(12): 1398-1401.

[16] Heyward VH. Advance Fitness Assessment and Exercise Prescription. 6th ed. Thomas-Shore, Inc. 2010.

[17] Irazusta A, Gil S, Ruiz F, Gondra J, Jauregi A, Irazusta J, Gil J. Exercise, physical fitness, and dietary habits of first-year female nursing students. Biol Res Nurs 2006, 7(3): 175-186.

[18] Pennathur A, Lopes A, Contreras LR. Aerobic capacity of young Mexican American adults. Int J Industrial Ergonomics 2004; 35(1): 105-117.

[19] Varghese MA, Saha PN, Atreye N. Aerobic capacity of urban women homemakers in Bombay. Ergonomics 1995; 38(9): 1877-1883.

[20] Voss C, Sandercock G, Wharf Higgins J, Macdonald H, Nettelfold L, Naylor PJ, McKay H. A cross-cultural comparison of body composition, physical fitness and physical activity between regional samples of Canadian and English children and adolescents. Can J Public Health 2014; 105(4): e245-250.

[21] Tompuri T, Lintu N, Savonen K, Laitinen T, Laaksonen D, Jääskeläinen L, Laiikka TA. Age-predicted maximal oxygen consumption. Med Sci Sports Exerc 2000; 32(8): 1455-1461.

[22] So WY, Choi DH. Differences in Physical Fitness and Cardiovascular Function Depend on BMI in Korean Men. J Sports Med Sci 2010; 9(2): 239-244.

[23] Gläser S, Friedrich N, Koch B, Schäper C, Völzke H, Felix SB, et al. Exercise blood pressure and heart rate reference values. Heart Lung Circ 2013; 22(8): 661-667.

[24] Mariampillai JE, Engeseth K, Kjeldsen SE, Grundvold I, Liestal K, Eriksen G, Eriksen JE, Bødgård J, Skretteberg PT. Exercise systolic blood pressure >/=190 mmHg at moderate workload predicts coronary heart disease in healthy, middle-aged men. J Hypertens 2013; 31 Suppl 1: e28.

[25] Lauthkanen JA, Rauramaa R. Systolic blood pressure during exercise testing and the risk of sudden cardiac death. Int J Cardiol 2013; 168(3): 3046-3047.

[26] Laukkonen JA, Rauramaa R. Systolic blood pressure during exercise testing and the risk of sudden cardiac death. Int J Cardiol 2013; 168(3): 3046-3047.

[27] Esmailezadeh S, Kalantari H, Nakhhostin-Rooobi B. Cardiorespiratory fitness, activity level, health-related anthropometric variables, sedentary behaviour and socioeconomic status in a sample of Iranian 7-11 year old boys. Biol Sport 2013; 30(1): 67-71.

[28] Pennathur A, Lopes A, Contreras LR. Aerobic capacity of young Mexican American adults. Int J Industrial Ergonomics 2004; 35(1): 105-117.

[29] Tompuri T, Lintu N, Savonen K, Laitinen T, Laaksonen D, Jääskeläinen L, Laiikka TA. Age-predicted maximal oxygen consumption. Med Sci Sports Exerc 2000; 32(8): 1455-1461.

[30] Tompuri T, Lintu N, Savonen K, Laitinen T, Laaksonen D, Jääskeläinen L, Laiikka TA. Age-predicted maximal oxygen consumption. Med Sci Sports Exerc 2000; 32(8): 1455-1461.

[31] Koch B, Schäper C, Ittermann T, Spielhagen T, Dörr M, Völzke H, Opitz CF, Ewert R, Gläser S. Reference values for cardiopulmonary exercise testing in healthy volunteers: the SHIP study. Eur Respir J 2009; 33(2): 389-397.

[32] Association WM. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. JAMA 2013; 310(20): 2191-2194.
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objectively measured physical activity, cardiorespiratory fitness and risk factors for metabolic syndrome in 12- to 15-year old Tianjin city children. Health Educ J 2015; 74(4): 403-410.

[30] Hurtig-Wennlöf A, Ruiz JR, Harro M, Sjöström M. Cardiorespiratory fitness relates more strongly than physical activity to cardiovascular disease risk factors in healthy children and adolescents: the European Youth Heart Study. Eur J Cardiovasc Prev Rehabil 2007; 14(4): 575-581.

[31] Indumathy J, Pal GK, Pal P, Ananthanarayanan PH, Parija SC, Balachander J, Dutta TK. Association of sympathovagal imbalance with obesity indices, and abnormal metabolic biomarkers and cardiovascular parameters. Obes Res Clin Pract 2015; 9(1): 55-66.

[32] Pal GK, Adithan C, Dutta TK, Pal P, Nanda N, Lalitha V, Syamsunder AN. Association of hypertension status and cardiovascular risks with sympathovagal imbalance in first degree relatives of type 2 diabetics. J Diabetes Investig 2014; 5(4): 449-455.

[33] Wong A, Figueroa A. Eight weeks of stretching training reduces aortic wave reflection magnitude and blood pressure in obese postmenopausal women. J Hum Hypertens 2014; 28(4): 246-250.

[34] Goulopoulos S, Baynard T, Franklin RM, Fernhall B, Carhart R Jr, Weinstock R, Kanaley JA. Exercise training improves cardiovascular autonomic modulation in response to glucose ingestion in obese adults with and without type 2 diabetes mellitus. Metabolism 2010; 59(6): 901-910.
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هل معدل اللياقة البدنية لدى السيدات الشابات في المملكة العربية السعودية يشكل مصدر خطر صحي لهن؟

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الدمام – المملكة العربية السعودية

المستخلص. بعد اتخاذ اللياقة البدنية إحدى عوامل الخطورة للإصابة بأمراض القلب والثنايب ومماثلة الانتقادات الأيدي. لذا نود في هذا البحث دراسة معدل اللياقة البدنية لدي السيدات السعوديات الشابات ودراسة العلاقة بين هذا معدل ومعايير البدانة ومعلومات الجهاز الديوي.

تم جمع عينة من 46 طالبة من جامعة الدمام خضعن اختبار الجهد البدني الأقصى وتم قياس المؤشرات الديوية للجهاز الدوري كمعدل التبخر وضغط الدم قبل الاختبار وللحل. كما تم تحديد معدل كتلة الجسم ومحيط الخصر والحوض لدى.

أظهرت النتائج أن مستوى جحمالأكسجين الأقصى للسيدات المشاركات 33.6 مل/ كيلوغرام. وأن 67.2% من العينة المدروسة تعاني من انخفاض في معدل اللياقة البدنية. وعند مقارنة مجموعة اللياقة البدنية الطبيعية والمتضخة، وجد أن الأخيرة تتفوق بكثافة بدنية وضغط الدم الابساطي ومتزامن عند أقصى جهد، أعلى من المجموعة الأولى. كما وجدنا علاقة سلبية قوية بين حجم الأكسجين الأقصى ومعدل كتلة الجسم وضغط الدم الابساطي والمتزامن عند أعلى جهد.

من هنا نستخلص أن معدل اللياقة البدنية لدى طالبات جامعة الدمام منخفض بصورة عامة وأن هناك علاقة سلبية قوية بين معدل اللياقة البدنية ومعدل كتلة الجسم والضغط الابساطي والمتوسط عند أعلى جهد، مما يعني زيادة احتمالات الإصابة بالأمراض المزمنة في المستقبل. وهذا يستلزم زيادة الوعي ودراسة أسباب الانخفاض وأخذ 措施 وقائية لرفع مستوى اللياقة البدنية لدى النساء في السعودية.