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Associations of Mentally Active Versus Passive Sedentary Behavior with Smartphone Addiction in Adults

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ABSTRACT: Background: Sedentary behavior (SB) has been linked to problematic smartphone use: however, whether different types of SB differentially relate to smartphone addiction risk remains unclear. This study aimed to examine the prevalence of smartphone addiction risk and the independent associations of mentally active and mentally passive SB—across total, weekday, and weekend estimates—with smartphone addiction scores among Saudi adults. **Methods:** This cross-sectional, web-based study recruited adults aged 18–65 years residing in Saudi Arabia through social media platforms. After excluding participants with missing anthropometric data, implausible body mass index (BMI) values, or total SB >24 h/day, 1037 participants were included (mean age 28.9 ± 11.5 years; 52.9% female). SB was assessed using the Arabic Sedentary Behavior Questionnaire and categorized into mentally active (e.g., desk work, reading, computer use) and mentally passive (e.g., television viewing, sitting while listening to music) domains. Smartphone addiction risk was measured using the Smartphone Addiction Scale (SAS). Multiple linear regression analyses were conducted to examine associations. **Results:** Participants reported 9.7 ± 4.6 h/day of total SB, including 5.3 ± 3.3 h/day mentally active SB and 4.4 ± 2.5 h/day mentally passive SB. High-risk smartphone addiction was prevalent (66.2%). In multiple linear regression models, mentally passive SB was strongly and positively associated with higher smartphone addiction risk in crude and adjusted analyses, including weekday and weekend estimates, whereas mentally active SB showed no significant associations. Adults with excessive total SB (≥ 8 h/day) had higher smartphone addiction scores than those with < 8 h/day (107.5 ± 32.0 vs. 94.6 ± 31.2 ; $p < 0.001$). **Conclusions:** These findings indicate that mentally passive SB, rather than mentally active SB, is consistently linked to elevated smartphone addiction risk, with stronger associations observed across both weekdays and weekends.

KEYWORDS: Sedentary behavior; smartphone addiction; behavioral epidemiology; cognitive engagement

1 Introduction

Sedentary behavior (SB), defined as waking activity in a sitting, reclining, or lying posture with low energy expenditure, is linked to various adverse health outcomes, including obesity, metabolic syndrome, and cardiovascular disease [1]. Mentally active sedentary behaviors refer to seated activities requiring cognitive engagement, such as desk work or reading, whereas mentally passive sedentary behaviors involve low cognitive demand activities such as television viewing [2,3]. Emerging research indicates that mentally passive SB, such as watching television rather than mentally active SB like desk work, is associated with higher odds of depressive symptoms (odds ratio (OR) 1.06 per 30 min increase), whereas mentally active SB is related to lower odds of depression (OR 0.86) [4]. Further, longitudinal evidence from a United

Kingdom cohort found mentally passive SB increased the hazard of incident depression by 43%, with no significant effect for mentally active SB; waist circumference and C-reactive protein partially mediated this association [5]. Given these differential effects of sedentary behavior on mental health, it is important to examine whether similar distinctions between mentally active and mentally passive sedentary behaviors are also relevant for other technology-related outcomes, such as smartphone addiction.

Sedentary behavior may contribute to smartphone addiction through behavioral and cognitive pathways. Prolonged sedentary time increases opportunities for smartphone engagement and is associated with greater sitting time and sedentary patterns [6–8]. In low-stimulation contexts, smartphone use may become more habitual through repetitive checking behaviors [9]. Furthermore, problematic smartphone use has been linked to reward-processing tendencies and self-control/attentional deficits, which may reinforce repetitive use patterns [10–12]. Smartphone addiction is considered a form of problematic smartphone use characterized by impaired control over use, withdrawal-like symptoms when access is restricted, and continued use despite negative consequences [13,14]. This condition has been linked to a range of negative physical and psychological outcomes, including poor sleep, musculoskeletal pain, loneliness, and impaired academic performance [13]. Prior research has demonstrated inverse associations between physical activity and problematic smartphone use, social media use, and gaming behaviors [15]. Additionally, psychosocial factors such as nomophobia and avoidance of physical activity have been shown to mediate the association with problematic social media use [16], while weight-related stigma and physical activity avoidance have been identified as mediators in gaming disorder [17]. In Saudi Arabia, a population-based study reported a prevalence of problematic smartphone use of approximately 64% among adults aged 18–65 in the Qassim region, with students being three times more likely to be affected and protective factors such as using apps for academic or religious purposes identified [18]. Another study among students at Umm Al-Qura University reported an overall smartphone addiction prevalence at 67.0% overall (59.3% in male and 73.4% in female participants), with high daily use (6–11 h) and significant associations with poor physical and mental well-being [19].

