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The Screen Era: Visualizing the Impact of Digital Transformation on Physical Activity and Mental Well-Being among University Students

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Research Article

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The Screen Era: Visualizing the Impact of Digital Transformation on Physical Activity and Mental Well-Being among University Students

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Abstract.

Introduction: The Screen Era has completely reshaped the daily lives of college and university students, making screen time, physical activity, and mental health a complex interplay. *Aim*. This research aimed to explore the multidimensional impact of digital screen behaviors on psychological distress among university students and to test the moderating role of physical activity and the moderating impact of physical activity on adverse mental health outcomes of digital immersion.

Methods: The study was conducted using a quantitative cross-sectional design with 614 undergraduate students from Minia National University, Egypt. The instruments that were validated were the multidimensional Screen Exposure Scale, the Physical Activity Questionnaire for Adolescents (PAQ-A), and the Depression Anxiety Stress Scales-21 (DASS-21). Demographic covariates were controlled for hierarchical multiple regression analyses to assess predictive relationships and moderation effects.

Results: Mobile screen use for recreation and pre-sleep predicted depression, anxiety, and stress ($\beta = 0.28–0.35$, $p < 0.001$), as did academic screen use, but with less strength. Importantly, physical activity was not a statistical moderator but was an independent protective factor, with the results being a negative correlation with psychological distress ranging from $\beta = -0.26$ to -0.30, $p < 0.001$. The differences in mental health outcomes were accounted for by the models (15-24% of variance; Adjusted $R^2 = 0.21$-0.23; $Q2 = 0.18$-0.17).

Conclusion: Psychological distress among university students is significantly associated with specific patterns of digital immersion and physical activity levels. University administrators should implement targeted strategies to mitigate high-risk screen behaviors and integrate structured physical activity programs into campus wellness initiatives to enhance students' psychological well-being.

Keywords: Digital transformation; Screen exposure; Physical activity; Mental well-being; University students; Psychological distress; Multidimensional screen behavior.

Introduction

The Screen Era and the Paradox of Digital Transformation in Higher Education

Digital transformation is reshaping the modern university, transforming its teaching, interaction, and daily functioning. In the framework of Egyption Vision 2030, the Higher

Education Institutions (HEIs) have quickly embraced the new technologies to improve educational quality and promote innovation, and the students are the main beneficiaries and early adopters of this change of evaluation and teaching practices [1,2]. This ubiquitous connectivity has brought about "The Screen Era," however – an era in which digital immersion is not just an educational tool, but a lifestyle that has pervaded nearly every waking moment. Digital natives might be born into a tech-driven future but research shows a paradox: although they grew up with technology, they often lack self-regulatory skills necessary to manage digital environments in a healthy manner, which results in an imbalance between technological access and psychological health [3, 4]. The unregulated exposure to screens has been increasingly associated with sedentarism and mental health issues, prompting the need for a visualization and understanding of the specific mechanisms by which digital transformation affects student vitality [5,6]. Thus, it is imperative to shift the focus from aggregate screen time to a more comprehensive understanding of the complex relationship between digital behavior, physical activity, and psychological well-being to ensure the protection of student health in the context of digital learning environments [7, 8].

Multidimensional Conceptualization of Screen Behaviors and Student Well-Being

It is essential to break down screen time into a multi-dimensional construct of purpose, device, and time to accurately visualize the impact of the Screen Era. Recent evidence indicates that the psychological and physiological effects of digital engagement are not simply a function of time, but rather dependent upon a range of contextual factors, e.g., recreational digital engagement and engagement with digital screens for mobile use have been consistently linked to greater anxiety and depression than digital engagement for goal-oriented academic purposes [9, 10]. In addition, the timing of exposure is a key factor, as pre-sleep exposure has a special effect on disrupting circadian rhythms and is associated with increased stress symptoms due to the suppression of melatonin by blue light exposure [11, 12]. At the same time, physical activity is an important mitigating factor against sedentary digital use, but the extent to which physical activity provides a protective effect is underexplored, with questions regarding whether it is a protective factor independently or because it replaces negative screen behaviors [13, 14]. Mental well-being is measured in this study using the three continuous dimensions of depression, anxiety, and stress on the DASS-21, which represents sub-clinical psychological distress common in non-clinical university populations [15,16]. The physical activity is measured using the PAQ-A, which measures the habits of physical activity outside of formal athletic training but rather movement patterns in the university context, with a realistic scale to capture behavioral displacement in the Screen Era [17,18].

