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Smartwatch adoption and physical activity levels in Saudi Arabia: implications for digital health interventions

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ABSTRACT

Background: Wearable devices such as smartwatches are increasingly used for self-monitoring of physical activity; however, evidence regarding their association with physical activity levels in Middle Eastern settings remains limited. This study examined the relationship between smartwatch use and physical activity among adults in Saudi Arabia, using the World Health Organization Global Physical Activity Questionnaire.

Methods: A cross-sectional online survey was conducted between August 2024 and February 2025 among Saudi adults aged ≥18 years (n = 1,082), recruited through social media platforms. Data collected included sociodemographic characteristics, smartwatch ownership and usage patterns, and physical activity quantified as metabolic equivalent task minutes per week (MET-minute/week). Multivariable linear regression models were used to identify factors independently associated with physical activity level.

Results: The mean participant age was 27 ± 11 years, and 51% were female. Overall, 56% reported smartwatch use, with Apple Watch being the most commonly reported device (40.8%). Smartwatch users had higher physical activity levels compared with non-users (5,284 ± 7,821 *vs.* 4,098 ± 6,987 MET-minute/week; p = 0.014) and were more likely to meet WHO physical activity recommendations (71.5% *vs.* 63.3%; p = 0.008). Activity tracking was the most frequently reported smartwatch function (47%) and was associated with higher activity levels. In multivariable analyses, male sex (β = 2,563.65; p < 0.001), employment status (β = 1,663.97; p = 0.044), and smartwatch use for general health monitoring (β = 1,439.03; p = 0.037) were independently associated with higher physical activity.

Conclusion: Smartwatch use was associated with higher physical activity in this convenience sample of Saudi adults; the findings may not be generalizable to older, rural, or less technology-engaged populations.

Keywords: Smartwatches, wearable devices, physical activity, global physical activity questionnaire (GPAQ), metabolic equivalent task (MET), health monitoring, Saudi Arabia, cross-sectional study.

Introduction

Physical inactivity remains a major public health issue and an independent risk factor for cardiovascular disease, diabetes, obesity, and premature death [1,2]. The World Health Organization recommends at least 150 minutes of moderate or 75 minutes of vigorous aerobic physical activity per week for adults, yet adherence remains low globally [3]. Physical inactivity is particularly prevalent in Saudi Arabia, where over 70% of adults fail to meet these recommendations [4].

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The emergence of wearable technology, particularly smartwatches, has provided new avenues for encouraging physical activity through real-time monitoring, goal setting, and behavioral feedback [5,6]. Previous studies have shown promising yet inconclusive results, with many reporting increased moderate-to-vigorous activity and daily steps among users [7,8]. A systematic review by Cadmus-Bertram et al. [9] found that body-worn activity monitors produced significant increases in physical activity, with small to moderate effect sizes. However, most studies have been conducted in Western populations, with limited data from Middle Eastern nations where determinants of technology adoption and physical activity may differ considerably.

The association between smartwatch use and physical activity may be complex because smartwatches offer features beyond fitness tracking, including communication, entertainment, and health monitoring. Different usage patterns and primary device functions may have distinct impacts on physical activity behavior. Understanding these associations is essential to maximize the health benefits of wearable technology and develop evidence-based recommendations.

Saudi Arabia offers a distinctive context to explore this association, with high technology adoption rates, a large youth population, and strong public health initiatives to enhance physical activity as part of Vision 2030 [10]. The Kingdom's drive for modernization and digitalization provides a conducive environment to explore the role of emerging technologies, such as smartwatches, in addressing physical inactivity.

This study investigated the prevalence of smartwatch usage and its association with physical activity levels among Saudi adults using the validated WHO Global Physical Activity Questionnaire (GPAQ). We hypothesized that smartwatch users would demonstrate higher physical activity levels than non-users and that certain usage purposes, particularly activity tracking, would be associated with greater physical activity outcomes.