Although different types of SB, including mentally active and mentally passive forms, show differential associations with mental health outcomes [5], evidence directly examining these subtypes in relation to smartphone addiction remains limited in Saudi Arabia, as most studies focus on total screen time or overall smartphone use [20,21]. In contrast, studies from European and East Asian populations have reported that passive, screen-based sedentary behaviors are more strongly associated with problematic smartphone or social media use than cognitively engaging sedentary activities [15,20,22]. Moreover, sedentary behavior patterns often differ between weekdays and weekends due to variations in work, academic schedules, and leisure time, which may influence both the duration and context of smartphone use and consequently addiction risk. However, these temporal differences have received little empirical attention in Middle Eastern populations. Therefore, the primary aims of this study were to: 1) determine the prevalence of high risk of smartphone addiction among Saudi adults, 2) examine the associations between mentally active vs. passive SB and smartphone addiction risk, including distinctions between weekdays and weekends. We hypothesized that smartphone addiction risk would be highly prevalent in this population, and that mentally passive SB would be positively associated with higher addiction risk, whereas mentally active SB would not.

2 Materials and Methods

This study adhered to the Strengthening Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Approval of the study protocol was obtained from the Institutional Review Board at King Saud

University (Approval No.: KSU-HE-23-345; 28 March 2023). All participants provided informed electronic consent prior to participation, and participation was voluntary and no incentives were provided. All outputs were critically reviewed by the author, who takes full responsibility for the final content.

2.1 Study Design

This study employed a cross-sectional, web-based design to examine the association between mentally active and mentally passive sedentary behaviors and the risk of smartphone addiction among adults in Saudi Arabia. Participants were recruited using an online convenience sampling approach via social media platforms (Twitter/X, Instagram, Snapchat, and WhatsApp). The survey link was disseminated publicly and through personal and institutional networks to maximize reach. Eligible participants were adults aged 18–65 years who were able to read Arabic and were currently residing in Saudi Arabia. A total of 1054 adults completed the questionnaire. After excluding individuals with missing anthropometric data, implausible BMI values, or sedentary time reports exceeding 24 h per day, the final sample included 1037 participants.

2.2 Measurements

The questionnaire consisted of several sections capturing demographic characteristics, anthropometric information, socioeconomic indicators, sedentary behavior patterns, and smartphone addiction symptoms. All responses were self-reported. The survey structure was adapted from validated Arabic instruments previously used in Saudi populations.

2.3 Demographic, Anthropometric, and Socioeconomic Variables

All participants self-reported their age (in years), biological sex (male or female), and region of residence within Saudi Arabia (e.g., Central, Western, Eastern, Southern, Northern, or not reported). Participants also indicated whether they have been diagnosed with a chronic physical disease (yes/no). Participants provided their last known height (in centimeters) and weight (in kilograms). From these values, body mass index (BMI, kg/m^2) was calculated. BMI was treated as a continuous covariate given its established link to behavioral health and digital device usage [7,23]. Further potential confounders related to socioeconomic status were recorded. Participants indicated their marital status (single, married, divorced, or widowed) and their highest educational attainment (high school or less, diploma, bachelor's degree, master's degree, or PhD). Additionally, they reported their current occupational status (governmental sector, private sector, unemployed, retired, or student). These demographics, anthropometrics, and socioeconomic variables were included in the adjusted models to provide a more comprehensive control of potential confounding influences on sedentary behavior and smartphone addiction risk.

