Movement behaviors, cardiorespiratory fitness, and cardiovascular disease risk factors in children from the gulf cooperation council countries: A narrative review

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Abstract

Movement behaviors inclusive of physical activity (PA), sedentary behavior (SB), and sleep time (ST), and cardiorespiratory fitness (CRF) are associated with cardiovascular disease (CVD) risk factors in children. The aim of this narrative review is to synthesize data on movement behaviors (PA, SB, and ST) and CRF in relation to CVD risk factors in children from the Gulf Cooperation Council (GCC). Three online databases were searched up until August 2019. Movement behaviour studies were included if cut-offs were ≥60 min/day for PA, ≤2 or ≤3 h/day for SB (screen time), and ≥8 or ≥9 h/day for ST. Laboratory- and field-based CRF measures were included. Thirty-five studies were included in the review. Participants were aged 8–19 years old. Seven studies were on males and one study on female-only participants. PA was reported in 13 studies, with 28% considered physically active. SB was reported in 13 studies and 56% met the guidelines. Only one study measured ST, with 23% meeting the recommendation. Eight studies measured CRF, and in six of these studies, the mean maximal oxygen uptake (VO_{2max}) was 42 and 36 mL/kg/min for males and females, respectively. Two studies used the one-mile walk/run test on male participants, with a mean performance time of 10 min. One study investigated multiple CVD risk factors in relation to CRF, and four studies with body mass index (BMI) only. One study on PA and SB was examined in relation to BMI. Overall, weak correlations were found between movement behaviors and CRF in relation to CVD risk factors. The prevalence of meeting PA and ST guidelines among children from GCC is low. On average, CRF is slightly above the proposed healthy cut off points for both genders. Future prospective research is needed on children from the GCC to comprehensively examine the relationship between movement behaviors, CRF and CVD risk.

Keywords: Epidemiology, physical activity, physical fitness, school children, sedentary time, sleep

سلوكيات الحركة واللياقة القلبية التنفسية وعوامل خطر اإلصابة بأمراض القلب واألوعية الدموية لدى االطفال من دول مجلس التعاون الخليجي: دراسة مرجعية

الملخص:

ترتبط سلوكيات الحركة (النشاط البدني السلوك الخامل، وقت النوم)، واللياقة القلبية التنفسية بعوامل خطر الإصابة بأمراض القلب والأوعية الدموية لدى الأطفال. تهدف هذه الدراسة المرجعية إلى جمع بيانات حول سلوكيات الحركة واللياقة القلبية التنفسية وعوامل خطر الإصابة بأمراض القلب والأوعية الدموية لدى الأطفال من دول مجلس التعاون الخليجي. تم البحث خلال ثلاث قواعد بيانات على الإنترنت حتى شهر أغسطس 2019، ولقد شملت هذه الدراسة السلوكيات الحركية في حال كان قياس النشاط البدني ≤ 60 دقيقة في اليوم، والخمول البدني (وقت الشاشة) ≥ 2 أو ≥ 3 ساعات في اليوم، وكذلك النوم ≤ 8 أو ≤9 ساعات في اليوم. وتضمنت الدراسة كذلك القياسات المختبرية والميدانية للياقة القلبية التنفسية. شملت هذه الدراسة المرجعية 35 دراسة، حيث تراوحت أعمار المشاركين مابين 8 إلى 19 سنة. سبع دراسات منها كانت مقتصرة على الذكور، ودراسة واحدة اقتصرت على الإناث فقط. تضمنت هذه الدراسة المرجعية 13 دراسة عن النشاط البدني والتي أظهرت بأن 28% فقط من المشاركين نشطين، كذلك 13 دراسة عن السلوك الخامل واتضح بأن 56% من المشاركين حققوا التوصيات، ودراسة واحدة فقط عن النوم و التي أظهرت أن 23% فقط من المشاركين حققوا التوصيات.أيضاً شملت هذه الدراسة المرجعية على 8 دراسات عن اللياقة القلبية التنفسية. في 6 دراسات منها كان متوسط الاستهلاك الأقصى للأكسجين 42 و36 مل /كجم /دقيقة للذكور والإناث على التوالي، وفي دراستين استخدم اختبار المشي/الجري لمسافة ميل واحد على المشاركين الذكور، وكان متوسط قطع المسافة 10 دقائق. من خلال جميع الدراسات المشمولة؛ دراسة واحدة فقط بحثت عن اللياقة القلبية التنفسية والعوامل المتعلقة بمخاطر الإصابة بأمراض القلب والأوعية الدموية، أربع دراسات بحثت عن اللياقة القلبية التنفسية ومؤشر كتلة الجسم، وأخيراً دراسة واحدة حول النشاط البدني، والسلوك الخامل، وعلاقتهما بمؤشر كتلة الجسم. بشكل عام ، تم التوصل إلى أن هناك ارتباطات ضعيفة بين سلوكيات الحركة واللياقة القلبية التنفسية وعلاقتهما بعوامل خطر الإصابة بأمراض القلب والأوعية الدموية. كذلك كشفت هذه الدراسة عن انخفاض معدل انتشار تحقيق توصيات النشاط البدني والنوم، بينما كان متوسط اللياقة القلبية التنفسية أعلى بقليل من الحد الأدنى للصحة لكلا الجنسين. لا تزال هناك حاجة لأبحاث مستقبلية على أطفال دول مجلس التعاون الخليجي لتحديد تأثير سلوكيات الحركة واللياقة القلبية التنفسية وعلاقتهما بعوامل خطر الإصابة بأمراض القلب والأوعية الدموية