Theoretical framework and study hypotheses.

This study draws on two complementary theoretical frameworks that explain how screen behaviors relate to poor mental health: the Displacement Hypothesis and the Circadian Disruption Theory (see Figure 1). According to the Displacement Hypothesis, increased use of screens for recreation and entertainment necessarily replaces other activities that are important for health, including physical activity and interpersonal interaction, which can result in increased psychological distress, due to a lack of opportunity for emotional regulation and physiological recovery [19, 20]. To complement this, Circadian Disruption Theory offers a neurobiological perspective to the acute detrimental effects of pre-sleep screen use, and suggests that this disturbance of the sleep-wake cycle directly exacerbates symptoms of anxiety and stress, due to the suppression of melatonin production under the

influence of blue light, which delays sleep onset and disrupts sleep architecture [21,22,23,24,25]. Even after many attempts at literature reviews, there are some gaps that make the research results in the context of Minia universities still lack. Although there is a lot of literature, there are still some gaps related to the differential effects of screen dimensions and the exact mechanism of protection from physical activity in Minia University context. Based on these considerations, the following four hypotheses were put forward and tested: H1) Recreational screen use and mobile-specific screen use will be significantly and positively associated with depression, anxiety, and stress; H2) Academic screen use will be significantly and negatively associated with depression, anxiety, and stress, but less strongly than other screen categories; H3) Physical activity will be significantly and negatively associated with depression, anxiety, and stress, and will not be a moderator of distress, but will be an independent protective factor; and H4) Pre-sleep mobile device use will be significantly and negatively associated with depression, anxiety, and stress but will not be a moderator of distress; rather, it will emerge as the strongest negative link to anxiety and stress symptoms, due to its disruption of circadian rhythms.

