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Health-related physical fitness among adolescent schoolgirls in Madinah city, western Saudi Arabia

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Abstract

In Saudi Arabia, health-related physical fitness components in girls have received far less attention than physical activity. Therefore, the aim of this study was to assess health-related physical fitness components (cardiorespiratory fitness, body fat, muscle strength, and flexibility) among adolescent schoolgirls in Madinah city, western Saudi Arabia. Thirty-six female students (mean ± standard deviation, age, 17.4 ± 1.3 years; body mass, 51.6 ± 11.1 kg; height, 154.5 ± 6.9 cm) performed a Queen's College Step Test to estimate maximal oxygen consumption. Body fat percentage was determined using a bioelectrical impedance analyzer. Hand grip strength was measured using a hand grip dynamometer, and flexibility was determined by using the sit and reach test. The mean (±standard deviation) of estimated maximal oxygen consumption was 39.5 ± 6.3 (ml.kg.min). The mean (±standard deviation) of Body fat percentage, right-hand grip strength, left-hand grip strength, and flexibility were 31.0 ±9.0 (%), 16.5±5.5 (kg), 17.1 ±4.9 (kg), and 10.6±4.8 (cm), respectively. We conclude that multiple health-related physical fitness components—with the exception of cardiorespiratory fitness—should be targeted, particularly body composition, muscle strength, and flexibility, to enhance health status among Saudi adolescent schoolgirls in Madinah. This may be accomplished by local schools, which should offer exercise programs to improve students' physical fitness components.

Keywords: Exercise training, Physical activity, Body fat, Overweight, Obesity.

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INTRODUCTION

Physical inactivity and overweight/obesity are recognized as significant risk factors of non-communicable diseases and are considered to be one of the leading factors of global mortality [1, 2]. In Saudi Arabia, the prevalence of overweight status, obesity, and severe obesity in children and adolescents aged 5–18 years has been estimated at 23.1%, 9.3%, and 2%, respectively [3], and this has become a major public health problem that is growing at an alarming rate [4]. Moreover, research suggests that physical fitness should be considered an important health marker in childhood and adolescence [5]. High levels of physical fitness in young adults are already recognized as significant, as low fitness levels may indicate the potential for several health problems in later adulthood [6-11]. Higher levels of physical fitness are associated with a lower risk of cardiovascular disease (CVD) and cancer [12-14]. Risk factors for CVD can develop during childhood and adolescence, and these risk factors are likely to persist into adulthood, continuing to place these individuals at greater risk [15]. In Saudi Arabia, health-related physical fitness components have received far less attention than physical activity [16-26]. There appears to be only one previous study has addressed health-related physical fitness components among Saudi schoolgirls aged 8–15 years in Riyadh city; however, that study's findings were not generalizable as it was limited to one city [27]. Further research is necessary to assess health-related physical fitness among Saudi schoolgirls more comprehensively. To the best of our knowledge, no previous study has assessed physical fitness among young female students in Madinah city. To fill this gap, the present study aimed to assess the key health-related physical fitness components (cardiorespiratory fitness, body fat, muscle strength, and flexibility) among adolescent schoolgirls in Madinah city, western Saudi Arabia.

METHODS

1. Participants and study procedure:

Thirty-six female students (mean ± SD, age, 17.4 ± 1.3 years; body mass, 51.6 ± 11.1 kg; height,

154.5 ± 6.9 cm) participated in this study. The students were selected from a public school, and one class from each educational level was randomly chosen from the selected high school in Madinah city, western Saudi Arabia, during the 2018–2019 academic year. The study protocol and procedures conform to the ethical guidelines of the 1975 declaration of helsinki as reflected in a priori approval by the institution's human research committee, and all participants signed an informed consent form. Participants were included if they answered "No" to all questions in the Physical Activity Readiness Questionnaire. Participants suffering from any musculoskeletal disorder and those with a history of CVD or other serious health concerns were not included.

2. Measurements

2.1 Anthropometry and Body Composition

Body weight was measured to the nearest 100 g using a portable digital scale (Seca, Germany), and height was measured to the nearest 0.1 cm using a portable stadiometer (Seca, Germany). Body mass index (BMI; weight/stature2) was calculated from height and weight measurements.

Body fat percentage was measured without shoes in light indoor clothes using a bioelectrical impedance analyzer (OMRON, BF511 body composition monitor). In accordance with the manufacturer's instruction manual, the participants wore light clothes and no shoes and the bioelectric impedance measurement was carried out by placing the feet together on the foot electrodes with the weight equally distributed. The participant's knees and back were held in a straightened position, with the arms extended forward and hands holding the grip electrodes for a few seconds. The fat percentage readings appeared on the display unit and were recorded.