2.4 Sedentary Behavior Assessments

Sedentary behavior (SB) was assessed using the Arabic version of the Sedentary Behavior Questionnaire (SBQ), which estimates the amount of time spent in various sedentary activities expressed in hours per day [24]. The SBQ has demonstrated high reliability in Arabic-speaking adult populations, with a reported reliability coefficient of 0.92 for total sedentary time [24,25]. The SBQ captures time spent in multiple sedentary activities separately for a typical weekday and a typical weekend day, allowing for the assessment of variations in daily routines. Participants reported time spent in nine sedentary activities, including sitting while driving or riding in a car, bus, or train; performing paperwork or computer-based tasks; reading books or magazines; engaging in artwork or crafts; playing a musical instrument; sitting while talking on the phone; playing computer or video games; watching television; and sitting while listening to

music [25]. Sedentary behavior is defined as waking behavior only; accordingly, the SBQ was designed to assess time spent in waking sedentary activities and does not include items assessing sleep duration. Therefore, sleep time was not included in SB estimates. Based on an established conceptual framework that distinguishes sedentary behaviors by cognitive engagement, these activities were categorized into mentally active and mentally passive sedentary behaviors [2]. Watching television, sitting, and listening to music were classified as mentally passive sedentary behaviors, as they typically involve minimal cognitive processing. In contrast, the remaining activities (i.e., transportation-related sitting, desk-based work, reading, creative tasks, musical performance, phone conversations, and computer or video gaming) were classified as mentally active sedentary behaviors due to their higher cognitive demands. It should be noted that certain sedentary contemporary activities, such as social media use or smartphone-based gaming while sitting, were not explicitly captured by SBQ.

Time spent in mentally active sedentary behavior during weekdays was calculated by summing the reported duration of all mentally active activities on a weekday, while weekend values were computed in a similar manner using weekend-day responses. Average daily mentally active sedentary time was then derived using a weighted formula that accounted for five weekdays and two weekend days: mentally active SB per day = $([\text{mentally active SB during a weekday} \times 5] + [\text{mentally active SB on a weekend day} \times 2])/7$. The same computational approach was applied to mentally passive sedentary behavior to estimate weekday, weekend, and overall daily values [26]. These derived variables were subsequently used in all analyses examining associations between sedentary behavior patterns and smartphone addiction risk. For categorical analyses, excessive sedentary behavior was defined as ≥ 8 h/day, based on epidemiological evidence indicating that total sitting time at or above this level is associated with increased risk of adverse health outcomes [27,28].

2.5 Smartphone Addiction

Smartphone addiction was assessed with the Smartphone Addiction Scale (SAS), originally developed by Kwon et al. [29] and used in its validated Arabic adaptation suitable for populations in Saudi Arabia [30]. The scale comprises 33 items rated on a six-point Likert scale (1 = strongly disagree to 6 = strongly agree) and assesses multiple addiction-related domains, including daily life disturbance, withdrawal, overuse, and loss of control. Total scores are obtained by summing responses across all items, yielding a possible range of 33 to 198, with higher scores indicating greater severity of addictive smartphone use. Based on recommended scoring guidelines for the Arabic version, participants were classified into low-risk (≤ 92), medium-risk (93–118), and high-risk (≥ 119) categories, with the high-risk group serving as the primary outcome for regression analyses. Internal consistency in the present sample was excellent (Cronbach's $\alpha > 0.90$).

2.6 Statistical Analyses

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 29.0 (IBM Corp., Armonk, NY, USA). First, descriptive statistics summarized participant characteristics and key study variables, with means and standard deviations reported for continuous measures and frequencies and percentages for categorical variables. To identify potential outliers, interquartile ranges were calculated, and values beyond the fences (i.e., first quartile $-1.5 \times$ interquartile range (IQR); third quartile $+1.5 \times$ IQR) were carefully evaluated and removed if deemed implausible.

