DIGITAL SEDENTARISM AND MENTAL HEALTH: CAN PHYSICAL ACTIVITY OFFSET THE PSYCHOLOGICAL TOLL OF SCREEN-BASED LIFESTYLES IN URBAN PAKISTAN?

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ABSTRACT

This study examined relationships between physical activity, screen time, and depression among urban Pakistani adults. Contrary to global evidence, physical activity showed no significant protective effects against depression, while screen time demonstrated strong positive associations. Findings suggest traditional exercise recommendations may be less effective in this context, highlighting the need for culturally-adapted interventions prioritizing digital wellness and accessible movement opportunities. The results challenge universal assumptions about activity's mental health benefits, emphasizing how urban environments and lifestyle patterns can modify these relationships. Practical implications include workplace screen time policies, community-based activity programs, and redesigned urban spaces that better address local barriers to mental health promotion. **Keywords:** Screen-time, Fitness, Physical Activity, Depression, Anxiety, Pakistan.

INTRODUCTION

In an era dominated by digital lifestyles and rapid urbanization, the intersection between physical activity and mental health has never been more critical. The global shift toward sedentary behaviors, fueled by prolonged screen time and remote work, has contributed to rising levels of depression, anxiety, and stress, particularly in densely populated urban areas (1, 3). While the protective role of physical activity against mental health disorders is well-documented in Western contexts (3, 4), there remains a striking lack of localized research in regions like Pakistan, where urbanization and digital adoption are accelerating without parallel investments in public health infrastructure (6, 7). Karachi, one of the world's largest and fastest-growing megacities, presents a compelling case study. Its residents face unique socio-economic pressures, limited recreational spaces, and increasing reliance on digital platforms for work and social interaction, factors that may exacerbate mental health challenges (7, 8). Despite these growing concerns, empirical evidence on how physical activity influences psychological well-being in such settings remains scarce, leaving policymakers without actionable insights to address this silent crisis.

The problem is twofold. First, while international studies consistently highlight the mental health benefits of regular exercise (1, 3, 5), these findings may not fully translate to low-resource urban environments like Karachi, where cultural, economic, and environmental barriers to physical activity differ significantly (6, 9). For instance, safety concerns, lack of parks, and demanding work schedules often hinder consistent exercise, yet their impact on mental health outcomes is poorly understood. Second, the explosion of digital sedentarism, a lifestyle increasingly dependent on screens for work, education, and



leisure, has introduced new mental health risks (4, 5, 7), but whether physical activity can counteract these effects in high-stress urban populations remains unexplored. This gap is particularly alarming given that Karachi's workforce, including its youth, is rapidly transitioning to gig economy jobs and remote roles that demand long hours of screen time, potentially intensifying psychological distress (7,8). Without localized data, public health risk strategies relying on generic recommendations that fail to address the city's specific challenges.

The rationale for this study lies in its potential to bridge these gaps by examining the nuanced relationship between physical activity and mental health in an underserved urban population. By focusing on Karachi, the research will not only generate context-specific evidence but also uncover actionable insights for cities facing similar challenges across the Global South. For example, if findings reveal that even modest increases in physical activity can mitigate screenrelated stress (1, 3), interventions could range from workplace wellness programs to urban planning initiatives that prioritize accessible recreational spaces. Conversely, if socioeconomic barriers prove insurmountable (6, 9), the study could advocate for policy shifts, such as integrating physical activity into public health campaigns or leveraging digital platforms to promote movement. Either way, the results will fill a critical void in literature, offering a blueprint for addressing mental health in rapidly urbanizing, digitally saturated societies. Ultimately, this research transcends academic interest, it responds to an urgent public health need, providing a foundation for strategies that could enhance well-being in cities where the pressures of modern life are outpacing the resources to manage them.

Literature Review

Theoretical Background

The relationship between physical activity, sedentary behavior, and mental health has been extensively studied, yet the nuances of this dynamic in urban, low-resource settings like Karachi remain underexplored. Physical activity is defined as any bodily movement that requires energy expenditure, ranging from structured exercise to daily activities like walking (5). Sedentary behavior, particularly screen-based activities, has emerged as a significant risk factor for mental health disorders, with meta-analyses demonstrating a dose-response relationship between screen time and depression risk (12,14). This association appears particularly strong in adolescent populations, where excessive screen use displaces critical developmental activities and social interactions (5,13).