2.2 Prediction of maximal oxygen consumption (VO2max) by Queen's College Step Test

The step test was performed on a stool 41.3 cm in height for three minutes in total. A metronome was set at the rate of 24 cycles per minute. Upon completion of the test, the participant was asked to remain standing and the carotid pulse rate was measured for 5–20 seconds during the recovery period. This 15-second pulse rate was converted into beats per minute. To estimate VO2max, the following equation was used by McArdle *et al* [28]:

VO2max (ml.kg.min) = 65.81- (0.1847 x pulse rate in beats per min)

2.3 Hand grip strength

Maximal isometric handgrip strength was measured using a hand grip dynamometer (Takei Kiki Kogyo® dynamometer) adjusted to hand size. A single measurement was taken for each hand to obtain the maximal isometric handgrip strength values. Each subject was instructed to maintain maximal isometric contraction for three seconds during each measurement [29, 30]. The participants performed the contractions with each hand and with both feet on the floor, their shoulders bent at 90°, and the elbow completely extended. Both hands were assessed, and handgrip strength was obtained from the preferred hand and rounded to the nearest 1 kg. The higher value was recorded and used for analysis.

2.4 Flexibility

Flexibility was determined using the sit and reach test. In this test, the participants sat with their knees straight, feet flat against a bench, and hands in front of them with one on top of the other and palms facing downwards. Each participant then gradually inclined her trunk forward as far as possible. The participants were not permitted to bounce or lunge. Participants reached out and held that position for two seconds. The distance was then recorded in centimeters (cm).

3. Statistical analysis

Data were analyzed using the statistical software package SPSS, version 21. Descriptive statistics were presented as mean values and standard deviation (SD).

RESULTS

Thirty-six female students were assessed to determine the four main components of health-related physical fitness. The participants' mean age was 17.0 (SD = 1.3) years (ranging from 15 to 19 years). Table 1 presents the average and SD values for the participants' characteristics and their four components of health-related physical fitness: cardiorespiratory fitness (expressed as VO2max), body composition (expressed in %), muscle strength (expressed as hand grip strength), and flexibility.

Table 1: Physical characteristics and health-related physical fitness components of Saudi adolescent schoolgirls

Variables	Mean (±SD)
Age (years)	17.0 ± 1.3
Body mass (kg)	51.6 ± 11.1
Height (cm)	154.5 ± 6.9
BMI (kg/m2)	21.7 ± 4.3
VO2max (ml.kg.min)	39.5 ± 6.3
Body fat percentage (%)	31.0 ± 9.0
Hand grip strength(kg)	17.1 ± 4.9
Flexibility (cm)	10.6 ± 4.8

DISCUSSION

The main aim of our study was to assess the components of health-related physical fitness (cardiorespiratory fitness, body fat, muscle strength, and flexibility) in a sample of adolescent schoolgirls in Madinah, western Saudi Arabia. To the best of our knowledge, our study is the first of its kind to assess the four main aspects of health-related physical fitness in young Saudi female students in Madinah city. Only one study to date has assessed the components of health-related physical fitness in relation to BMI in a sample of Saudi girls and adolescents aged 8–15 Years [27]. Al-Asiri *et al* [27] found that Saudi girls had lower scores in health-related physical fitness components, such as body fat composition and cardiorespiratory fitness, and were associated with higher BMI, indicating potential health risks in overweight and obese children, and adolescents.

The importance of cardiorespiratory fitness is recognized, as low levels of cardiorespiratory fitness can be a significant predictor of risk for developing type 2 diabetes, CVD, and metabolic syndrome [31]. Moreover, high levels of cardiorespiratory fitness during adolescence are associated with better cardiovascular health indicators, such as normal blood pressure and lipid profiles, and reduced risk of morbidity and mortality in adulthood [32, 33]. Saudi schoolgirls in the present study achieved higher cardiorespiratory fitness scores (39.5 ± 6.3 ml.kg.min) than those previously recorded in Saudi schoolgirls aged 15 years using the same protocol (38.6 ± 2.8 ml.kg.min) [27]. The cardiorespiratory fitness level scores attained by Saudi schoolgirls in our study were even higher than those found in studies using similar tests to predicate VO2max, namely the Queen's College Step Test [34, 35]. Das *et al* [34] reported that the average VO2max score in schoolgirls aged 16–20 years was 35.3 ± 2.6 (ml.kg.min). A recent study of 25 schoolgirls aged

16–18 years also found that the average VO2max score was 38.5 ± 8.2 (ml.kg.min) [35].

