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Review Article

Physical inactivity in Saudi Arabia revisited: A systematic review of inactivity prevalence and perceived barriers to active living

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ABSTRACT

Objectives: Saudi Arabia has recently witnessed enormous economic growth accompanied by undesirable lifestyle behaviors, along with an associated increase in non-communicable diseases (NCD's). This systematic review presents a comprehensive and an updated overview of the status of physical activity (PA) or inactivity among the Saudi population and examines the major barriers and correlates of PA.

Methods: A systematic search was conducted using MEDLINE and Google Scholar databases. The electronic search yielded an initial 434 articles. However, the majority of these articles were eliminated because they did not meet the inclusion criteria. The remaining relevant papers were 65 articles that became the bases for this review.

Results: The majority of Saudi children, youth and adults were not active enough to meet the recommended guidelines for moderate to vigorous PA. Saudi females were disproportionately less active than males, beginning from early school years. The proportions of Saudis who are at risk of inactivity are exceedingly higher than those at risk for other coronary heart diseases. Active Saudi boys tend to have favorable levels of blood lipids and body composition profile compared to inactive boys. Increased urbanization, crowded traffic, extreme weather, cultural barriers, lack of social support, the absence of female school PA program and lack of time and resources, all make PA a difficult choice for the Saudis.

Conclusion: More intensified efforts toward promoting PA and reducing sedentary behaviors among the Saudi population are needed to curtail the risks of NCD's.

Keywords: Barriers, exercise, health promotion, inactivity, non-communicable disease, physical activity

Introduction

Physical activity (PA) is a health-enhancing behavior. According to the worldwide health statistics, lack of PA is among the major risk factors for non-communicable diseases (NCDs) and total mortality.[1-3] It is estimated that inactivity is globally responsible for 9% of premature mortality, or more than 5.3 million deaths annually.[3] In contrast, PA is well recognized to have significantly decrease cardiovascular risks, improve lipids profile, control type 2 diabetes, prevent the incidence of some types of cancers, increase bone density, improve psychological health, and well-being and reduce total mortality.[2-4] In 2013, the World Health Assembly agreed on a global voluntary reduction of 10% in insufficient PA by 2025.[5] However, the recent World Health Organization (WHO) reports indicate that policies to address insufficient PA are operational in only 56% of the WHO member states.[1] According to the same WHO report, around 23% of adults aged 18 and over were not physically active enough, with more inactive women than men, while 81% of the adolescent population aged 11–17 years were insufficiently physically active, with adolescent girls as being more inactive than adolescent boys.[1]

Possible barriers to PA must be determined and eliminated to promote active living and reduce inactivity among the population. A number of environmental barriers related to urbanization are believed to be attributed to such global inactivity epidemic, including fear of violence and outdoor crime, high-density traffic, low air quality and lack of suitable exercise places, sports facility, sidewalks, and parks.[1] In developed countries, advancing age and lack of time appear to be among the most commonly reported barrier to PA.[6] Family income may also influence physical inactivity, as lower income people are less likely to meet PA guidelines when compared to higher income people.[7] In addition, as a recent review has demonstrated, the perception of environmental or personal

barriers among adults was inversely related to the levels of PA participation.[6]

Not very long time ago, our ancestors in Saudi Arabia had lived a simple, yet, active life. The physical challenges of daily life and demanding works were sufficient then to maintain a lean body mass and an appropriate level of physical fitness for them.[8,9] However, during the past several decades, Saudi Arabia has witnessed enormous economic growth and prosperity, accompanied by the technological transformation that has led to major negative changes in lifestyle. Consequently, physical inactivity, sedentary behaviors, and consumption of caloric dense diet, and sugar-sweetened beverages went on the increase and became prevalent among Saudi society. This has contributed significantly to an increase in lifestyle-related NCD's in the country, which includes, obesity, diabetes mellitus, coronary artery diseases (CADs), and hypertension.[3,10-12]

It is a well-recognized fact that to implement effective NCD prevention programs in Saudi Arabia, policy makers and health-care authorities need recent and valid data for the prevalence of physical inactivity and its trends, barriers and major determinants. Early published reviews and articles about PA and health among Saudi population indicated high prevalence of inactivity among every segment of the society.[9,13] However, in the past decade, many PA-related studies have been conducted and published, thus, necessitating an update on the inactivity prevalence in this rapidly growing Middle Eastern country. Therefore, the purpose of this systematic review was to provide a comprehensive and an updated overview of the status of physical inactivity/activity among Saudi population and to discuss major correlates and barriers to PA.

Methods

Data sources and search strategy

A systematic search was conducted using MEDLINE and Google Scholar databases up to January 15, 2018, while utilizing keywords such as PA, exercise, physical inactivity, PA barriers and PA determinants, in combination with the words "Saudi Arabia," "Saudi population," and "Saudi people." In addition to the electronic search, all references of the selected articles were manually examined and identified for possible inclusion as relevant papers in this search. The inclusion criteria were articles in English literature, which included Saudi adults, adolescents or children without orthopedic problems and have a clear description of PA assessment methods and physical inactivity criteria. Full articles were obtained for all the inclusive studies and were then thoroughly read and analyzed.

Data extraction

The following information from each study were checked and recorded: The prevalence of physical inactivity, the type of instrument used for measuring PA, the criteria used for quantifying inactivity prevalence, the number of the participants, mean and standard deviation (or range) of age of the sample, sex, the location where sample was selected, and whether the study was conducted at national, subnational, or local level. The initial electronic search yielded 434 articles. The titles and the abstracts of these articles were read and reviewed for possible inclusion. However, the majority of the articles were eliminated because they did not meet the inclusion criteria. The remaining relevant papers were 65 articles, which then became the bases for the initial systematic review screening [Figure 1]. 11 articles were excluded because of duplicates or have no full text. Of the eligible 54 articles, 12 articles were excluded because there were no clear criteria for physical inactivity (not determined) or there was no clear description of the PA instruments used, and the remaining articles became 42 papers.

Results

The results of this systematic review are shown in Tables 1 and 2 for the prevalence of physical inactivity, as well as the major reasons for being active and correlates of (or barriers to) PA, respectively. Among those studies that utilized subjective measures of PA assessment, approximately half of the studies in this review have used un-validated PA instruments. As clearly seen from the findings, there are not too many PA studies that have been published locally before the year 2000. In fact, the majority of the published articles, which are related to PA in Saudi Arabia, were published within the past 7 years or so.

Physical inactivity prevalence and its relation to health indicators

As shown in Table 1, the prevalence of physical inactivity, in general, ranged from 26% to 85% among Saudi males and from 43% to 91% among Saudi females, depending on the population measured, region, age, gender, the type of PA instrument utilized, and the physical inactivity criteria