NTRODUCTION

The Gulf Cooperation Council (GCC) consists of six countries, namely Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Oman, and Qatar.[1] The prevalence of mortality due to cardiovascular diseases (CVD) is 35% in the GCC region.[2] A systematic review highlights the high prevalence of several CVD risk factors (obesity, type 2 diabetes, hypertension, and dyslipidemia) in adults from the GCC, which is a major public health issue.[3] This concern extends to children from the GCC,[4] as they also present with CVD risk factors (high low‐density lipoprotein cholesterol, low high‐density lipoprotein cholesterol, hypertriglyceridemia, pre‐hypertension, and central obesity).[5‐8] Several studies have documented that the origin of CVD begins in childhood, and are related to subclinical changes in CVD risk.[9,10] This underscores the importance of health screening and prevention programs for children from the GCC to mitigate current and future risk of CVD. Movement behaviors, such as physical activity (PA), sedentary behaviors (SB), and sleep time (ST), are daily behaviors found to be independently related to health outcomes in children.[11‐15] It is recommended by the World Health Organization (WHO) that children aged 5–17 years should engage in ≥60 min of moderate to vigorous PA (MVPA) daily for promoting health and wellbeing.[16] Studies have also found that recreational screen time >2 h/day is positively associated with obesity.[17] In addition, in systematic reviews, total time spent in SB was found to be inversely associated with high‐density lipoprotein and positively associated with blood pressure.[14,18] For ST, the National Sleep Foundation recommends ST between 9 to 11 h/day for 6-13 year olds and 8 to 10 h/day for 14-17 year olds.[19] A meta‐analysis has reported negative associations between ST duration and risk of obesity in children.[20] In addition to movement behaviors, cardiorespiratory fitness (CRF) in children is related to CVD outcomes, independent of PA and SB.[21,22] Consequently, The European Youth Heart Study has recommended to the Pan‐European health monitoring system to include CRF tests as a health screening tool for children.[23] Currently, the suggested minimum average fitness level for male and female 8–17 years old is 42 and 35 mL/kg/min, respectively, to indicate elevated CVD risk.[24] Current data on the relationships between movement behaviors and CRF on CVD risk factors are mostly derived from America (North), Australia, and Europe countries, which may not be representative of children from the GCC. Therefore, in children and adolescents from the GCC, this narrative review aims to: (1)

identify the prevalence of each movement behavior(PA, SB, and ST) and it association with CVD risk factors, and (2) examine CRF level and it relation to CVD risk factors.

METHODS

This narrative review follows the steps in writing a narrative biomedical review that is recommended by Gasparyan et al.,[25] and are outlined below.

Search

The review search dates were from September 2018 to August 2019 and were conducted using Google Scholar, PubMed, and the WHO database. The Google Scholar research engine was used initially as it provides research sources from several databases.[26] The PubMed database was used to extend the search to locate articles not found in Google Scholar. Search terms used were related to exposures and outcomes which included: physical activity, physical inactivity, sedentary behavior, sedentary time, screen time, sleep, short sleep duration, cardiorespiratory fitness, maximal aerobic fitness, maximal oxygen uptake, children, adolescents, blood pressure, hypertension, lipids, dyslipidemia, cholesterol, triglycerides, diabetes, cardiovascular disease, cardiovascular disease risk factors risk factors, Gulf Cooperation Council, Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Oman, and Qatar. In addition, this review used backward citation chasing on three systematic reviews.[27–29] The WHO database was used to pool country fact sheets, which then provided the different reported countries fact sheets. Full studies and fact sheets written in English were only included in this narrative review.

Participants, exposures, and outcomes

Participants

Children and adolescents were defined as being ≤19 years old.[30] This review included studies undertaken on ostensibly healthy participants from the six countries of the GCC (Saudi Arabia, United Arab Emirates, Kuwait, Bahrain, Oman, and Qatar). Studies on subpopulations, such as expatriates (>50% of the sample), athletic (i.e., soccer players), or disease groups (i.e., type I diabetes), were excluded. Exposures: Physical activity, sedentary time, sleep time, and cardiorespiratory fitness Studies were included if they reported one or more of the three‐movement behaviors (PA, SB, and ST) and/or CRF. Studies reporting PA, SB, and ST were included if they employed either objective (i.e., accelerometer) or subjective (i.e., questionnaire) measurement approaches. CRF studies were included if they used either a validated laboratory (direct and indirect) or field (the 20 m shuttle run and one‐mile run/walk) test.