To examine the associations between sedentary behavior domains (mentally active vs. passive) and smartphone addiction risk, multiple linear regression models were constructed. The first model assessed

crude associations. A second model was then adjusted for potential confounders, including demographic (age, sex, smoking status, chronic disease), anthropometric (BMI), and socioeconomic (marital status, parental status, education, occupation, income) variables. Age and sex were included as covariates in the adjusted models given their established associations with both sedentary behavior patterns and technology-related behaviors. For models including both mentally active and mentally passive SB, simultaneous adjustment was applied to estimate their independent contributions. Regression analyses were used because they allow estimation of adjusted associations and are robust to moderate departures from normality, particularly in large samples. Effect sizes were calculated using Cohen's *d* to facilitate interpretation of association magnitude, with conventional thresholds for small (0.2), medium (0.5), and large (0.8) effects [31].

Finally, to evaluate whether excessive total sedentary time (≥ 8 h/day) was associated with differences in smartphone addiction scores, participants were dichotomized accordingly and compared using the Mann-Whitney U test, given the non-normal distribution of SAS scores. The magnitude of these between-group differences was expressed using the rank-biserial correlation coefficient (*r*_B), with small (0.1), medium (0.3), and large (0.5) thresholds [32]. Statistical significance was set at $p < 0.05$ for all analyses.

3 Results

Of the initially recruited participants, 17 individuals were excluded from the analyses due to missing anthropometric data ($n = 2$), implausible body mass index (BMI) values ($n = 3$), or reporting total sedentary behavior (SB) exceeding 24 h per day ($n = 12$). The final analytic sample comprised 1037 Saudi adults.

Participant characteristics are presented in Table 1. The mean age was 28.9 ± 11.5 years, and the mean BMI was 25.6 ± 5.9 kg/m². Females constituted 52.9% of the sample, and most participants were single (62.2%), students (52.7%), and resided in the Central region of Saudi Arabia (85.1%). Approximately 10.7% reported having at least one chronic disease.

The mean total sedentary time was 9.7 ± 4.6 h/day, comprising 5.3 ± 3.3 h/day of mentally active and 4.4 ± 2.5 h/day of mentally passive sedentary behaviors. Regarding smartphone addiction risk, 66.2% of participants were classified as high risk, while 25.9% as medium risk, and 7.9% as low risk.

Table 1: Participant characteristics ($n = 1037$).

Characteristic	Mean (SD)/ <i>n</i> (%)
Age	28.9 ± 11.5
Height	165.6 ± 9.2
Weight	70.6 ± 18.5
BMI (kg/m ²)	25.6 ± 5.9
Sex	
Male	488 (47.1%)
Female	549 (52.9%)
Marriage Status	
Single	645 (62.2%)
Married	349 (33.7%)
Divorced	39 (3.7%)
Widower	4 (0.4%)
Degree	
Diploma or Less	319 (30.8%)
Bachelor	511 (49.3%)
Master's	137 (13.2%)
PhD	70 (6.8%)

Table 1: Cont.

Characteristic	Mean (SD)/n (%)
Occupation	
Governmental Sector	300 (28.9%)
Private Sector	106 (10.2%)
Currently Unemployed	62 (6.0%)
Retired	23 (2.2%)
Student	546 (52.7%)
Region of Saudi Arabia	
Central	883 (85.1%)
Western	108 (10.4%)
Eastern	25 (2.4%)
Southern	11 (1.1%)
Northern	10 (1.0%)
Chronic Disease	
Yes	111 (10.7%)
No	926 (89.3%)
Total SB (hour/day)	9.7 ± 4.6
Mentally Active SB (hour/day)	5.3 ± 3.3
Mentally Passive SB (hour/day)	4.4 ± 2.5
Risk of Smartphone Addiction	
Low	82 (7.9%)
Medium	269 (25.9%)
High	686 (66.2%)

BMI: body mass index; kg/m²: kilogram per meter squared; SB: sedentary behavior; SD: standard deviation.

Associations between sedentary behavior domains, and smartphone addiction risk are presented in Table 2. In the crude model (Model 1), mentally passive sedentary behavior was positively associated with smartphone addiction risk (unstandardized regression coefficient (B) = 4.502, $p < 0.001$; $d = 1.80$), whereas mentally active sedentary behavior showed no significant association. Similar patterns were observed for weekday and weekend analyses.