Methods

Study design and sample size

This cross-sectional study employed a non-probability convenience sampling design to recruit adults living in Saudi Arabia aged 18 years and older. Participants younger than 18 years or those without informed consent were excluded. The minimum sample size was determined using the standard formula:

$$n_0 = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

where n_0 is the desired sample size, Z is the Z-score for the required confidence level, p is the population proportion of the characteristic to be estimated, and e is the desired margin of error. Parameters were set as follows: $Z = 1.96$ (95% confidence level), $p = 0.50$ (maximum variability), and $e = 4\%$, yielding a minimum sample size of 600. However, data were collected from 1,082 participants to enhance statistical power and representativeness.

Data collection tool

The data collection tool was developed using an evidence-based approach to ensure capture of key variables [11,12]. Lay respondents and subject matter experts reviewed the draft questionnaire for clarity, consistency, and appropriateness, and a pilot study with 20 participants was conducted to assess feasibility and ease of completion.

The final questionnaire comprised three sections. The first section collected sociodemographic information, including age, sex, nationality, weight, height, region, residence, marital status, occupation, monthly income, smoking status, and chronic disease history. The second section assessed smartwatch use, including possession, type of smartwatch, type of smartphone, and primary reasons for use, such as health monitoring or activity tracking.

Physical activity was measured using the Arabic version of the World Health Organization GPAQ [13,14]. This standardized 16-item tool assesses physical activity across work, transport, and leisure domains, as well as sedentary time. It computes total activity in metabolic equivalent task units (MET-minutes/week) to classify participants into low, moderate, or high activity levels.

Data collection process

An online self-administered survey was conducted between August 2024 and February 2025. The survey link was distributed via Facebook, Instagram, Telegram, Snapchat, X, and WhatsApp [15]. Incomplete responses were excluded, and the dataset was regularly monitored to detect and remove errors.

Statistical analysis

After data collection, responses were cleaned and screened in Microsoft Excel. Statistical analysis was conducted using R (version 4.2.3; R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics, including means, standard deviations, frequencies, and percentages, were computed to summarize key variables. Comparisons between smartwatch users and non-users were performed using independent *t*-tests for continuous data and chi-square tests for categorical data. Multiple linear regression was used to identify predictors of physical activity (MET-minutes/week), adjusting for relevant demographic, health, and technology-related variables. Model assumptions were verified, and all tests were two-tailed with $\alpha = 0.05$ and 95% confidence intervals where appropriate.

Ethical approval

This research was approved by the Jazan University Standing Committee for Scientific Research (Reference No. REC-46/02/1165, 01/09/2024). All procedures were aligned with institutional and national research committee guidelines and the Declaration of Helsinki [16]. Informed consent was obtained from all participants.

Results

Sociodemographic characteristics

The sample consisted of 1,082 participants with a mean age of 27 ± 11 years. Participants were nearly equally distributed between females (51%, *n* = 548) and males (49%, *n* = 534), and most were Saudis (96%, *n* = 1,042). Geographically, most participants were from the southern (40%, *n* = 437) and western (33%, *n* = 361) regions. The majority were unmarried (76%, *n* = 820), resided in urban areas (77%, *n* = 837), and had a diploma or bachelor's degree (72%, *n* = 778). Regarding employment, 64% (*n* = 695) were students, 25% (*n* = 267) were employed, and 11% (*n* = 120) were unemployed. Monthly income varied, with 30% (*n* = 317) earning above 15,000 riyals. Sociodemographic characteristics are presented in Table 1.

Health characteristics

The mean body mass index (BMI) was 24 ± 6 kg/m². Among chronic diseases, asthma (9%, *n* = 93), hypercholesterolemia (8%, *n* = 86), diabetes mellitus (6%, *n* = 63), and hypertension (5%, *n* = 55) were the most prevalent. Regarding self-reported physical activity, 41% (*n* = 443) reported moderate or vigorous activity for ≥30 minutes on 5 days per week, 22% (*n* = 238) reported <30 minutes on 5 days per week, and 37% (*n* = 401) reported no physical activity. Most participants were never smokers (81%, *n* = 874), while 12% (*n* = 134) were current smokers and 7% (*n* = 74) were ex-smokers. Detailed health characteristics are shown in Table 2.

