

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

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Abstract:

This study aimed to measure health-related physical fitness components (cardiorespiratory fitness, body fat, muscle strength, flexibility) among adolescent school boys in Madinah, western Saudi Arabia. The participants comprised 36 male students who performed a maximal multistage 20-m shuttle run test to estimate maximal oxygen consumption ($VO_2\text{max}$). Body fat percentage (BF%) was determined using the bioelectrical impedance scale; hand grip strength was measured using a hand grip dynamometer; and flexibility was determined using the sit and reach test. The results of the health-related physical fitness tests reveal that the mean (\pm SD) value of estimated $VO_2\text{max}$ was 41.1 ± 6.9 (ml.kg.min). The mean (\pm SD) values of BF%, right-hand grip strength, left-hand grip strength, and flexibility were 18.7 ± 8.6 (%), 33.3 ± 5.6 (kg), 32.8 ± 5.7 (kg), and 15.8 ± 3.9 (cm), respectively. With the exception of flexibility, we conclude that it is necessary to improve health-related physical fitness components, particularly muscle strength, among Saudi adolescent school boys in Madinah city.

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

Introduction:

Physical fitness is defined as the ability to achieve certain performance standards in physical activity and is an outcome of habitual physical activity or exercise (Freedson, Cureton, & Heath, 2000; Tuero-del-Prado, de paz, & Márquez, 2001). Evaluation of physical fitness in young adults is particularly important, as low fitness levels may indicate the potential for several health problems in later adulthood (Chen et al., 2005; Cheng et al., 2004; fu & Hao, 2002; Heitzler, Martin, Duke, & Huhman, 2006; Ready, Naimark, Tate, & Boreskie, 2005; Sato, Demura, Murase, & Kobayashi, 2005). Higher levels of physical fitness are associated with a lower risk of cardiovascular disease (CVD) and cancer (Guerra et al., 2006; Lacombe, Armstrong, Wright, & Foster, 2019). Moreover, there is a substantial body of scientific evidence to show that risk factors for adult CVD are present from childhood, and preventive measures taken during childhood and adolescence may be key in mitigating these risk factors in later life (Shrestha & Copenhaver, 2015). Risk factors for atherosclerotic CVD can develop during childhood and adolescence, and these risk factors are likely to be seen in adults, continuing to make them more susceptible (Daniels, Pratt, & Hayman, 2011). Moreover, physical fitness has been demonstrated to be potentially beneficial in helping high school students cope with stress (Guszkowska, 2005). Earlier studies have defined several health-related components of physical fitness, including cardiorespiratory fitness, body composition, muscle strength, and flexibility (Cvejic, Pejović, & Ostojic, 2013; Secchi, García, España-Romero, & Castro-Piñero, 2014). A

recent study found that high cardiorespiratory fitness combined with high muscular fitness was positively associated with improved health-related quality of life in adolescents (Evaristo et al., 2019). Moreover, several earlier studies have measured cardiorespiratory fitness among adolescents (Ekblom, Oddsson, & Ekblom, 2005; Morinder, Mattsson, Marcus, & Larsson, 2007). Enhancement of cardiorespiratory fitness during adolescence is known to be associated with better cardiovascular health indicators in adulthood (Harber et al., 2017; Lang et al., 2017). Moreover, the measurement of body composition, particularly fat percentage, is important, because the prevalence of obesity and overweight status in Saudi Arabia has increased dramatically in recent decades (DeNicola, Aburizaiza, Siddique, Khwaja, & Carpenter, 2015) and has become a major public health problem among Saudi adolescents (Habbab & Bhutta, 2020). Moreover, decreased muscular strength is a risk factor for major causes of death in the early stages of adulthood, such as CVD (Ortega, Silventoinen, Tynelius, & Rasmussen, 2012). This is why hand grip strength is a popular means of predicting health throughout an individual's lifetime (Cooper et al., 2011) and is a field test that measures muscular strength among school adolescents (Saint-Maurice, Laurson, Karsai, Kaj, & Csányi, 2015). Flexibility is also regarded as an important component of physical fitness and has several positive effects on overall health (Fleg et al., 2000; Mikkelsen et al., 2006; Okuda, Horii, & Kano, 2005).

