Physical Activity Knowledge, Attitude and Behaviours among Adolescents in the Kingdom of Saudi Arabia prior to and during COVID-19 restrictions

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Abstract

Background: The prevalence of childhood and adolescent obesity has increased dramatically and poses a major public health threat globally. In Kingdom Saudi Arabia (KSA), the main cause of adolescent obesity is an increase in physical inactivity and unhealthy eating habits due to lifestyle changes. The aim of this study is to assess the factors associated with physical activity (PA) prior to and during COVID-19 among middle school students in Jeddah, KSA.

Method: We conducted a cross-sectional online survey among 1500 middle school students aged 11 to 15 years in Jeddah, KSA. Descriptive statistics were used to present data summaries. Continuous variables were presented as means with standard deviations or median with interquartile range and categorical variables as frequencies and percentages. We used Chi-square tests to compare knowledge, attitude and behaviours of PA before and during COVID-19 restrictions and to compare between both sexes. Univariate and multivariate logistic regression analyses were conducted to assess the determinants of PA.

Results: Data from 1500 (54% female) showed a significant difference in PA knowledge and behaviours by sex. Most students did not participate in the recommended levels of daily PA during COVID-19 lockdowns and school closures. After adjusting for demographic, knowledge and attitude, students who do not participate in school sports ($p=0.017$) and members of club members ($p=0.002$) were less likely to be active during COVID-19 lockdown.

Conclusions: Efforts to enhance PA should be implemented through coordinated school and community-based programs to achieve the recommended PA among adolescents at home and in schools.

Introduction

Physical inactivity represents the fourth highest cause of premature and preventable death globally [1]. The risk of all causes of mortality increases by 20–30% for inactive compared to active people [2]. Inactive people are at increased risk of non-communicable diseases (NCD) such as obesity [3], ischemic heart disease, diabetes [4], stroke [5] and numerous types of cancer [6].

Childhood and adolescent obesity is considered to be a major public health crisis globally. Globally the prevalence of overweight among adolescents increased from 4% in 1975 to more than 18% in 2016 [7]. In 2019, it was estimated around 38 million children under the age of five were overweight or obese, and half of these children lived in Asia [8]. Overweight and obese children are at least twice more likely to be obese at during adolescence and adulthood [9–11].

The fundamental cause of overweight and obesity among all age groups is the imbalance of calories consumed and expended. This is primarily associated with decreased physical activity (PA) and increased intake of energy dense foods [12]. A WHO led study among 1.6 million school-aged adolescents worldwide found more than 80% do not meet the minimum recommendation of PA and the percentage is higher among girls (85%) [13]. Physical inactivity is detrimental to adolescents' current and future health given the documented benefits of PA, which includes improved cardiorespiratory circulation, muscular fitness, and metabolic health [14]. In addition, PA has been found to have a positive impact on cognitive performance, academic attainment, and mental health outcomes among adolescents [15, 16].

Prior to the industrialisation of the Kingdom of Saudi Arabia (KSA) (approx. 30 years ago), people led a simple and active life with the physical challenges of daily life demanding an active lifestyle [17]. However, the KSA has undergone significant lifestyle changes, including an increase in sedentary behaviours and unhealthy eating habits that have coincided with increases in the prevalence of overweight and obesity. These lifestyle changes have been associated with significant increases in NCDs and associated complications [18, 19]. National estimates of combined overweight and obesity prevalence among 13–18-year-old Saudi students were 36.6% and 38.4% for males and females, respectively [17]. Over 84% of Saudi males and 91.2% of female adolescents reported more than the recommended screen time (ST) (>2 hours) daily, and almost 50% of males and 75% of females did not meet daily PA guidelines at least 60 minutes daily of moderate-to-vigorous intensity) [20]. Sedentary behaviour among adolescents as a result of increased ST was also associated with a negative impact on eating behaviours irrespective of PA levels [21].

A study among Saudi adolescents ($n = 2571$) found good knowledge and positive attitude towards PA and this was associated with increased PA levels [22]. Adolescents' negative attitude towards adopting regular PA has been recognised as a barrier to PA behaviour later in life [23]. In addition to behaviour-related barriers, other identified barriers include: environmental (expense and inaccessibility of structures activities); school-based (limited PA time allocated, lack of variety of PA choices and lack of teacher support); and policy (policy facilitating school-based PA) may influence PA among adolescents [24]. Cultural influences and beliefs in the Arabic-speaking region may also present a barrier to PA for females [25, 26].