Smartwatch usage and related characteristics

The majority of participants (56%, *n* = 610) used a smartwatch, while 44% (*n* = 472) did not. Apple Watch was the most used smartwatch (40.8%, *n* = 441), followed by Linux/Android-based smartwatches (15.6%, *n* = 169). Most participants used iPhones (84%, *n* = 910), followed by Android phones (12%, *n* = 128) and Huawei / Honor phones (4%, *n* = 44). Among smartwatch users, activity tracking was the primary purpose for 47% (*n* = 287/610). When multiple functions were reported, physical activity monitoring was the most utilized feature (45%, *n* = 485). Detailed smartwatch usage patterns are presented in Table 3.

Physical activity levels based on WHO questionnaire

The mean MET score was 4,759 ± 7,494 MET-minutes/week, and participants reported a mean of 5.8 ± 3.1 hours/day of sedentary behavior. When categorized according to WHO guidelines, 68% (*n* = 735) met recommended physical activity levels, while 32% (*n* = 347) were classified as inactive. Physical activity data are presented in Table 4.

Table 1. *Sociodemographic characteristics of study participants (n = 1,082).*

Characteristics	Mean ± SD/Frequency (%)
Age	27 ± 11 years
Sex	
Female	548 (51%)
Male	534 (49%)
Nationality	
Saudi	1,042 (96%)
Non-Saudi	40 (4%)
Region	
Central Region	151 (14%)
Eastern Region	73 (7%)
Northern Region	60 (6%)
Southern Region	437 (40%)
Western Region	361 (33%)
Marital status	
Single	820 (76%)
Married	247 (23%)
Divorced/Widowed	15 (1%)
Residence	
Rural	245 (23%)
Urban	837 (77%)
Education	
High School Degree or Lower	258 (24%)
Bachelor/Diploma degree	778 (72%)
Postgraduate Studies	46 (4%)
Employment	
Employed	267 (25%)
Student	695 (64%)
Unemployed	120 (11%)
Income	
Less than 5,000 Riyals	313 (29%)
Between 5,000-9,999 Riyals	265 (24%)
Between 10,000-14,999 Riyals	187 (17%)
More than 15,000 Riyals	317 (30%)

Abbreviations: SD: Standard deviation, *n*: Sample size.

Comparison between smartwatch users and non-users

Smartwatch users (*n* = 610, 56%) differed notably from non-users (*n* = 472, 44%) across a range of demographic and health-related factors. Users were significantly younger than non-users (25.8 ± 9.4 *vs.* 28.6 ± 12.1 years, *p* = 0.001). Importantly, smartwatch users had significantly higher physical activity levels. Mean MET scores were significantly higher among users (5,284 ± 7,821 compared to 4,098 ± 6,987 MET-minutes/week, *p* = 0.014). Smartwatch users also spent significantly less time on sedentary behavior (5.6 ± 3.0 compared to 6.1 ± 3.2 hours/day, *p* = 0.023). When physical activity categories were compared, smartwatch users were more likely to meet WHO physical activity guidelines, with 71.5% being active compared to 63.3% of non-users (*p* = 0.008). Complete comparison results are presented in Table 5.

Table 2. *Health-related characteristics of the study participants (n = 1,082).*

Characteristics	Mean ± SD/Frequency (%)
BMI	24 ± 6 kg/m²
DM	
No	1,019 (94%)
Yes	63 (6%)
HTN	
No	1,027 (95%)
Yes	55 (5%)
Hypercholesterolemia	
No	996 (92%)
Yes	86 (8%)
Asthma	
No	989 (91%)
Yes	93 (9%)
Weekly physical activity	
Moderate or vigorous activity for ≥30 minutes, 5 days/week	443 (41%)
Moderate or vigorous activity for <30 minutes, 5 days/week	238 (22%)
No physical activity during the week	401 (37%)
Smoking status	
Never	874 (81%)
Current smoker	134 (12%)
Ex-smoker	74 (7%)

Abbreviations: SD: Standard deviation, *n*: Sample size, DM: Diabetes Mellitus, HTN: Hypertension.