After adjusting for age, BMI, sex, marital status, education, occupation, and health status (Model 2), mentally passive sedentary behavior remained independently associated with higher smartphone addiction risk (B = 4.216, $p < 0.001$; $d = 1.69$), including during weekdays and weekend days. Mentally active sedentary behavior was not significantly associated with smartphone addiction risk in any model.

Participants with excessive total sedentary behavior (≥ 8 h/day) reported higher smartphone addiction scores than those without excessive sedentary behavior (< 8 h/day) (107.5 ± 32.0 vs. 94.6 ± 31.2 , $p < 0.001$). Although the magnitude of this difference was small (rank-biserial correlation, $r(B) = 0.037$), the association remained statistically significant, indicating that prolonged sedentary time was consistently related to greater smartphone addiction risk.

Table 2: Multiple linear regression analyses of associations of mentally active vs. passive SB with the risk of smartphone addiction.

Variables	Model	Mentally Active SB		Mentally Passive SB		Mentally Active SB on Weekdays		Mentally Passive SB on Weekdays		Mentally Active SB on Weekend Days		Mentally Passive SB on Weekend Days	
		B ± SE (p-Value)	D	B ± SE (p-Value)	d	B ± SE (p-Value)	D	B ± SE (p-Value)	d	B ± SE (p-Value)	d	B ± SE (p-Value)	d
Risk of Smartphone Addiction	1	-0.055 ± 0.300 (0.855)	0.02	4.502 ± 0.397 (<0.001)	1.80	-0.518 ± 0.388 (0.183)	0.15	1.946 ± 0.533 (<0.001)	0.75	0.508 ± 0.412 (0.218)	0.15	2.728 ± 0.551 (<0.001)	1.05
	2	0.003 ± 0.301 (0.993)*	0.00	4.216 ± 0.404 (<0.001)*	1.69	-0.513 ± 0.396 (0.196)#	0.15	1.913 ± 0.534 (<0.001)*	0.73	0.572 ± 0.422 (0.176)#	0.17	2.474 ± 0.552 (<0.001)*	0.95

d; Cohen's *d*, SB; sedentary behavior. B ± SE; unstandardized regression coefficient ± standard error. Bold indicates significant associations ($p < 0.05$). Model 1 is a crude model. Model 2 is with adjustment for the confounders, including age, BMI, sex, marriage status, current degree, occupations, and current health status. *indicates that models simultaneously adjust for mentally active and passive SB in addition to the confounders. # indicates that models simultaneously adjust for mentally active and passive SB in weekdays and on weekend days, in addition to the confounders.

4 Discussion

This study examined smartphone addiction risk in a large sample of Saudi adults and tested associations of mentally active versus mentally passive sedentary behavior (SB) with addiction risk. As hypothesized, the prevalence of high-risk smartphone addiction in our sample was substantial (66.2%). Consistent with our second hypothesis, mentally passive SB, but not mentally active SB, showed strong, independent positive associations with smartphone addiction in both crude and adjusted models. Weekend patterns showed larger associations for mentally passive SB than weekday patterns. Finally, adults with excessive total SB (≥ 8 h/day) scored higher on smartphone-addiction scales and had higher smartphone addiction scores. Overall, these findings largely support the hypotheses proposed in this study.

