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Digital wearable use and mental health outcomes in Saudi Adults: a function-specific cross-sectional study

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ABSTRACT

Background: Smartwatches are increasingly used as personal health-monitoring tools, but evidence regarding their relationship with mental well-being remains limited in Middle Eastern populations. This study investigated the association between smartwatch use, specific smartwatch functions, and mental health symptoms among Saudi adults.

Methods: This cross-sectional study included 1,217 Saudi adults aged ≥18 years recruited through social media. An online questionnaire assessed sociodemographic characteristics, smartwatch use, and mental health outcomes using the validated Arabic depression, anxiety, and stress scale-21 (DASS-21). Multiple linear regression analyses identified predictors of depression, anxiety, and stress scores.

Results: Smartwatch use was reported by 48.9% of participants. Depression, anxiety, and stress symptoms above normal levels were reported by 49.1%, 56.1%, and 53.1% of participants, respectively. Among smartwatch functions, only activity tracking was significantly associated with mental health outcomes, showing lower anxiety scores (β = −2.14; 95% CI: −4.54 to −0.26; p = 0.035). Ex-smoker status was the strongest associated factor for higher symptom scores across all domains (β = 3.66–4.96; all $p < 0.05$). Higher income, male sex for anxiety and stress, and increasing age were associated with lower symptom scores. Overall smartwatch ownership and other functions showed no significant associations.

Conclusions: Activity-tracking features were associated with lower anxiety symptoms, whereas overall smartwatch ownership was not associated with mental health symptoms. These findings support a function-specific approach to studying wearable technologies and mental health, but longitudinal and interventional studies are needed. Findings may not be generalizable to older, non-student, rural, or less technologically engaged populations.

Keywords: Smartwatch, wearable devices, digital health, depression, anxiety, Saudi Arabia.

Introduction

The rapid development of wearable technology has transformed the way individuals interact with their health information. Smartwatches, for instance, have evolved from basic timekeeping devices into advanced health-monitoring tools capable of monitoring heart rate, physical activity, sleep, and even performing electrocardiograms [1,2].

Aside from their physiological health monitoring, smartwatches may also influence psychological health.

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Exposure to health data, activity reminders, and milestone alerts may either positively or negatively affect users' psychological health [3,4]. Some evidence suggests that wearable technology may decrease anxiety by encouraging greater awareness and regulation of health behaviors, whereas other evidence suggests that it may increase health anxiety or promote dependence [5,6].

Mental health disorders are a growing global problem, with hundreds of millions affected by depression and anxiety worldwide [7]. In Saudi Arabia, mental illnesses have been increasing, especially among youth experiencing social and economic transformation [8,9]. Technology-based approaches to mental health have shown promise in other settings, but studies assessing the contribution of consumer wearables in Saudi Arabia remain limited.

Earlier studies on wearable technology and mental health have yielded contradictory results. Studies from Western populations indicate that smartwatches and fitness trackers may promote self-efficacy and motivation, which may be associated with lower depressive symptoms [10,11]. However, most previous work has focused on general wearable-device use rather than specific smartwatch functions, and limited evidence is available from Middle Eastern populations, where cultural and social settings may affect the technology-health relationship.

Smartwatch use may relate to mental health differently depending on how the device is used, such as for activity tracking, health monitoring, communication, or productivity, making Saudi Arabia a relevant setting given its young population, widespread technology use, and increasing emphasis on healthcare and wellness under Vision 2030 [12].

The purpose of this study was to investigate the relationship between smartwatch use and mental health among Saudi adults, as defined by symptoms of depression, anxiety, and stress.

Methods

Study design and sample size

This cross-sectional study used convenience sampling among Saudi adults aged 18 years or older. Individuals under 18 years of age or those who refused to provide consent were excluded in the study. The required sample size was computed using the following formula:

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

where n_0 is the sample size, Z is the Z-score for the desired confidence level, p is the anticipated proportion, and e is the margin of error. To capture smartwatch usage patterns among Saudi adults, we used a 95% confidence level ($Z = 1.96$), an anticipated proportion of 0.50, and a margin of error of 4%. This calculation yielded a minimum required sample of 600 participants. Data were collected from 1,217 participants.