The other major component of health-related physical fitness is body fat. In Saudi Arabia, the prevalence of obesity and overweight status is alarming and it has increased dramatically in recent decades to become one of the highest overweight status and obesity prevalence rates worldwide [4, 36]. The average body fat percentage (31%) in Saudi adolescent schoolgirls in our study was higher than the average (24.3%) estimated using a bioelectrical impedance analyzer (Tanita) reported by Kurtoglu *et al* [37]. This body fat percentage is considerably higher than the norms developed by Saint-Maurice *et al* [38], showing that the 50th-percentile values resulted in a score of 24.23% for girls aged 17 years. Al-Asiri *et al* [27] found that body fat percentage increased with age, whereby adolescent schoolgirls (13-15 years) showed the highest fat percentage mean (35%), although body fat in that study was estimated based on skin fold thickness measurement. For this reason, it is far more practical to measure body fat using more accurate techniques, such as bioelectrical impedance analysis which used by our study, to obtain important clinical information regarding fat mass and adiposity [39].

In addition to body fatness, decreased muscular strength may be a risk factor for major causes of death in early adulthood, such as CVD [40]. Hand grip strength is a particularly popular means of predicting health throughout an individual's lifetime [41] and is a field test that measures the maximum isometric strength of both hands' grip strengths [38].

In Saudi Arabia, few studies have measured hand grip strength in children [42-44], adults [45], and elderly women [46]. For Saudi female students aged 19 years, the mean score of hand grip strength for dominant and non-dominant hands was 24.2 kg and 21.9 kg, respectively [45]. It is clear that our hand grip strength value (17.1 kg) is somewhat lower than the muscle strength norms for Saudi girls developed by Shaheen, *et al* (2021). Moreover, the normal hand grip strength range for Middle Eastern females (aged 35–40 years) is between 22 kg and 30 kg [47]. Our results showed that the average hand grip strength of Saudi adolescent schoolgirls (17.1 kg) was lower than that reported (21 kg) by Saint-Maurice *et al* [38]. In fact, this score is considerably lower than the muscle strength norms developed by Saint-Maurice *et al* [38], who reported that the 50th-percentile values resulted in a score of 26.1 kg for girls aged 17 years. Interestingly, vitamin D supplementation has been recommended for young and middle-aged Saudi females. A recent study conducted among Saudi women ranging in age from 18 to 45 years (30.82 ± 7.5) found that muscle strength improved following vitamin D supplementation, with the hand grip mean for both hands showing higher values (13.2 vs. 17.8 kg) [48].

Flexibility, as a major component of health-related physical fitness, is important for both fitness and health [49, 50]. For example, greater flexibility in the lower back and hamstring areas has been linked to a reduced risk of lower back pain and other musculoskeletal injuries [51]. High levels of flexibility in adolescence have also been found to reduce the risk of neck tension in older men [52]. Research further suggests that children who have high adiposity or low flexibility levels are more likely to continue to do so into adolescence, putting them at greater risk for developing diseases later in life [53]. Although flexibility is regarded as an important component of physical fitness, genetic influence is believed to play a role in flexibility in children and young adults and may account for 18–55% of variations in flexibility, as measured by the sit and reach test [54]. The present study's findings showed that the average flexibility value in Saudi adolescent schoolgirls was 10.6 ± 4.8 cm, which is lower than that found in a large study (29.0 ± 9.6 cm) conducted among 255 female children and young adults (mean age 17.2 ± 1.2) [55]. The average flexibility scores of Saudi adolescent schoolgirls obtained in this study are considered to indicate a fair flexibility level based on normative data from schoolchildren aged 7–19 years developed by Dobosz, *et al* [56]. The 50th-percentile values for flexibility, measured using the sit and reach test, showed 10.3 cm for girls aged 17 years old. The 50th percentile is typically used to present the highest accuracy to discriminate between the sub-healthy and healthy zones of the physical fitness criteria for all physical fitness tests [57].

CONCLUSION

Our findings indicated that multiple physical fitness components, particularly body composition, muscle strength, and flexibility, should be targeted to enhance health status among Saudi adolescent schoolgirls in Madinah. Body fat percentage in Saudi adolescents in Madinah is also alarmingly high, indicating overweight and obesity status and elevating health risk. Moreover, like most adolescents, Saudi adolescents in Madinah may benefit from additional fitness programs and opportunities that allow them to increase their health-related physical fitness. This may be facilitated by local schools, which should offer exercise groups to improve students' physical fitness, and through participation in programs run by local health organizations or universities. Our study is the first to have been conducted among schoolgirls in Madinah using validated measurements for data collection and providing greater assurance of the findings' accuracy. However, further research involving larger samples that include both boys and girls is recommended to support the design of more appropriate physical fitness interventions.

Conflict of interest

The author has no conflicts of interest to declare.

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