The COVID-19 Coronavirus (SARS-CoV-2) pandemic and the associated shutdown of schools, organised activities and public sports facilities in most countries has further impacted PA behaviour [27]. This has resulted in significant changes in adolescent's daily habits and their opportunity to remain active [28]. Following the WHO declaration of COVID-19 as a pandemic on March 11, 2020, the Saudi Arabian government imposed a nationwide curfew to restrict movement for most of the daylight hours [29]. The Ministry of Health [30] outlined the following actions that were undertaken. In line with the WHO guidelines in dealing with the outbreak, Saudi Arabia also closed multiple facilities including schools, gyms, and other sports clubs, in an attempt to monitor the pandemic situation and contain the virus. Partial lockdowns were imposed between April 21st and May 11th and total lockdown from May 23rd to May 27th, 2020 which included the complete closure of all universities and educational institutions with a shift to online education. On May 28, the lockdown was partially lifted in all cities, the movement between regions was eased, and shopping malls were opened. The restrictions on domestic flights, restaurants and cafes, and parks were eased on May 31. The latest action was on June 21, where the partial lockdown was lifted on all regions. However, all levels of schools including higher education institutions continued online-based remote learning [30].

PA participation for adolescents offers benefits for physical and psychological well-being, particularly during the pandemic era [31]. At this critical stage of their development, it is important for them to achieve the recommended level of PA [32]. While WHO social distancing regulations were implemented to control

the spread of COVID-19, it is essential to recognise that these restrictions have impacted adolescent PA and general well-being [33]. This paper reports findings from a broader study to explore knowledge, attitude and behaviours around overweight and obesity among adolescent students in Jeddah, KSA [34]. This paper will present self-reported PA knowledge, attitudes and behaviours and explore the associations between PA behaviours, and demographics, knowledge and attitudes. Influences on PA for males and females were also compared.

Methods

Procedures

The study was approved by the Curtin University of Human Research Ethics Committee (HR2020-0337) and permission was granted by the KSA Ministry of Education. Participant information sheets were provided to principals, parents and students. Consent was obtained from the principals of each school involved, and individual consent and assent was attained from parents and students, respectively. An online survey link using Qualtrics was sent to students via their school email accounts, and data collection took place from October 20, 2020, until November 11, 2020 as students were using online distance learning platforms. No identifying data were collected from students.

To ensure the representativeness of the study population, the minimum sample size (n) required was estimated from the calculations below [35]:

$$n = \frac{Z_{1-\alpha/2}^2 - \alpha / 2P(q)}{d^2}$$

Where, $Z_{1-\alpha/2}$ = standard error when $\alpha = 0.05$ (95% Confidence Interval) = 1.96

$q = 1-P$

P = prevalence of the attribute = (23.1%)

d = Acceptable difference using 5% (0.05)

n = number of sample

Based on this formula, the minimum sample of intermediate school students aged 12-15 years after adjusting 10% non-response rate and taking into account the design effect (considered to be 2) [36] is approximately 1200 (600 males and 600 females).

Setting

The study was conducted in six government schools (three boys' and three girls' Intermediate Schools) in Jeddah City, KSA. The students involved were from grade seven to grade nine (12 to 15 years). At the time of data collection, due to COVID-19 restrictions, schools were conducting online learning, hence the surveys were administered online. Qualtrics, a secure web-based survey software, was used to conduct the survey. After consent for school participation was obtained, the schools emailed 3483 students. Of those students, 815 (23.3%) participants (or their parents) did not provide assent or consent to participate resulting in an initial response rate of 76.6%. Of the surveys received, 1500 were complete, while 1168 (33.5%) were extensively incomplete (more than 50% incomplete items within the survey form). Incomplete questionnaires were excluded during the data cleaning process.

Instruments

Sociodemographic characteristics, PA knowledge, attitudes and behaviours and information about the impact of COVID-19 on PA were collected. It was intended Body Mass Index (BMI) would be calculated by measuring students' height and weight [34]; however, this was not possible due to distancing restrictions. During the COVID pandemic, online surveys provide a useful platform to conduct research and ensured the implementation of this project was feasible [37].

Measures

Sociodemographic Characteristics

Sociodemographic characteristics included age, gender (male or female) and school level. Students were also asked about maternal and paternal education levels (primary, intermediate, high school, undergraduate and postgraduate).

Knowledge

Level of physical activity knowledge was assessed by five items which allowed "true", "false" and "I don't know" responses (score range 5 to 0; 5 highest). These items are listed in Table 1. The knowledge score was then collapsed to high (≥ 4) or low (≤ 3). These binary scores were calculated based on distributions relative to the median score of 4, similar to A Azrin Shah, N Aishath, H Al Oran, N Hani Farhana, M Azreena, M Fatima Dahiru, Y Saba Babeli, S Suwanmanee, I Hassan and K Alsharif Mohammed [38]. The reliability of knowledge items was at the lower border of acceptable level (Cronbach alpha =0.59).