Data collection tool

The data collection instrument was systematically developed to capture essential variables. A literature review was first conducted to identify local and global smartwatch usage patterns and features, and key factors were selected based on relevance and appropriateness [13,14]. The initial instrument was then reviewed by domain experts and non-experts to assess item clarity, consistency, and appropriateness, with modifications made accordingly. Subsequently, the tool was tested with 20 participants to assess feasibility and finalize the instrument.

The final questionnaire comprised three sections: [1] demographic characteristics, including age, sex, nationality, weight, height, region, residence, marital status, occupation, income, smoking status, physical activity, and chronic conditions; [2] smartwatch usage patterns, including ownership status, device brand, smartphone brand, and primary reasons for use; and [3] mental health assessment using the Arabic version of the depression, anxiety, and stress scale-21 (DASS-21). The DASS-21 is a validated 4-point Likert scale measuring depression, anxiety, and stress symptoms, with severity differentiated by subdomain scores [15,16]. Consistent with standard DASS-21 scoring, raw subscale scores were multiplied by two to enable comparison with DASS-42 normative cutoffs. The DASS-21 demonstrates high internal consistency, with Cronbach's alpha coefficients of 0.94 for depression, 0.87 for anxiety, and 0.91 for stress [17].

Data collection process

Data collection were conducted from August 2024 to February 2025 using an online self-administered questionnaire. The survey link was distributed through multiple social media platforms (WhatsApp, X, Snapchat, Instagram, Telegram, and Facebook). The questionnaire included a clear description of the study purpose, participant rights, and all survey measures. Data were continuously monitored for quality assurance, and incomplete responses were excluded from the final analysis.

Statistical analysis

Data were initially compiled in Microsoft Excel for review, cleaning, and error checking. Statistical analyses were conducted using RStudio (version 4.2.3, R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics, including means, standard deviations, and frequencies, were calculated for key variables. Between-group comparisons of smartwatch users versus non-users were performed using independent t-tests and chi-square tests. Correlations among DASS-21 subscales were assessed using Pearson correlation coefficients. Multiple linear regression analyses were conducted to identify predictors of DASS-21 subscale scores. Model performance was evaluated using F-statistics, R^2, and adjusted R^2. All statistical tests were two-tailed with significance set at $\alpha = 0.05$, and 95% confidence intervals (CIs) were reported. The study adhered to STROBE guidelines for reporting observational studies [18].

Ethical approval

This study received approval from the Standing Committee for Scientific Research, Jazan University (Reference No. REC-46/02/1165, dated September 1, 2024). All procedures complied with institutional and national research ethics standards and adhered to the 1964 Declaration of Helsinki and its subsequent amendments [19]. Study objectives, procedures, potential risks, and benefits were clearly explained to all participants before participation, and informed consent was obtained from each participant.

Results

Study population characteristics

The sample consisted of 1,217 participants with a mean age of 26.0 ± 9.7 years. Females accounted for 69.1% (*n* = 841), and Saudis comprised 93.5% (*n* = 1,138). Most participants lived in urban areas (78.4%, *n* = 954), and the largest regional group was from the Southern Region (40.5%, *n* = 493). Most participants held bachelor's or diploma degrees (76.3%, *n* = 929), were students (60.3%, *n* = 734), and were single (75.1%, *n* = 914). Monthly family income was <5,000 SAR for 38.7% (*n* = 471), while 22.9% (*n* = 279) earned more than 15,000 SAR. Additional data are presented in Table 1.

Health characteristics

Mean body mass index (BMI) was 24.0 ± 5.6 kg/m². The most prevalent chronic condition was asthma (10.6%, *n* = 129), followed by hypercholesterolemia (6.9%, *n* = 84), diabetes mellitus (5.3%, *n* = 65), and hypothyroidism (5.1%, *n* = 62). Regarding physical activity, 44.2% (*n* = 538) reported no physical activity during the week, while 34.3% (*n* = 417) engaged in moderate or vigorous activity for ≥30 minutes on 5 days per week. Most participants had never smoked (85.5%, *n* = 1,040), while 9.4% (*n* = 115) were current smokers and 5.1% (*n* = 62) were former smokers. Complete health characteristics are presented in Table 2.