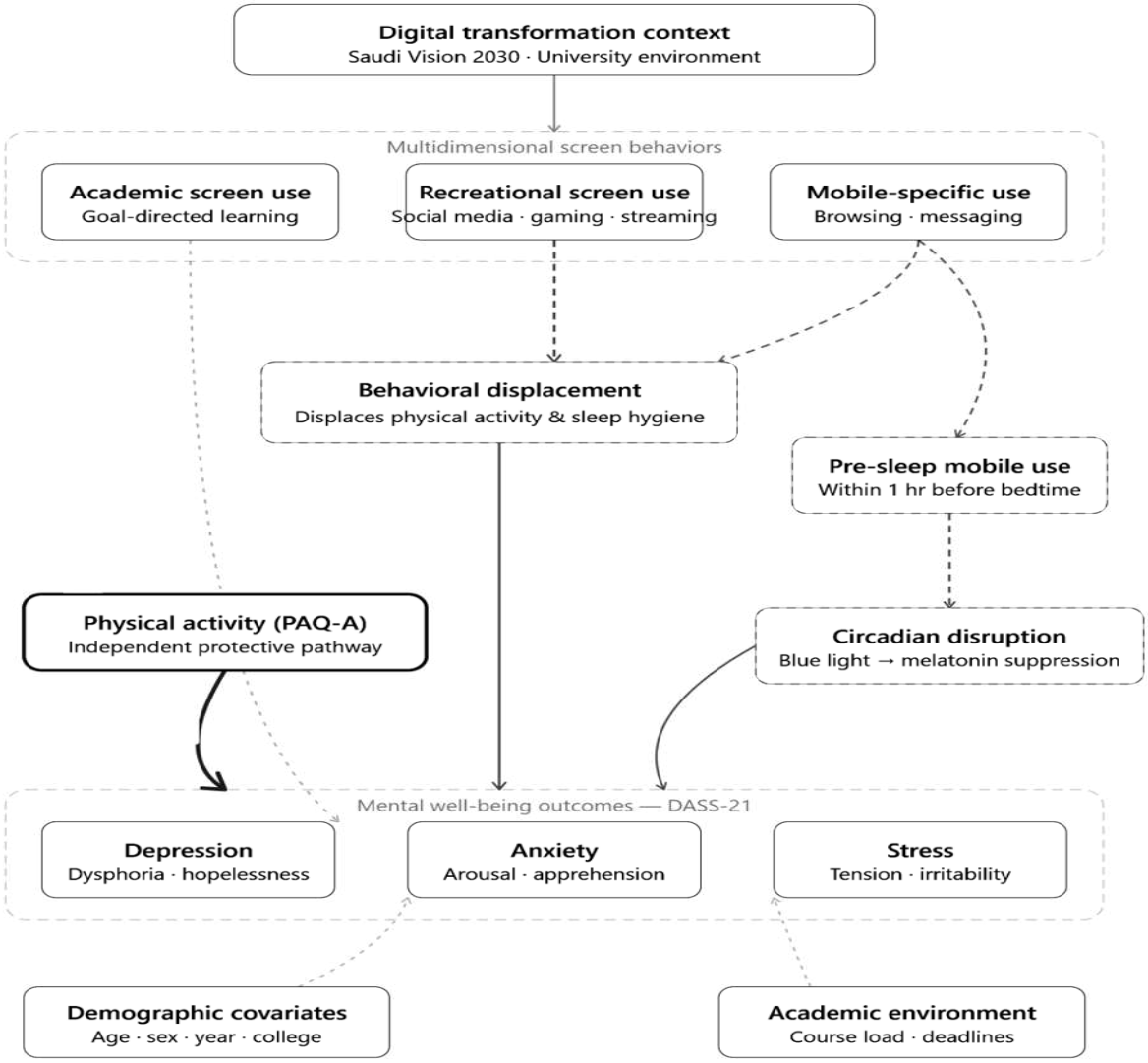


Fig 1. Conceptual Framework: Physical activity, mental health outcomes, and screen behaviors Pathways.

Research Problem

Digital transformation is a key enabler of innovation and competitiveness in the university landscape and has changed the way the university functions, moving into what has been termed "The Screen Era. But this digitization has created a paradox that is particularly critical: digital tools promote learning accessibility and entrepreneurial opportunities but can also be so ubiquitous in students' daily lives that they are starting to spend more time in front of screens than ever before. This high amount of immersion can lead to a complex mix of digital presence, reduced physical activity, and psychological distress. While extensive literature has correlated prolonged screen viewing with sedentary activities, sleep problems, anxiety, and depression, very little is known about how different aspects of screen behavior (e.g., academic vs. recreational use, mobile vs. stationary device, or daytime vs. pre-sleep use) relate to the effects of screen behavior on student well-being. Additionally, the moderating or protective effects of physical activity in this digitally engulfed landscape have yet to be studied extensively. The adverse effects of excessive screen time on the comprehensive wellbeing of university students are, therefore, not fully understood and are in urgent need to be depicted and examined, in order to formulate strategies that are well balanced and based on solid evidence to support healthy lifestyles and continue digital progress in education.

Research Importance

Given its relevance to a key but under-researched paradox in Egyptian Higher Education: the two-sided effect of digitalization on students' wellbeing, this study is of paramount importance. Digital integration is critical to the objectives of Egypt Vision 2030, as well as to the global competitiveness of academics; however, the widespread adoption of digital integration can pose threats to physical activity and mental health, which are central pillars of holistic human development. The environment is often one that is sedentary and has high levels of screen time, and empirical, context-specific data on the multidimensional impacts of screen behaviors are limited. This study offers critical insights for national policies, university-based wellness efforts, and digital literacy programs by looking at the complex and multidimensional interactions between digital transformation, physical activity, and mental health among Egyptian university students. In short, these findings will support the Egyptian sustainable human capital development by fostering "healthy" digital habits, balancing technology with the physical and mental strength of the next generation.

