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Association between fitness tracker use, physical activity, and general health of adolescents in Eastern Province of Saudi Arabia

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Abstract:

BACKGROUND: Physical inactivity is a major problem of adolescents worldwide. Fitness trackers are widely used technologies that assess physical activity and allow self-monitoring of daily activities. Thirty-five percent of the Saudi population is made up of adolescents, which makes them an important target population. Few studies have evaluated the association of fitness trackers with physical activity levels of adolescents. This study aimed to evaluate physical activity among adolescents and its relationship to their use of fitness trackers and overall health.

MATERIALS AND METHODS: A cross-sectional study was carried out among adolescents in middle and high schools in the Eastern Province. Data was collected using a structured questionnaire and physical activity was assessed using International Physical Activity Questionnaire for Adolescents. Chi-square test and ANOVA were performed to test for statistical significance. Unadjusted and adjusted odds ratios (ORs) were obtained through ordered logistic regression models. Model diagnostics were run as *post hoc* analyses.

RESULTS: Majority of participants (82.6%) had low physical activity levels, 12.2% had moderate and 5.2% had vigorous activity level. The model revealed that as participants' ages increased, the odds of having higher levels of physical activity decreased (OR = 0.92; 95% confidence interval [CI]: 0.85–0.99). Moreover, participants who did not go to a gym regularly or own a fitness tracker were less likely to have higher physical activity levels (OR = 0.43; 95% CI:0.30–0.61, and OR = 0.44; 95% CI: 0.33–0.59, respectively). Motivation for using fitness trackers was mostly "no specific reason" for females. However, "luxury and esthetics" were mostly reported by males.

CONCLUSION: Physical activity tends to be higher in younger adolescents who use fitness trackers, or go to the gym regularly, with no significant difference between males and females. However, the motivation behind adolescents' use of fitness trackers varied by gender.

Keywords:

Adolescents, fitness tracker, physical activity

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Introduction

Physical inactivity is a major global health problem whose prevalence significantly affects the most common chronic illnesses.[1] The World Health Organization has identified the lack of physical activity as the fourth leading cause of all deaths globally.[2]

In the last 10 years, smartphones and wearable technologies that have gained widespread popularity offer metrics of one's own self-monitored health, such as the number of steps taken, heart rate, distance

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traveled, and amount of energy expended. Being a feasible intervention and an area of interest for users, such technologies can be effective tools for promoting physical activity and thereby improve the individual's overall health.[3]

In 2019, wearable trackers became the number one trend of all other fitness-enhancing methods such as personal trainers and group exercises.[4] In a cross-sectional study of 1604 mobile phone users in the US, it was discovered that 58.2% of mobile phone users had health-related applications, with fitness and nutrition-related apps being the most popular. The likelihood of these applications being used was found to be 11% higher in the obese compared to people with normal body mass index (BMI).[5] The usage of fitness trackers was not just for weight loss but also for individualized programs for maintenance of health. However, for another group, the use of the apps was for amusement.[6]

There are two major types of fitness tracker technologies: accelerometers and pedometers.[6] Pedometers are used as simple counters of daily steps while accelerometers are more advanced in detecting amplitude movements and differences in the velocity and strength of the activity.[7] A systematic review that assessed the impact of accelerometers concluded that they had a positive effect on the physical activity of adults aged 18 years and above.[7] Similarly, a meta-analysis of the effect of pedometers revealed that they increased physical activity of different age groups (7 to >60 years), and this was greater in females.[8]

A systematic review of seven studies was unable to make a clear recommendation because of the small sample size, use of studies with lower levels of evidence, and participants' poor compliance with fitness trackers as the only tool for evaluating physical activity.[9] However, according to a pilot randomized controlled trial conducted of adolescents visiting a weight loss clinic, fitness trackers have influenced sustained levels of physical activity of compliant participants, as opposed to the decline in physical activity levels of the noncompliant participants.[10]

The use of fitness trackers and physical activity by adolescents is positively correlated, according to other studies.[11] A systematic review of the age group (5–19 years) showed that the use of fitness trackers has increased the number of steps taken, improved moderate-to-vigorous activity, and motivation for physical activity.[12]

From our knowledge, there is not much research that examines the impact of these technologies on adolescents, and there is much less research on this issue with regard to Arabs, especially Saudi populations.