Table 1
shows Sociodemographic Characteristics and Knowledge and Attitude towards Physical Activity by Sex

Variables	Levels	Frequency	Male n=688(45.6%)	Female n=822(54.4%)	p-value
Demographic info		<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
<i>Age</i>	11	35(2.3)	16(2.3)	19(2.3)	<0.001**
	12	250(16.6)	88(12.8)	162(19.7)	
	13	466(30.9)	222(32.3)	244(29.7)	
	14	658(43.6)	357(51.9)	301(36.6)	
	15	101(6.7)	5(0.7)	96(11.7)	
<i>Grade</i>	7	485(32.1)	173(25.1)	312(38.0)	<0.001**
	8	645(42.7)	363(52.8)	282(34.3)	
	9	380(25.2)	152(22.1)	228(27.7)	
<i>Maternal level of education</i>	< Primary	276(18.3)	133(19.3)	143(17.4)	0.470
	Intermediate	193(12.8)	92(13.4)	101(12.3)	
	High school	447(29.6)	195(28.3)	252(30.7)	
	Undergrad	513(34.0)	226(32.8)	287(34.9)	
	Postgraduate	81(5.4)	42(6.1)	39(4.70)	
<i>Paternal level of education</i>	< Primary	513(34.0)	102(14.8)	115(14.0)	0.034*
	Intermediate	81(5.4)	80(11.6)	83(10.1)	
	High school	444(29.4)	210(30.5)	234(28.5)	
	Undergrad	515(34.1)	207(30.1)	308(37.5)	
	Postgraduate	171(11.3)	89(12.9)	82(10.0)	
Knowledge items					
<i>Regular physical activity can help build strong bones and muscles.</i>	False/don't know	97(6.4)	44(6.4)	53(6.4)	0.967
	True	1413(93.6)	644(93.6)	769(93.6)	
<i>Regular physical activity can prevent obesity</i>	False/don't know	121(8.0)	59(8.6)	62(7.5)	0.462
	True	1389(92.0)	629(91.4)	760(92.5)	
<i>Regular physical activity leads to a lower risk of diseases.</i>	False/don't know	276(18.3)	134(19.50)	142(17.3)	0.270
	True	1234(81.7)	554(80.5)	680(82.7)	
<i>Physical activity can reduce stress</i>	False/don't know	374(24.8))	219(31.8)	155(18.9)	<0.001
	True	1136(75.2)	469(68.2)	667(81.1)	
<i>Sitting more than 2 hours is bad for bones and muscles.</i>	False/don't know	496(32.8)	252(36.6)	244(29.7)	0.004**
	True	1014(67.2)	436(63.4)	578(70.3)	
<i>Knowledge scores</i>	≤2	141(9.3)	82(11.9)	59(7.2)	<0.001**
	3	244(16.2)	131(19.0)	113(13.7)	
	4	391(25.9)	169(24.6)	222(27.0)	
	5	734(48.6)	306(44.5)	428(52.1)	
Attitude items					
<i>People who regularly participate in physical activity live longer than those who do not.</i>	Agree	990(65.6)	467(67.9)	523(63.6)	0.083
	Disagree	520(34.4)	221(32.1)	299(36.4)	
<i>Everyone should participate in physical activity</i>	Agree	1261(83.5)	583(84.7)	678(82.5)	0.239

Variables	Levels	Frequency	Male n=688(45.6%)	Female n=822(54.4%)	p-value
	Disagree	249(16.5)	105(15.3)	144(17.5)	
<i>I dislike participating in physical activity.</i>	Agree	457(30.3)	206(29.9)	251(30.5)	0.803
	Disagree	1053(69.7)	482(70.1)	571(69.5)	
<i>Girls should not participate in physical activity.</i>	Agree	377(25.0)	263(38.2)	114(13.9)	<0.001**
	Disagree	1133(75.0)	425(61.8)	708(86.1)	
<i>Regular participation in physical activity makes me healthy.</i>	Agree	1425(94.4)	645(93.8)	780(94.9)	0.338
	Disagree	85(5.6)	43(6.3)	42(5.1)	
<i>Physical activity can be used to manage the higher risk of some diseases such as heart disease, diabetes, and high blood pressure.</i>	Agree	1256(83.2)	562(81.7)	694 (84.4)	0.156
	Disagree	254(16.8)	126(18.3)	128(15.6)	
<i>When I participate in physical activity, I feel happy.</i>	Agree	1290(85.4)	572(83.1)	718(87.3)	0.021*
	Disagree	220(14.6)	116(16.9)	104(12.7)	
<i>Regular physical activity increase blood circulation</i>	Agree	1195(79.1)	528(76.7)	667(81.1)	0.036*
	Disagree	315(20.9)	160(23.3)	155(18.9)	

Attitude

Eight attitude items requiring a Likert scale response (5 items; strongly disagree to strongly agree), were included. These items are listed in Table 1. Total scores were computed, negative items were reverse coded (Score range: 40 – 8; 40 represents the most positive attitude). The Cronbach's alpha test for the total PA-related attitude questions was 0.73. As for other studies—discussing how categorising Likert scales provide equivalent estimate compared to their original form—this scale was dichotomised to agree or disagree [39, 40]. The PA attitude item responses were explored using three levels of scales: the original five Likert scale, the dichotomisation of the scale and the total continuous score derived from the Likert scale.