Table 3. *Smartwatch usage and related characteristics among participants (n = 1,082).*

Characteristics	Frequency (%)
Smartwatch usage	
Yes	610 (56%)
No	472 (44%)
Smartwatch type	
Apple Watch	441 (40.8%)
Linux/Android-based smartwatch	169 (15.6%)
Not using a smartwatch	472 (43.6%)
Phone type	
iPhone (Apple)	910 (84%)
Android phone	128 (12%)
Honor/Huawei	44 (4%)
Primary purpose of smartwatch use	
Tracking physical activities	287 (27%)
Monitoring general health	96 (9%)
Receiving notifications, alerts, and payments	96 (9%)
Controlling the smartphone	94 (8.5%)
Tracking sleep quality	37 (3%)
Not using a smartwatch	472 (43.5%)
Other purposes of smartwatch use (multiple options)	
Tracking physical activities	485 (45%)
Controlling the smartphone	436 (40%)
Receiving notifications, alerts, and payments	432 (40%)
Monitoring general health	339 (37%)
Tracking sleep quality	319 (29%)

Abbreviations: *n*: Sample size.

Physical activity by smartwatch function

Analysis of physical activity levels by primary smartwatch function revealed significant variation across user groups ($F = 4.23$, $p < 0.001$). Participants who primarily used smartwatches for activity tracking had the highest mean MET scores (6,124 ± 8,456 MET-minutes/week). The difference between activity tracking users and smartphone control users was particularly notable, with activity trackers achieving over 2,000 more MET minutes per week. Results are presented in Table 6.

Predictors of physical activity levels

Multiple linear regression analysis identified several significant predictors of MET scores. Male sex was the strongest predictor (β = 2,563.65, 95% CI: 1,657.80-3,469.51, $p < 0.001$), with males accumulating approximately 2,564 more MET-min/week than females after adjustment. Among smartwatch-specific variables, using smartwatches for general health monitoring was independently associated with higher physical activity (β = 1,439.03; 95% CI: 84.50-2,793.57; $p = 0.037$). Employment status also demonstrated an independent association, with employed individuals having significantly higher MET scores than unemployed participants (β = 1,663.97; 95% CI: 41.43-3,286.52; $p = 0.044$). Income levels between 5,000 and 9,999 SR (β = −1,776.95, $p = 0.010$) and 10,000-14,999 SR (β = −1,228.44, $p = 0.047$) were inversely associated with MET scores relative to the lowest income category. Complete regression results are presented in Table 7 and Figure 1.

Table 4. *WHO physical activity questionnaire scores among study participants (n = 1,082).*

Characteristics	Mean ± SD/Frequency (%)
MET score	4,759 ± 7,494
Inactivity time (hours/day)	5.8 ± 3.1
Physical activity categorization	
Active	735 (68%)
Inactive	347 (32%)

Abbreviations: SD: Standard deviation, *n*: Sample size, MET: Metabolic Equivalent of Task.

Discussion

This large cross-sectional study presents new evidence regarding the association between smartwatch adoption and physical activity levels among Saudi adults. Our findings demonstrate that smartwatch use is associated with significantly higher physical activity levels compared to non-use, particularly for certain device functions, such as activity tracking and health monitoring.

Smartwatch adoption and physical activity benefits

The 56% smartwatch ownership rate in our sample reflects the rapid adoption of wearables in Saudi Arabia, consistent with high technology penetration and ongoing digital transformation efforts across the country [10]. Smartwatch users had significantly higher physical activity levels, with a mean difference of 1,186 MET-minutes per week compared to non-users. This difference suggests clinically meaningful benefits of smartwatch utilization [17]. The magnitude of the difference is consistent with evidence from other studies on wearables [18,19]. Given that even small increases in population-level physical activity can deliver substantial public health gains, the evidence is consistent with a potential role for smartwatches in addressing physical inactivity [20].

Function-specific effects and usage patterns

Individuals who used smartwatches primarily for activity tracking achieved the highest MET scores (6,124 ± 8,456 MET-minutes/week), significantly higher than all other functional categories. This suggests that how individuals use their smartwatches may be more important than simply owning one. The hierarchical pattern observed:

Table 5. *Comparison between smartwatch users and non-users (n = 1,082).*

Characteristics	SW users (*n* = 610)	Non-users (*n* = 472)	*p*-value*
Demographics			
Age (years), mean ± SD	25.8 ± 9.4	28.6 ± 12.1	0.001
Male sex, n (%)	312 (51.1)	222 (47.0)	0.183
Urban residence, n (%)	485 (79.5)	352 (74.6)	0.045
Bachelor's degree or higher, n (%)	485 (79.5)	339 (71.8)	0.003
Income >10,000 SR, n (%)	303 (49.7)	201 (42.6)	0.020
Health characteristics			
BMI (kg/m²), mean ± SD	23.8 ± 5.8	24.3 ± 6.3	0.214
Current smoker, n (%)	68 (11.1)	66 (14.0)	0.158
Any chronic disease, n (%)	142 (23.3)	118 (25.0)	0.506
Physical activity outcomes			
MET score, mean ± SD	5,284 ± 7,821	4,098 ± 6,987	0.014
Inactivity time (hours), mean ± SD	5.6 ± 3.0	6.1 ± 3.2	0.023
Physically active, n (%)	436 (71.5)	299 (63.3)	0.008

*$p < 0.05$ for bold values.

Table 6. Physical activity levels by primary smartwatch function (n = 610 SW users).

Primary SW function	*n* (%)	MET score (Mean ± SD)
Activity tracking	287 (47.0%)	6,124 ± 8,456
General health monitoring	96 (15.7%)	4,892 ± 7,234
Notifications/alerts	96 (15.7%)	4,156 ± 6,987
Smartphone control	94 (15.4%)	4,023 ± 6,745
Sleep tracking	37 (6.1%)	4,567 ± 7,123

One-way ANOVA $F = 4.23$, $p < 0.001$. Activity tracking significantly higher than all other functions (Tukey's HSD, $p < 0.05$).

Table 7. Association between participants' characteristics and MET scores: multiple linear regression analysis (n = 1,082).

Predictors	*β*	95% CI	*p*
Smartwatch functions (reference: [No])			
[Monitoring general health]	1,439.03	84.50-2,793.57	0.037
[Tracking physical activities]	250.90	-35.19-2,536.98	0.057
[Tracking sleep quality]	121.40	-1,200.09-1,442.89	0.857
Demographics			
[Male sex]	2,563.65	1,657.80-3,469.51	<0.001
Age	-29.71	-89.75-30.33	0.332
BMI	-49.76	-128.74-29.22	0.217
Employment (reference: [Unemployed])			
[Employed]	1,663.97	41.43-3,286.52	0.044
[Student]	-3.71	-1,643.75-1,636.32	0.996
Income (reference: [<5,000 SR])			
[5,000-9,999 SR]	-1,776.95	-3,124.52-429.38	0.010
[10,000-14,999 SR]	-1,228.44	-2,442.79-14.09	0.047
[>15,000 SR]	-818.59	-1,992.21-355.02	0.171
Chronic conditions			
[Diabetes]	1,473.67	-482.70-3,430.05	0.140

Model Performance: $R^2 = 0.082$, $F = 7.95$, $p < 0.001$. Only significant predictors and key variables shown.

tracking > health monitoring > notifications > smartphone control > sleep tracking – has important implications. These findings are consistent with behavior change theory, which predicts that technologies with explicit health-focused features may be more strongly associated with behavior change than technologies designed primarily for convenience or communication purposes [21,22]. Interestingly, while activity tracking showed the strongest association in descriptive analysis, it was not an independent predictor in the multivariable regression model, possibly reflecting interactions between user demographics, device functionality, and behavioral outcomes.

Demographic and socioeconomic trends

Our study revealed notable differences in both smartwatch adoption and physical activity outcomes. Smartwatch adopters were younger, more educated, and had higher incomes than non-adopters, consistent with typical early adopter patterns for consumer technology [23]. These socioeconomic factors are likely associated with both smartwatch adoption and increased physical activity, as previous studies have consistently documented associations between higher socioeconomic status and increased physical activity [24,25]. Male sex was strongly associated with higher physical activity levels (β = 2,563.65 MET-min/week) consistent with global patterns of physical activity participation [26]. The absence of sex differences in smartwatch adoption, however, suggests that while women and men are equally likely to use smartwatches, men achieved higher physical activity levels or may be more likely to use smartwatches specifically for activity-related purposes.