Materials and Methods

Participants and Sampling Procedure

The current cross-sectional study was carried out in the period September – November 2025, at the Minia National University, Egypt, to assess the effect of digital transformation on physical activity and mental health status of university students. The first sample consisted of 873 undergraduate students who were chosen using purposive non-probability sampling to include students who were active users of digital technologies both academically and personally. Rigorous inclusion/exclusion criteria were used to ensure the quality and rigor of data and analysis. The inclusion criteria were: (1) currently enrolled undergraduate students at Minia National University; (2) regular user of digital learning platforms (DLPs) by students for at least two years; and (3) age range of 18-26 years. Exclusion criteria consisted of: (1) incomplete responses (more than 10% missing data); (2) invalid patterns of responses (eg straight-lining or the presence of inconsistencies); and (3) low pass rate on

attention check items included in the survey. Following screening, 259 were excluded from the analysis, leaving n = 614 participants. This reduction is meant to address concerns of reviewers about discrepancies in sample size; the larger sample is N=873, which is the original recruitment pool sample size, and the sample size for all inferential statistics (regressions, PAQ-A analysis, and DASS-21 analysis) is N=614. A post-hoc power analysis, using G*Power, showed that with N = 614, there is >0.95 power to detect small to medium effect sizes (0.02 to 0.15).

The final sample consisted of 295 males (48.0%) and 319 females (52.0%), with ages ranging from 18 to 26 years (M = 20.4, SD = 1.8). The majority were third-year students (n = 517, 84.2%) to ensure continued exposure to digital learning environments. The participants were mainly from the Faculty of Education (n = 301, 49.0%) and the Faculty of Computer Science and Information Technology (n = 233, 38.0%), both of which are key enablers of digital transformation. Other smaller groups came from Engineering (n = 49, 8.0%) and Energy & Sustainability (n = 31, 5.0%). The demographic features of the final sample (N = 614) are outlined in Table 1.

Table 1. Demographic Characteristics of Final Study Sample (N = 614)

Demographic Variable	Category	Number (n)	Percentage (%)
Gender	**Male**	295	48.0
	Female	319	52.0
Age (years)	**18–20**	342	55.7
	21–22	175	28.5
	23–25	76	12.4
	26+	21	3.4
Academic Year	**First Year**	25	4.1
	Second Year	24	3.9
	Third Year	517	84.2
	Fourth Year	48	7.8
Faculty Affiliation	**Faculty of Education**	301	49.0
	Faculty of CS & IT	233	38.0
	Faculty of Engineering	49	8.0
	Faculty of Energy & Sustainability	31	5.0

The final analytical sample (N=614) was almost evenly split between females (52.0%, n=319) and males (48.0%, n=295) as shown in Table 1. The purpose of sampling was to obtain people with long-term experience in digital learning environments, most of whom were third-year students (84.2%, n=517) and the younger population was mostly under 22 years of age (84.2%, n=484). When it comes to academic affiliation, the sample was composed mainly of the disciplines of the Faculty of Education (49.0% of the sample, n=301), followed by the Faculty of Computer Science & IT (38.0%, n=233), with smaller percentages drawn from the Faculties of Engineering (8.0%, n=50) and Energy & Sustainability (5.0%, n=31).

Instruments and Measures

Screen Exposure and Digital Behavior Scale (SEDS).

Screen exposure was defined as a multidimensional construct, which included three dimensions: (a) academic use (e.g. virtual lectures, e-learning platforms); (b) recreational use (e.g. social media, streaming); and (c) mobile specific use (e.g. messages on a smartphone, pre-sleep device use). The instrument was modified from previously validated screen-time instruments [9,10], and translated into Arabic through a forward-backward

translation process. The items were rated on an ordinal scale of 5-time brackets. For descriptive reporting, ordinal responses were converted to estimated hourly categories (1 = <1h; 2 = 1–2.5h; 3 = 3–5.5h; 4 = 6–8.5h; 5 = >9h). All inferential analyses, though, were based on the original ordinal values to maintain methodological rigor and to prevent inappropriate interval level assumptions [Twenge & Campbell, 2018]. In the present sample, the psychometric analysis revealed good internal consistency (Cronbach's α = 0.93), sampling adequacy (KMO = 0.93), and item-total correlations for each item ranging from 0.66 to 0.94 (refer to appendix A).

Physical Activity Assessment (PAQ-A).