Earlier studies in the Saudi Arabian context have assessed only individual component of health-related physical fitness in isolation (Albawardi, Jradi, Almalki, & Al-Hazzaa, 2017; Alqarni, 2016). However, reliance on one or two components of health-related physical fitness is unlikely to provide a complete picture of an individual's health status. It has been recommended that various components of health-related physical fitness should be measured and then considered individually because all the outcomes of these components are complex entities, involving several different characteristics (Kiernan, 2000). Moreover, no study has measured the main components of health-related physical fitness among Saudi male school adolescents. Only one study to date has assessed the components of health-related physical fitness in a sample of Saudi girls aged 8–15 years (Al-Asiri & Shaheen, 2015). In addition, although few studies of health-related physical fitness have been conducted in Saudi Arabia (H. Al-Hazzaa, 1993; H. M. Al-Hazzaa, 2002), most studies conducted in Saudi Arabia have focused on physical activity rather than health-related physical fitness (H. M. Al-Hazzaa & Albawardi, 2019; Al-Nozha et al., 2007; Albawardi et al., 2017; Aljuhani & Sandercock, 2019; Almutairi et al., 2018; AlQuaiz, Siddiqui, Kazi, Batais, & Al-Hazmi, 2019; Awadalla et al., 2014; Khalaf et al., 2013; Samara, Nistrup, Al-Rammah, & Aro, 2015; Yahia, Wang, Rapley, & Dey, 2016; Zaidi, 2020). A study conducted among schoolboys in Riyadh found that Saudi children and adolescents do not meet the minimal weekly requirement of moderate to vigorous physical activity necessary for an effectively functioning cardiorespiratory system and that 16% of them are considered obese (i.e., their fat content constitutes over 25% of their body mass) (H. Al-Hazzaa, 1993). It is thus critically important to distinguish between physical activity and physical fitness. To the best of our knowledge, no study hitherto has assessed physical fitness among young students in Madinah. Therefore, further research is necessary to assess health-related physical fitness in Saudi youth in Madinah more comprehensively, assessing measures of fitness for which an association with health outcomes has been demonstrated and to provide information about current fitness status. This may help to improve or evaluate health status among school-aged adolescents and to establish health programs within the school

environment or as part of the physical education curriculum. Therefore, the present study aimed to measure the key health-related physical fitness components (cardiorespiratory fitness, body fat, muscle strength, flexibility) among adolescent school boys in Madinah city, western Saudi Arabia.

Methods:

1- Participants and study procedure:

This study was a descriptive-analytic study consisting of 36 male students (mean \pm SD, age, 17.4 ± 0.9 years; body mass, 63.1 ± 11.2 kg; height, 169.6 ± 5.7 cm). Students were selected from a public school, and one class from each educational level (grades 10–12) was randomly chosen from the selected high school in Madinah city (Prince Nayef bin Abdulaziz Secondary School—East Madinah Education Office—General Administration of Education in Madinah Region. Madinah). The study was conducted in April, the second semester of the academic year 2018–2019. All health related physical fitness tests were performed in the morning (8:00 am). All physical fitness tests for all participants were performed in one day. Anthropometric and body composition measurements were performed first, followed by sit and reach test, hand grip strength test, and cardiorespiratory test. The study protocol and procedures conformed to the International Ethical Guidelines, and all participants signed an informed consent form. Participants were included if they answered “No” to all questions in the Physical Activity Readiness Questionnaire (Warburton, 211). Participants suffering from any musculoskeletal disorders and those with a history of CVD or other serious health concerns were excluded.

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) was calculated from height and weight measurements ($\text{mass}/\text{height}^2$). Body fat percentage was measured using a bioimpedance analyzer (OMRON, BF511 body composition monitor). In accordance with the manufacturer’s instructions, the participants dressed in light indoor clothes and wore no shoes, and the bioelectric impedance measurement was taken by placing the feet together on the foot electrodes with the weight equally distributed. The participants’ knees and backs were straight; they extended their arms forward and held the grip electrodes for a few seconds. The fat percentage readings appeared on the display unit and were recorded.