A 2016 Saudi census of the population revealed that 30.5% of all Saudi households are made up of individuals aged between 10 and 20 years.[13] Our study's target age group was adolescents because they form the majority of the Saudi population. Our aim was to evaluate adolescents' (aged 11–19 years) level of physical activity and its relationship to their use of fitness trackers and overall health.

Materials and Methods

This cross-sectional study was conducted between April 2021 and May 2022. Ethical approval was obtained from the Institutional Review Board (IRB) Vide Letter No. IRB-PGS-2021-01-115 dated 22/03/2021, and informed written consent was taken from all participants and their parents in the study.

The study targeted adolescents of both genders aged between 11 and 19 years in the middle and high grades of governmental and private schools in all ten Eastern Province governorates.

Convenience sampling was used. The minimum necessary sample size was calculated as 584 by using Epi Info software (version 3.4.3) (CDC, Atlanta, GA, USA). Researchers employed a fitness tracker study prevalence of 58.2% in the software setting, with a confidence interval (CI) of 95% and a margin of error of 4%.[14]

The first phase of data collection was done via the Ministry of Education. After obtaining their approval, a questionnaire was distributed online through the education administrative offices.

The second phase of data collection was conducted by a group of data collectors who, with the approval of the Ministry of Education, directly approached the administration of selected schools to gain access to the adolescents and their families.

The first section of the questionnaire asked about the participants' demographics, general health status, use of fitness tracker apps, and an open-ended question about the purpose of use, which was categorized during analysis. General health was assessed using BMI, smoking status, chronic diseases, and the use of medication. Chronic diseases included any disease for which the participant needed to take regular treatment. Medication use included any medication taken regularly.

Physical activity levels were assessed by using the International Physical Activity Questionnaire for Adolescents (IPAQ-A). The IPAQ is a validated assessment tool designed to measure multiple aspects of physical activity in people between the ages of 18

and 65 years. The IPAQ-A is a modified version of IPAQ, which measures physical activity in adolescents. It has been validated in European[15] as well as in Arab populations[16] (Arabic translation Cronbach's alpha: 0.73). IPAQ-A was obtained in English. Different translators translated IPAQ-A from English to Arabic and back-translated to English before its fluency was assessed by the research team. Two experts revised the tool. Prior to conducting the full study, a pilot study was conducted on twenty adolescents.

IPAQ-A covers four key areas of physical exercise encountered by teenagers. It involves physical activities in school, participation in household chores, and transportation-related and recreational activities. In each of the four aspects, the subject is asked to indicate how many days per week and how much time is spent walking each day, or engaged in a moderate or intense activity.

By following the IPAQ manual,[17] data obtained through a questionnaire were converted into metabolic equivalent events (METs), i.e., the metabolic cost of physical activity. It was determined through previous studies on physical activity that the cost of intensive physical effort was 8 METs/min, while the cost for moderate activities was 4 METs, and 3.3 METs for light activities.[17] The minutes each participant spent engaged in each distinct type of activity was multiplied by these costs. Minutes in excess of 180 at any physical activity level were truncated to avoid exaggerations according to the tool's protocol.

Weekly physical activity was obtained through the summation METs for light, moderate, and vigorous activities, and through the original IPAQ protocol and a Polish study that had specifically investigated physical activity in adolescents, three levels of physical activity were obtained: low physical activity when the total METs were <600 min/week, moderate when METs were between 600 and 1500 METs min/week, and vigorous when the total METs exceeded 1500 min/week.[16,18]

The analysis was done using STATA software version 15. (TX StataCrop LLC.2019. california, USA) Descriptive statistics were reported as means and standard deviations (SDs) for continuous variables and frequencies and percentages for categorical variables. Tests of associations were done through Chi-squared tests and ANOVA where appropriate. ANOVA was used to compare means across multiple categories. Unadjusted and adjusted odds ratios (ORs) were obtained through ordered logistic regression models. Model diagnostics were run as *post hoc* analyses.

Table 1: Characteristics of adolescents in Eastern Province, Saudi Arabia, 2021–2022 (*n*=1684)

Characteristics	*N* (%)
Age, mean±SD	15.60±1.66
Sex	
Males	609 (36.2)
Females	1075 (63.8)
Educational level	
Intermediate level	485 (28.8)
Secondary level	1199 (71.2)
School system	
Governmental	1112 (66.0)
Private	499 (29.6)
International	73 (4.3)
Father's occupation	
Administrative	633 (37.6)
Healthcare provider	107 (6.4)
Military	147 (8.7)
Self-employed	340 (20.2)
Retired	368 (21.9)
Unemployed	89 (5.3)
Mother's occupation	
Administrative	314 (18.7)
Healthcare provider	69 (4.1)
Military	3 (0.2)
Self-employed	114 (6.8)
Retired	93 (5.5)
Unemployed	1091 (64.8)

SD=Standard deviation

Results

The IPAQ-A questionnaire was completed by 1684 students, 485 (28.8%) of whom were in the intermediate and 1199 (71.2%) in the secondary levels of education. The mean age of participants (±SD) was 15.60 years (1.66). A total of 1075 (63.8%) and 609 (36.2%) participants were females and males, respectively [Table 1].