Smartwatch usage and related characteristics

Nearly half of participants (48.9%, *n* = 595) reported using a smartwatch. Among smartwatch users, Apple Watch was the predominant device (69.7%, *n* = 415), followed by Linux/Android-based smartwatches (30.3%, *n* = 180). Regarding smartphone preferences, most participants used iPhones (85.8%, *n* = 1,044). Physical activity tracking was the most common primary smartwatch use (20.7%, *n* = 252), followed by receiving notifications, alerts, or payments (9.2%, *n* = 112), monitoring general health (8.2%, *n* = 100), smartphone control (8.1%, *n* = 99), and sleep quality tracking (2.6%, *n* = 32). For multiple-choice responses regarding smartwatch purposes, the most frequently selected functions were notifications, alerts, and payments (39.5%, *n* = 481), followed by activity tracking (38.8%, *n* = 472), smartphone control (35.8%, *n* = 436), general health monitoring (31.1%, *n* = 378), and sleep quality tracking (23.7%, *n* = 288). Complete usage patterns are detailed in Table 3.

Table 1. *Sociodemographic characteristics of study participants (n = 1,217).*

Characteristics	Mean ± SD
Age	26.0 ± 9.7 years
Characteristics	**Frequency (%)**
Sex	
Female	841 (69.1%)
Male	376 (30.9%)
Nationality	
Saudi	1,138 (93.5%)
Non-Saudi	79 (6.5%)
Region	
Central region	187 (15.4%)
Eastern region	97 (8.0%)
Northern region	36 (3.0%)
Southern region	493 (40.5%)
Western region	404 (33.2%)
Marital status	
Single	914 (75.1%)
Married	267 (21.9%)
Divorced/Widowed	36 (3.0%)
Residence	
Rural	263 (21.6%)
Urban	954 (78.4%)
Education	
High School Degree or Lower	254 (20.9%)
Bachelor/Diploma degree	929 (76.3%)
Postgraduate Studies	34 (2.8%)
Occupation	
Unemployed	237 (19.5%)
Employed	246 (20.2%)
Student	734 (60.3%)
Income	
<5,000 SAR	471 (38.7%)
5,000-9,999 SAR	245 (20.1%)
10,00014,999 SAR	222 (18.2%)
>15,000 SAR	279 (22.9%)

n, sample size; SAR, Saudi Riyals.

DASS-21 scores and psychological characteristics

The mean depression score was 12.0 ± 11.0, with 49.1% (*n* = 598) of participants exhibiting depressive symptoms above normal levels. The mean anxiety score was 11.0 ± 11.0, with 56.1% (*n* = 683) reporting anxiety symptoms above normal levels. The mean stress score was 14.0 ± 12.0, with 53.1% (*n* = 646) experiencing stress symptoms above normal levels. Strong positive correlations were observed between all DASS-21 subscales: depression-anxiety (r = 0.78, p < 0.001), depression-stress (r = 0.81, p < 0.001), and anxiety-stress (r = 0.76, p < 0.001). Mental health comorbidity, defined as symptoms in all three domains simultaneously, was present in 34.8% (*n* = 424) of participants. Additional information is presented in Table 4.

Table 2. Health characteristics of study participants (n = 1,217).

Characteristics	Mean ± SD
BMI	24.0 ± 5.6 kg/m²
Characteristics	**Frequency (%)**
Weekly physical activity	
No physical activity during the week	538 (44.2%)
Moderate or vigorous activity for ≥ 30 minutes, 5 days/week	417 (34.3%)
Moderate or vigorous activity for < 30 minutes, 5 days/week	262 (21.5%)
Smoking status	
Never	1,040 (85.5%)
Current	115 (9.4%)
Ex-smoker	62 (5.1%)
DM	
No	1,152 (94.7%)
Yes	65 (5.3%)
HTN	
No	1,170 (96.1%)
Yes	47 (3.9%)
Hypercholesterolemia	
No	1,133 (93.1%)
Yes	84 (6.9%)
Asthma	
No	1,088 (89.4%)
Yes	129 (10.6%)
SCA	
No	1,188 (97.6%)
Yes	29 (2.4%)
Thalassemia	
No	1,204 (98.9%)
Yes	13 (1.1%)
Hyperthyroidism	
No	1,198 (98.4%)
Yes	19 (1.6%)
Hypothyroidism	
No	1,155 (94.9%)
Yes	62 (5.1%)
RA	
No	1,195 (98.2%)
Yes	22 (1.8%)
Hernia	
No	1,190 (97.8%)
Yes	27 (2.2%)