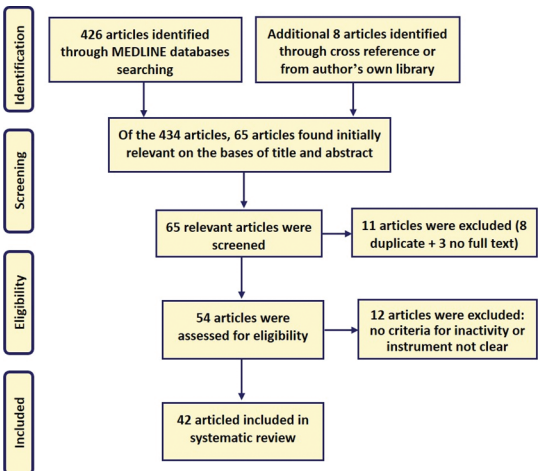

Figure 1: Flow chart showing articles selection process

Table 1: Prevalence of PA among Saudi population

Sample description (publication year)	Region or city	Gender	Number of subjects	Age (years)	Inactivity prevalence (%)	Inactivity criteria	Assessment method	Reference number
Children								
Preschoolers (2007)	Jeddah	Male Female	109 115	5.2±0.8 5.2±0.9	72.9 81.4	< 10000 step counts per day	Electronic pedometer	[14]
School children (1993)	Riyadh	Male	212	9.5±1.4	85	Daily heart rate <159 bpm for at least 20 min/day	Continuous heart rate monitoring	[15]
School children (2002)	Riyadh	Male	92	9.6±1.5	57.1	Daily heart rate <140 bpm for at least 30 min/day	Continuous heart rate monitoring	[13]
School children (2007)	Riyadh	Male	296	10.3±1.3	47.1	<13000 step counts	Electronic pedometer	[16]
School children (2017)	Makkah	Female	78	8-11	Low 6757 step/day (20.2 min/day of MVPA)	<10000 step counts/day	Accelerometer (Actigraph for 4 days)	[17]
Adolescents								
Adolescents (2003)	Riyadh	Male	894	15.7±1.8	72.3	<30 min for <4 days/week	Questionnaire	[18]
Adolescents (2008)	Al-Khobar	Male Female	1240 1331	16.3±1.7	54.4 66.3	<3 times/week	Questionnaire	[19]
Adolescents (2011)	Riyadh, Jeddah and Al-Khobar	Male Female	1401 1507	16.7±1.1 16.5±1.1	44.5 78.1	<1680 METs-min per week	Arab Teens Lifestyle Study Questionnaire	[20]
Adolescents (2012)	Aseer	Male Female	1249 620	17.2±1.2 (12-19)	25.7 42.9	<30 min of PA in previous week	Questionnaire	[21]
Adolescents (2014)	Riyadh	Male	1335	13, 14, 17-18	63.7	<60 min, 5 day/week	Health Behaviour in School-aged Children (HBSC)	[22]
Adolescents (2015)	Riyadh	Male	453	15-18	84.5 (20.1=no exercise at all)	<5 days/week	Questionnaire	[23]
Adolescents (2017)	Jeddah	Female	405	3-18	low	Sum of moderate to vigorous activity	PA questionnaire for adolescents	[24]
Adolescents (2018)	Jeddah	Female	410	17.2±1.2	86.1	<150 min per week	Questionnaire	[25]
Adults								
College students (1990)	Riyadh	Male	362	21.9±2.1	78.2	No regular activity	Questionnaire	[26]
College students (2008)	Abha	Male	456	17+	83.3	<3 times/week	Questionnaire	[27]
College students (2008)	Riyadh	Male Female	150 152	21.4±1.8	72 78.9	<3 days/week	Questionnaire	[28]
College students (2013)	Abha	Female	663	20.4±1.5	37.6	<150 min/week	Arab teens lifestyle study questionnaire	[29]
College students (2014)	Abha	Male Female	426 831	17–25	56.1 58.8	<600 METs-min per week	IPAQ	[30]
College students (2015)	Dammam	Female	215	19.3±0.95	72.5	<1 time per week	Questionnaire	[31]
College students (2015)	Riyadh	Female	94	18–22	44	<600 METs-min/week	Arab Teens Lifestyle Study Questionnaire	[32]
Medical students (2012)	Madinah	Male Female	98 100	21.1±1.9	63.8 65.0	<150 min/week moderate activity or <60 min/week vigorous activity	IPAQ	[33]

(Contd...)

Table 1: (*Continued*)

Sample description (publication year)	Region or city	Gender	Number of subjects	Age (years)	Inactivity prevalence (%)	Inactivity criteria	Assessment method	Reference number
Primary care physicians (1998)	Riyadh	Male	98	42.0±6.5	76.5	No regular activity	Questionnaire	[34]
Physicians and non-physicians (2013)	Riyadh	Male Female	100 100	20+years	41 45	No PA	Questionnaire	[35]
Primary care professional (2014)	Riyadh	Male Female	127 195	39.2±8.9	78.7 79	Active category	"How physically active are you" questionnaire	[36]
Primary care patients (1998)	Eastern province	Male Female	90 137	41.5±11.2 32.5±11.4	43.3 84.7	<3 times/week for 20 min	Questionnaire	[37]
Primary care patients (2009)	Riyadh	Male Female	144 306	33.3±13.3	71.5 87.6	<150 min/week	Questionnaire	[38]
Family medicine clinics (2010)	Taif	Male Female	190 139	43.1±9.3	46 47	<150 min/week moderate activity or <60 min/week vigorous activity	IPAQ	[39]
Primary health-care participants (2011)	Al-Hassa region	Males Female	1209 967	32.8±10.1 33.4±9.2	50.5 44.8	<600 METs-min/week	Global PA Questionnaire	[40]
Lowlanders and highlanders (1995)	Aseer province	Male Female	905	16–60	59.4 99.5	No strenuous exercise for ≥3 times per week	Lipid Research Clinic Questionnaire	[41]
Military personnel (2013)	5 region of Saudi Arabia	Male	10229	18-50	30.8	< 30 min per day	WHO step-wise questionnaire	[42]
Adult population (2001)	Riyadh	Male	1333	41.1±9.7	80.9	No regular activity	Questionnaire	[43]
Adult population (2007)	Riyadh	Male Female	702 362	15-78	43.7 34.3	<600 METs-min per week	IPAQ	[44]
Adult population (2007)	National sample	Male Female	17395	30-70	84.8 91.3	<600 METs-min per week	Leisure- and sport-related physical activities questionnaire	[45]
University employee (2014)	Al-Hassa	Male and female	691	40.4±9.8	73	<600 METs-min per week	WHO step-wise questionnaire	[46]
Adults (2015)	National sample	Male Female	3240 2418	15-64	66.6 72.9	<600 METs-min/week of moderate, or <60 min/week vigorous activity	Global PA Questionnaire	[47]
Adults (2015)	National sample	Male Female	5432 5303	15-65+	50.0 77.6	15-17: <420 MET-min/week; 18+: <150 MET-min/week	IPAQ	[48]
Adults (working women) (2016)	Riyadh	Female	420	31.7±8.3	52.1	<600 METs-min per week	Modified ATLS questionnaire	[49]
Adults (physicians) (2016)	Riyadh	Male Female	222 138	24-65	36.9	MVPA	Modified STEPwise questionnaire	[50]
Adults (control group) (2017)	Tabuk	Male Female	97 53	20-65+	86.7	<30 min/day, 5 days/week	Questionnaire	[51]

MVPA: Moderate to vigorous intensity physical activity, PA: Physical activity, IPAQ: Global physical activity questionnaire

used.[13,14-51] Moreover, the vast majority of the PA activity studies were conducted in urbanized areas of the country, apart from the few national studies,[45,47,48] and very limited studies that included samples from rural areas.[40,52] The findings from national,[45,47,48] or subnational studies,[20,53] indicated that the mean physical inactivity prevalence ranged from 50% to 85% among males and from 73% to 91% among females. In regard to regional variations, one national study, involving participants aged 15–64 years, observed that northern and central regions have the highest prevalence of physical inactivity.[47] Another national study conducted on Saudis between the ages of 30 and 70 years, indicated that inactivity was the highest in the central region and the lowest in the southern region of Saudi Arabia.[45] Among Saudi adolescents sampled from three major locations in the country, PA was also found to be lower in the central region as compared with the eastern region, and there was a significant PA interaction between location and gender.[20]

Moreover, the majority of Saudi children and youth were not active enough to meet the minimal weekly requirements of moderate to vigorous PA (MVPA) that was recommended by international guidelines.[54] In fact, data from the recent Arab teens lifestyle study (ATLS),[20] which was conducted on a large group of adolescents from three major cities and which used a validated PA questionnaire, indicated that PA levels were somewhat moderate (averaged prevalence was 55.5%) among adolescent males and very low among females (average prevalence was 21.9%). The cutoff score that was used in this study corresponds to 1 h per day of moderate-intensity (4 metabolic equivalents [METs]) PA. This level of activity is equivalent to the amounts of energy expenditure which corresponds to 1680 METs-minutes per week (60 min of activity per day × 7 days per week × 4 METs).[21]

Figure 2 illustrates the PA levels, based on step counts, for Saudi preschool children aged 4–6 years along with daily television viewing time. As can be clearly seen, while PA was declining by 23.4% from age 4 to age 6, the screen time was similarly increasing by 22.5% during the same period.[14] Moreover, the prevalence of physical inactivity/activity and sedentary behaviors among a subnational group of Saudi adolescents is shown in Figure 3. The proportion of Saudi adolescents who were considered inactive, especially females, is quite high.[20] In addition, sedentary behaviors appear to be highly prevalent among Saudi adolescents, as 84% of males and 91.2% of females spent more than 2 h of screen time daily. High prevalence of both inactivity and sedentary behaviors is considered a double risk for their future health. Unhealthy lifestyle habits, including inactivity, high screen time, and inappropriate dietary habits seem to cluster among Saudi adolescents; as PA has been shown to correlate with healthy dietary habits while sedentary behaviors were associated with unhealthy dietary intake.[20,55] Indeed, a logistic regression analysis conducted on 2886 Saudi adolescents from three major urbanized areas of the country revealed that active adolescents exhibited significant associations with higher consumption of healthy dietary habits (breakfast, fruit, vegetables, and milk intakes), whereas higher screen time was significantly associated with greater consumption of sugar-sweetened drinks, fast foods, cake/doughnuts, and energy drinks.[55]

This review has also shown that the proportions of Saudi children,[13,15] youth,[56,57] and adults,[8] who are at risk of physical inactivity are exceedingly higher than those people who are at risk for hypertension, hypercholesterolemia, hypertriglyceridemia, cigarette smoking, or obesity. Such findings emphasized the importance of lowering inactivity prevalence to reduce the population attributable fraction to several NCD due to physical inactivity among Saudi people.[8,57] In another study conducted on young Saudi medical students, the most common risk factors of coronary heart disease were high fat intake (73.4%), physical inactivity (57.9%), and overweight or obesity (31.2%).[58] In addition, active Saudi boys tend to have favorable levels of serum triglycerides and high-density lipoprotein cholesterol