Behaviour of Physical Activity before and during COVID-19

As the survey was administered during a COVID-19 isolation period where students were online learning, students were asked to consider these questions ‘as they relate to your daily life when you were at school before the COVID-19 outbreak’. Students were asked a series of questions to determine their regular involvement in physical activity at school and outside school. Students were asked how they usually get to or from school. To measure physical activity opportunities at school, students were asked if their school has regular sports classes, if they participate in the classes and if so, for how often each week. Students were also asked if their school organised sports competitions in school and with other schools and if they participated in out of school recreational activities. Students were asked about the frequency and duration of participation, as well as the type of sport. These questions were adapted from the Australian National Nutrition and Physical Activity Survey [41].

Physical activity during the COVID-19 restrictions was assessed asking the number of days students participated in vigorous or moderate physical activity for at least 60 minutes during a week. This question has previously been validated in the Australian National Nutrition and Physical Activity Survey and provided examples of activities that are considered moderate to vigorous [41]. Similar to other studies [42, 43], binary variables were created to represent less active and more active students: <5 days per week (less active) and ≤ 5 days per week (more active). Other questions included comparative questions of PA, ST, social media use and sleep changes after COVID-19 restrictions began. Response options were “a lot less”, “a little less”, “same”, “a little more” and “a lot more”. An open-ended question regarding how the COVID-19 pandemic and related restrictions impacted their physical activity was included.

Statistical Analysis

Data were analysed using SPSS 25 (SPSS Inc., Chicago, IL, USA). All data were entered and checked through data exploration, out of range values were identified and corrected from the raw data. The outcome variables were examined using skewness and kurtosis scores to treat outliers, including distribution plots. Descriptive statistics were run for all independent and dependent variables and reported as mean, median, frequency and percentage. Correlation testing was employed for continuous scores. Chi-square tests were used to compare PA knowledge, attitude and behaviours of physical activity before and during COVID-19 restrictions. Comparisons between male and female students for all variables were also undertaken. Univariate and multivariate logistic regression analyses of students’ moderate to vigorous PA less than five days during COVID-19 was conducted and a crude odds ratio (COR) and adjusted OR (AOR) were determined. The significance level was set at $p=0.05$.

Results

Descriptive Results

Just over half the participants were female (54%, $n = 822$); the majority (75%, $n = 1124$) were aged 13 and 14 years; and 43%, 32% and 25% were in grade eight, seven and nine respectively (See Table 1). Thirty nine percent of mothers had completed tertiary level and 30% high school education, while 45% and 29% of fathers had completed tertiary or high school education, respectively.

Knowledge Items

The proportion of female students (81.1%, n=667) who correctly responded that PA reduces stress was higher than male participants (68.2%, n= 469) ($p < 0.001$). Similarly, 70% (n= 578) of female and 63% (n=436) of male students correctly identified the disadvantage of sitting more than two hours ($p= 0.004$). The median knowledge score was four (mean = 4.2) out of a possible score of five (interquartile range (IQR)=1.1). Around half of students (48.6%, n=734) answered all of the knowledge questions correctly with 25% (n=391) correctly answering four out of five. There was a significant difference ($p<0.001$) between gender with more females answering all of the questions correctly (52%, n= 428) compared to males (44.5%, n=306) (See Table 1).

Attitude Items

Under three quarters of students agreed that people who regularly participate in physical activity live longer (65.6%, n= 990) and that everyone should be physically active (83.5%, n=126). There were no significant differences between males and females for these questions. However, 38% (n=263) of male students agreed that girls should not participate in physical activity compared to around 14% (n=114) of girls ($p<0.001$). Females (87%, n=718) were more likely than males (83%, n=572) to feel happy when participating in physical activity ($p=0.021$). More female students (81%, n= 667) agreed ($p=0.036$) that regular physical activity increased blood circulation compared to males (77%, n=528). The total scores were calculated, and the minimum score recorded was ten and a maximum of 40 with a median of 34 (IQR=6) (See Table 1).