2-2 A maximal multistage 20-m shuttle run test to estimate maximal oxygen consumption (VO_2max)

Each participant performed a shuttle run test in accordance with Leger et al. (1988). The shuttle run test consisted of 20-m sprints with increasing speed in each run, the pace indicated with audible signals. Participants had to run back and forth along a 20-m course in the gymnasium and touch the 20-m line. The test began at a speed of 8.5 km/h and was increased by 0.5 km/h at one-minute intervals. Participants were verbally encouraged throughout the test, and they continued until they were unable to

reach the cones three times consecutively after the signals. The VO_2 max was estimated based on the speed reached by the participants during the last period until fatigue using the following equation (Leger & Lambert, 1982):

$$VO_2 \text{ max} = 5.857 \times \text{speed (km/h)} - 19.458.$$

2-3 Hand grip strength:

Maximal isometric hand grip 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 hand grip strength values. Each subject was instructed to maintain maximal isometric contraction during each measurement for three to six seconds (Kamimura & Ikuta, 2001; Trossman & Li, 1989). The participants contracted each of their hands with both feet placed on the floor, their shoulders bent by 90°, and their elbows completely extended.

2-4 Flexibility:

Flexibility was determined using the sit and reach test (Liemohn, Sharpe, & Wasserman, 1994; Mayorga-Vega, Merino-Marban, & Viciano, 2014). In this test, participants sat with knees straight, feet pressed flat against a box, one hand placed on top of the other with palms facing downwards. Each participant then gradually inclined his trunk forward as far as possible. Participants were not permitted to bounce or lunge: they reached forward and held that position for two seconds, and 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:

A total of 36 adolescent school boys were measured for attributes of health-related physical fitness. Table 1 presents the participants' results of tests used to measure health-related physical fitness components (cardiorespiratory fitness [VO_2 max], body composition, muscle strength, and flexibility).

Table 1. Physical characteristics and health-related physical fitness components of Saudi adolescent school boys.

Variables	Mean (\pm SD)
BMI (kg/m^2)	22.0 \pm 3.7
VO_2 max (ml.kg.min)	41.1 \pm 6.9
Body fat percentage (%)	18.7 \pm 9.0
Right-hand grip strength(kg)	33.3 \pm 5.6
Left-hand grip strength(kg)	32.8 \pm 5.7
Flexibility (cm)	15.8 \pm 3.9

Discussion:

Assessment of the components of health-related physical fitness in adolescents and young adults has received little scholarly attention. To the best of our knowledge, this is the first study to describe multiple aspects of health-related physical fitness in a sample of adolescent school boys in Madinah, western Saudi Arabia. Improvement in cardiorespiratory fitness during adolescence is known to be associated with improved cardiovascular health indicators, such as healthy blood pressure levels, favorable lipid profiles, and reduced risk of morbidity and mortality in adulthood (Harber et al., 2017; Lang et al., 2017). The present study's main finding was that cardiorespiratory fitness was 41 (ml.kg.min) and almost comparable with earlier studies' outcomes. For example, the cardiopulmonary fitness results in the present study were close to those previously recorded in young adults (~37 ml.kg.min) (Ekblom et al., 2005; Morinder et al., 2007; Sallis, Patterson, Buono, & Nader, 1988). New research has also suggested that cardiorespiratory fitness levels are related to brain properties and cognitive functions in adolescents (Ruotsalainen et al., 2020). This suggests that physical fitness in young people should receive more attention because adolescence is a critical life stage that can significantly influence adult life and may therefore be a crucial period for intervention. VO_2max is a standard measure associated with cardiorespiratory fitness levels, with values expected to increase as cardiorespiratory fitness level improves, and an important indicator of successful physical activity interventions. However, many methods for directly or indirectly determining VO_2max are available, making it more difficult to compare outcomes and indicating that the results should be interpreted with caution.