Outcomes: Physical activity, sedentary behaviors, sleep time, cardiorespiratory fitness, and cardiovascular disease risk factors

Studies on any of the three‐movement behaviors were considered when the outcomes were based on defined cut‐points for health. These were defined as: MVPA ≥60 min 7 days/week;[16] SB (screen time) ≤2 or ≤3 h/day;[31,32] and ST for 9–11 and 8–10 h for 6–13 and 14–17 years, respectively.[19] Data presented as the proportion (%) of participants meeting the recommendation for the three‐movement behaviors were included. CRF studies were included if reported mean or % of VO_{2max} (mL/kg/min), predicted VO_{2max}, number of laps completed, or performance time in minutes, and separated by sex. Studies measuring traditional CVD risk factors such as dyslipidemia, hypertension, diabetes mellitus, and obesity were included if presented alongside any of the three‐movement behaviors and CRF.[33]

Study designs

Cross‐sectional, prospective, and retrospective studies were eligible for this review.

Study selection

The search strategy, study selection, and data extraction were undertaken by a single author (MA). Stage 1: Searching for articles on the databases with the key terms as mentioned previously in the search method. Stage 2: Titles that included any of the key terms were selected. Stage 3: Abstracts were reviewed to identify the exposure and outcomes. Stage 4: Full‐text screening of selected articles. Stage 5: Only eligible studies were included that met the narrative review inclusion criteria.

Data extraction and categorization

The following information was extracted from each study: Country, author, sample characteristics (i.e., age, sex), measurement instrument, proportion meeting the recommendation or mean (of the specific variable), and correlations with CVD risk factors.

RESULTS

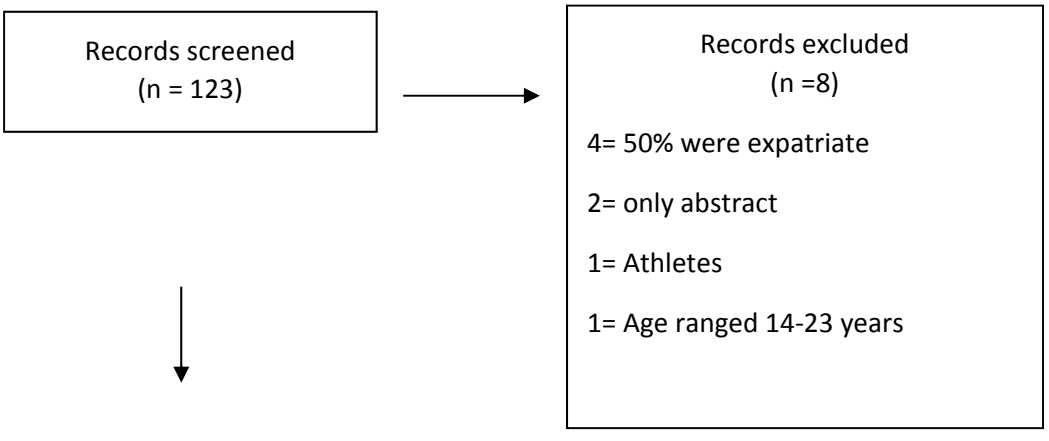
Study selection

One hundred and twenty‐three studies were eligible for inclusion in this review [Figure 1]. Eighty‐eight studies were excluded, which in four studies expatriate participation were more than 50% of the sample size,[34‐37] two studies were abstract only,[38,39] one study included participants aged up to 23 years old,[40] and one study was specific to athletes.[41] In addition, 79 studies were excluded that did not use internationally recognized cut offs for the movement behaviors,[42] and one study did not separate VO_{2max} by sex.[43] After screening for eligible and duplicated studies and fact sheets, 35 studies were included in this narrative review (PA = 13, SB = 13, ST = 1, and CRF = 8).

Physical activity

Subjective measurements

Ten studies met the inclusion criteria of measuring MVPA for 7 days/week [Table 1]. Five studies used the Arab Teens Lifestyle Study (ATLS) questionnaire on both sexes with an age range from 13 to 19 years old. Daily MVPA for males ranged between 29% and 70% and for females 4%–39%.[44,45,48,53,56] Five studies used the Global School‐based Student Health Survey (GSHS) questionnaire on both sexes aged 13–17 years old, which 16%–32% and 8%–14% of males and females, respectively, met the guidelines.[49,50,52,54,55]