The prevalence of high-risk smartphone addiction observed in this study (66.2%) is high but aligns with estimates reported in other online and regional surveys, which vary substantially depending on sampling frame and measurement approach. For example, a population-based Saudi study reported problematic smartphone use in approximately 64% of adults [18], whereas a lower prevalence has been observed in student and young adult samples when alternative instruments or cut-off scores were applied [33]. The elevated prevalence in the present study may partly reflect the use of an online convenience sampling strategy and the overrepresentation of students, who are known to engage more intensively with smartphones. In addition, prevalence estimates are highly sensitive to the cut-off thresholds used for the Smartphone Addiction Scale, and different scoring criteria can substantially alter classification into high-risk categories. Together, these factors limit the generalizability of the prevalence estimates to the broader Saudi adult population and suggest that the results should be interpreted primarily as indicative of relative associations rather than population-level burden. Several complementary mechanisms may explain why mentally passive SB (e.g., aimless scrolling, passive video watching) is more strongly related to addictive patterns than mentally active SB (e.g., reading, work-related phone use). First, engineered reward structures—characterized by variable, high-frequency reinforcement—are commonly embedded within digital platforms. These platforms use variable reward schedules (e.g., likes and unpredictable novel content) that mimic reinforcement patterns known to promote compulsive seeking behavior, making passive scrolling particularly “sticky.” Empirical and theoretical work on reward variability in digital contexts supports this mechanism [34,35]. Second, attentional capture and cue-reactivity mechanisms may contribute. Passive content often leverages autoplay, infinite scroll, and push notifications; these design features repeatedly capture attention and create conditioned cue-reward loops, thereby increasing compulsive checking and time-on-device [36]. Neurocognitive studies and reviews have demonstrated overlap between social-media engagement and activation of reward-related neural circuitry [37]. Third, lower cognitive load may make mentally passive SB easier to sustain and escalate. Also, mentally passive SB requires relatively little executive control, enabling longer sessions and seamless transitions (e.g., from brief checks to prolonged use). This low barrier favors escalation into problematic patterns, while mentally active SB often imposes natural stopping rules (task completion). Behavioral and conceptual analyses of “problematic vs. effectual” phone use support this distinction [38]. Finally, affective regulation and escape, people often use passive smartphone activities to escape negative effects or boredom; when these behaviors are repeatedly reinforced, they can develop into maladaptive coping strategies that resemble behavioral addictions [34]. Reviews of social-media motives and reward-based motives find affect-regulation and reward-seeking as consistent predictors of problematic use [39]. Taken together, these mechanisms explain both the direction and magnitude of the associations we observed. Mentally passive SB provides the ideal behavioral substrate for platform-engineered reinforcement and sustained engagement, thereby elevating addiction risk.

We found stronger associations of mentally passive SB with phone addiction on weekend days than on weekdays. This pattern is plausible and supported by recent literature: weekends typically offer more discretionary time and fewer structured obligations, permitting longer passive sessions and less natural interruption (e.g., work tasks). Several recent studies examining weekday/weekend differences in screen time and problematic use report similar weekend-amplified effects, suggesting that leisure-context permissiveness increases the manifestation of problematic patterns. For instance, a large-scale cross-sectional study found that among older adolescents, weekend smartphone use was negatively associated with mental well-being at all usage levels, while weekday use showed more nuanced (often dose-dependent) associations [40]. Another recent mobile tracking study noted that weekday screen time over 2 h notably increased mental health risks, especially when tied to passive scrolling behaviors [41]. These findings suggest that interventions aiming to reduce problematic smartphone use may be more effective if they specifically target passive weekend use, when individuals are most susceptible to prolonged, unstructured engagement.

Adults with excessive sedentary behavior (≥ 8 h/day) in our sample had higher smartphone addiction scores, indicating a greater burden of problematic smartphone use among individuals with prolonged sedentary time. This comorbidity echoes meta-analytic and longitudinal findings linking high screen time and problematic smartphones and social media use to adverse behavioral and psychosocial outcomes. For example, a meta-analysis of longitudinal cohort studies demonstrated that increased screen time significantly predicted a higher risk of depression, even after adjusting for confounders and baseline mental health status [42]. Additionally, a prospective study found that higher screen time was longitudinally associated with increased anxiety and depression symptoms at one-year follow-up among adolescents [43]. The relationship is likely bidirectional: poor mental health may drive more passive phone use as emotion regulation, while passive use can worsen mood via upward social comparison, sleep disruption, and displacement of restorative activities. These findings underscore the importance of addressing excessive total sedentary screen time not only as a marker of smartphone addiction but also as a potentially modifiable target to improve mental health outcomes at both individual and population levels.