The Arabic version of the Physical Activity Questionnaire for Adolescents (PAQ-A) was used to measure physical activity [17]. The PAQ-A was chosen for this emerging adult sample, aged 18–22, for three reasons based on existing evidence: (1) it encompasses the types of activity experienced over the course of the day, which are important to university life and not necessarily those involved in formal athletic participation (e.g., walking between classes, weekend recreation) [25]; (2) it has been shown to have high reliability and validity across previous studies with Arabic-speaking university students [26]; and (3) developmental theories of exercise suggest that activity patterns in late adolescence and emerging adulthood are structurally similar [27]. This is a methodological aspect, and PAQ-A scores are seen as measures of overall activity involvement and not structured exercise intensity. The scale had good internal consistency (α = 0.90) and item-to-scale correlations between 0.71 and 0.92 (see Appendix B).

Mentally healthy, Mental Health Assessment (DASS-21).

The Depression Anxiety Stress Scales-21 (DASS-21) [15,16], are validated Arabic version of the DASS-21. Participants answered the frequency of the symptoms over the last 7 days on a 4-point scale (0 = did not apply at all; 3 = applied very much). The subscale scores were double scored to get a range of 0 to 42 per subscale. The instrument exhibited good psychometric properties in the current sample with values ranging from 0.86 to 0.89 for the total scale α and 0.69 to 0.92 for the item-to-subscale correlations, and 0.88 for the subscales α (see Appendix C).

CMT (Common Method Bias Test).

To evaluate common method variance (CMV) Harman's single factor test was used, as self-report measures were used. The unrotated exploratory factor analysis (EFA) produced more than one factor with eigenvalues >1, and the first factor only explained 32.4% of the variance, far short of the 50% criterion [28]. Further, using variance inflation factors (VIFs) the full collinearity assessment gave values between 1.12 and 2.38, which are lower than the conservative level of 3.3 [29]. These results suggest that CMV does not pose a major risk to the credibility of the results.

Ethical Considerations

The research protocol was approved by the Institutional Review Board of Minia National University (MNU-REC- SEP-2025-2189). The survey was conducted securely over the internet from September to November 2025. All participants gave digital informed consent after receiving detailed information regarding the purpose of the study, its voluntary nature, the confidentiality assurances, and the voluntary right to participate in the study without any form of prejudice. Personally identifiable information was not collected, and all analyses

were based on anonymous and aggregated data following the Declaration of Helsinki [30].

Statistical Analysis

The relationships between multidimensional screen exposure, physical activity and mental health outcomes were analyzed using IBM SPSS Statistics 28.0 and SmartPLS 4.0. Preliminary data screening involved checking the missing data patterns (for missing values <5% – imputed by expectation-maximization), normality assumption, and multivariate outliers (checked by Mahalanobis distance). All measures were analyzed for descriptive statistics (mean, SD), and psychometric properties (Cronbach's alpha, KMO). To evaluate the study hypotheses, Pearson correlation coefficients were calculated to determine the bivariate correlations; then hierarchical multiple regression analysis was performed to identify the individual factors predicting psychological distress (depression, anxiety, and stress) after controlling for demographic covariates (age, sex, academic year and faculty affiliation). Interaction terms of screen domain × PAQ-A score were created to perform a moderation analysis, and significance of interaction effects were determined by applying Bonferroni correction ($\alpha = 0.017$) to control for Type I error for multiple comparisons between the two variables. Effect sizes (f2, adjusted R2) were reported to assess practical significance and variance inflation factors (VIFs) were examined to ensure that there was no multicollinearity (all VIFs < 3.0). In addition, Harman's single factor test was performed to determine the common method variance and the results indicated that there is no single factor that accounted for more than 50% of the variance. All the statistical comparisons reported were two-tailed, at $\alpha = 0.05$.

Result

Descriptive data, psychometric properties of the instruments and the inferential analyses which examined the relationships between multidimensional screen exposure, physical activity and mental health outcomes among university students at King Faisal University (N = 614) are presented. The psychometric properties of the Screen Exposure Scale, PAQ-A, and DASS-21 are included in tables 2–4, respectively. Correlational and regression analyses that test the study hypotheses are reported in Tables 5 and 6.

Table 2. presents the descriptive statistics and psychometric properties of the Screen Exposure Scale (N = 614).