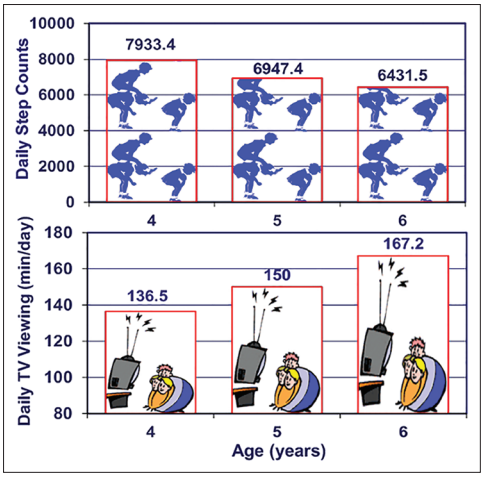

Figure 2: Pedometer-determined physical activity (step counts per day) and TV viewing time (minutes per day) in Saudi preschoolers (n = 224). The mean reduction in physical activity level (23.4%) almost parallels that of the increase (22.5%) in sedentary time. Data are from reference[14]

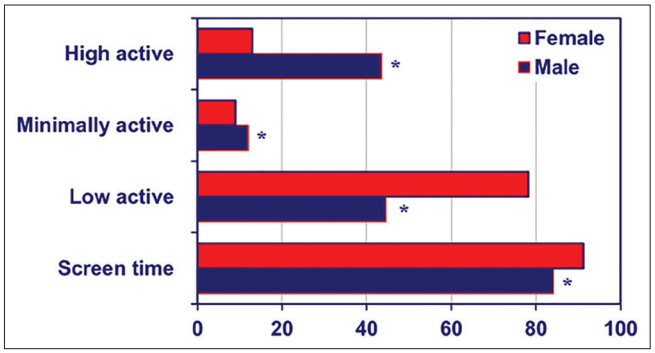

Figure 3: The prevalence (%) of physical inactivity/activity and sedentary behaviors among Saudis Adolescents (n = 2908). Low active: <1680 METs-min/week; minimally active: 1680–2519 METs-min/week; and high active: 2520 + METs-min/week. Screen time: > 2 h/day. *Denotes significant differences between males and females at $P < 0.01$. Data are from reference[20]

compared with inactive boys.[57,59] Active Saudi adolescents and adults also tend to have favorable anthropometric and body composition profile compared with inactive peers,[13,45,57] as illustrated in Figures 4 and 5. Further, inactive Saudi boys, aged 8–12 years, were also fatter by more than 17%, compared to their active peers (fat% = 25.3% vs. 21.6%). However, there were no significant differences in this study between the two groups in fat-free mass.[16]

Furthermore, longitudinal assessment of Saudi youth indicated that the percentage of young Saudi males, who were at risk for CAD, increased substantially at early adulthood as compared with childhood.[27,60] Most notably is the fact that the increases in levels of obesity, physical inactivity, low cardiorespiratory fitness, hypertension, low HDL-C, and screen time were seen. Further analysis of the data showed that the tracking coefficients from childhood (with mean age = 9.5 years) to adulthood (with mean age = 20.5 years) for body fat content, blood pressure and most of blood lipids appeared to be fairly strong (r = 0.42–0.58); however, tracking coefficients for vigorous (r = 0.02), moderate (0.22), and light (0.37) intensity PA were varied and declining with increasing activity intensity.[27,60] In another study using Kaiser's PA Survey and Godin's Leisure Time Exercise questionnaire and the non-laboratory-based Framingham risk, cardiovascular disease (CVD) risk scores, Alquaiz *et al*. found that activities such as households and strenuous exercises had a protective role against CVD risk among Saudi females.[61]

Studies using objective assessments of PA indicated a significant correlation coefficient ($r = 0.48$; $P < 0.05$) between Saudi children's activity levels during physical education lesson, and activity levels outside of school time.[13,62,63] This means that boys who were active during physical education classes were likely to be active during outside school time, and vice versa. It is also interesting to note that the heritability coefficient of PA between brothers is higher for vigorous-intensity compared with moderate intensity PA. The analysis of PA data for a group of 40 prepubescent brothers (at age 8.5 ± 1.0 vs. 10.8 ± 1.0 years, for the younger and older brothers, respectively), revealed a heritability coefficient of 0.52 ($P < 0.01$) in the percentage of active time spent at heart rate above 159 bpm. However, the heritability coefficient was somewhat lower for a moderate level of PA ($r = 0.28$). These findings may indicate that vigorous PA exhibits familial resemblance in prepubescent boys.[13,64]

Furthermore, it was very noticeable from the findings of this review that Saudi females were much less active than males. This finding applies to studies involving children and adolescents,[14,19-21,52,64] as well as to those studies reporting PA data for adults.[28,30,37,38,41,45,47,48,65,66,67] In one study involving females from Riyadh between 19 and 44 years, the mean daily step counts were considerably low (5114 steps).[67] Such low mean daily steps placed them in the low active category, according to some proposed pedometer-determined PA standards.[68] In addition, it appears that the difference in PA levels between Saudi males and females may be due more so to leisure-time PA, as findings from a large subnational study conducted on adolescents in secondary schools showed that males spent more time per week in leisure PA than females, while there was no significant difference in non-leisure-time PA relative to gender.[69] As to the PA levels relative to the type of schools that students were attending, PA studies from Saudi Arabia indicated, in general, that, male students in public schools were more active than those in private schools, whereas, the opposite was true for female students.[52,53] However, Taha has reported no significant differences in inactivity prevalence between students sampled from intermediate and secondary public or private schools in Al-Khobar.[19]

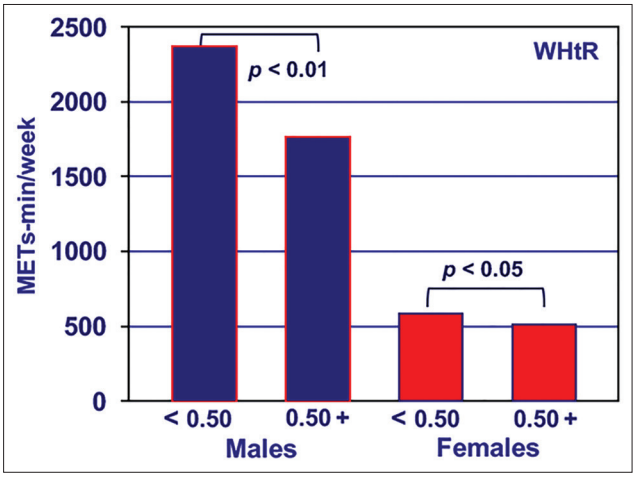

Figure 4: Activity energy expenditure (METs-minutes per week) among Saudi adolescents (n = 2906) relative to waist/height ratio (WHtR) category (below or above 50% of WHtR). Data are from reference[71]

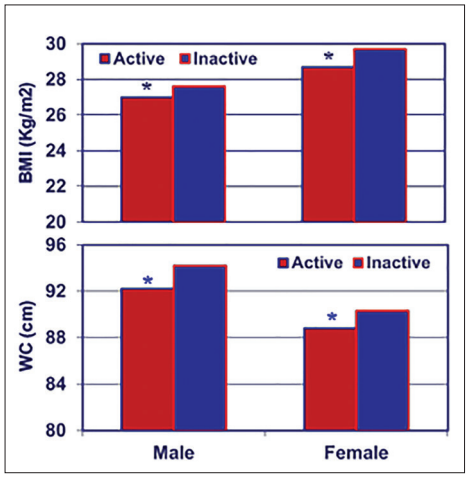

Figure 5: Body mass index (in kg/m^2; *P = 0.001) and waist circumference (in cm; *P = 0.005) among active (>600 METs-minutes per week) and inactive (<600 METs-minutes per week) Saudi adults aged 30–70 years old (n = 17395). Data are from reference[45]

The present review found that the prevalence of physical inactivity appears to increase with advancing age, whether in studies involving adolescents,[14,16,20] or adults.[43-45,47-49] However, there appear to be some interactions between age and gender among adolescents between 15 and 19 years old, as the time in minutes spent weekly in PA declined in males with advancing age, but stayed almost the same in females.[52,53] Furthermore, the high prevalence of physical inactivity seems to have occurred at a rather an early age among Saudi children.[14,16] PA among children in these studies was objectively assessed by an electronic pedometer. The cutoff used when calculating inactivity prevalence among Saudi preschool children was <10,000 steps per day,[14] whereas for older boys aged 8–12 years, the cutoff score was 13,000 steps per week,[16] as previous research has shown that boys who accumulated 13,000 steps per day were engaged in 60 min or more of at least moderate-intensity PA.[70]