Clinical and public health implications

The observed associations between smartwatch use and physical activity have important implications for clinical practice and public health policy. Clinicians should consider recommending specific smartwatch features to promote physical activity among inactive patients. Our findings suggest that ownership alone may not be sufficient; intentional use of health-related features appears to drive the observed benefits. Second, smartwatch users demonstrated higher physical activity levels and greater adherence to WHO guidelines (71.5% *vs.* 63.3%), suggesting that wearable technology may serve as a marker of health-conscious behavior and may complement physical activity promotion. Third, socioeconomic disparities in smartwatch adoption raise important equity concerns, and efforts must ensure equitable access to prevent widening health disparities [27].

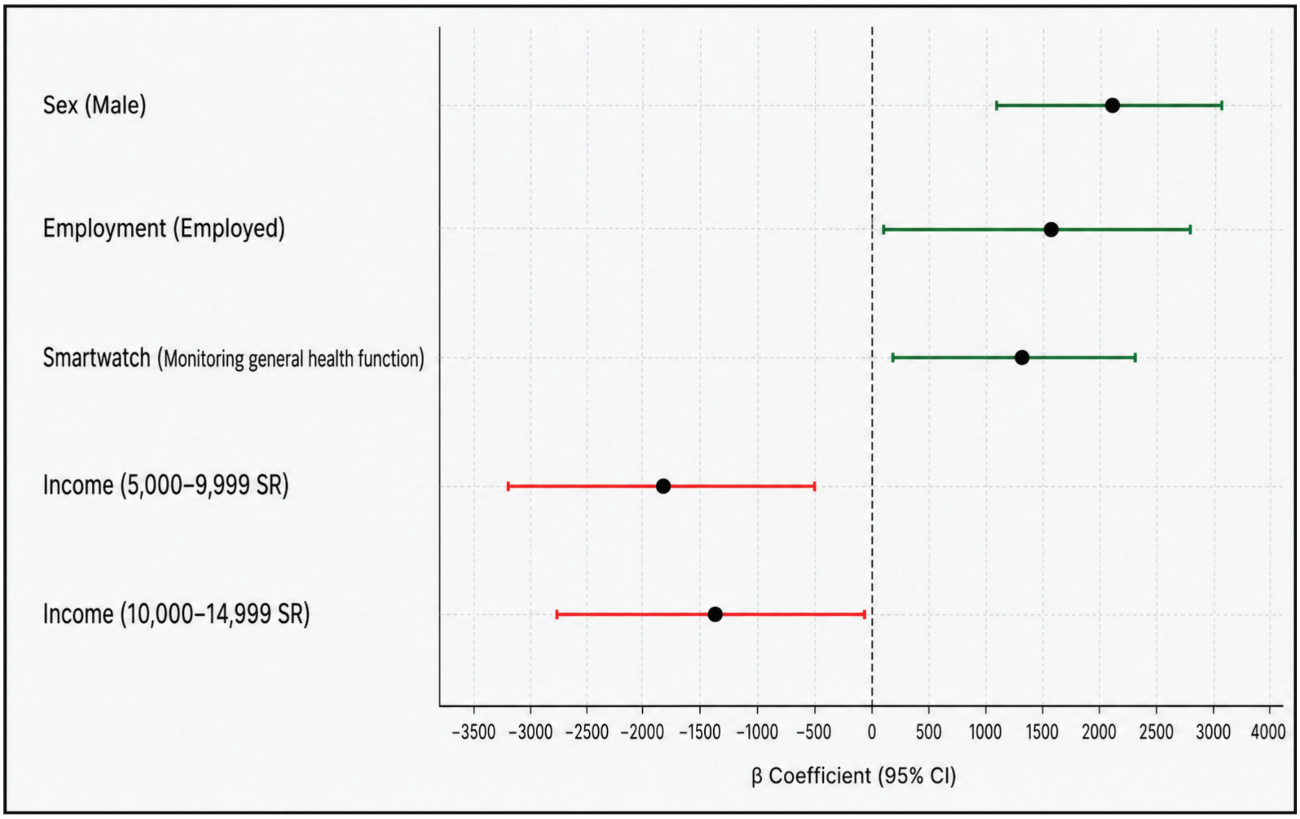

Figure 1. *Significant predictors of MET scores. Positive predictors (green) indicate an increase in MET scores, while negative predictors (red) indicate a decrease. Error bars represent 95% confidence intervals.*

Interpretation and potential mechanisms

Several mechanisms likely explain the observed associations between smartwatch use and increased physical activity levels. First, the real-time feedback and goal-setting features of activity tracking applications have been associated with increased physical activity, supporting their role as motivational tools for behavior change [28]. Second, gamification features in smartwatch fitness apps - such as step challenges, achievement badges, and social competition - may provide additional motivational benefits. Third, continuous monitoring may increase users' awareness of their activity patterns, leading to more deliberate decisions about physical activity throughout the day [29]. However, our cross-sectional design prevents us from establishing causality. More physically active individuals may be more likely to purchase and use smartwatches, especially for activity tracking, introducing potential self-selection bias [30].