In addition to cardiorespiratory fitness, body fat was found to correlate positively with systolic blood pressure and blood lipids, such as triglycerides, in Saudi children (H. Al-Hazzaa, 1993). Obesity and overweight status contribute to metabolic disease and are linked to increased risk of several chronic diseases, such as diabetes, heart disease, and cancer (Deckelbaum & Williams, 2001). The prevalence of obesity and overweight status in Saudi Arabia has increased dramatically in recent decades and has become one of the highest overweight and obesity prevalence rates worldwide (DeNicola et al., 2015). The prevalence of overweight status and obesity among Saudi adolescents is a major public health problem that is growing at an alarming rate (Habbab & Bhutta, 2020). However, most studies conducted in Saudi Arabia have examined obesity among children and adolescents based on waist-to-hip ratio (WHR) and/or BMI (Alqarni, 2016). In the present study, body fat was measured directly using bioelectrical impedance analysis, which provides a more accurate assessment than BMI of overweight status or obesity in adolescents (Albawardi et al., 2017). Saudi adolescent school boys' average body fat percentage (19%) in our study was similar to that reported by Taylor et al. (2003) (21%), though Taylor et al. (Taylor et al., 2003) used dual-energy X-ray absorptiometry to estimate body fat percentage. It is well known that BMI is widely used and accepted as indicative of body fat, however, more accurate methods, such as bioelectrical impedance analysis, can yield lower values than BMI. In a cross-sectional study (Shaikh et al., 2016) conducted among Saudi male and female students (aged 12–14 years) from three large cities in Saudi Arabia's Qassim region, the prevalence of overweight status and obesity was studied using three different methods (BMI, skin fold thickness, and bioelectrical impedance analysis), and the results showed that the obesity prevalence estimated using a bioelectrical impedance analyzer was lower than that measured using the other

methods.

The third component of health-related physical fitness among Saudi adolescents evaluated in our study is muscle strength. Research has shown that low muscular strength is a risk factor for major causes of death in the early stages of adulthood, such as CVD (Ortega et al., 2012). Hand grip strength is a particularly popular means of predicting health throughout an individual's lifetime and is a field test that measures the maximum isometric strength of both hands' grip strengths (Cooper et al., 2011). Our results showed that the average hand grip strength of Saudi school adolescents (33 kg) was similar to that reported (31.4 kg) by Saint-Maurice et al. (2015), whereby the 50th-percentile values resulted in a score of 42.6 kg for boys aged 17 years.

In addition to muscle strength, flexibility in the lower back and hamstring areas was linked to reduced risk of lower back pain and other musculoskeletal injuries (Battié et al., 1990; Pollock et al., 1998). Adequate flexibility reduced the risk of lesions, prevented and reduced pain, and improved motor coordination (Fleg et al., 2000). High flexibility in adolescence has also been found to reduce the risk of neck tension in older men (Mikkelsen et al., 2006). Moreover, research suggests that children who have high adiposity or low levels of flexibility are more likely to continue to do so into adolescence, putting them at greater risk for developing diseases later in life (Marshall, Sarkin Ja Fau - Sallis, Sallis Jf Fau - McKenzie, & McKenzie, 1998). Although flexibility is regarded as an important component of physical fitness, it has been reported that genetic influences can account for about 18–55% of variations in flexibility, as measured by the sit and reach test, in children and young adults (Okuda et al., 2005). The results of the present study showed that the average flexibility value in Saudi school adolescents was 15.8 ± 3.9 cm, which is lower than that found in a large study (19.8 ± 10.1 cm) conducted among 243 male children and young adults (mean age 17.2 ± 1.2) (Schutte, Nederend, Hudziak, de Geus, & Bartels, 2016). The flexibility scores of Saudi school adolescents obtained in this study are considered to indicate high flexibility levels based on normative data from schoolchildren aged between 7 and 19 years developed by Dobosz, Mayorga-Vega, and Viciano (2015). The 50th-percentile values for flexibility, measured using the sit and reach test, resulted in 7.1 cm for boys aged 17 years old (Dobosz et al., 2015).

Limitations:

This study has several key limitations, including the low sampling power of the health-related physical fitness components. Further research involving larger samples that include both boys and girls is recommended. Another limitation of this study concerns physical fitness test motivation. Tests of this nature usually depend on the adolescent's motivation to perform them at maximum effort. For this reason, our results may be impacted by some participants' potential lack of motivation. These limitations notwithstanding, our study is the first conducted among school adolescents in Madinah using validated measurements for data collection and providing greater assurance of the findings' accuracy.

Conclusion:

Based on our findings, with the exception of the high flexibility score, we conclude that health-related physical fitness components, particularly muscle strength, should

be improved among Saudi school adolescents. Moreover, like most adolescents, Saudi male adolescents in Madinah may benefit from additional fitness programs and opportunities that allow them to increase their components of health-related physical fitness. This may be achieved through participation in programs run by local health organizations or universities.

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