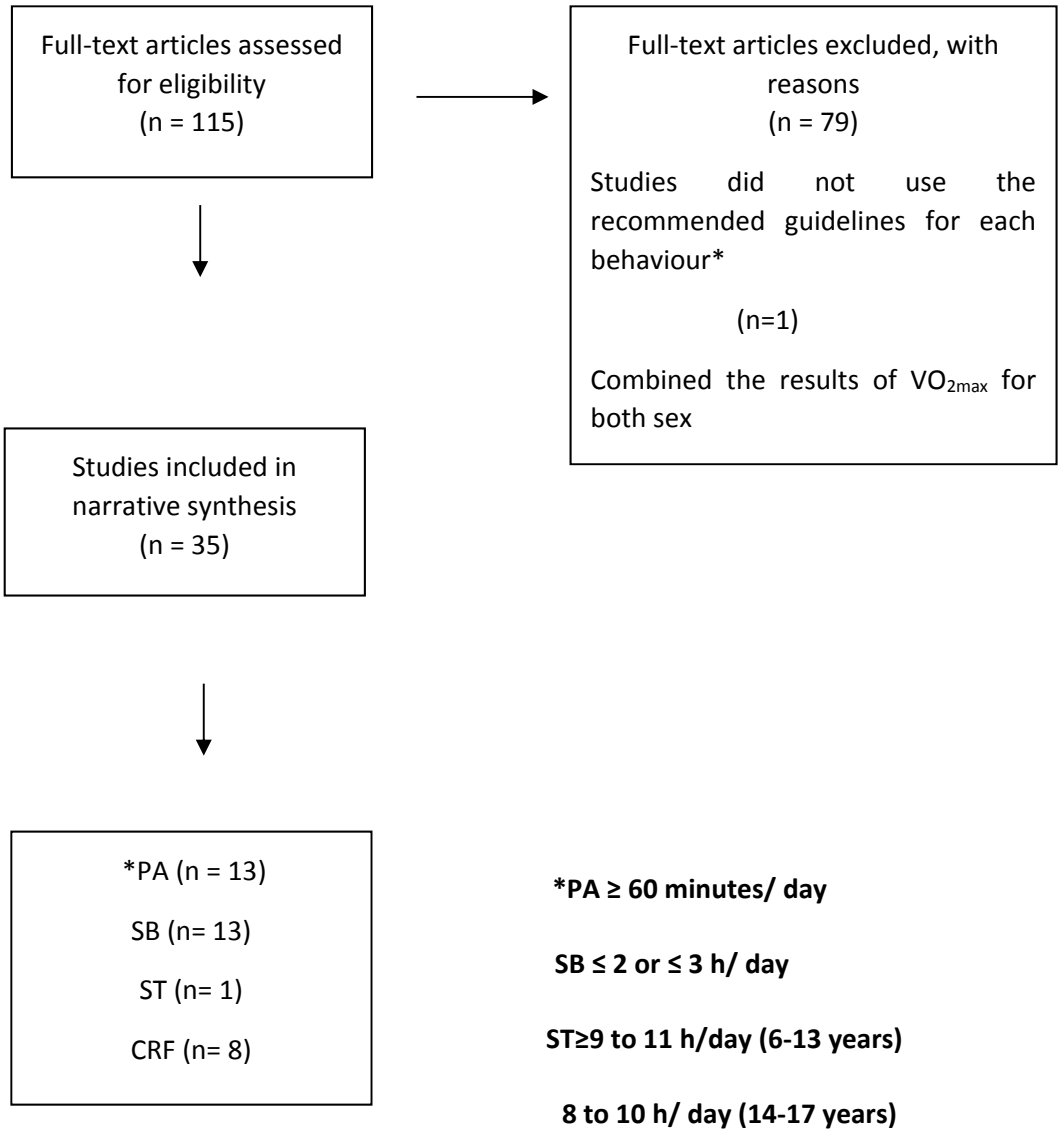


Figure 1. *Flow diagram of selected and extracted articles.*

Table 1: Physical activity prevalence and correlations with health outcomes

					PA			
Country	**Authors and year**	**Sample [%]**	**Design of Study**	**Age (years)**	**Instrument/ Method**	**PA%**	**Health outcomes %**	**Associations ***
Saudi Arabia	(Al-Hazzaa et al., 2011) [44]	Total= 2,908 M= 1401 [48%] F= 1507 [52%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 55.5 F; 21.9	BMI M; 24.6 ± 6.7 F; 2:3.6 ±6.1	PA and BMI M; -0.10 **(P < 0.001)** F; 0.02 (P > 0.05)
	(Al-Nuaim et al., 2012) [45]	Total= 1,270 M= 663 [52%] F= 607 [48%]	Cross sectional	15-19	Arab Teens Lifestyle Study (ATLS)	M; 44.5 F; 4	Obesity BMI M; 19.1 F; 17.7 WC M; 34.1 F; 62.5	NR
	(Al-Kutbe et al., 2017) [46]	Total= 78 F= [100%]	Cross sectional	8-11	WGT3X-BT Actigraph, Fort Walton, Florida	0	Obesity BMI 17.293	NR
	(Aljuhani and Sandercock, 2019) [47]	Total= 111 M= [100%]	Cross sectional	12–14	wGT3X-BT, ActiGraph LLC, Pensacola, FL	24	BMI 19.3 ± 3.3 BMI (z-score) 0.2 ±1.5	NR
	(Alqahtani et al., 2015) [48]	Total= 370 M= 196 [53%] F= 174 [47%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 29 F; 25	M; Normal: 55 M; Overweight: 17 M; Obese: 28 F; Normal: 55 F; Overweight: 27 F; Obese: 18	OR results are unclear
United Arab Emirates	(WHO, 2016) [49]	Total= 5,849* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student	M; 51.4 (47.3-55.6)	BMI M; 21.1 (18.7-23.7) F; 12.3 (10.8-14.1)	NR