A total of 808 (45%) participants reported their BMI in the normal weight range, 498 (29.6%) were underweight, and 378 (22.5%) were overweight or obese. A total of 968 (57.5%) owned a fitness watch or app, and 203 (12.1%) participants went to the gym regularly. Of the participants, 82.6% had low physical activity levels, 12.2% had moderate levels, and for 5.2%, the levels were vigorous [Table 2].

According to the IPAQ-A instrument used in the current study, the proportion of the participants with different levels of physical activity varied significantly according to their school system ($P = 0.03$). More participants in the private schools (7.4%) and international (5.5%) schools showed vigorous activity level than participants in the governmental schools (4.1%). The mean age (±SD) of participants in three levels of physical activities was

Table 2: Health and fitness characteristics of adolescents in Eastern Province, Saudi Arabia, 2021–2022 (*n*=1684)

Characteristics	*N* (%)
BMI	
Underweight (<18.5 kg/m^2)	498 (29.6)
Normal weight (18.5–24.9 kg/m^2)	808 (48.0)
Overweight or obesity (>25 kg/m^2)	378 (22.5)
Chronic conditions	
No	1571 (93.3)
Yes	113 (6.7)
Medication use	
No	1606 (95.4)
Yes	78 (4.6)
Smoking status	
No	1638 (97.3)
Yes	46 (2.7)
Own a fitness watch or app	
No	716 (42.5)
Yes	968 (57.5)
Go to a gym regularly	
No	1481 (88.0)
Yes	203 (12.1)
Physical activity level	
Low	1391 (82.6)
Moderate	206 (12.2)
Vigorous	87 (5.2)

BMI=Body mass index

15.63 (1.65) for low, 15.45 (1.70) for moderate, and 15.48 (1.77) for vigorous levels. This association was statistically insignificant (P = 0.25). Males reported higher vigorous physical activity than females (6.1% and 4.7%), but again, this association was insignificant statistically (P = 0.44). Similarly, the level of physical activity was not associated with participants' education level (P = 0.16), their father's occupation (P = 0.07), or their mother's occupation [P = 0.75, Table 3].

There were no significant differences according to their BMI (P = 0.91), history of chronic conditions (P = 0.57), the medication used (P = 0.77), or smoking status (P = 0.44). However, moderate and vigorous levels of physical activity were found to be less by participants who did not own a fitness watch or app than their counterparts (12.2% vs. 15% and 5.2% vs. 07.2%) (P < 0.001). Similarly, a highly statistically significant association was shown between physical activity levels and regular attendance at the gym (P < 0.001). Participants who did not go to the gym regularly had lower, moderate, and vigorous physical activity levels than those who went regularly (11.3% vs. 19.2%, and 4.3% vs. 11.8%) [Table 4].

After adjusted analysis for possible confounders, it was found that participants who did not own a fitness watch or app had lower odds of having higher levels of physical activity (OR = 0.44; 95% CI: 0.33–0.59) which was statistically significant. Moreover, increasing age of participants and those who did not go to a gym regularly had lower odds of having higher levels of physical activity (OR = 0.43; 95% CI: 0.30–0.61 and OR = 0.92; 95% CI: 0.85–0.99, respectively), which were statistically significant. The association between participants' physical activity levels and their sex and the school system was statistically insignificant after adjusted analysis. However, it was noted that males had lower odds of higher physical activity than females (OR = 0.79; 95% CI: 0.53–1.18). Furthermore, participants in the international (OR = 1.25; 95% CI: 0.66–2.37) and private (OR = 1.17; 95% CI: 0.78–1.75) schools had a higher level of physical activity than those from the governmental schools [Table 5].

With regard to the motivation for using the apps and watches, "no specific reason" was mostly reported by females, followed by those who were "adopting a healthier lifestyle" and "influenced by others." On the other hand, "luxury and esthetics'" followed by "entertainment and functionality" and "influenced by others" were mostly reported by males for using these watches or apps [Figure 1].