Reasons for exercise and known barriers to PA in Saudi Arabia

Table 2 illustrates the reasons for being active and the correlates of (or barriers to) PA among Saudis.[14,16,18,19,23,26,28-32,38,40,41,43,45,49,50,53,65] The present review shows that the most important reasons for engaging in PA among adolescents and adults are health, losing or maintaining weight, recreation, and socializing. The most important barriers to PA among adolescents are the lack of time in both males and females, followed by no appropriate place, especially in females and lack of facility and resources.[23,53] It seems that there is a gender difference in reason for being active. In one study, male adolescents reported health benefits as the main reasons for being physically active, whereas, weight loss was the major reason for females to be active.[53] As to the place of exercise among adolescents, females exercise mostly at home. Whereas, males exercise mostly at public areas and they do that commonly with friends.[53] Male and female adolescents in grades 9–12 from Al-Khobar, knew that PA was protective against disease and in preventing obesity, however, they had poor knowledge about the role of PA in preventing diabetes or hypertension.[19]

Among Saudi adults, the most important reason for being physically active was to maintain health or to lose weight, while time constraint and lack of space or facilities seem to be the major factors for not being physically active.[26,28,29,31,32,38,43,50,66,71] Interestingly, adults attending health centers in Al-Ahsa perceived the major barriers to PA as lack of energy (more so in males), lack of motivation, lack of self-confidence, lack of time (more so among females), lack of social support (more so among females), and lack of resources (more so among females).[66] In another study conducted on females (71% university students), daily step counts showed strong correlation (r = 0.75, P = 0.03) with self-efficacy.[67] Furthermore, the 1st year female university students from 8 health sciences programs in a major female university in Riyadh reported that the main barriers to PA were the lack of designated areas for PA and low self-efficacy.[32] Students exhibited high awareness of the benefits of PA for health. There was no lack of knowledge about the importance of PA for health. These females did not agree that family or Islamic related reasons were barriers to PA.[32]

In western Saudi Arabia, students from the Health Colleges at King Khalid University indicated from top downward that barriers to PA were time limitation, followed by lack of suitable sport places, lack of social support (from family and friends), lack of safe place, lack of motivation, and finally lack of sport skills.[30] In addition, among patients attending primary care clinic at university hospital in Riyadh, the major barriers to PA were said to be lack of resources (80.5%), especially among low-income people, lack of will-power (76.8%), and lack of skills (43.5%), especially so among females and lack of energy, which was reported by more females than males. Surprisingly enough, lack of time was not significantly reported by this sample, and this can be explained by the fact that more than 50% of the females were not working.[38] In Dammam, in eastern Saudi Arabia, the major reason for not exercising among female university students was lack of time (57%), while the most important reasons for exercising were for health (40.7%), for weight loss (32.9%), and for enjoyment (17.9%).[31]

As to correlates of physical inactivity, the level of activity was associated with obesity (BMI) and abdominal obesity (waist circumference [WC]) among Saudi adult population,[45] as well as among children and adolescents.[14,16,72] Furthermore, PA seems to be negatively influenced by age among adults [43,45,47,48] and adolescents.[23,53] Furthermore, a review of the factors negatively affecting PA participation in Saudi children and adolescents concluded that the most influencing determinants appear to be age, obesity, low cardiorespiratory fitness, high television viewing, and poor physical education program.[71] Another study conducted on a large sample of Saudi adolescents from three major cities in the country showed that gender, vegetable and fruit intakes, milk consumption, intake of energy drinks, and waist to height ration were independently associated with total duration spent in PA per week.[53] In addition, Collison *et al.* reported that PA was positively correlated with fruit, vegetable, and cereal intake among adolescent from Riyadh.[65]

Discussion

This systematic review is considered as the first comprehensive review on PA in Saudi Arabia, covering inactivity prevalence, reasons for exercise, correlates, and barriers to PA. Based on the number of published papers in this systematic review, it is clearly apparent that PA research in Saudi Arabia has grown substantially over the past decade. Nevertheless, our ability to relate PA to health indicators depends on accurate, precise, and dependable measures of activity levels. PA is commonly measured through mechanical/electronic, physiological measurements, or validated self-reported questionnaires.[73]

Table 2: Major reasons for being active and correlates or barriers to engaging in physical activity among Saudi population

Category	Region or city	Gender	Number of subjects	Age	Reason for exercise	Correlates or barriers	Reference number
Children							
Preschoolers (2007)	Jeddah	Male Female	109 115	5.2±0.8 5.2±0.9		High screen time Gender	[14]
Preadolescent (2007)	Riyadh	Male	296	10.3±1.3		Obesity Age	[16]
Adolescents							
Adolescent (2003)	Riyadh	Male	894	15.7±1.8		Obesity Inadequate school PE program	[18]
Adolescents (2008)	Al-Khobar	Male Female	1240 1331	16.3±1.7		Being female Age (older is less active) Knowledge about obesity prevention	[19]
Adolescents (2014)	Riyadh, Jeddah and Al-Khobar	Male Female	1384 1482	15–19	Health Lose weight Recreation Socializing with other	Lack of time No suitable place Age (older adolescents) Sex (being female)	[53]
Adolescents (2015)	Riyadh	Male	453	15–18	Enhancing muscle and strength Enjoyment Improving body appearance	Lack of sports facilities Lack of time Lack of friends' support	[23]
Adolescents (2015)	Riyadh, Jeddah and Al-Khobar	Male Female	1388 1500	16.7±1.1 16.5±1.0		Age Gender (being female) WC Sleeping hours Eating habits	[68]
Adults							
College students (1990)	Riyadh	Male	362	21.9±2.1	Health Recreation Socializing	Lack of time No suitable place	[26]
College students (2008)	Riyadh	Male Female	150 152	21.4±1.8		Lack of time Lack of resources Self-efficacy	[28]
College students (2013)	Abha	Female	663	20.4±1.5	Health Losing weight Have fun	Lack of time No suitable place No one to exercise with	[29]
College students (2014)	Abha	Male Female	426 831	17–25		Lack of time Lack of suitable place Lack of social support No safe place Lack of motivation Lack of sport skills	[30]
College students (2015)	Dammam	Female	215	19.3±0.9	Health Lose/maintain weight Enjoyment	No time No access to sport facilities	[31]
College students (2015)	Riyadh	Female	94	18–22	Health Losing weight Recreation	Lack of facilities Low self-efficacy	[32]
Primary care patients	Riyadh	Male Female	144 306	33.3±13.3		Lack of resources Lack of will-power Lack of sports skills Lack of energy	[38]
Primary care patients (2011)	Al-Hassa region	Males and Female	2176	37.0		Being female High educational level High occupational status Lack of time Lack of facilities Bad weather Culture and tradition	[40]

WC: Waist circumference

(Contd...)

Table 2: (***Continued***)

Category	Region or city	Gender	Number of subjects	Age	Reason for exercise	Correlates or barriers	Reference number
Primary health patients (2013)	Al-Ahsa region	Male Female	118 124	20–56		Lack of energy Lack of motivation Lack of self-confidence Lack of time Lack of social support Lack of resources	[65]
Adult population (2001)	Riyadh	Male	1333	41.1±9.7	Health Losing weight Recreation	Lack of time Being married Work in private section Less educated	[43]
Adult population (2007)	National sample	Male Female	17395	30–70		Age Low educational level Increased BMI and WC	[45]
Adults (working women) (2016)	Riyadh	Female	420	31.7±8.3	Health Weight maintenance	Working in private sector Working 7 or more h Lack of time	[49]
Lowlanders and highlanders (1995)	Aseer province	Male Female	905	16–60 16–60		Obesity (in men)	[41]
Adults (physicians) (2016)	Riyadh	Male Female	222 138	24–65		Lack of time (58%) Work duties (22.5%) Lack of interest (12.5%) Lack of facilities (3.9%)	[50]

WC: Waist circumference

Unfortunately, many of the studies reporting PA prevalence among Saudi population used questionnaires that were not validated.[18,19,21,23,24,27,28,31,34,35,37,38,43,45,51] However, nine studies in this review adopted validated and commonly used international PA questionnaires (IPAQs),[30,33,39,40,42,44,46,47,50] and several studies used the validated ATLS PA questionnaire.[20,29,32,74,75]

The prevalence of physical inactivity in Saudi Arabia

The current review confirmed the presence of high inactivity prevalence among the Saudi population. In many of the examined studies in this review, inactivity prevalence among Saudi adults was defined as <600 METs-minutes per week or the equivalent of 150 min per week of moderate-intensity PA.[31,41,45,47,48] Such level of activity represents the minimal health-enhancing PA that was previously recommended for health benefits.[2-4] As for children and adolescents' health, the recommendations from major consensus statements call for the accumulation of at least 60 min of daily moderate to vigorous intensity PA plus adding muscle-strengthening activities.[2,4,74] However, not many studies [18,19,21,23] observed in the current review used stringent criteria for adolescent's physical inactivity as formerly defined by international recommendations.[76]

The remarkable economic prosperity, rapid developments in the standards of living, increased mechanization, and massive urbanization during the past few decades have significantly influenced the lifestyle habits of all the Saudi people. As a result, PA has undoubtedly been systematically reduced, while sedentary living becomes increasingly prevalent in all segments of the society.[8] It is well established that physical inactivity is considered an important contributor to NCDs in countries with high income and is increasingly becoming so in those countries with low and middle income.[3,77] In Saudi Arabia, it was estimated that over 18% of the burden of disease, which is due to all-cause mortality, can be eliminated if all inactive persons in the country become active.[3] No other medical intervention can positively influence the overall well-being as PA can do.