Several potential moderators, confounders, and alternative explanations should be considered. First, age and student status may influence the observed associations, as younger adults and students typically report higher levels of problematic smartphone use. Differences in our sample composition, particularly the large student subgroup, may partly explain the high prevalence observed. Second, the app portfolio and number of apps used may act as contributing factors; use of multiple social media applications or apps designed to maximize engagement has been shown to predict problematic use, and device or application characteristics may serve as plausible mediators [18]. Finally, measurement and self-report biases should be acknowledged. Self-reported SB and retrospective recall may introduce estimation errors; incorporating objective device logging or activity monitoring would help triangulate and strengthen these associations [44].

Our findings indicate that public-health efforts should distinguish between types of sedentary behavior (SB) when designing prevention and intervention strategies. Targeting mentally passive behaviors such as reducing passive scrolling, limiting autoplay features, curating notifications, and encouraging “active” alternatives may yield larger benefits than blanket screen-time reduction messages. For instance, a randomized trial reducing screen time to ≤ 2 h/day for three weeks demonstrated small-to-medium improvements in depressive symptoms, stress, sleep quality, and overall well-being [45]. At the school and workplace level, digital-wellness tools and community-level campaigns that reduce passive consumption and promote structured, active engagement (and physical activity) have the potential to mitigate addiction risk and related mental-health burdens [46]. Additionally, interventions like phone bans and digital-wellness tools have shown promising effects. For example, meta-analytic evidence indicates that school smartphone

bans can modestly reduce social problems such as bullying and improve social well-being (effect size $d = 0.162$, $p < 0.05$) [47]. These findings demonstrate that environment-level interventions such as school-wide phone restrictions, digital-wellness tools, or curated device-use policies can be effective in mitigating smartphone addiction risk and its associated mental-health burdens, especially when they limit mentally passive consumption and promote structured, active engagement.

Evaluate interventions aimed specifically at passive-use reduction (e.g., disabling autoplay, batching notifications, promoting app limits) in randomized or quasi-experimental designs. Employ passive-sensing (device logs) paired with activity monitors to validate and extend self-report findings and to map temporally fine-grained associations (e.g., momentary affect \rightarrow subsequent passive use) [44]. Test whether increasing physical activity or structured, mentally active alternatives reduce passive SB and addiction risk; exercise-based strategies are increasingly suggested as adjunctive measures [46].

5 Limitations

Cross-sectional design prevents causal inference; bidirectionality remains possible (poor mental health \rightarrow passive use \rightarrow higher addiction scores). Self-reported sedentary time and smartphone measures are susceptible to recall bias and social desirability; objective logging would strengthen inference [44]. Sample composition (high proportion from the Central region and many students) may limit generalizability to the full Saudi adult population. The addiction construct and cutoffs vary across instruments and studies; prevalence comparisons must be interpreted considering instrument-specific thresholds [18].

6 Strengths

Large sample size with detailed separation of mentally active vs. mentally passive SB (including weekday/weekend breakdown), a relatively novel approach in smartphone-addiction epidemiology. Adjustment for multiple sociodemographic and anthropometric confounders increases confidence in the specificity of passive SB associations. Results are concordant with mechanistic literature on reward and designed engagement, lending construct validity to the observed associations [35].

7 Conclusion

Mentally passive sedentary behaviors (e.g., aimless scrolling, passive video consumption) were robustly associated with a higher risk of smartphone addiction in this large Saudi adult sample, whereas mentally active sedentary behaviors were not. Associations were stronger during weekend days and among adults with excessive total SB who also reported higher smartphone addiction risk. Health promotion initiatives should prioritize reducing mentally passive smartphone use by encouraging app-use limits, disabling autoplay and infinite-scroll features, and promoting structured screen-free periods, particularly during weekends. Workplace and university-based programs could incorporate digital-wellbeing education and scheduled movement breaks to interrupt prolonged sitting and habitual smartphone checking. At the community level, public awareness campaigns may promote substitution of passive screen time with cognitively engaging or physically active alternatives, such as reading, hobbies, or structured exercise programs.

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Ethics Approval: This study involved human participants and was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval was obtained from the Institutional Review Board of King Saud University (Approval No.: KSU-HE-23-345; 28 March 2023). All participants provided informed electronic consent prior to participation, and participation was voluntary and no incentives were provided.

Conflicts of Interest: The author declares no conflicts of interest.

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