INSERT Table 1 ABOUT HERE

Pre-COVID-19 Physical Activity Behaviour

The most common way to get to school was via private vehicles (65%), followed by bus (17%) and walking (15%) (See Table 2). Among those who walked or rode a bike to and from school, 63% and 81%, respectively were male students ($p<0.001$). Only 65.5% of students (n=989) indicated that their school held regular sport classes; and of these 70.5% (n=697) of students reported that they participated. About half of the students reported that their school organised sports competitions at school (female = 31%, male= 69%) and only 31% (n=470) organised sports competitions with other schools (female = 30%, male= 69%, $p< 0.001$). Approximately 30% (n=456) of students (female= 21%, male= 79%) participate in after school sport ($p<0.001$). Of these 10.6% (n=160) students (female = 35%, male= 65%) participate daily and 19.7% (n=298) students (female = 54%, male= 46%) participate most days. Only around 17% (n=254) of students indicated they are members of organised sport clubs. Of these 70% were males and 30% females ($p<0.001$).

Table 2
Illustrates Physical Activity Behaviour among Students (pre COVID-19 restrictions)

<i>Items</i>		Total n(%)	Male n(%)	Female n(%)	p-value
How do you usually get to or from school?					
<i>Walk</i>	Yes	238(15.8)	150(63.0)	88(37.0)	<0.001**
<i>Ride skateboard/scooter/rollerblades</i>	Yes	17(1.1)	9(52.9)	8(47.1)	0.539
<i>Private vehicle (incl. taxi</i>	Yes	988(65.4)	400(40.5)	588(59.5)	<0.001**
<i>Ride bike</i>	Yes	36(2.4)	29(80.6)	7(19.4)	<0.001**
<i>Bus</i>	Yes	259(17.2)	92(35.5)	167(64.5)	<0.001**
<i>Does your school have regular sport</i>	Yes	989(65.5)	669(67.6)	320(32.4)	<0.001**
<i>classes?</i>	No	521(34.5)	19(3.6)	502(96.4)	
<i>If yes, do you participate?</i>	Yes	697(70.5)	481(69.0)	216(31.0)	0.014*
	No	53(5.4)	42(79.2)	11(20.8)	
	Sometimes	239(24.2))	146(61.1)	93(38.9)	
<i>How often each week?</i>	None	574(38.0)	61(10.6)	513(89.4)	<0.001**
	< 1 hour	282(18.7)	173(61.3)	109(38.7)	
	1 hour	343(22.7)	203(59.2)	140(40.8)	
	1-2 hours	159(10.5)	119(74.8)	40(25.2)	
	2-3 hours	65(4.3)	54(83.1)	11(16.9)	
	> 3 hours	87(5.8)	78(89.7)	9(10.3)	
<i>Does your school organise sports</i>	Yes	756(50.1)	522(69.0)	234(31.0)	<0.001**
<i>competitions at school?</i>	No	754(49.9)	166(22.0)	588(78.0)	
<i>Does your school organise sports</i>	Yes	470(31.1)	373(79.4)	97(20.6)	<0.001**
<i>competitions with other school?</i>	No	1040(68.9)	315(30.3)	725(69.7)	
<i>Do you participate in after school sport</i>	Yes	456(30.2)	297(65.1)	159(34.9)	<0.001**
	No	476(31.5)	188(39.5)	288(60.5)	
	Sometimes	578(38.3)	203(35.1)	375(64.9)	
<i>How often?</i>	Daily	160(10.6)	104(65.0)	56(35.0)	<0.001**
	Most days	298(19.7)	138(46.3)	160(53.7)	
	Some days	576(38.1)	258(44.8)	318(55.2)	
	none	476(31.5)	188(39.5)	288(60.5)	
<i>For how long?</i>	< hour	256(17.0)	91(35.5)	165(64.5)	<0.001**
	1 hour	383(25.4)	171(44.6)	212(55.4)	
	1-2 hour	279(18.5)	162(58.1)	117(41.9)	
	2-3 hour	68(4.5)	47(69.1)	21(30.9)	
	> 3 hours	48(3.2)	29(60.4)	19(39.6)	
	none	476(31.5)	188(39.5)	288(60.5)	
<i>Member</i>	Yes	254(16.8)	178(70.1)	76(29.9)	<0.001**
<i>of a sports club</i>	No	1256(83.2)	510(40.6)	746(59.4)	

INSERT Table 2 ABOUT HERE

Football was the most popular sport played by male students (81%, n=554/688) as a moderate to vigorous PA during a school week, followed by athletics (23%, n= 160/688) and swimming (17%) (See Figure 1). Athletics (50%, n= 484/822), football (33%, n= 270/822) and swimming (23%, n= 190/822) were the most popular moderate to vigorous PA during a school week among female students (See Figure 1b). Similarly, football (54%), athletics (43%) and swimming (20%) were the three most common sports all students participated in after school (extracurricular activity). Football, athletics, swimming and basketball were

the most common sports that that schools offer as part of intra-school and interschool competitions in both female and male schools. Overall, except for athletics, more males reported participating in each type of school and club activities compared to female students.