The present review has also revealed that females are much more inactive than males. This finding is similar to what was previously reported elsewhere.[78,79] The reduced female's PA in Saudi Arabia could be attributed mainly to social and cultural reasons, as females have generally limited opportunities when compared with males, to engage in PA, especially outdoor leisure-type activity. Furthermore, there are much fewer and more expensive fitness centers available to females compared to those of males.[66] Another factor that may contribute to the reduction of PA includes more reliance on cars rather than walking for short-distance travels, including trips to and from work or school.[8,80] Elsewhere, research indicated that actively commuting to school can significantly enhance children's PA levels and increase their energy expenditure.[81]

It is well understood that a comparison between PA studies should be made with caution since wide variations among studies can exist in the age range, gender, representation, PA assessment, and inactivity criteria. However, it is important to put the inactivity prevalence findings from this review in

perspectives and compare them with that of international prevalence data. A recent study used pooled analysis of three multi-center studies, which were conducted between 2002 and 2004, and investigated the prevalence of physical inactivity in 76 countries with almost 300,000 participants aged 15 years or older.[82] The IPAQ or the global PA Questionnaire (GPAQ) were used in these studies to assess physical inactivity. The findings indicated that the crude worldwide prevalence of physical inactivity was 21.4% (95% confidence interval [CI] 18.4–24.3) and that inactivity was higher among women (23.7%; 95% CI 20.4–27.1) than men (18.9%; 95% CI 16.2–21.7).[82] Furthermore, a recent worldwide survey using data for participants 15 years and older from 122 countries, indicated that physical inactivity was the highest among people in the Americas and the Eastern Mediterranean regions, and that inactivity rises with age, higher in women as compared with men, and increase in high-income as compared with low-income countries.[77] In another study conducted on university students in 23 countries, using the IPAQ, the prevalence of physical inactivity was 41.4%, ranging from 21.9% in Kyrgyzstan to 80.6% in Pakistan.[83]

It is well recognized that there are substantial health benefits from regular PA for children and adolescents.[54] They need regular PA for normal growth and development and maintenance of good health and fitness. The findings of this review showed that the majority of Saudi children and youth were not active enough to meet the minimal weekly requirements of MVPA levels. Elsewhere, a recent study on the global PA prevalence among adolescents has combined the two most comprehensive data sets on adolescents' PA levels; the Global School-based Student Health Survey (GSHS)[84] and the health behavior in school-aged children's survey.[85] The findings of the above-mentioned study showed that the proportion of adolescents aged 13–15 years engaging in <60 min of moderate to vigorous intensity PA per day was 80.3% and that girls were less active than boys.[77] In addition, the GSHS, which reported PA data for school children in 34 countries, showed that nearly 24% of boys and over 15% of girls across the countries met the PA recommendations.[86]

The current review observed that in some studies which used the short version of IPAQ, inactivity among Saudi women was surprisingly somewhat lower than that of men.[40,44] This could have been due to the fact that the IPAQ includes household PA, in which females in Saudi Arabia may engage in, and thus, report plenty of such household activities (such as carrying babies, scrubbing floors, sweeping, and vacuuming, which are classified as moderate-type of PA in IPAQ). Other studies, which utilized IPAQ, have also found no significant differences in inactivity prevalence between Saudi males and females.[30,33,39] This may be due to the fact that, previous studies have shown that there was the possibility of over-reporting moderate levels of PA when using IPAQ.[44,87,88] Therefore, the real overall prevalence of physical inactivity among Saudi females in those studies using IPAQ may be much higher than what have been previously reported.

The present report revealed some inconsistencies between studies regarding PA levels among students attending public versus private schools.[19,52,53] It appears that the location, from which the study sample was selected, may have influenced such inactivity levels among female students, as physical education classes are not compulsory in all females' private schools. However, the majority of private schools do offer physical education classes on elective bases. In contrast, no physical education classes are offered as yet in girls' public schools. Such differences between the two types of schools were mirrored in the findings of a recent subnational study conducted on adolescent girls, which revealed that females in private schools spent more time per week in leisure-time PA as compared to females in public schools.[69]

Factors influencing PA in Saudi Arabia

Understanding the reasons behind PA or inactivity is very important for implementing effective intervention strategies for the promotion of active living in Saudi society. Research into PA correlates and determinants has proliferated in the past few decades. Factors such as age, sex, health status, self-efficacy, and motivation are known to associate with PA.[89] Variables that are found to positively associate with adult's PA include high education level, high income, enjoyment of PA, self-efficacy, social support, and safe environment.[6] On the other hand, the factors that are believed to be negatively associated with adult PA include advancing age, low income, lack of time, low motivation, obesity, and poor health.[6] Among children and adolescents, the following factors have been found to positively associate with PA: Gender (boys), self-efficacy, parental support, parental education, physical education, or sports at school and support from friends and family.[90]

The present study indicates that physical inactivity increased with advancing age in children and adolescents as well as in adults. Age-related decline in PA has been well documented in the literature. For instance, data from the Behavioral Risk Factors Surveillance System (BRFSS) study in the United States indicated that physical inactivity steadily increased in both sexes with advancing age from 18– 29 years to 70+ years.[78] Among adolescents, PA was also shown to decline during adolescence years.[91]

The present review revealed that reduced PA was associated with obesity and WC in adults, children, and adolescents.[13,16,45,58,75] WC is considered a surrogate measure of abdominal obesity. In an international comparison survey involving youth 10–16 years from 34 countries, it was demonstrated that PA

levels were lower and screen viewing times were higher in overweight compared to normal weight youth.[92] Furthermore, a multicenter European study conducted on 9–10-year-old children reported a significant difference in body fatness measurement between children who engaged in more than 2 h of MVPA per day and those who participated in <1 h per day.[93] Other correlates of PA also include social and physical environment such as urban planning, transportation systems, and parks, and trails.[6,89,90] Evidently, there is a shortage of local researches in studying the environmental influences of PA in Saudi Arabia. Such information is extremely important for designing and implementing PA intervention programs. A recent findings from a study conducted on 9–12 year-old same-sex twin pairs (n = 234) showed that the shared environmental effects explained 73% of the variance in objectively-measured total PA (95% CI = 63–81%) with no significant genetic effect, whereas fidgetiness was largely under genetic control, with the genetic effects explaining 75% of the variance (95% CI: 62–84%).[94]

Before the recent economic growth surge that started four decades ago, traditional urban designs in Saudi cities, with narrow and shaded streets, supported pedestrian travel is common daily activities within the community, thus, facilitating walking and cycling and resulting in increased daily living activity. Walking and cycling to and from nearby school were also common in the past. However, major Saudi Arabian cities are now modernized, with large street networks and separate zoning for residential and commercial areas. This kind of design requires, of course, the use of cars for all trips and, hence, totally discourages walking. Consequently, incongruous urban designs, as well as extreme weather and safety issues, discourage most students from walking to schools. In a study conducted on a representative sample of primary school children in Riyadh, it was found that the proportion of children walking to schools was only 28.7%.[80] The same study found that body fat percent was 15% lower among those students walking to schools, as compared to their peers who were not walking to school (17.9% vs. 20.6%).[80] Therefore, there is a need to restructure our built environments to become safer and more PA promoting all season round. In addition, the population growth of major cities in Saudi Arabia has escalated over the past 40 years or so. For instance, the population of Riyadh city, the Capitol, has increased from 350 thousands in 1970 to an astonishing figure of 6.15 billion in 2015.[95] Undeniably, major Saudi cities are becoming very crowded and densely populated with heavy traffic leading to long sitting hours in cars, thus simultaneously increasing sedentary behaviors and decreasing PA.