The neurobiological mechanisms linking physical activity to improved mental health are wellestablished, including endorphin release and reduced inflammation (8). Conversely, sedentary lifestyles may exacerbate mental health symptoms through disrupted circadian rhythms and social isolation (6,15). However, these relationships are moderated by cultural and environmental factors. In Pakistan specifically, studies reveal concerning trends: medical students with high during COVID-19 reported screen time significantly elevated depressive symptoms (8), while youth in low-income urban areas showed strong associations between sedentary behavior and psychological distress (7,9). These findings suggest that the mental health impacts of physical inactivity may be amplified in resourceconstrained environments.

Theoretical Development of Hypotheses

Building on this foundation, three key hypotheses emerge from the literature. First, the compensatory hypothesis suggests that physical activity may offset the negative mental health effects of sedentary behavior. This is supported by cross-national studies showing that meeting physical activity guidelines attenuates the depression risk associated with high screen time (16,17). In Karachi's context, where 78% of youth exceed recommended screen time limits (10), even moderate physical activity may provide protective benefits against depression and anxiety (7,20).

Second, the digital transition hypothesis highlights how rapid technological adoption may exacerbate mental health risks. Studies in Pakistan found pandemic-related increases in screen time were associated with poorer sleep quality and higher stress levels among university students (11), while gig economy workers reported unprecedented levels of screen-based sedentary behavior (21). These findings suggest that traditional physical activity



recommendations may need adaptation for digitally saturated populations (22).

The World Health Organization's 2022 mental health report emphasizes the urgent need for context-specific interventions in urban environments (22). This study's hypotheses directly address this gap by examining: 1) the compensatory potential of physical activity, 2) the moderating role of urban stressors, and 3) the emerging challenges of digital transition in Karachi. The findings will provide critical evidence for developing targeted interventions that account for Pakistan's unique socio-cultural and technological landscape (6,19).

Methodology

This cross-sectional study was conducted among adult residents of Karachi, to examine associations between physical activity levels and mental health outcomes (depression, anxiety, and stress). The target population comprised individuals aged 18 years and above selected through non-probability purposive sampling to ensure socio-economic diversity. Based on a 95% confidence level and 4% margin of error, the calculated sample size was 200 participants after accounting for potential non-responses.

Data Collection

Trained researchers administered structured questionnaires through face-to-face interviews after obtaining verbal informed consent. The tool consisted of three sections:

1. **Socio-demographics**: Collected data on age, gender, education, income, employment status, and household characteristics.

2. Physical Activity Assessment: Utilized the International Physical Activity Questionnaire (IPAQ) to quantify activity levels. MET-minutes/week were calculated for walking, moderate, and vigorous activities, with participants categorized into low, moderate, or high activity groups per IPAQ guidelines.

3. Mental Health Assessment: Employed the Depression, Anxiety, and Stress Scale (DASS-21) to evaluate symptom severity.

4. Each subscale (7 items per condition) used a 4-point Likert scale, with total scores doubled to align with the full DASS-42 scale.

Data was collected from 200 subjects from Karachi, Pakistan after taking informed consent. The sample comprised of both male and female gender with mostly young individuals.

Statistical Analysis

Data were analyzed using SPSS version 21. Descriptive statistics (frequencies, percentages, means ± SD) summarized participant characteristics and variable distributions. Cronbach's alpha assessed the internal consistency of DASS-21 and IPAQ scales, with values ≥ 0.70 considered acceptable. The primary analysis involved hierarchical multiple regression to model relationships between physical activity levels (independent variable), Screen Time and mental health outcomes (dependent variables: depression, anxiety, stresses severity categories). The analysis controlled for confounders including age, gender, and income. Model adequacy was evaluated using likelihood ratio tests and pseudo \mathbb{R}^2 values, with statistical significance set at $p < \infty$ 0.05.

Ethical Considerations

the study protocol received approval from the institutional review board. All participants provided verbal consent, and data were anonymized to ensure confidentiality. Access to raw data was restricted to the principal investigator and supervisor.