INSERT FIGURES 1A AND B ABOUT HERE

Perceived Physical Activity, ST and Sleep Time during COVID-19 restrictions

When asked about the impact of COVID-19 on their physical activity, 41% of students (n = 604) reported being a lot less active, and 18% (n = 267) a little less active during isolation (Table 3). In contrast, students reported the time they spent watching television, movies, spending leisure time with computers and playing games, increased a lot (26%; n = 382) or a little (28%; n = 412). About 22% (n=329) and 26% (n=380) of students spent a lot or a little more time on social media, respectively, during the COVID-19 isolation measures, while 28% reported time spent on social media did not change. Sleep patterns remained the same (38%; n= 554), a little more (21%; n=315), and a lot more (15%; n=217) compared to prior to COVID-19 restrictions. While some students reported participating in more physical activity (19.2%; n = 283), a further 21.6% (n = 318) indicated their level of activity did not change while 59% (n = 871) indicated they participated in less physical activity than before the isolation measures. Most responses to the open-ended question on the impact of COVID-19 isolation measures was around reduced level of PA due to closure of gymnastic clubs, school sport clubs, or fear of becoming infected with the virus if they go to public places. Increased ST was also mentioned as a reason for lower PA levels.

Table 3
showing Physical Activity, ST and Sleep Time during COVID-19 (row percentage)

COVID Items	A lot less	A little less	About the same	A little more	A lot more
<i>Have you participated in physical activities or sport?</i>					
<i>Male</i>	326(48.6)	114(17.0)	137(20.4)	53(7.9)	41(6.1)
<i>Female</i>	278(34.7)	153(19.1)	181(22.6)	111(13.9)	78(9.7)
<i>Have you watched TV, movies, used the computer for leisure, or plays video games?</i>					
<i>Male</i>	106(15.8)	73(10.9)	139(20.7)	178(26.5)	175(26.1)
<i>Female</i>	110(13.7)	71(8.9)	179(22.3)	234(29.2)	207(25.8)
<i>Have you used social media?</i>					
<i>Male</i>	108(16.1)	78(11.6)	193(28.8)	164(24.4)	128(19.1)
<i>Female</i>	85(10.6)	72(9.0)	227(28.3)	216(27.0)	201(25.1)
<i>How was your sleep?</i>					
<i>Male</i>	97(14.5)	94(14.0)	263(39.2)	141(21.0))	76(11.3)
<i>Female</i>	84(10.5)	111(13.9)	291(36.3)	174(21.7)	141(17.6)

INSERT Table 3 ABOUT HERE

Regular physical activity was low with 226 (20.3%) students participating in at least 60 minutes of moderate or vigorous PA for at least 5 days of the week. About 24% of students reported they never participated in any vigorous or moderate PA and 25% reported participating in PA on one day per week (See Table 4).

Table 4
showing the Distribution of Moderate to Vigorous Physical Activity during COVID-19 restriction

	level	Frequency n(%)	Male n(%)	Female n(%)	Chi-square p-value
<i>Vigorous or moderate physical activity for at least 60 minutes/week</i> <i>Missing 46(3%)</i>	None	352(24.0)	140(39.8)	212(60.2)	0.107
	1	363(24.8)	171(47.1)	192(52.9)	
	2	259(17.7)	117(45.2)	142(54.8)	
	3	182(12.4)	81(44.5)	101(55.5)	
	4	82(5.6)	36(43.9)	46(56.1)	
	5	75(5.1)	38(50.7)	37(49.3)	
	6	28(1.9)	14(50.0)	14(50.0)	
	7	123(8.4)	69(56.1)	54(43.9)	
	≥5 days/week	226(20.3)	121(53.5)	105(46.5)	
	<5 days/week	886(79.7)	405(45.7)	481(54.3)	

INSERT Table 4 ABOUT HERE

Comparison of Least and More Active Students

Table 5 presents the association between participants' sociodemographic characteristics knowledge and attitude of PA with frequency of moderate to vigorous PA per week. Male participants (53.5%, n= 121) were more likely to participate in regular (≥5 hours weekly) moderate to vigorous PA compared to female students (46.5%; n=105; p=0.035). Among students who scored above the median (>4 out of 5 total score) knowledge score, 70.4% (n=159) were more active (participated in ≥5 hours weekly of moderate to vigorous PA) compared to 77.5% (n= 687) of students reporting lower levels of PA (p=0.024). Interestingly, there was a significant difference (p = 0.004) between students reporting high levels and those reporting lower levels of PA with regard to attitudes towards use of PA to manage the higher risk of some diseases (such as heart disease, diabetes and high blood pressure) with students reporting lower PA levels more likely to agree with the statement (85.4%, n = 757 vs 77.4%, n = 51) (no included in the Table 5). There were no other significant associations observed between students who participate in high levels of regular activity and those reporting lower levels with regard to other attitude items and other demographic characteristics.