n, sample size; DM, Diabetes Mellitus; HTN, Hypertension; RA, Rheumatoid Arthritis; SCA, Sickle Cell Anemia.

Comparison between smartwatch users and non-users

Smartwatch users (n = 595) were significantly younger than non-users (n = 622), with mean ages of 24.8 ± 8.9 years versus 27.1 ± 10.3 years, respectively ($p < 0.001$). A higher proportion of females used smartwatches (72.4% *vs.* 65.9%, p = 0.012). Educational attainment differed significantly between groups, with 81.2% of users holding bachelor's degrees or higher compared to 71.5% of non-users ($p < 0.001$). Income levels also varied significantly, with 28.9% of users earning >15,000 SAR compared to 17.4% of non-users ($p < 0.001$). Mean DASS-21 scores showed no significant differences between smartwatch users and non-users: depression (11.7 ± 10.8 *vs.* 12.3 ± 11.2, p = 0.341), anxiety (10.6 ± 10.9 *vs.* 11.4 ± 11.1, p = 0.163), and stress (13.6 ± 11.8 *vs.* 14.4 ± 12.2, p = 0.229). Complete comparisons are presented in Table 5.

Summary of significant factors associated with DASS-21

Regression analysis identified several factors associated with depression, anxiety, and stress symptoms (Table 6 and Figure 1). Among smartwatch variables, only activity tracking demonstrated a significant association with mental health outcomes and was associated with lower anxiety scores (β = −2.14, 95% CI: −4.54 to −0.26, p = 0.035). Overall smartwatch ownership, device type, and other specific functions showed no significant associations. Increasing age was associated with lower scores across all three DASS-21 domains, with β values ranging from −0.15 to −0.17 for each additional year. Male sex was associated with lower anxiety (β = −1.56, p = 0.041) and stress (β = −2.02, p = 0.013), but not depression. Higher income levels were consistently associated with lower symptom scores across most domains. Among lifestyle factors, both moderate and high levels of physical activity were associated with lower depression scores. Ex-smoker status was the strongest associated factor across all mental health domains, with higher depression (β = 4.96), anxiety (β = 3.66), and stress (β = 4.37) scores. Current smoking was associated only with increased stress (β = 2.07). Regarding health conditions, asthma was associated with increased stress symptoms.

Discussion

This cross-sectional study of 1,217 Saudi adults provides novel insights into the relationship between smartwatch use and mental health outcomes. The results highlight both a potential beneficial association between activity tracking technology and reduced anxiety symptoms, as well as notably high mental health symptom prevalence.

Novel technology-mental health relationships

The most notable finding was the selective association between smartwatch activity tracking and lower anxiety scores. Among all smartwatch functions examined, only activity tracking showed a significant association with mental health outcomes, and this effect was specific to anxiety rather than depression or stress. This finding aligns with prior research demonstrating associations between physical activity and reduced anxiety, extending these observations to the digital health domain [20,21]. Several mechanisms may potentially explain this association. The objective feedback provided by activity trackers may enhance users' sense of control and self-efficacy regarding physical activity, factors previously linked to

Table 3. Smartwatch usage and related characteristics among participants (n = 1,217).