Discussion

The aim of the current study was to assess the level of physical activity and its association with the use of fitness trackers by adolescents of Eastern Province, Saudi Arabia. A significant result from the study showed that most school students had low physical activity levels (82.6%), followed by moderate (12.2%) and vigorous (5.2%) levels. This finding is a reflection of the widespread phenomenon of adolescent inactivity, which is supported by a global cross-sectional study[19] conducted in 2016 on 1.6 million school-aged populations in 146 countries using 298 surveys based on the WHO's recommendation that adolescents need at least 60 min of daily moderate-to-vigorous activity.[20] A study by Guthold *et al*.,[19] resulted in 81% of adolescents being labeled as inactive. A different study that assessed the physical activity of adolescents by accelerometers provided a similar percentage (84% and 75%) of physical inactivity of girls and boys, respectively.[21] The percentage of physical inactivity was high as well (87.1% for girls and 56.5% for boys) according to research conducted as a part of the Arab Teens Lifestyle Study in 2011, which found females to be less active than males although our current study showed no statistical difference in the activity levels of the two genders.[22] On a national level, a study conducted in Al-Qassam in 2021 revealed 82% of insufficient physical activity in adolescents.[23]

The high prevalence of physical inactivity of adolescents in Saudi Arabia can be attributed to two issues. The first

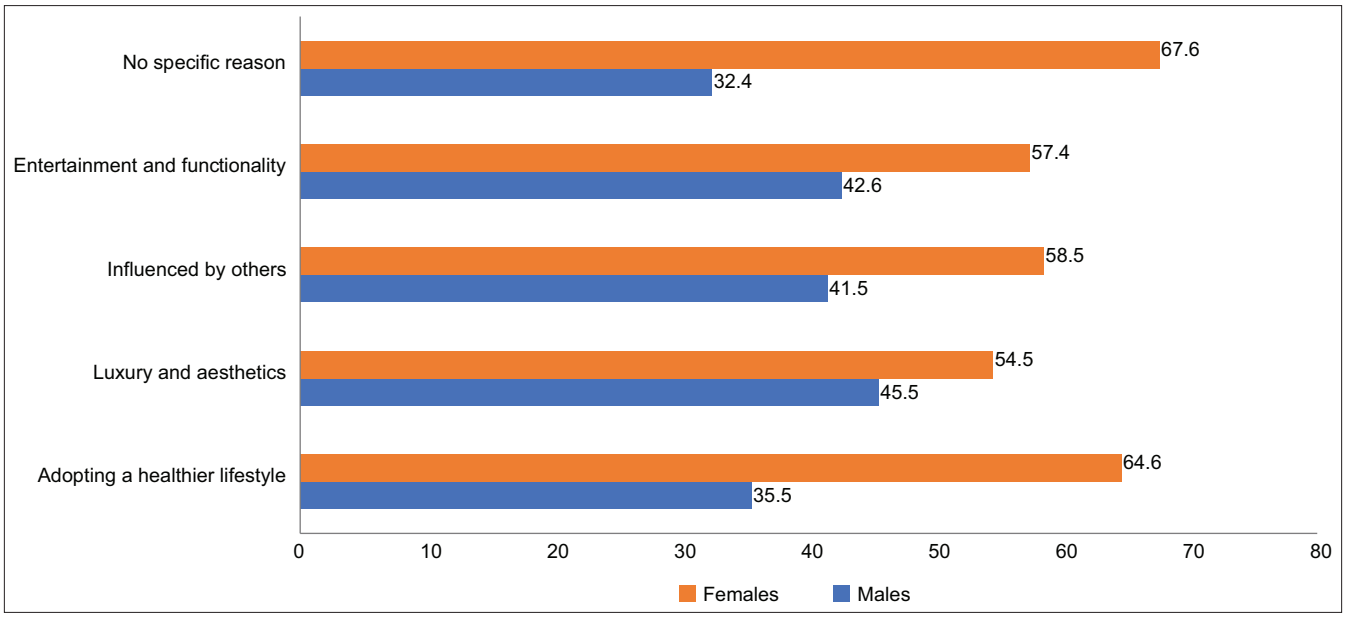

Figure 1: Motivations for using fitness watches and apps by gender among Saudi adolescents in Eastern Province, Saudi Arabia (2021-2022)*. *Reported by percentage