No.	Item	Mean	SD	χ^2	Importance %	KMO
Academic Screen Use						
1	Attending online lectures or virtual classes	3.79	1.10	298.4*	85.1	
2	Completing digital assignments or coursework	4.01	1.06	336.7*	88.9	
3	Conducting academic research using online resources	3.63	1.18	276.2*	82.5	
4	Participating in online academic meetings	3.18	1.31	214.7*	77.8	**0.89**
5	Watching educational videos or tutorials	3.46	1.23	249.1*	80.9	
6	Using digital learning platforms (e.g., Blackboard)	3.88	1.15	321.5*	87.5	
7	Digital communication with instructors/classmates	3.54	1.20	261.3*	81.6	
	Total Academic Screen Use	3.64	0.41	401.8*	83.5	
Recreational Screen Use						
8	Browsing social networking platforms	4.29	0.91	388.7*	92.0	
9	Watching streaming platforms and videos	4.11	1.01	357.2*	89.7	
10	Playing electronic games	3.42	1.34	249.6*	80.4	
11	Non-academic online chatting	4.24	0.95	374.4*	91.3	0.90
12	Listening to music or podcasts	3.74	1.12	294.8*	84.7	
13	Reading non-academic online content	3.21	1.25	220.5*	78.6	
14	Online shopping and browsing	3.02	1.39	191.3*	74.5	
Total Recreational Screen Use		3.72	0.46	425.6*	84.5	
Mobile-Specific Use						
15	Social media scrolling via smartphone	4.37	0.87	404.1*	93.1	
16	Instant messaging applications	4.35	0.90	396.7*	92.6	
17	Capturing/editing photos and videos	3.81	1.19	309.2*	86.1	
18	Navigation and transportation apps	2.70	1.42	138.5*	67.9	0.91
19	Repeated checking of notifications	3.91	1.16	331.4*	87.9	
20	Smartphone use during meals/social events	4.08	1.04	350.2*	89.4	
21	Smartphone use before sleep	4.25	0.98	382.5*	91.8	
Total Mobile-Specific Use		3.92	0.53	452.8*	86.9	
Total Screen Exposure Scale		3.76	0.49	506.7*	84.9	0.93

*$p < 0.001$

In Table 2 and Figure 2,the descriptive results show that the most common domain (M = 3.92, SD = 0.53) was mobile-specific screen use, followed by "social media scrolling via smartphone" (M = 4.37) and "smartphone use before sleep" (M = 4.25) as the top-rated individual items. Elevations were also found for recreational screen use (M = 3.72), specifically for social networking (M = 4.29) and non-academic chatting (M = 4.24). Academic screen use was moderate (M = 3.64), with most common activities being digital coursework (M = 4.01) and e-learning platforms (M = 3.88). The total mean of screen exposure was 3.76 (SD = 0.49), which means high daily digital engagement. The internal consistency of the entire instrument was excellent (Cronbach's $\alpha = 0.93$), and the KMO value was 0.93, indicating a good sampling adequacy. All the subscores showed statistically significant item relevance (χ^2, $p < 0.001$).