It is interesting to note that the recent national study on PA and other NCD risks reported that PA was low among more educated Saudis.[48] However, another community based national study conducted on Saudi adults between the ages of 30 and 70 years found that inactivity prevalence decreased with increasing education levels.[45] Elsewhere, PA was shown to increase with increasing education levels,[96,97] and inactivity was reported to be more prevalent among less educated American people.[98] It appears that the association between PA and education levels depends on the domain of PA assessed. PA is often categorized into four domains based on the location or purpose of the activity. These major domains are (1) leisure, (2) domestic or household, (3) occupational or work-related, and (4) transportation. Such an inverse association between activity and education level would very likely to be present when levels of education were associated with leisure-time PA.[98] However, the inclusion of work-related PA revealed that less educated individuals, who were involved in the manual occupation, were more active people.[99] In accordance with this finding, several previous reports have shown that leisure-time physical inactivity is inversely associated with socioeconomic status.[99,100] In addition, it appears that in developed countries, both income level and urban/rural status were significant predictors of adults' likelihood of meeting PA guidelines.[7]

Some studies in the present review indicated that Saudi females had much energy and motivation to exercise than males and less internal barriers than males.[38,66] Females also reported more barriers than males with lack of time as the major external barrier along with the lack of social support, low self-efficacy, and lack of facility, and resources.[66,69] These, along with the cultural and traditional barriers, may partially explain the lower participation levels in PA among Saudi females as compared to males. Furthermore, a recent study focused on the barriers and facilitators to PA among Arabic adults concluded that the barriers included those happening at the individual level (e.g., lack of time and health status), at the social/cultural/policy level (e.g., traditional roles for women, lack of social support, and use of housemaids), and at the environmental level (e.g., hot weather and lack of exercise facilities), whereas activity facilitators included Muslim religion, desire to have slimmer bodies, and having good social support systems.[101]

Promoting physical inactivity in Saudi Arabia

This systematic review has clearly shown that Saudis need to be more physically active than the current estimates, to control the escalating prevalence of NCDs in this country, such as obesity, diabetes mellitus, cardiovascular diseases, and cancer.[3,10,11] At present, PA in Saudi Arabia appears to be an underserved public health issue.[102] Although the benefits of PA are well acknowledged, getting inactive people to start participating in PA and to keep exercising remains a great challenge. Therefore, Saudis need to create ways to make PA opportunities more available in schools, workplaces, and within the community settings.

Health-care providers have definitely an important role to play in promoting PA, by providing routine assessment and counseling on increasing PA, improving fitness and reducing sedentary behaviors for their patients. Health-care providers can encourage PA for patients and communities by making

PA a vital sign and designing innovative active health-care environments.[103] Health-care institutions can promote active living and invest and advocate for community health through active transportation, public recreation space, and school health initiatives.[103] They can also adopt a comprehensive curriculum that potentially closes the gap in medical schools, residency programs, graduate education, and nursing curricula on topics related to PA, and exercise prescription and lifestyle health. Physicians and other health professionals receive very limited formal training in the PA science and clinical applications of exercise, including obesity prevention, nutrition, lifestyle medicine, and PA prescription in health and disease. The incorporation of a well-tested PA module into the residency curriculum was shown to be feasible, efficacious, well received, and easily incorporated into the existing curriculum.[104] In Saudi Arabia, a recent survey conducted on primary health-care centers in Eastern province of the country revealed that only one-third of the health-care professional believed that they were well prepared to treat obesity, and 83% of the respondents had negative attitudes toward the concept of overweight and obesity.[105] This may not encourage them to prescribe PA for their obese patients.

It is interesting to know that findings from a study on Saudi population showed that preventable risk factors such as smoking, obesity, and physical inactivity were not associated with Saudis' self-rated health.[106] Such inadequate knowledge indicates a distorted perception of health and may represent a major challenge to PA promotional interventions in Saudi Arabia. Thus, requiring increased efforts to raise public awareness about unhealthy lifestyle habits such as physical inactivity and harmful sedentary behaviors. Furthermore, there are urgent needs for reliable and widely disseminated information for the public in nutrition, PA and health, obesity prevention, and live-long active living. The new social media, which is widely used by the Saudi people, can be fully utilized for PA promotion and obesity prevention.

Strength and limitations

This is the first comprehensive review on the prevalence and correlates of PA/inactivity among Saudi population, a country that has been going into rapid economic development and dramatic lifestyle transition in the past few decades. However, this review is subjected to several limitations. Obviously, the review is limited by the quality of the reviewed studies reported in this paper. Some of the reviewed studies are lacking in one or more of the following limiting factors: The sample was not accurately represented, especially for some of the local studies, not reporting response rate, using less validated PA questionnaires and lack of statistical power calculation of the sample size. In addition, calculating usual PA prevalence for a population from different studies using varied PA instruments must be viewed with caution.

Summary and Conclusion

It was clear from the available evidences that PA is increasingly becoming prevalent among the Saudi population of all ages and sexes. This may be largely due to the result of the recent dramatic changes in the people's lifestyle. The proportion of Saudi children and adults who are at risk for inactivity is exceedingly much higher than those at risk of any of the other traditional coronary heart disease risk factors. The high prevalence of inactivity in Saudi Arabia, particularly among females, represents a major public health burden and a precursor for obesity prevalence. In addition, compared with men, Saudi women have less access to exercising facilities and limited opportunities to engage in PA. School children and university students appear to have fairly good knowledge about the benefits of PA. However, a large percentage of schools' girls lacked proper information and skills on how to exercise or to be physically active. Although time constraint, lack of facilities and resources, low self-efficacy, and lack of social support (especially in the part of women) represent a major barriers to being physically active among Saudis, there remains a need to further understand the personal, social and environmental barriers to PA in Saudi population, particularly in relation to different domain of PA (leisure time, occupational, transports, and households PA). It is recommended that a national policy encouraging active living and discouraging inactivity be established. Health-care providers have an important role in promoting PA and encouraging and adopting healthy lifestyle habits among all Saudi people.

References

1. World Health Organization (WHO). Physical Activity Fact Sheet No.385, 2015. Available from: http://www.who.int/mediacentre/factsheets/fs385/en. [Last accessed on 2016 Jan 10].
2. World Health Organization (WHO). Global Recommendations on Physical Activity for Health. Geneva, Switzerland: WHO; 2010.
3. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, *et al*. Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. Lancet 2012;380:219-29.
4. United States Department of Health and Human Services. Physical Activity Guidelines for Americans: Be Active, Healthy and Happy. Washington, U.S. Department of Health and Human Services, USA; 2008.
5. World Health Organization (WHO). Global Action Plan for the Prevention and Control of NCDs; 2013-2020. Available from: http://www.who.int/nmh/publications/ncd-action-plan/en. [Last accessed on 2016 Jan 10].
6. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: Review and update. Med Sci Sports Exerc 2002;34:1996-2001.
7. Parks SE, Housemann RA, Brownson RC. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. J Epidemiol Community Health 2003;57:29-35.
8. Al-Hazzaa HM. The public health burden of physical inactivity in Saudi Arabia. J Family Community Med 2004;11:45-51.