Table 3: Association between sociodemographic characteristics and physical activity among Saudi adolescents in Eastern Province, Saudi Arabia (2021-2022)

Characteristics	Physical activity level			*P-value*
	Low *N* (%)	Moderate *N* (%)	Vigorous *N* (%)	
Age, mean±SD	15.63±1.65	15.45±1.7	15.48±1.8	0.25
Sex				
Males	499 (81.9)	73 (12.0)	37 (6.1)	0.44
Females	892 (83.0)	133 (12.4)	50 (4.7)	
Educational level				
Intermediate level	388 (80.0)	66 (13.6)	31 (6.4)	0.16
Secondary level	1003 (83.7)	140 (11.7)	56 (4.7)	
School system				
Governmental	927 (83.4)	139 (12.5)	46 (4.1)	0.03
Private	408 (81.8)	54 (10.8)	37 (7.4)	
International	56 (76.7)	13 (17.8)	4 (5.5)	
Father's occupation				
Administrative	508 (80.3)	86 (13.6)	39 (6.2)	0.07
Healthcare provider	88 (82.2)	17 (15.9)	2 (1.9)	
Military	127 (86.4)	16 (10.9)	4 (2.7)	
Self-employed	284 (83.5)	40 (11.8)	16 (4.7)	
Retired	302 (82.1)	45 (12.2)	21 (5.7)	
Unemployed	82 (92.1)	2 (2.3)	5 (5.6)	
Mother's occupation				
Administrative	249 (79.3)	47 (15.0)	18 (5.7)	0.75
Healthcare provider	59 (85.5)	6 (8.7)	4 (5.8)	
Military	2 (66.7)	1 (33.3)	0	
Self-employed	97 (85.1)	13 (11.4)	4 (3.2)	
Retired	80 (86.0)	8 (8.6)	5 (5.1)	
Unemployed	904 (82.9)	131 (12.0)	56 (5.1)	

SD: Standard deviation

is the psychological and social health of adolescents, which affects their decision-making on their preferred pastimes. More than 80% of the youth reported screen time of more than 2 h/day.[23] High screen time has been connected to less physical activity.

The second issue is environmental and cultural. Although the nation's way of life is constantly evolving, certain changes have not yet taken root. For instance, physical education lessons were added formally to the curriculum for girls in public schools in 2017–18. In addition, many Saudis do not walk but depend on automobiles for transportation.[23]

Moreover, as has been reported in multiple other studies,[22,23] this study showed a decrease in physical activity proportionate to increasing age of adolescents. Although the lack of motivation for physical activity has not been investigated, it may be related to the fact that older adolescents give priority to their academic work rather than focus on physical activity.[23]

In the present study, the prevalence of the use of fitness trackers is 57.5%. This value is close to the 61.6% reported by Kwok Ng in his cross-sectional study of Finnish adolescents published in 2020.

However, its prevalence in Irish adolescents was nearly half of that of the Finland value (36.2%). We found higher levels of physical activity in adolescents who owned fitness trackers than in those who did not. Kwok Ng's research, which indicated that adolescents aged 11–15 years who used fitness trackers engaged in higher amounts of physical activity, also validated this finding.[11]

This finding is also supported by a systematic review conducted in 2019 on 33 studies of children

and adolescents aged 5–19 years. It concluded that wearable fitness trackers could increase physical activity levels (moderate-to-vigorous physical activity and step count) and reduce inactive lifestyles.[12] In a 2021 randomized controlled study, Australian adolescents (13 and older) were subjected to the Raising Awareness of Physical Activity model, which called for the use of a fitness tracker and a 12-week intervention period. Within the first 12 weeks of the intervention, no increase in physical activity was seen in the intervention group nor the control group of males or females. Although the cause of this finding was not entirely clear, it was probably because of the adolescents' feelings of disappointment after failing to meet the daily goals set by the fitness tracker throughout the intervention period. In addition, it was found that direct face-to-face motivation was more successful than technological assistance and incentive. Moreover, it was suggested that conducting the study in regions of low socioeconomic status could have played a role in this finding, as adolescents in these areas had more issues with using fitness trackers.[24]

Table 4: Association between physical activity levels and health and fitness characteristics gender among Saudi adolescents in Eastern Province, Saudi Arabia (2021-2022)