					Health Survey (GSHS)	F; 67.6 (64.4-70.7)		
Bahrain	(WHO, 2016) [50]	Total = 7,141* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 26.0 (24.1-27.9) F; 12.6 (11.2-14.1)	Obesity M; 18.6 (16.5-20.9) F; 17.1 (15.9-18.4)	NR
Kuwait	(Hashem et al., 2018) [51]	Total= 351 M= 162 [46%] F= 189 [54%]	Cross sectional	14.6-17.6	Actigraph GT1M activity monitor (Actigraph, LLC, Pensacola, FL, USA)	M; 5.6 F; 1.6	NR	NR
	(WHO, 2015) [52]	Total= 3,637* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 18.1 (15.2-21.3) F; 13.1 (11.0-15.4)	Obesity M; 21.1 (18.7-23.7) F; 12.3 (10.8-14.1)	NR
	(Allafi et al., 2014) [53]	Total= 906 M= 463 [51%] F= 443 [49%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 70.5% F; 39.2%	Obesity M; 25.5% F; 21.3%	NR
Oman	(WHO, 2005) [54]	Total= 2,979* M= [NR] F= [NR]	Cross sectional	13-15	Global School-based Student Health Survey (GSHS)	M; 32.1 ± 3.6 F; 13.5 ± 2.5	NR	NR

	(WHO, 2015) [55]	Total= 3,468* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 15.4 (12.9-18.3) F; 8.3 (6.8-10.1)	Obesity M; 11.6 (9.9-13.7) F; 13.4 (11.7-15.3)	NR
	(Kilani et al., 2013) [56]	Total= 802 M= 360 [45%] F= 442 [55%]	Cross sectional	15–18	Arab Teens Lifestyle Study (ATLS)	M; 66.7 F; 23.1	Obesity M; 5 F; 9.2	NR
Qatar **Total (T) ,** **Range (R),** **or Average**	NA Total = 13	NA Total = 29,870	NA	NA Range= 8-19	NA	NA Average M; 28% F; 12%	NA	NA

*Associations represented as OR, *Sample was not separated by sex. P=P□value, NR=Not reported, NA=Not available, GSHS=Global School□based Student Health Survey, ATLS=Arab Teens Lifestyle Study, OR=Odds ratio, PA=Physical activity, BMI: Body mass index

Objective measurements

Three studies used an objective measure of PA [Table 1]. Two studies used the ActiGraph wGT3X□BT[46,47] and one study used ActiGraph GT1M.[51] All studies used the Evenson et al. cut□point for MVPA, which was validated on children from the United States of America aged 5–8 years old.[57] Participants aged from 8 to 17.6 years old. One study included both sexes,[51] one study included only females,[46] and one study included only males.[47] These studies revealed that the proportion meeting the PA guideline ranged from 7% to 24% for males, and from 0% to 2% for females.[46,47,51]

Relationship with cardiovascular disease risk factors

One study using the ATLS questionnaire[44] investigated the relationship between PA and body mass index (BMI) (kg · m2) and reported a negative association in males but this was positive in females [Table 1].

Sedentary behavior

Subjective measurements

Thirteen studies investigated SB by questionnaire. Participants were aged between 13 and 19 years old across both sexes [Table 2]. Four studies[44,48,53,56] used the ATLS questionnaire (cut□point for screen time of ≤2 h/d),[62] with 4%–55% and 3%– 45% of males and females respectively, meeting the guideline. The GSHS questionnaire (cut□point for screen time ≤3 h/d) was used in 9 studies, with 36%–67% of males and 30%–65% of females participants meeting the guideline.[49□53,58□61]

Objective measurements

No studies were identified that measured sedentary time using an objective method. Relationship with cardiovascular disease risk factors One study investigated SB with BMI (kg · m2),[44] reporting a non-significant and trivial correlations in male and female participants [Table 2].

Sleep time

Subjective measurement

One study used the ATLS questionnaire to determine ST on both sexes aged 15–18 years old.[56] This study found that 23% of the participants met the ST recommendation of ≥8 h/day [Table 3].

Objective measurement

No studies were identified that measured ST using an objective method.

Relationship with cardiovascular disease risk factors

No studies were identified that measured ST and its relationship to CVD risk factors.

Cardiorespiratory fitness

Field measurements

Five studies used field tests to estimate CRF in participants aged 9–17 years old [Table 4]. Three studies were male only,[47,68,69] and two included both both sexes.[66,67] Three studies used the 20 m shuttle run test, but with different protocols (Léger, PACER, The Queen's University of Belfast). These studies found that male and female participants had a mean predicted VO_{2peak} of 43 and 36 mL/kg/min,

respectively.[47,66,67] Two studies used the one‐mile walk/ run test (male only) and reported a mean performance time of 10 min.[68,69]

Laboratory measurements

Three studies used a direct measurement of CRF on male participants aged 7–18 years old during treadmill exercise [Table 4] and reported a mean VO_{2peak} of 41. 9 mL/kg/min.[64,65,70]

Relationship with cardiovascular disease risk factors

Three CRF field test studies investigated the relationship between CRF and BMI [Table 4]. Studies that used the 20 m shuttle run test to estimate VO_{2peak} in male and female participants found weak correlations with BMI (kg·m2) [66,67] [Table 4]. One study that used the one‐mile walk/run test and found a positive correlation (only male) between performance time and BMI (kg·m2).[69] Onelaboratory study examined directly measured CRF withseveral CVD risk factors,[71] and found a moderate correlation with BMI (kg·m2) and body fat %, and weak correlations with a range of blood lipid outcomes and blood pressure [Table 4].