Characteristics	Frequency (%)
Smartwatch usage	
Yes	595 (48.9%)
No	622 (51.1%)
Smartwatch type	
Apple Watch	415 (34.1%)
Linux/Android-based smartwatch	180 (14.8%)
Not using a smartwatch	622 (51.1%)
Phone type	
Android phone	125 (10.3%)
Honor/Huawei	48 (3.9%)
iPhone (Apple)	1,044 (85.8%)
Primary purpose of smartwatch use	
Tracking physical activities	252 (20.7%)
Tracking sleep quality	32 (2.6%)
Monitoring general health	100 (8.2%)
Receiving notifications, alerts, and payments	112 (9.2%)
Controlling the smartphone	99 (8.1%)
Not using a smartwatch	622 (51.1%)
Other purposes of smartwatch use (participants could select multiple options)	
Tracking physical activities	472 (38.8%)
Tracking sleep quality	288 (23.7%)
Monitoring general health	378 (31.1%)
Receiving notifications, alerts, and payments	481 (39.5%)
Controlling the smartphone	436 (35.8%)

n, Sample size.

anxiety reduction [22]. Importantly, general smartwatch ownership and other specific functions showed no mental health associations. Instead, our findings suggest that any mental health benefits of wearable technology may be function-specific and require active engagement with particular features rather than passive device ownership.

Young Saudi adults and the mental health burden

The prevalence of mental health symptoms in our sample was notably high, with 56.1% reporting anxiety symptoms, 49.1% depression symptoms, and 53.1% stress symptoms above normal levels. These rates appear elevated compared to some global estimates for similar age groups [23,24]. The high proportion of university students (60%) in our sample may reflect academic pressures commonly experienced in competitive educational environments [25]. The strong correlations observed between depression, anxiety, and stress symptoms (r = 0.76-0.81) indicate substantial psychological comorbidity in this sample.

Socioeconomic and demographic patterns

Income showed consistent inverse associations with mental health symptom scores, with higher income levels associated with lower symptom scores. This suggests that economic factors may play an important role in psychological well-being. Age demonstrated small but consistent inverse associations across all DASS-21 measures, with each additional year associated with 0.15-0.17-point decreases in symptom scores. Sex differences showed specificity by symptom type: males reported significantly lower anxiety and stress symptoms but showed no difference in depression compared to females.

Ex-smoker status and mental health symptoms

Ex-smoker status was the strongest associated factor for mental health symptoms across all domains, with ex-smokers scoring 3.66-4.96 points higher on DASS-21 measures than never-smokers. Several hypotheses may explain this association. Ex-smokers may have initially used smoking to cope with pre-existing mental health conditions that became more apparent after cessation. The smoking cessation process itself, while beneficial for physical health, can temporarily reveal or exacerbate underlying psychological symptoms that may have been masked by nicotine's psychoactive effects [26,27]. The observation that current smokers showed elevated stress symptoms but not depression or anxiety adds complexity to this relationship, though this should not be interpreted as evidence that smoking provides net psychological benefits. These findings suggest that smoking cessation programs might benefit from incorporating mental health screening and support services.

Disease-specific mental health associations

The observed associations between specific chronic conditions and mental health symptoms provide

Table 4. *DASS-21 scores and psychological characteristics among participants (n = 1,217).*

Characteristics	Mean ± SD / Frequency (%)
Depression score	12.0 ± 11.0
Depression severity	
Normal	619 (50.9%)
Mild	128 (10.5%)
Moderate	228 (18.7%)
Severe	92 (7.6%)
Extremely Severe	150 (12.3%)
Depression status	
Yes	598 (49.1%)
No	619 (50.9%)
Anxiety score	11.0 ± 11.0
Anxiety severity	
Normal	534 (43.9%)
Mild	93 (7.6%)
Moderate	215 (17.7%)
Severe	100 (8.2%)
Extremely severe	275 (22.6%)
Anxiety status	
Yes	683 (56.1%)
No	534 (43.9%)
Stress score	14.0 ± 12.0
Stress severity	
Normal	571 (46.9%)
Mild	287 (23.6%)
Moderate	167 (13.7%)
Severe	123 (10.1%)
Extremely Severe	69 (5.7%)
Stress status	
Yes	646 (53.1%)
No	571 (46.9%)
Inter-scale correlations	
Depression-anxiety	r = 0.78, p < 0.001
Depression-stress	r = 0.81, p < 0.001
Anxiety-stress	r = 0.76, p < 0.001
Comorbidity (all three domains)	424 (34.8%)

n, Sample size.