Characteristics	Physical activity level			*P-value*
	Low *N* (%)	Moderate *N* (%)	Vigorous *N* (%)	
BMI				
Underweight	418 (83.9)	56 (11.2)	24 (4.3)	0.91
Normal weight	662 (81.9)	102 (12.6)	44 (5.5)	
Overweight	311 (82.3)	48 (12.7)	19 (5.0)	
Chronic conditions				
No	1298 (82.6)	194 (12.4)	79 (5.0)	0.57
Yes	93 (82.6)	12 (10.6)	8 (7.1)	
Medication use				
No	1326 (82.6)	198 (12.3)	82 (5.1)	0.77
Yes	65 (83.3)	8 (10.3)	5 (6.4)	
Smoking status				
No	1353 (82.6)	202 (12.3)	83 (5.1)	0.44
Yes	38 (82.6)	4 (8.7)	4 (8.7)	
Own a fitness watch or app				
No	638 (89.1)	61 (12.2)	17 (5.2)	<0.001
Yes	753 (77.8)	145 (15.0)	70 (7.2)	
Go to a gym regularly				
No	1251 (84.5)	167 (11.3)	63 (4.3)	<0.001
Yes	140 (69.0)	39 (19.2)	24 (11.8)	

BMI=Body mass index

Fitness trackers give users the ability to track and compare their daily physical activity accomplishments and progress by setting daily activity goals.[11] Because of these statistics, it is our belief that fitness trackers are positively connected with higher levels of exercise. In addition, it was discovered that it was less likely for people who did not regularly go to a gym to engage in more physical exercise. The effectiveness of the use of fitness trackers by adolescents who were physically active before they used the tracker is inconclusive, according to research that does not accord with this. Four studies that addressed this topic included in the systematic review discovered a link between the use of wearables and the physical activity of adolescents who were not physically active while three other studies came to the conclusion that the activity levels of those who were already physically active before using fitness trackers were not enhanced.[12] According to another study, the use of fitness trackers increased physical activity in adolescents who were already physically active rather than in those who were not.[25] Future research may address this issue, which was not in the scope of the current study.

Table 5: Correlates of physical activity level among Saudi adolescents in Eastern Province, Saudi Arabia (2021-2022)

Factors	Univariate analysis Crude OR (95% CI for OR)	Multivariate analysis AOR (95% CI for AOR)
Age	0.94 (0.87–1.01)	0.92 (0.85–0.99)
Sex		
Males	1.08 (0.83–1.41)	0.79 (0.53–1.18)
Females	Reference	Reference
School system		
Governmental	Reference	Reference
Private	1.15 (0.87–1.52)	1.17 (0.78–1.75)
International	1.50 (0.85–2.62)	1.25 (0.66–2.37)
Go to a gym regularly		
No	0.39 (0.28–0.55)	0.43 (0.30–0.61)
Yes	Reference	Reference
Own a fitness watch or app		
No	0.42 (0.31–0.55)	0.44 (0.33–0.59)
Yes	Reference	Reference

OR=Odds ratio, CI=Confidence interval, AOR=Adjusted OR

An open-ended question gave us insight into adolescents' motivations for using fitness trackers. Females were more committed to adopting a healthier lifestyle (64.5%) and males were more inclined to luxury and aesthetics (45.5%) and entertainment and functionality (42.6%). The reasons for this were found in a study of adults which categorized motivations into three stages: the early-stage motivation focuses on the originality of the technology and interests behind it, and could last up to 3 months or until the curiosity has worn off. Other motivations are either personal (i.e., staying active), social (i.e., competition with others), or entertainment (i.e., gaming and goal setting).[26] Another factor is the attraction to this new technology because of its possible use as personal adornment, especially by younger generations.[11]

The rising rate of physical inactivity necessitates the creation of multi-level authority initiatives to encourage the younger generation to lead healthy lifestyles. Adolescent groups in Saudi Arabia particularly are understudied; therefore, comprehensive national studies are few. More research to get representative statistics for Saudi Arabia's youthful population is therefore necessary.

Conclusion

The conclusion drawn from this study is that there tends to be more physical activity by younger adolescents who use fitness trackers (either wearables or smartphone applications). There was no significant difference between males and females in previous associations. Fitness trackers can be a viable method for increasing physical activity in teenagers in Saudi Arabia.

The strength of the current study came from our knowledge of the lack of evaluation of this subject in the literature. However, the cross-sectional design is a limitation, and the causality of the observed associations could not be assured. The self-reported data could also have affected the accuracy of some variables, such as BMI.

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Conflicts of interest
There are no conflicts of interest.

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