DISCUSSION

This is the first narrative review to synthesize movement behaviors (PA, SB, and ST) and CRF in relation to CVD risk factors in children and adolescents from the GCC. Previous research has highlighted the importance of meeting the cut‐points for the movement behaviors and CRF to reduce CVD risk factors[11‐13,24,72] In addition, meeting all the three‐movement behaviors .combined has been found to be associated with more favourable health outcomes.[73] This review indicated that there are only 27 studies on movement behaviors (13 PA, 13 SB, and 1 ST) and eight for CRF on children and adolescents from the GCC. The proportion meeting the movement behavior guidelines were 28% (PA), 56% (SB), and 23% (ST) among GCC children. Participants mean VO_{2max} was 42 and 36 mL/kg/min for males and females, respectively, and the mean one‐mile walk/run test (male only) performance was 10 min. This review also revealed that few studies examined PA, SB, and CRF in relation to different CVD risk factors (mainly BMI), which overall found a weak relationship.[44,48,64,65,67,68,70]

Table 2: Sedentary behaviour (screen time) prevalence and correlations with health outcomes

					SB			
Country	**Authors**	**Sample [%]**	**Design of Study**	**Age (y)**	**Instrument/ Method**	**SB%**	**Health outcomes %**	**Associations ***
Saudi Arabia	(Al-Hazzaa et al., 2011) [44]	Total= 2,908 M= 1401 [48%] F= 1507 [52%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 16 F; 9	BMI (kg/m^2) M; 24.6 ± 6.7 F; 23.6 ±6.1	Obesity with SB M; 0.02 (P > 0.05) F; -0.03 (P > 0.05)
	(Alqahtani et al., 2015) [48]	Total= 370 M= 196 [53%] F= 174 [47%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 25 F; 22	M; Normal: 55 M; Overweight: 17 M; Obese: 28 F; Normal: 55 F; Overweight: 27 F; Obese: 18	Screen time (hours per day) and BMI M; Overweight: OR 2.58 (P 0.02) M; Obese: OR 9.63 (P <0.001) F; Overweight: OR 4.75 (P <0.01) F; Obese: OR 7.41 (P <0.001)
United Arab Emirates	(WHO, 2010) [58]	Total= 2,581* M= [NR] F= [NR]	Cross sectional	13-15	Global School-based Student Health Survey (GSHS)	M; 55 F; 45	Obesity M; 17.1 ± 1.6 F; 14.2 ± 1.2	NR
	(WHO, 2016) [49]	Total= 5,849* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 49 F; 32	Obesity M; 21.1 (18.7-23.7) F; 12.3 (10.8-14.1)	NR

Bahrain	(WHO, 2016) [50]	Total= 7,141* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 47 F; 30	Obesity M; 18.6 (16.5-20.9) F; 17.1 (15.9-18.4)	NR
Kuwait	(WHO, 2011) [59]	Total= 2,672* M= [NR] F= [NR]	Cross sectional	13-15	Global School-based Student Health Survey (GSHS)	M; 50 F; 42	Obesity M; 26.3 (20.4-33.2) F; 19.0 (15.8-22.8)	NR
	(WHO, 2015) [52]	Total= 3,637* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 36 F; 34	Obesity M; 21.1 (18.7-23.7) F; 12.3 (10.8-14.1)	NR
	(Allafi et al., 2014) [46]	Total= 906 M= 463 [51%] F= 443 [49%]	Cross sectional	14-19	Arab Teens Lifestyle Study (ATLS)	M; 4 F; 3	Obesity M; 25.5% F; 21.3%	NR
Oman	(WHO, 2005) [54]	Total= 2,979* M= [NR] F= [NR]	Cross sectional	13-15	Global School-based Student Health Survey (GSHS)	M; 67 F; 65	NR	NR
	(WHO, 2010) [60]	Total= 1,606* M= [NR] F= [NR]	Cross sectional	13-15	Global School-based Student Health Survey (GSHS)	M; 67 F; 68	NR	NR
	(WHO, 2015) [55]	Total= 3,468* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 59 F; 61	Obesity M; 11.6 (9.9-13.7) F; 13.4 (11.7-15.3)	NR