Table 5. *Comparison between smartwatch users and non-users (n = 1,217).*

Characteristics	Smartwatch Users (*n* = 595)	Non-Users (*n* = 622)	*p*-value
Demographics			
Age (years)	24.8 ± 8.9	27.1 ± 10.3	**<0.001**
Female sex	431 (72.4%)	410 (65.9%)	**0.012**
Bachelor's degree or higher	483 (81.2%)	445 (71.5%)	**<0.001**
Income > 15,000 SAR	172 (28.9%)	108 (17.4%)	**<0.001**
DASS-21 Scores			
Depression	11.7 ± 10.8	12.3 ± 11.2	0.341
Anxiety	10.6 ± 10.9	11.4 ± 11.1	0.163
Stress	13.6 ± 11.8	14.4 ± 12.2	0.229

Data are presented as mean ± SD or frequency (%). *p*-values from *t*-tests for continuous variables and chi-square tests for categorical variables.
Bold values indicate statistical significance ($p < 0.05$).

Table 6. Significant predictors of DASS-21 scores: summary of multiple linear regression analysis (n = 1,217).

Variable category	Predictors	Depression β (95% CI)	Anxiety β (95% CI)	Stress β (95% CI)
Smartwatch variables				
Device ownership	Smartwatch use (*vs.* non-use)	NS	NS	NS
Device type	Apple Watch (*vs.* non-users)	NS	NS	NS
	Android smartwatch (*vs.* non-users)	NS	NS	NS
Usage Functions	Activity tracking	NS	–2.14 (–4.54, –0.26)*	NS
	Sleep tracking	NS	NS	NS
	Health monitoring	NS	NS	NS
Demographic factors				
Age and sex	Age (per year)	–0.17 (–0.29, –0.05)	–0.15 (–0.26, –0.04)	–0.17 (–0.29, –0.06)
	Male sex (*vs.* female)	NS	–1.56 (–3.06, –0.06)*	–2.02 (–3.61, –0.42)*
Socioeconomic factors				
Income level	5,000-9,999 SAR (*vs.* < 5,000 SAR)	–2.82 (–4.64, –0.99)	–3.14 (–4.87, –1.41)	–2.23 (–4.08, –0.39)*
(Reference: <5,000 SAR)	10,000-14,999 SAR (*vs.* < 5,000 SAR)	–2.36 (–4.28, –0.45)*	–2.61 (–4.42, –0.79)	NS
	> 15,000 SAR (*vs.* < 5,000 SAR)	–1.90 (–3.66, –0.14)*	–2.85 (–4.52, –1.18)	–1.82 (–3.61, –0.04)*
Lifestyle behaviors				
Physical activity	≥ 30 minutes, 5 days/week (vs. none)	–1.28 (–2.79, –0.23)*	NS	NS
(Reference: No activity)	< 30 minutes, 5 days/week (vs. none)	–1.55 (–3.29, –0.18)*	NS	NS
Smoking status	Current smoker (vs. never)	NS	NS	2.07 (0.35, 4.48)*
(Reference: Never)	Ex-smoker (vs. never)	4.96 (1.92, 8.00)	3.66 (0.78, 6.55)*	4.37 (1.30, 7.45)
Health conditions				
Chronic diseases	Hypercholesterolemia	2.77 (0.12, 5.66)*	3.23 (0.49, 5.97)*	NS
	Asthma	NS	NS	2.11 (0.07, 4.28)*
Model performance				
Statistical metrics	*F*-statistic	6.89	7.45	5.92
	p-value	<0.001	< 0.001	< 0.001
	R^2	0.184	0.198	0.162
	Adjusted R^2	0.151	0.166	0.128
	Observations	1,217	1,217	1,217

*$p < 0.05$, NS, non-significant.

preliminary insights into condition-specific psychological impacts. Hypercholesterolemia was associated with elevated depression and anxiety symptoms but not stress, while asthma was linked specifically to increased stress symptoms. These findings should be interpreted within the broader context of increasing cardiometabolic risk factors in Saudi Arabia [28]. These patterns may reflect different pathways through which chronic conditions affect psychological well-being. Hypercholesterolemia, as a cardiovascular risk factor, might contribute to chronic worry about health outcomes [29], while asthma's unpredictable, acute episodes could create stress related to functional limitations and breathing difficulties [30].