Table 5
Comparing Least Active Students versus More Active Students

Variables	Moderate to vigorous exercise (≥60m min.)		Chi-square (<i>p</i> -value)	Adjusted Odds Ratio (aOR) (confidential interval (CI))	<i>p</i> -value
	≥5 days/week	<5 days/week			
	N=226(20.3%)	N= 886(79.7%)			
Age					
11-12	34(15.0)	179(20.2)	0.212	1.69(0.97-2.94)	0.065
13	70(31.0)	260(29.3)		1.09(0.73-1.62)	0.688
14-15	122(54.0)	447(50.5)		1	
Gender					
Male	121(53.5)	405(45.7)	0.035	1	
Female	105(46.5)	481(54.3)		1.00(0.68-1.47)	0.987
Grade					
7	74(32.7)	289(32.6)	0.918	0.77(0.45-1.30)	0.324
8	94(41.6)	380(42.9)		1.13(0.75-1.70)	0.562
9	58(25.7)	217(24.5)			
Maternal level of education					
< Primary	45(19.9)	165(18.6)	0.589	1.42(0.69-2.95)	0.344
Intermediate	28(12.4)	116(13.1)		1.56(0.74-3.29)	0.243
High school	62(27.4)	251(28.3)		1.39(0.72-2.70)	0.327
Undergrad	72(31.9)	304(34.3)		1.45(0.76-2.76)	0.258
Post-graduate	19(8.4)	50(5.6)		1	
Paternal level of education					
< Primary	36(15.9)	121(13.7)	0.637	0.93(0.49-1.78)	0.833
Intermediate	25(11.1)	89(10.0)		0.94(0.49-1.81)	0.850
High school	62(27.4)	255(28.8)		1.08(0.63-1.85)	0.784
Undergrad	71(31.4)	315(35.6)		1.15(0.69-1.92)	0.596
Post-graduate	32(14.2)	106(12.0)		1	
Knowledge score					
Above median	159(70.4)	687(77.5)	0.014	1.21(1.04-1.40)	0.020*
Below median	67(29.6)	199(22.5)			
Participation in school sport					
All the time	131(58.0)	430(48.5)	0.040	1	
Sometimes	29(12.8)	134(15.1)		1.11(0.73-1.68)	0.626
No	66(29.2)	322(36.3)		1.15(0.72-1.86)	0.559
Participation in after school sport					
All the time	103(45.6)	270(30.5)	<0.001	1	
Sometimes	75(33.2)	369(41.6)		1.60 (1.05-2.45)	0.029*
No	48(21.2)	247(27.9)		1.59 (1.09-2.31)	0.017*
Member of sport club					
Yes	70(31.0)	144(16.3)	<0.001	1	
No	156(69.0)	742(83.7)		1.78(1.23-2.57)	0.002*
# Total continuous scores of Knowledge and Attitude used to fit in the model					
* Statistically significant difference detected (<i>P</i> <0.05)					

A multivariable logistic regression model was employed, adjusted for all demographic, attitude score, knowledge score and PA behaviour variables, to identify the predictors of less active students (<5 days/week moderate to vigorous PA) (See Table 3). As the total knowledge score increases by one unit, the odds of students being less active increases (aOR=1.14 (95%CI:1.04-1.40), $p=0.014$). Students who do not participate in afterschool sport were 1.6 times more likely to be less active (i.e. report less than five hours per week moderate to vigorous exercise) compared to those who participate. Moreover, students who are not members of sport clubs were less active compared to students with sport club membership (aOR=1.78 (95%CI: 1.23-2.57), $p=0.002$). Other demographic and attitude variables were not significantly identified as predictors of daily moderate to vigorous physical activity.

INSERT Table 5 ABOUT HERE

Discussion

This study stratified the sociodemographic characteristics, PA knowledge, attitude and behaviour by gender. Both male and female students included in this study had similar distribution of age, and level of education of children and parents. Findings revealed students had high knowledge scores of the health benefits of physical activity with female students reporting higher scores overall than males. Similarly, a cross-sectional study in Iran among middle-school students (N=1741) reported higher mean score of PA knowledge among female compared to male students (8.2 ± 2.05 vs. 7.8 ± 1.97 , $P < 0.001$) [44]. There was gender-based disparity identified in this study with females reporting significantly lower levels of PA compared to males. When asked if girls should participate in PA the majority of females (86.1%) agreed compared to only 61.8% of boys. Interestingly, males and female.