Data Analysis Table 1 Respondent Profile

Variable	Category	Frequency	Percentage (%)
Gender	Male	110	55%
	Female	90	45%
Location	Korangi	20	10%
	North Nazimabad	50	25%
	Nazimabad	45	22.5%
	North Karachi	25	12.5%

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	Orangi Town	15	7.5%
	Bufferzone	25	12.5%
	Federal B Area	20	10%
Income Bracket	Low	40	20%
	Moderate	120	60%
	High	40	20%
Employment	Employed	100	50%
2 /	Unemployed	50	25%
	Student	50	25%
Nature of Job (Those Employed)	R&D	25	25%
	Management	25	25%
	Education	20	25%
	Engineering (General)	10	10%
	Engineering (Civil)	10	10%
	Medical	10	10%

The sample profile highlights important work patterns that may influence mental health outcomes. Among employed respondents (50% of total sample), a significant proportion worked in research & development (25%), management (25%), and education (20%), occupations typically requiring prolonged screen time and sedentary behavior. These desk-bound jobs often involve 8-10 hours of daily computer use with limited movement breaks. The high representation (70%) of these screen-intensive professions suggests most working participants

face occupational conditions that may contribute to physical inactivity and excessive digital exposure, known risk factors for depression and anxiety. This work pattern characteristic helps explain the study's findings linking screen time with poor mental health, as participants' job demands likely compound leisure-time digital overuse, creating a 24-hour cycle of sedentary behavior with minimal opportunities for stressrelieving physical activity or social interaction during work hours.

Table 2 Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.666	.769	9

The Cronbach's alpha of .666 for the 9-item scale falls slightly below the conventional .70

threshold, indicating modest internal consistency.

Table 3 Model Summary

				Std. Error Change Statistics					
Model	R	R Square	Adjusted R Square	of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.805ª	.649	.647	.467	.649	363.894	1	197	.000
2	.807 ^b	.652	.645	.469	.003	.546	3	194	.652

a. Predictors: (Constant),

Screen_Time

b. Predictors: (Constant), Screen_Time, Walk, Vigorous_Activity, Moderate_Activity



The analysis reveals screen time powerfully predicts depression levels, accounting for nearly 65% of symptom variation (R^2 =.649, p<.001). When physical activity measures were added, the model improved only marginally (R^2 change=.003), with this tiny increase being statistically non-significant (p=.652). This pattern indicates that while screen exposure strongly relates to depressive symptoms, the current data

don't support physical activity meaningfully counteracting this relationship. The vigorous, moderate and walking activity measures collectively failed to demonstrate a clinically relevant protective effect against screen-related depression in this sample. These findings suggest screen time operates as an independent risk factor rather than one modifiable through exercise in this population.

Table	4 ANOVA _c	

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	79.506	1	79.506	363.894	.000ª
	Residual	43.042	197	.218		
	Total	122.548	198			
2	Regression	79.867	4	19.967	90.754	.000 ^b
	Residual	42.682	194	.220		
	Total	122.548	198			

a. Predictors: (Constant), Screen_Time

b. Predictors: (Constant), Screen_Time, Walk, Vigorous_Activity, Moderate_Activity

c. Dependent Variable: Depression

The ANOVA table confirms both regression models statistically predict depression (p<.001). Model 1 (screen time only) shows strong predictive power (F=363.89). Model 2 (adding activity variables) maintains significance (F=90.75) but reveals the additional predictors contribute minimally - the mean square residual barely changes (.218 vs .220), indicating physical activity variables don't meaningfully improve the model beyond screen time alone. The extremely small reduction in residual sum of squares (79.506 to 79.867) when adding three extra predictors further confirms their negligible impact. Essentially, while screen time powerfully predicts depression, the current analysis finds no evidence that physical activity variables provide substantial additional explanatory value.

Table 5 Coefficients

		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model		В	Std. Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	1.020	.138		7.371	.000		
	Screen_Time	.731	.038	.805	19.076	.000	1.000	1.000
2	(Constant)	1.086	.153		7.108	.000		
	Screen_Time	.738	.039	.813	18.983	.000	.979	1.022
	Vigorous_Activity	021	.018	048	-1.118	.265	.984	1.016
	Moderate_Activity	015	.033	019	452	.652	.973	1.027
	Walk	007	.018	015	356	.722	.983	1.017

a. Dependent Variable: Depression



The regression analysis reveals several important patterns about depression in this urban Pakistani population. Screen time shows a strong, consistent positive relationship with depression symptoms (β =.805-.813, p<.001), where each additional hour of screen use corresponds with about a 0.74-point increase in depression scores, even after accounting for physical activity. This robust association suggests digital overuse may be a key mental health risk factor in this setting. By contrast, none of the physical activity measures whether vigorous (β =.048, p=.265), moderate $(\beta = .019, p = .652)$, or walking $(\beta = .015, p = .722)$. demonstrate statistically significant protective effects. The minimal effect sizes and nonsignificant p-values indicate physical activity may not meaningfully buffer against depression in this context, contrary to findings from Western populations.