Clinical and public health implications

Our findings have potential relevance for future research directions and public health planning, but should not be interpreted as having direct clinical implications given the cross-sectional design and modest effect sizes observed. First, the association between activity tracking and reduced anxiety symptoms suggests this relationship warrants further study in controlled trials to determine potential benefits and underlying mechanisms. Second, the high prevalence of mental health symptoms in this sample, while potentially reflecting selection bias from our recruitment method, highlights the importance of mental health screening and support services for young adults, particularly in academic and technological environments. Third, the elevated mental health symptoms among ex-smokers suggest that smoking cessation programs might benefit from incorporating mental health screening and support. These findings require validation in larger, more representative samples and longitudinal studies before informing clinical practice guidelines or policy decisions.

Strengths and limitations

This study has several strengths. It represents one of the first comprehensive investigations of smartwatch use and mental health outcomes in a Middle Eastern population. The large sample size (*n* = 1,217) provided adequate statistical power for the analyzes. The study employed a well-validated psychometric instrument (DASS-21)

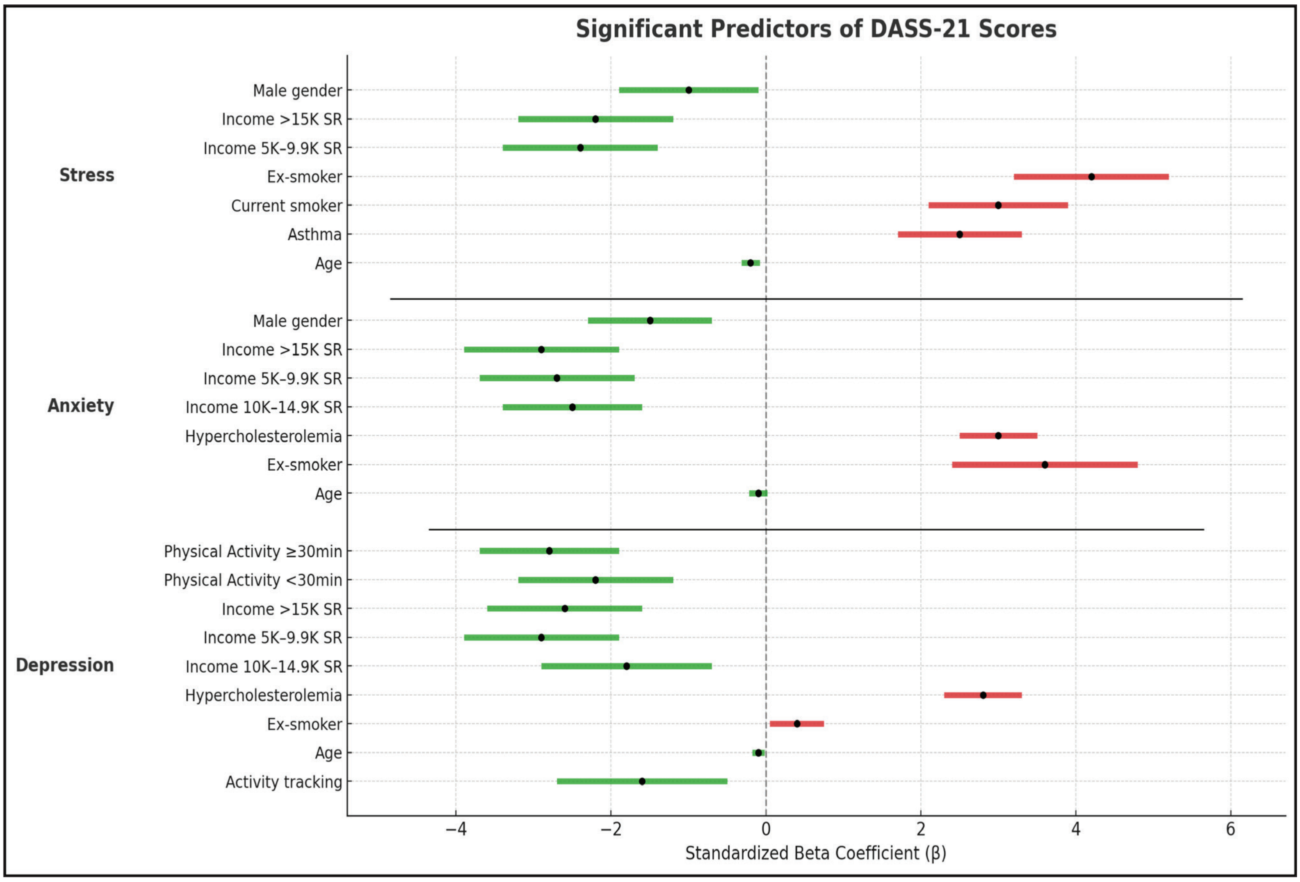

Figure 1. *Predictors of DASS-21 mental health scores among Saudi adults (n = 1,217). The forest plot shows significant beta coefficients (p < 0.05) from regression models for depression, anxiety, and stress. Error bars represent 95% confidence intervals.*

to assess mental health symptoms with established reliability. The analysis distinguished between overall smartwatch ownership and specific usage functions, allowing for a more nuanced examination of technology-health relationships.

However, several important limitations must be acknowledged. The cross-sectional design precludes causal inferences about the observed associations and raises the possibility of reverse causation. Convenience sampling through social media likely introduced selection bias, resulting in overrepresentation of young, educated, urban, and technologically engaged individuals. This limits generalizability to the broader Saudi population. All measures relied on self-report, introducing potential recall and social desirability bias, particularly in relation to self-reported mental health symptoms. The study did not assess the duration or intensity of smartwatch use, which may have influenced the strength or direction of the observed associations. The study also did not assess potential mediating mechanisms that might explain the observed associations. Finally, while DASS-21 measures symptom severity and is useful as a screening tool, it is not a clinical diagnostic instrument, limiting interpretation of the clinical significance of the findings.

Future research directions