9. Al-Hazzaa HM. Prevalence of physical inactivity in Saudi Arabia: A brief review. East Mediterr Health J 2004;10:663-70.
10. Almahmeed W, Arnaout MS, Chettaoui R, Ibrahim M, Kurdi MI, Taher MA, *et al.* Coronary artery disease in Africa and the middle east. Ther Clin Risk Manag 2012;8:65-72.
11. Majeed A, El-Sayed AA, Khoja T, Alshamsan R, Millett C, Rawaf S, *et al.* Diabetes in the middle-east and North Africa: An update. Diabetes Res Clin Pract 2014;103:218-22.
12. Rahim HF, Sibai A, Khader Y, Hwalla N, Fadhil I, Alsiyabi H, *et al.* Non-communicable diseases in the Arab world. Lancet 2014;383:356-67.
13. Al-Hazzaa H. Physical activity, fitness and fatness among Saudi children and adolescents: Implication for cardiovascular health. Saudi Med J 2002;23:144-50.
14. Al-Hazzaa HM, Al-Rasheedi AA. Adiposity and physical activity levels among preschool children in Jeddah, Saudi Arabia. Saudi Med J 2007;28:766-73.
15. Al-Hazzaa H, Sulaiman M, Al-Mobaireek K, Al-Attas O. Prevalence of coronary artery disease risk factors in Saudi children. J Saudi Heart Assoc 1993;5:126-33.
16. Al-Hazzaa HM. Pedometer-determined physical activity among obese and non-obese 8- to 12-year-old Saudi schoolboys. J Physiol Anthropol 2007;26:459-65.
17. Al-Kutbe R, Payne A, de Looy A, Rees GA. A comparison of nutritional intake and daily physical activity of girls aged 8-11 years old in Makkah, Saudi Arabia according to weight status. BMC Public Health 2017;17:592.
18. Al-Rukban MO. Obesity among Saudi male adolescents in Riyadh, Saudi Arabia. Saudi Med J 2003;24:27-33.
19. Taha AZ. Self-reported knowledge and pattern of physical activity among school students in al Khobar, Saudi Arabia. East Mediterr Health J 2008;14:344-55.
20. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Musaiger AO. Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. Int J Behav Nutr Phys Act 2011;8:140.
21. Mahfouz AA, Shatoor AS, Hassanein MA, Mohamed A, Farheen A. Gender differences in cardiovascular risk factors among adolescents in Aseer region, Southwestern Saudi Arabia. J Saudi Heart Assoc 2012;24:61-7.
22. Alzahrani SG, Watt RG, Sheiham A, Aresu M, Tsakos G. Patterns of clustering of six health-compromising behaviours in Saudi adolescents. BMC Public Health 2014;14:1215.
23. Alsubaie AS, Omer EO. Physical activity behavior predictors, reasons and barriers among male adolescents in Riyadh, Saudi Arabia: Evidence for obesogenic environment. Int J Health Sci (Qassim) 2015;9:400-8.
24. Bajamal E, Robbins LB, Ling J, Smith B, Pfeiffer KA, Sharma D, *et al.* Physical activity among female adolescents in Jeddah, Saudi Arabia: A Health promotion model-based path analysis. Nurs Res 2017;66:473-82.
25. Al-Raddadi R, Bahijri S, Borai A, AlRaddadi Z. Prevalence of lifestyle practices that might affect bone health in relation to Vitamin D status among female Saudi adolescents. Nutrition 2018;45:108-13.
26. Al-Hazzaa HM. Physical activity profile of college male subjects. King Saud Univ J 1990;2:383-96.
27. Al-Gelban KS. Dietary habits and exercise practices among the students of a Saudi teachers' training college. Saudi Med J 2008;29:754-9.
28. Gawwad ES. Stages of change in physical activity, self efficacy and decisional balance among Saudi university students. J Family Community Med 2008;15:107-15.
29. Khalaf A, Ekblom Ö, Kowalski J, Berggren V, Westergren A, Al- Hazzaa H, *et al.* Female university students, physical activity levels and associated factors – a cross-sectional study in Southwestern Saudi Arabia. Int J Environ Res Public Health 2013;10:3502-17.
30. Awadalla NJ, Aboelyazed AE, Hassanein MA, Khalil SN, Aftab R, Gaballa II, *et al.* Assessment of physical inactivity and perceived barriers to physical activity among health college students, South-Western Saudi Arabia. East Mediterr Health J 2014;20:596-604.
31. Majeed F. Association of BMI with diet and physical activity of female medical students at the University of Dammam, Kingdom of Saudi Arabia. J Taibah Univ Med Sci 2015;10:188-96.
32. Samara A, Nistrup A, Al-Rammah TY, Aro AR. Lack of facilities rather than sociocultural factors as the primary barrier to physical activity among female Saudi university students. Int J Womens Health 2015;7:279-86.
33. Allam AR, Taha IM, Al-Nozha OM, Sultan IE. Nutritional and health status of medical students at a university in Northwestern Saudi Arabia. Saudi Med J 2012;33:1296-303.
34. Al-Shahri MZ, Al-Almaei SM. Promotion of physical exercise by primary health care physicians in Riyadh city. Saudi Med J 1998;19:67-9.
35. Al Alwan I, Badri M, Al-Ghamdi M, Aljarbou A, Alotaibi H, Tamim H, *et al.* Prevalence of self-reported cardiovascular risk factors among Saudi physicians: A Comparative study. Int J Health Sci (Qassim) 2013;7:3-13.
36. AlAteeq MA, AlArawi SM. Healthy lifestyle among primary health care professionals. Saudi Med J 2014;35:488-94.
37. Taha AZ, Bella H. Heart disease risk factors: Prevalence and knowledge in a primary care setting, Saudi Arabia. East Mediterr Health J 1998;4:293-300.
38. AlQuaiz AM, Tayel SA. Barriers to a healthy lifestyle among patients attending primary care clinics at a university hospital in Riyadh. Ann Saudi Med 2009;29:30-5.
39. AboZaid HA, Farahat FM. Physical activity profile among patients attending family medicine clinics in Western Saudi Arabia. Saudi Med J 2010;31:428-33.
40. Amin TT, Suleman W, Ali A, Gamal A, Al Wehedy A. Pattern, prevalence, and perceived personal barriers toward physical activity among adult Saudis in Al-Hassa, KSA. J Phys Act Health 2011;8:775-84.
41. Khalid M. The association between strenuous physical activity and obesity in high and low altitude populations in Southern Saudi Arabia. Int J Obes Relat Metab Disord 1995;19:776-80.
42. Bin Horaib G, Al-Khashan HI, Mishriky AM, Selim MA, Alnowaiser N, Binsaeed AA, *et al.* Prevalence of obesity among military personnel in Saudi Arabia and associated risk factors. Saudi Med J 2013;34:401-7.
43. Al-Rafaee SA, Al-Hazzaa HM. Physical activity profile of adult males in Riyadh city. Saudi Med J 2001;22:784-9.
44. Al-Hazzaa HM. Health-enhancing physical activity among Saudi adults using the international physical activity questionnaire (IPAQ). Public Health Nutr 2007;10:59-64.
45. Al-Nozha MM, Al-Hazzaa HM, Arafah MR, Al-Khadra A, Al-Mazrou YY, Al-Maatouq MA, *et al.* Prevalence of physical activity and inactivity among Saudis aged 30-70 years. A population-based cross-sectional study. Saudi Med J 2007;28:559-68.
46. Amin TT, Al Sultan AI, Mostafa OA, Darwish AA, Al-Naboli MR. Profile of non-communicable disease risk factors among employees at a Saudi university. Asian Pac J Cancer Prev 2014;15:7897-907.
47. Al-Zalabani AH, Al-Hamdan NA, Saeed AA. The prevalence of physical activity and its socioeconomic correlates in Kingdom of Saudi Arabia: A cross-sectional population-based national survey. J Taibah Univ Med Sci 2015;10:208-15.
48. El Bcheraoui C, Tuffaha M, Daoud F, Kravitz H, Al Mazroa MA, Al Saeedi M, *et al.* On your mark, get set, go: Levels of physical activity

in the kingdom of Saudi Arabia, 2013. J Phys Act Health 2016;13:231-8.