	(Kilani et al., 2013) [56]	Total= 802 M= 360 [45%] F= 442 [55%]	Cross sectional	15–18	Arab Teens Lifestyle Study (ATLS)	M; 55 F; 45	Obesity M; 5 F; 9.2	NR
Qatar	(WHO, 2011) [61]	Total= 2021* M= [NR] F= [NR]	Cross sectional	13-17	Global School-based Student Health Survey (GSHS)	M; 56 F; 45	M; 25.3 (20.5-30.8) F; 10.8 (8.0-14.3)	NR
Total (T) , Range (R), or Average	Total= 13	Total = 36,940		Range = 13 – 19		Average = M; 45% F; 39%		

*Associations represented as OR, *Sample was not separated by sex. P=P-value, GSHS=Global School-based Student Health Survey, ATLS=Arab Teens Lifestyle Study, OR=Odds ratio, PA=Physical activity, BMI: Body mass index, NR=Not reported, NA=Not available, SB=Sedentary behavior

Table 3: Sleep time prevalence and correlations with health outcomes

ST								
Country	**Authors**	**Sample**	**Design of Study**	**Age**	**Instrument/ Method**	**SL%**	**Health outcomes %**	**Associations ***
Oman	(Kilani et al., 2013) [56]	Total= 802 M= 306 [38%] F= 442 [62%]	Cross sectional	15–18	Arab Teens Lifestyle Study (ATLS)	23*	BMI obesity M; 5 F; 9.2	NR
Total (T) , Range (R), or Average	Total = 1	Total = 802		15–18				

*Associations represented as OR, *Sample was not separated by sex. ST=Sleep time, NR=Not reported, OR=Odds ratio, ATLS=Arab Teens Lifestyle Study, BMI: Body mass index

Table 4: Cardiorespiratory fitness prevalence and correlations with health outcomes

CRF						
Country	**Authors**	**Sample**	**Age**	**Instrument/ Method**	**VO_{2max} ($ml.kg^{-1}.min^{-1}$) or minutes Mean SD**	**Associations ***
Saudi Arabia	(Al-Hazzaa et al., 1994) [63]	Total= 212 M= [100%]	7-12	Graded Exercise Testing Ergospirometry on treadmill	M; 48.4 SD [NR]	VO_{2max} and body fat % -0.55 **After controlling for age, BMI and body fat %:** VO_{2max} and TC -0.17 (P > 0.05) VO_{2max} and TG -0.11 (P > 0.05) VO_{2max} and HDL 0.01 (P > 0.05) VO_{2max} and LDL -0.12 (P > 0.05) VO_{2max} and HDL L/C 0.11 (P > 0.05) VO_{2max} and SBP -0.01 (P > 0.05) VO2max and DBP -0.08 (P > 0.05)
	(Al-Hazzaa, 2001) [64]	Total= 137 M= [100%]	7-15	Graded Exercise Testing Ergospirometry on treadmill	M; 49.6 SD [NR]	VO_{2max} and BMI - 0.59 VO_{2max} and body fat % -0.65
	(Aljuhani and Sandercock, 2019) [47]	Total= 111 M= [100%]	12-14	20 meters shuttle run test (PACER)	M; 38.5 ±0.5	NR
Kuwait	(El-Wahab, 1982) [65]	Total = 7 M [100%]	10- 14	Graded Exercise Testing Ergospirometry on treadmill	M; 27.6 ± 5	NR
Oman	(Al Barwani et al., 2001) [66]	Total = 147 M= 64 [44%] F= 83 [56%]	15–16	20 meters shuttle run test (L´eger)	M; 44.0 ± 6.3 F; 36.5 ± 4.5	VO_{2max} and BMI (M) 0.10 VO_{2max} and BMI (F) 0.342
	(Albarwani et al., 2009) [67]	Total = 529 M= 245 [46%] F= 284 [54%]	15–16	20 meters shuttle run test (The Queen's University of Belfast protocol)	M; 46.25 ± 8.05 F; 35.8 ± 8.55	VO_{2max} and BMI (M) 0.1705 VO_{2max} and BMI (F) 0.1945
	(Al-Shamli, A., 2010) [68]	Total= 330 M= [100%]	16-17	one mile walk/run	M; 7.56 ±1.59	NR

	(Hassan and Al-Kharusy, 2000) [69]	Total=109 M= [100%]	9–11	one mile walk/run	M; 11.53 ± 4.3	Time and BMI 0.69
Total (T) , Range (R), or Average	Total = 8	Total = 1582 M= 1215 [77%] F= 367 [23%]	Range= 7-17		Average VO_{2max} (ml.kg-1.min-1)= M; 42 F; 36 Average 1 mile walk/run (minutes)= M 10	

*Associations represented as OR, *Sample was not separated by sex. CRF: Cardiorespiratory fitness, NR=Not reported, OR=Odds ratio, P=P□value, SD=Standard deviation, TC=Total cholesterol, TG=Triglyceride, SBP=Systolic blood pressure, DBP=Diastolic blood pressure, LDL=Low density lipoprotein, HDL=High density lipoprotein, BMI=Body mass index, VO_{2max} =Maximal oxygen uptake

Movement behaviors (PA, SB, and ST)