These findings suggest several avenues for future research. Longitudinal studies are needed to establish temporal relationships and potential causal pathways between smartwatch use and mental health outcomes. Randomized controlled trials could test whether activity tracking interventions reduce anxiety symptoms in clinical populations. The high prevalence of mental health symptoms in this sample warrants further investigation using representative sampling methods. Finally, replication studies in diverse populations and cultural contexts are essential to establish the generalizability of these findings and guide evidence-based applications of wearable technology in mental health promotion.

Conclusion

This study provides initial evidence of an association between smartwatch activity tracking and reduced anxiety symptoms among Saudi adults. This relationship appeared function specific, with no associations observed for overall device ownership or other smartwatch features. The high prevalence of mental health symptoms in this sample (49%-56%) warrants attention, though the convenience sampling method limits generalizability. As the sample was predominantly young, student, urban, and technologically engaged, these findings may not be generalizable to older, non-student, rural, or less technologically engaged populations, and the elevated symptom prevalence may partly reflect this selection bias rather than population-level trends. Ex-smoker status was associated with elevated mental health symptoms across all domains, suggesting that smoking cessation programs might benefit from integrated mental health support. Higher income levels were consistently associated with better mental health outcomes. These findings suggest that specific wearable technology features may have potential mental health applications, though longitudinal studies and randomized controlled trials are needed to establish causation and clinical utility.

List of Abbreviations

BMI	Body mass index
CI	Confidence interval
DASS-21	Depression, anxiety, and stress scale-21
SAR	Saudi Riyal
STROBE	Strengthening the reporting of observational studies in epidemiology
SW	Smartwatch

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.

Institutional Review Board Statement

This study received ethical approval from the Standing Committee for Scientific Research at Jazan University (Reference No. REC-46/02/1165, dated 01/09/2024). All procedures containing human participants were carried out in full accordance with ethical guidelines set by the institutional and/or national research board, and the principles outlined in the 1964 Declaration of Helsinki and its later revisions or equivalent ethical standards.

Informed consent

Written informed consent was obtained by all applicants prior to their participation in the study.

Data availability statement

The data supporting this study are not publicly available due to confidentiality and privacy considerations of the participants. However, the data may be made available by the corresponding author upon reasonable request.

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Supplementary content (If any) is available online.

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