Generally, the majority of adolescents do not fulfil the WHO recommended amount of daily PA [14]. This study revealed that most students did not participate in the recommended levels of daily PA, with females reporting even lower rates than males. While these data were collected during COVID-19 restrictions, students were also asked to reflect on usual activity during a usual face-to-face school week. These data also found females to be less likely to be involved in in-school, interschool and out of school PA. It is well known that adolescent females in KSA have limited opportunities for involvement in sport and recreational activities due to cultural and gender norms. The cultural context in KSA may discourage females from becoming physically active [45, 46]. In addition, over 80% of students in this study reported they usually travelled to and from school via cars and/or bus, reducing incidental PA opportunities. Although the overall levels were lower, more males walked or rode their bike to and from school compared to female students. However, Saudi Arabia's hot dry year-round climate, with temperatures often rising above 50°C (122°F) during the hot season, likely discourages students from walking, cycling or using scooters in an effort to avoid exposure to sunlight and heat stroke [47]. Similarly, a previous study in Saudi Arabia found only 44% of males and 20% of female adolescents to be adequately active [48].

Approximately 60% of adolescents in this study reported they did 'less' or a 'lot less' PA level than usual during the COVID-19 restrictions. Other studies among adolescents have also found that PA levels have significantly decreased and compliance with the recommended daily levels of ST have decreased due to COVID-19 restrictions [49, 50]. Adolescents and children are more likely to adhere to healthy behaviours during structured days such as school days compared to unstructured days such as weekends or holidays [51]. COVID-19 restrictions have meant multiple structured organisations, clubs, gyms, and schools have been closed, reinforcing the pandemic of physical inactivity and sedentary lifestyles among children and adolescents by missing opportunities for regular PA [52].

Sociodemographic characteristics such as age and gender play an important role in shaping attitudes and behaviours towards PA and ST [48, 53] as well as their propensity to show changes during this pandemic [54]. In this study, females were more likely to report lower levels of PA both prior to and during COVID-19 compared to males. Students who were not participating in after school sports and those who were not members of sport clubs before COVID-19 were more likely to be less active during COVID-19. Regardless of the students' knowledge, attitude, and PA behaviour prior to COVID-19 restrictions, social isolation and imposed rules to stay at home for a prolonged period have negatively impacted PA levels and sedentariness. Under normal circumstance, PA has numerous physical fitness benefits, in addition to increasing positive mood, promoting self-esteem and reducing stress, anxiety and depression [54, 55].

A strength of this study was the 77% response rate which is considered an excellent rate for an online survey [56]. Despite its novel contributions, this study has some limitations. First, in the cross-sectional design, the temporal link between outcome and exposure cannot be established or imply causation as both are examined simultaneously. The study also used self-report PA behaviours and asked students their perception on how COVID-19 impacted their PA level, which may be subject to social desirability or recall bias. Thirdly, we originally intended measuring BMI [34], which would have enabled analysis between activity levels and body size, however this was not possible due to online schooling during the data collection period.

Conclusion

This study found while most students have good knowledge of the importance of PA, and their attitudes towards PA were positive, the majority of students did not meet recommended levels of PA. When PA opportunities were considered prior to COVID-19 restrictions, participation levels remained low, especially for females. Knowledge of the health benefits of PA is desirable and should be maintained, developed and improved by well-organised school health education and health promotion programs. More efforts to enhance attitudes towards PA and to provide opportunities for regular structured PA, especially for females should be encouraged [57]. Coordinated school and community based programs are recommended to achieve these recommendations. School-based and governmental policy to provide guidelines for regular PA opportunities are recommended. Further, given the likelihood of ongoing restrictions associated with COVID-19 schools, community groups and families should encourage adolescents to remain physically active through the use of virtual community classes, creating challenges with family members, and introducing PA during online school-based classes.

Abbreviations

KSA

Kingdom Saudi Arabia
PA
Physical Activity
NCD
Non-Communicable Diseases
WHO
World Health Organization
ST
Screen Time
BMI
Body Mass Index
SPSS
Statistical Package for the Social Sciences
COR
Crude Odds Ratio
AOR
Adjusted Odds Ratio
IQR
Interquartile Range

Declarations

Ethics approval and consent to participate

Ethics approval has been obtained from Curtin University (HRE2020-0337), and from the KSA Ministry of Education (4181827686).

Availability of data and material

The data that support the findings of this study are available on request from the corresponding author, [NA]. The data are not publicly available due to information that could compromise the privacy of research participants.

Conflict of interests

No potential conflict of interest was reported by the authors.

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Authors' contributions

All authors contributed significantly to the conceptualisation, design and drafting of this Study. NA, compiled the data and performed the analysis which was developed with guidance and support from SB and LP. NS wrote and drafted the paper which was critically reviewed and edited by SB and LP. All authors approved the final version of the manuscript.

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Figures

A. Male

B. Female

Figure 1

(A & B) illustrates sports played by students categorized by gender (A. Male, B. Female)