49. Albawardi NM, Jradi H, Al-Hazzaa HM. Levels and correlates of physical activity, inactivity and body mass index among Saudi women working in office jobs in Riyadh city. BMC Womens Health 2016;16:33.
50. Mandil AM, Alfurayh NA, Aljebreen MA, Aldukhi SA. Physical activity and major non-communicable diseases among physicians in central Saudi Arabia. Saudi Med J 2016;37:1243-50.
51. Al-Mountashiri NA, Al-Zhrani AM, Ibrahim SFH, Mirghani HO. Dietary habits, physical activity and diabetes perception among patients with Type 2 diabetes mellitus in Tabuk city, Saudi Arabia. Electron Physician 2017;9:5179-84.
52. Al-Nuaim AA, Al-Nakeeb Y, Lyons M, Al-Hazzaa HM, Nevill A, Collins P, *et al.* The prevalence of physical activity and sedentary behaviours relative to obesity among adolescents from Al-Ahsa, Saudi Arabia: Rural versus urban variations. J Nutr Metab 2012;2012:417589.
53. Al-Hazzaa HM, Alahmadi MA, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Musaiger AO, *et al.* Patterns and determinants of physical activity among Saudi adolescents. J Phys Act Health 2014;11:1202-11.
54. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act 2010;7:40.
55. Al-Hazzaa HM, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Alahmadi MA, Musaiger AO, *et al.* Association of dietary habits with levels of physical activity and screen time among adolescents living in Saudi Arabia. J Hum Nutr Diet 2014;27 Suppl 2:204-13.
56. Al-Hazzaa H. Health-related Physical Activity and Cardiovascular Fitness among Saudi Youth. Final Reports, Riyadh: King Abdulaziz City for Science and Technology; 2003.
57. Al-Hazzaa H. Prevalence and trends in obesity and physical inactivity among Saudi children and adolescents: A growing public health challenge. Int J Pediatr Obes 2009;4 Suppl 3:6-14.
58. Al-Hazzaa HM, Sulaiman MA, al-Matar AJ, al-Mobaireek KF. Cardiorespiratory fitness, physical activity patterns and coronary risk factors in preadolescent boys. Int J Sports Med 1994;15:267-72.
59. Al-Hazzaa H. Tracking of Physical Activity, Cardiorespiratory Fitness and Selected CAD Risk Factors from Childhood to Adulthood: An 11 Year Follow-Up Study. France: Proceedings of the 9th Annual Congress of the European College of Sports Science; 2004.
60. Alquaiz AM, Kazi A, Qureshi R, Siddiqui AR, Jamal A, Shaik SA, *et al.* Correlates of cardiovascular disease risk scores in women in Riyadh, kingdom of Saudi Arabia. Women Health 2015;55:103-17.
61. Al-Hazzaa H. In: Chan KM, editor. Heart Rate Telemetry of School Children during Physical Activity. Hong Kong: Sports, Medicine and Health-The Asian Perspective; 1992. p. 23-6.
62. Al-Hazzaa H, Sulaiman M. Maximal oxygen uptake and daily physical activity in 7-to-12 year-old boys. Pediatr Exerc Sci 1993;5:357-66.
63. Al-Hazzaa H. Familial Effect on Physiological Variables in Preadolescent Boys. Athens, Greece: Proceedings of XXV FIMS Congress of Sports Medicine; 1994. p. 16.
64. Collison KS, Zaidi MZ, Subhani SN, Al-Rubeaan K, Shoukri M, Al-Mohanna FA, *et al.* Sugar-sweetened carbonated beverage consumption correlates with BMI, waist circumference, and poor dietary choices in school children. BMC Public Health 2010;10:234.
65. Al-Otaibi HH. Measuring stages of change, perceived barriers and self-efficacy for physical activity in Saudi Arabia. Asian Pac J Cancer Prev 2013;14:1009-16.
66. Al-Eisa ES, Al-Sobayel HI. Physical activity and health beliefs among Saudi women. J Nutr Metab 2012;2012:642187.
67. Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. Sports Med 2004;34:1-8.
68. Al-Sobayel H, Al-Hazzaa HM, Abahussain NA, Qahwaji DM, Musaiger AO. Gender differences in leisure-time versus non-leisure-time physical activity among Saudi adolescents. Ann Agric Environ Med 2015;22:344-8.
69. Rowlands AV, Eston RG. Comparison of accelerometer and pedometer measures of physical activity in boys and girls, ages 8-10 years. Res Q Exerc Sport 2005;76:251-7.
70. Al-Hazzaa H. Patterns of physical activity among Saudi children, adolescents & adults with special reference to health. In: *Nutrition and Physical Activity in the Arab Countries of the Near East.* A. Musaiger and S. Miladi (Eds.). Manama: BCSR, 2000: 109-27.
71. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Musaiger AO. Lifestyle factors associated with overweight and obesity among Saudi adolescents. BMC Public Health 2012;12:354.
72. Hills AP, Mokhtar N, Byrne NM. Assessment of physical activity and energy expenditure: An overview of objective measures. Front Nutr 2014;1:5.
73. Al-Hazzaa HM, Musaiger AO, ATLS Research Group. Arab teen's lifestyle study (ATLS): Objectives, design, methodology and implications. Diabetes Metab Syndr Obes 2011;4:417-26.
74. Al-Hazzaa HM, Al-Sobayel HI, Musaiger AO. Convergent validity of the Arab teens lifestyle study (ATLS) physical activity questionnaire. Int J Environ Res Public Health 2011;8:3810-20.
75. Tremblay MS, Warburton DE, Janssen I, Paterson DH, Latimer AE, Rhodes RE, *et al.* New Canadian physical activity guidelines. Appl Physiol Nutr Metab 2011;36:36-46.
76. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U, *et al.* Global physical activity levels: Surveillance progress, pitfalls, and prospects. Lancet 2012;380:247-57.
77. Centers for Disease Control and Prevention (CDC). Prevalence of no leisure-time physical activity--35 states and the district of Columbia, 1988-2002. MMWR Morb Mortal Wkly Rep 2004;53:82-6.
78. Forrest KY, Bunker CH, Kriska AM, Ukoli FA, Huston SL, Markovic N, *et al.* Physical activity and cardiovascular risk factors in a developing population. Med Sci Sports Exerc 2001;33:1598-604.
79. Al-Hazzaa H. School backpack: How much loads do Saudi school boys carry on their shoulders? Saudi Med J 2006;27 1567-71.
80. Faulkner GE, Buliung RN, Flora PK, Fusco C. Active school transport, physical activity levels and body weight of children and youth: A systematic review. Prev Med 2009;48:3-8.
81. Dumith SC, Hallal PC, Reis RS, Kohl HW 3rd. World-wide prevalence of physical inactivity and its association with human development index in 76 countries. Prev Med 2011;53:24-8.
82. Pengpid S, Peltzer K, Kassean HK, Tsala Tsala JP, Sychareun V, Müller-Riemenschneider F, *et al.* Physical inactivity and associated factors among university students in 23 low-, middle- and high-income countries. Int J Public Health 2015;60:539-49.
83. World Health Organization (WHO). Global School-based Student Health Survey 2011. Available from: http://www.who.int/chp/gshs/en. [Last accessed on 2016 Jan 21].
84. World Health Organization (WHO). Regional Once for Europe. Inequalities in Young People's Health: HBSC International Report from the 2005/2006 Survey. Copenhagen: WHO Regional Once for Europe; 2008.
85. Guthold R, Cowan MJ, Autenrieth CS, Kann L, Riley LM. Physical activity and sedentary behavior among schoolchildren: A 34-country comparison. J Pediatr 2010;157:43-90.
86. Bauman A, Bull F, Chey T, Craig CL, Ainsworth BE, Sallis JF, *et al.* The international prevalence study on physical activity: Results from 20 countries. Int J Behav Nutr Phys Act 2009;6:21.
87. Rzewnicki R, Vanden Auweele Y, De Bourdeaudhuij I. Addressing overreporting on the international physical activity questionnaire

(IPAQ) telephone survey with a population sample. Public Health Nutr 2003;6:299-305.

88. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW, *et al.* Correlates of physical activity: Why are some people physically active and others not? Lancet 2012;380:258-71.
89. Van Der Horst K, Paw MJ, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. Med Sci Sports Exerc 2007;39:1241-50.
90. Dumith SC, Gigante DP, Domingues MR, Kohl HW 3rd. Physical activity change during adolescence: A systematic review and a pooled analysis. Int J Epidemiol 2011;40:685-98.
91. Ibrahim NK, Mahnashi M, Al-Dhaheri A, Al-Zahrani B, Al-Wadie E, Aljabri M, *et al.* Risk factors of coronary heart disease among medical students in King Abdulaziz University, Jeddah, Saudi Arabia. BMC Public Health 2014;14:411.
92. Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C, *et al.* Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obes Rev 2005;6:123-32.
93. Ekelund U, Sardinha LB, Anderssen SA, Harro M, Franks PW, Brage S, *et al.* Associations between objectively assessed physical activity and indicators of body fatness in 9- to 10-y-old European children: A population-based study from 4 distinct regions in Europe (the European youth heart study). Am J Clin Nutr 2004;80:584-90.
94. Fisher A, van Jaarsveld CH, Llewellyn CH, Wardle J. Environmental influences on children's physical activity: Quantitative estimates using a twin design. PLoS One 2010;5:e10110.
95. Arriyadh Development Authority. Investment Climate in Arriyadh, 2015. Riyadh: Kingdom of Saudi Arabia; 2015 Available from: http//:www.ada.gov.sa/ADA_E/Researches_ADA_E/index.htm?i=5. [Last accessed on 2018 Jan 21].
96. Brownson RC, Eyler AA, King AC, Brown DR, Shyu YL, Sallis JF, *et al.* Patterns and correlates of physical activity among US women 40 years and older. Am J Public Health 2000;90:264-70.
97. Giles-Corti B, Donovan RJ. The relative influence of individual, social and physical environment determinants of physical activity. Soc Sci Med 2002;54:1793-812.
98. Crespo CJ, Ainsworth BE, Keteyian SJ, Heath GW, Smit E. Prevalence of physical inactivity and its relation to social class in U.S. Adults: Results from the third national health and nutrition examination survey, 1988-1994. Med Sci Sports Exerc 1999;31:1821-7.
99. Gal DL, Santos AC, Barros H. Leisure-time versus full-day energy expenditure: A cross-sectional study of sedentarism in a Portuguese urban population. BMC Public Health 2005;5:16.
100. Macera C, Croft J, Brown D, Ferguson T, Lane M. Predictions of adopting leisure-time physical activity among a biracial community cohort. Am J Epidemiol 1995;142:629-35.
101. Benjamin K, Donnelly TT. Barriers and facilitators influencing the physical activity of Arabic adults: A literature review. Avicenna 2013;8: Doi.org/10.5339/avi.2013.8.
102. Al-Hazzaa H. Physical inactivity in Saudi Arabia. An underserved public health issue. Saudi Med J 2010;31:1278-9.
103. Lobelo F, Stoutenberg M, Hutber A. The exercise is medicine global health initiative: A 2014 update. Br J Sports Med 2014;48:1627-33.
104. Hill LL, Nichols J, Wing D, Waalen J, Friedman E. Training on exercise is medicine® within an integrative medicine curriculum. Am J Prev Med 2015;49:S278-84.
105. Sebiany AM. Primary care physicians' knowledge and perceived barriers in the management of overweight and obesity. J Family Community Med 2013;20:147-52.
106. Moradi-Lakeh M, El Bcheraoui C, Tuffaha M, Daoud F, Al Saeedi M, Basulaiman M, *et al.* Self-rated health among Saudi adults: Findings from a national survey, 2013. J Community Health 2015;40:920-6.