Several cultural and environmental factors could explain these results: physical activity in Karachi often occurs out of necessity rather than leisure, potentially lacking stress-relieving benefits; urban stressors like overcrowding and noise may overwhelm any psychological benefits of exercise; or measurement limitations may obscure true relationships. The near-identical coefficients for screen time across models (B=.731-.738) further confirm that physical activity does not moderate its harmful effects. These findings highlight how mental health determinants can vary substantially across cultures, suggesting urban Pakistani populations may require interventions targeting digital habits and environmental stressors rather than generic exercise promotion. The absence of multicollinearity (all VIFs<1.03) confirms each variable contributes unique information, strengthening confidence in these null findings for physical activity.

These findings present a nuanced understanding of mental health dynamics in urban Pakistan that both corroborates and challenges existing literature. The strong association between screen time and depression aligns with multiple international studies demonstrating dosedependent relationships between digital media use and poor mental health outcomes (4, 12, 14). Particularly relevant are findings from Pakistani research documenting similar patterns among university students (11) and adolescents (7), suggesting this is a nationwide concern. However, our results diverge from Western studies (5, 16) and some Asian research (20) by showing physical activity's protective effects may not translate to Karachi's urban context.

This discrepancy likely stems from how physical activity is practiced locally. While Karachi boasts numerous fitness facilities, our data suggest these resources may be underutilized by most residents. Previous Pakistani studies have noted similar patterns, where gym memberships and organized sports remain limited to lower-middle income groups (9, 10). Moreover, the cortisol-endorphin imbalance gains support from research on medical students in Sindh (8), who showed high stress levels despite some maintaining active lifestyles. This implies that activity quality (voluntary, enjoyable exercise) may matter more than mere participation.

The findings important carry practical implications. Corporations should follow global examples (22) by integrating workplace wellness programs, while universities could emulate successful campus initiatives from other Asian universities (20). Rather than generic exercise promotion, interventions might target specific barriers like: work-life balance policies to enable recreational activity, subsidized corporate gym memberships, and redesigned urban spaces that encourage walking. These approaches would address the voluntary exercise deficit while acknowledging Karachi's existing infrastructure.

Future research should investigate why Karachi's fitness resources aren't producing expected mental health benefits. Potential factors could include: high costs limiting access, cultural perceptions of exercise, or inadequate promotion of these facilities. Comparative studies between gym users and non-users in Karachi could clarify whether the null physical activity effects reflect measurement issues or true lack of benefit in this population. Such investigations would help tailor global mental health strategies to Pakistan's urban realities.

Conclusion

This study reveals that while screen time strongly predicts depression in Karachi's urban population, physical activity shows no significant protective effect. Neither vigorous exercise, moderate activity, nor walking demonstrated meaningful associations with reduced depressive symptoms, challenging global assumptions about exercise's mental health benefits. The findings



suggest that in high-stress, resource-constrained environments like Karachi, traditional physical activity interventions may be less effective than anticipated. Instead, screen time emerged as a dominant risk factor, requiring urgent attention. These results highlight the need for contextspecific approaches to mental health that account for local lifestyle patterns, urban stressors, and digital behaviors rather than relying solely on generalized physical activity recommendations.

The findings suggest medical practitioners in urban Pakistan should incorporate digital wellness assessments into routine care, helping individuals reduce harmful screen time while recognizing that traditional exercise recommendations may need adaptation to local realities. Policy makers could implement workplace regulations limiting after-hours digital communication and mandate movement breaks during the workday, approaches supported by regional studies showing benefits for mental health. Fitness professionals and physiotherapists might shift from gym-based programs to developing accessible community activities that align with cultural preferences and devise programs that align with physical fitness needs of the individuals. Academia and industry should collaborate for such programs and initiatives. These targeted interventions move beyond generic advice to offer concrete strategies that account for Karachi's unique combination of digital saturation, climate challenges, and existing infrastructure.

Further research should explore why physical activity fails to protect against depression in this context, is it measurement limitations, activity type, or environmental overrides? Longitudinal studies could assess whether specific activities (e.g., prayer-based movement, cricket) show different effects. Comparative urban-rural studies may clarify how city stressors modify these relationships. Qualitative work should investigate how locals perceive exercise and screen time; ensuring interventions align with cultural beliefs. Additionally, exploring non-exercise variables (sleep, social ties) could identify stronger protective factors. Finally, pilot interventions testing screen time reduction versus activity promotion could determine the most effective strategy for this population. These steps would refine mental health approaches for urban South Asia.

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