Cultural context and regional considerations

To our knowledge, this is the first comprehensive study examining smartwatch adoption and physical activity associations in a Middle Eastern cultural context. The high adoption rates and positive associations among Saudi participants suggest no major cultural barriers to wearable technology benefits. However, the predominance of iPhone use (84%) and Apple Watch preference may limit generalizability, and social and cultural factors in Saudi Arabia may influence the impact of smartwatch features.

Strengths and limitations

This study has several strengths, including a large sample size (n = 1,082), use of the validated WHO GPAQ, detailed categorization of smartwatch functions, and being among the first studies to examine this association in a Middle Eastern context. However, the sample was predominantly young adults (mean age 27), students (64%), and from the southern and western regions (73%), limiting generalizability. The cross-sectional design precludes causal inference. Self-reported measures may have introduced recall, social desirability, and measurement bias. Recruitment exclusively through social media platforms may have disproportionately captured younger, more technology-engaged, and more health-conscious individuals, further limiting the external validity of findings. Our analysis did not account for smartwatch ownership duration or use patterns over time, and the high prevalence of Apple Watch and iPhone use may limit generalizability to Android users.

Future research directions

Several important research questions emerge from these findings. Longitudinal studies are needed to determine whether smartwatch adoption leads to sustained increases in physical activity or whether active individuals are more likely to adopt these devices. Randomized controlled trials should identify which smartwatch features maximize benefits while minimizing adverse effects. Future research should clarify the role of smartwatches in population-wide interventions, assess generalizability across cultures, and evaluate their cost-effectiveness in healthcare settings.

Conclusion

This study demonstrates that smartwatch use is associated with higher physical activity levels among Saudi adults, with users reporting approximately 1,200 additional MET-minutes per week and higher rates of meeting World Health Organization guidelines. These benefits appear function-specific, particularly for activity tracking and health monitoring. However, the cross-sectional design precludes causal inference, and socioeconomic disparities in adoption raise equity concerns. These findings are limited to a convenience sample and may not generalize broadly. The 56% adoption rate suggests strong potential for wearable technology to support Vision 2030 health objectives.

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List of Abbreviations

BMI	Body mass index
GPAQ	Global physical activity questionnaire
MET	Metabolic equivalent of task
SR	Saudi Riyal

Conflicts of interest

The authors declare no conflicts of interest.

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Consent to participate

Informed consent was obtained from all subjects involved in the study.

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Ethical approval

The study was approved by the Research Ethics Committee of Jazan University (Reference No. REC-46/02/1165, 01/09/2024) and conducted in accordance with the Declaration of Helsinki and institutional ethical standards.

Author contributions

Author Contributions: Conceptualization: M.A.J., S.A.A. and D.A.H.O.; methodology: M.A.J., G.I.A. and D.A.H.O.; software: M.A.J.; validation: M.A.J., D.A.H.O. and K.I.H.; formal analysis: M.A.J. and G.I.A.; investigation: S.A.A., D.A.H.O., K.I.H., S.S.A., A.H.H., A.J.A., S.A.A., K.S.A., Z.I.M., F.H.A., A.F.Z., L.A.A. and F.A.R.; resources: M.A.J. and F.H.A.; data curation: S.A.A., D.A.H.O. and A.F.Z.; writing — original draft preparation: M.A.J.; writing — review and editing: M.A.J., G.I.A., D.A.H.O., A.J.A. and F.A.R.; visualization: M.A.J.; supervision: M.A.J., G.I.A. and F.H.A.; project administration: M.A.J. All authors have read and agreed to the published version of the manuscript.

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Supplementary content (If any) is available online.

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