The literature has emphasized the health benefits associated with meeting different movement behaviors.[11–13] The proportion meeting the PA guideline in children from the GCC is low, and it indicates that males are more active than females, 28% and 12%, respectively, which is consistent with the literature across the world.[74] In addition, males (45%) adhere more to SB guidelines than females (39%). This might explain why PA prevalence in GCC children is low, especially in females, as SB displaced being physically active.[75] ST data for children from the GCC are limited to a single study, which revealed that only 23% of both sexes met the ST guideline.[56] Currently, it is recommended to simultaneously meet all the three-movement behaviors for optimal health,[42] which has yet to be investigated among children from the GCC. In a Canadian sample of 1,126 children aged 12–17 years old, only 5.5% met all the three recommendations, and that meeting none of the three recommendations was associated with 8/10 of unhealthy indicators.[76] In addition, recent evidence on 7,372 children aged 9–11 years old from 12 different countries, found that only 7% met all the movement behaviour recommendations, and was associated with a lower BMI z-score.[77] Thus, further research should aim to investigate these movement behaviors jointly in children from GCC, to provide a more comprehensive insight into their current health status. This review revealed that the majority of movement behavior studies (24 out of 27) were based on subjective measurements, which are prone to reporting bias and likely to lead to over or underreporting of movement behaviors.[78–80] Of note is that this review identified that the proportion of children meeting the PA guideline was over-reported when comparing the questionnaire (males 41% and females 23%) to the accelerometer (males 15% and females 1%). In addition, all studies were cross-sectional, which cannot infer causality with CVD risk factors. Further, no studies have investigated the three-movement behaviors integratedly in association with CVD risk factors, and only few studies (2 out of 27) have explored single-movement behaviors in relation to BMI,[44] which is a questionable measure of adiposity in children.[81] Thus, the association between PA, SB, and ST and CVD risk factors in children from the GCC is currently poorly understood.

Cardiorespiratory fitness

Although debate exists on CRF and its association with CVD risk factors due to the confounding impact of body size and adiposity,[82–84] it has been found that CRF tests can evaluate the function of cardiovascular system and predict CVD risk factors in children and adolescents.[21,85] A recent systematic review provided international CRF cut off points to help identify children and adolescents with elevated CVD risk.[24]This systematic review illustrated that the minimum average CRF level for males and females 8–17 years old is 42 and 35 mL/kg/min, respectively.[24] Data from the GCC studies indicate that the mean CRF for male and female participants was 42.4 ± 5.0, and 36.2 ± 6.5 mL/kg/min, respectively, which are slightly above the recommended cut off points. However, there is no information on the proportion of children from the GCC meeting the CRF cut-point and this needs to be addressed in future research.

In children from the GCC, there are few studies investigating the association between CRF and CVD risk factors. Only one study (1 out of 8) examined CRF in relation to multiple CVD risk factors and reported weak associations.[63] In addition, four studies examined the association of CRF with obesity which found weak correlations.[64,66,67,69] All CRF studies were a cross-sectional design, which cannot draw a conclusion about the direction of the causal relationship between CRF and CVD risks factors. Unfortunately, this narrative review found that the majority of CRF data were reported in male participants meaning potential sex differences are currently unknown.

Strengths and limitations of this review

The main strength of this review was including studies that are based on the recommended cut‐off for each movement behavior. In addition, this review only considered studies that used valid instruments or tests and recognized questionnaires. As with all studies, some limitations must be acknowledged. This review was limited to three databases, which might miss other studies in other databases engines. In addition, the search only included studies in English language, thereby excluding data in the Arabic language.

RECOMMENDATIONS AND SUMMARY

• Since all the three‐movement behaviors are considered as individual risk factors for CVD, and one behavior can potentially replace the other, it is proposed to measure all three behaviors at once for better interpretation of optimal health benefits[42]

• We propose the use of the international recognized recommended cut offs of the three‐movement behaviors (PA ≥60 min/day, SB (mostly screen time) ≤2 h/day, and ST for 6–13 years old 9 to11 h/d, and 14–18 years old 8–10 h/d[19,42,86,87]

• It is recommended to use the Canadian 24‐Hour Movement Guidelines for Children and Youth, which has cut‐off points for each behavior (PA, SB, and ST)[42]

• Future studies should consider using objective methodologies when assessing movement behaviors among GCC children

• When testing the 20 m shuttle run test, it is important to report the protocol and running speed (km/h) at the last completed stage[88]

• In CRF studies, broadening the range of participant characteristics of the GCC states should be encouraged

• It is important to establish prospective studies among GCC children, as all the current studies are cross‐sectional, which cannot infer casualty with CVD risk factors.

Based on cross-sectional studies on GCC countries, few children are meeting the different movement behaviour (PA, SB and ST) guidelines separately, and the mean CRF is only just above the recommended minima. Furthermore, very few studies have investigated these movement behaviors separately and CRF in relation to CVD risk factors in children from GCC. Therefore, future prospective studies in the GCC region on children are needed to understand the health effect on meeting the three‐movement behaviors interactively and CRF in relation to CVD risk factors.

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Conflicts of interest

There are no conflicts of interest.

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