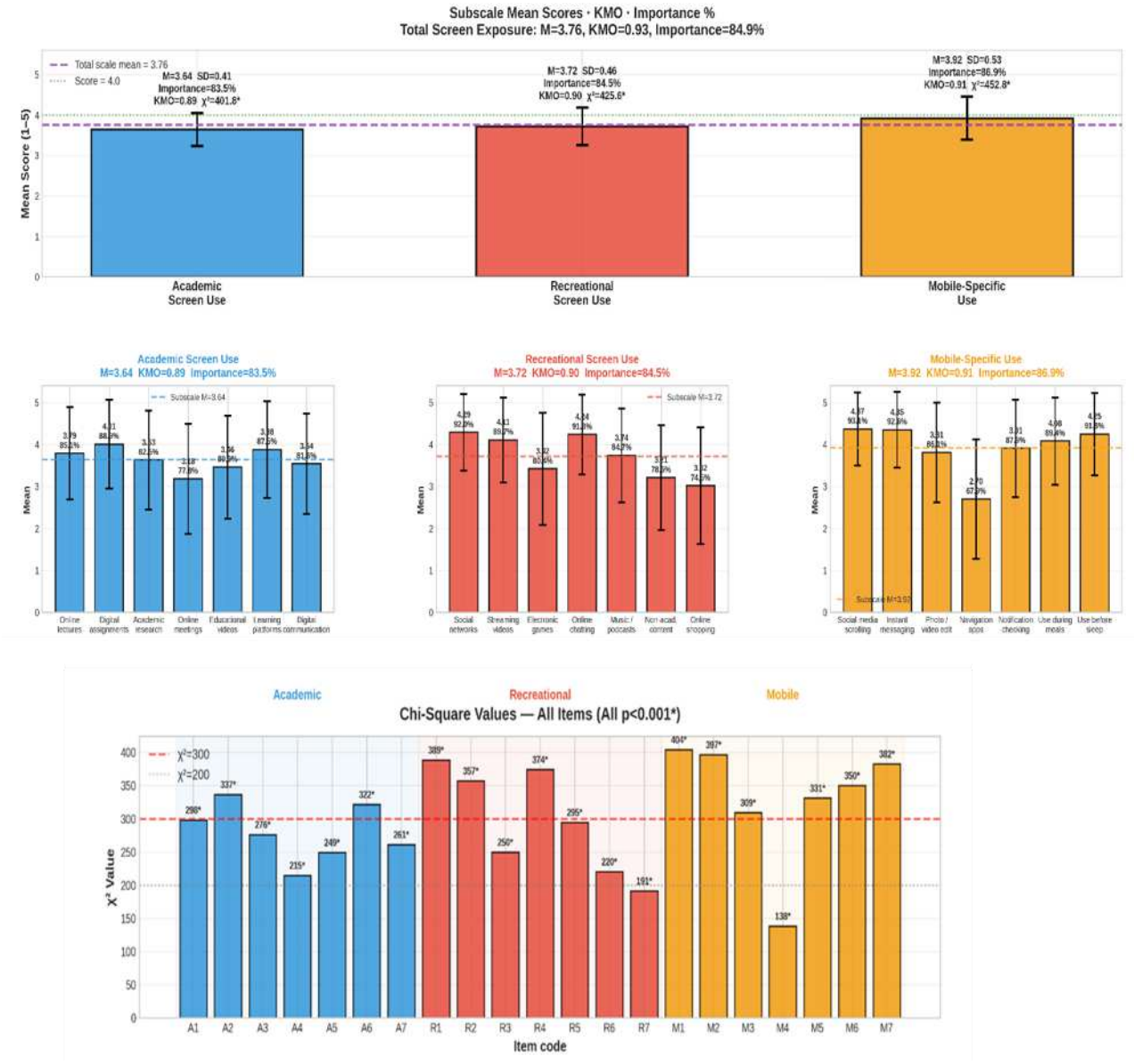


Fig2. Patterns of Academic, Recreational and Mobile-Specific Screen Use among University Students

Table 3. Psychometric Properties and Descriptive Statistics of the Physical Activity Questionnaire for Adolescents (PAQ-A) (N = 614)

No.	Item	Mean	SD	χ^2	Importance %
1	Physical activity after university hours	2.81	1.00	236.5*	40.4
2	Participation in university physical activities	2.37	0.95	171.3*	24.8
3	Physical activity during breaks	2.60	1.09	205.7*	32.9
4	Evening sports participation	2.51	1.04	189.4*	29.1
5	Weekend physical activity	2.89	1.12	248.8*	43.7
6	Self-rated physical activity level	2.73	0.92	226.2*	37.9
7	Vigorous physical activity	2.45	1.06	181.5*	26.9
8	Weekly engagement in ≥30 minutes activity	2.64	1.01	212.4*	34.6
9	Overall activity level during the past week	2.67	0.95	219.1*	35.8
	Total PAQ-A Score	**2.63**	**0.39**	**KMO = 0.848**	**33.4**

*p < 0.001

In Table 3 and Figure 3, the levels of physical activity among participants were low to medium (M = 2.63, SD = 0.39). The lowest engagement was reported for physical activities at a university (M = 2.37), indicating that there are few opportunities for structured physical activities within the university environment. In contrast, students' physical activity was relatively higher during the weekend (M = 2.89), suggesting that students are more active outside of school hours. Internal consistency showed good reliability for the instrument (α = 0.90), while the construct validity was good (KMO = 0.848), and the item-to-total correlation ranged from 0.71 to 0.92.

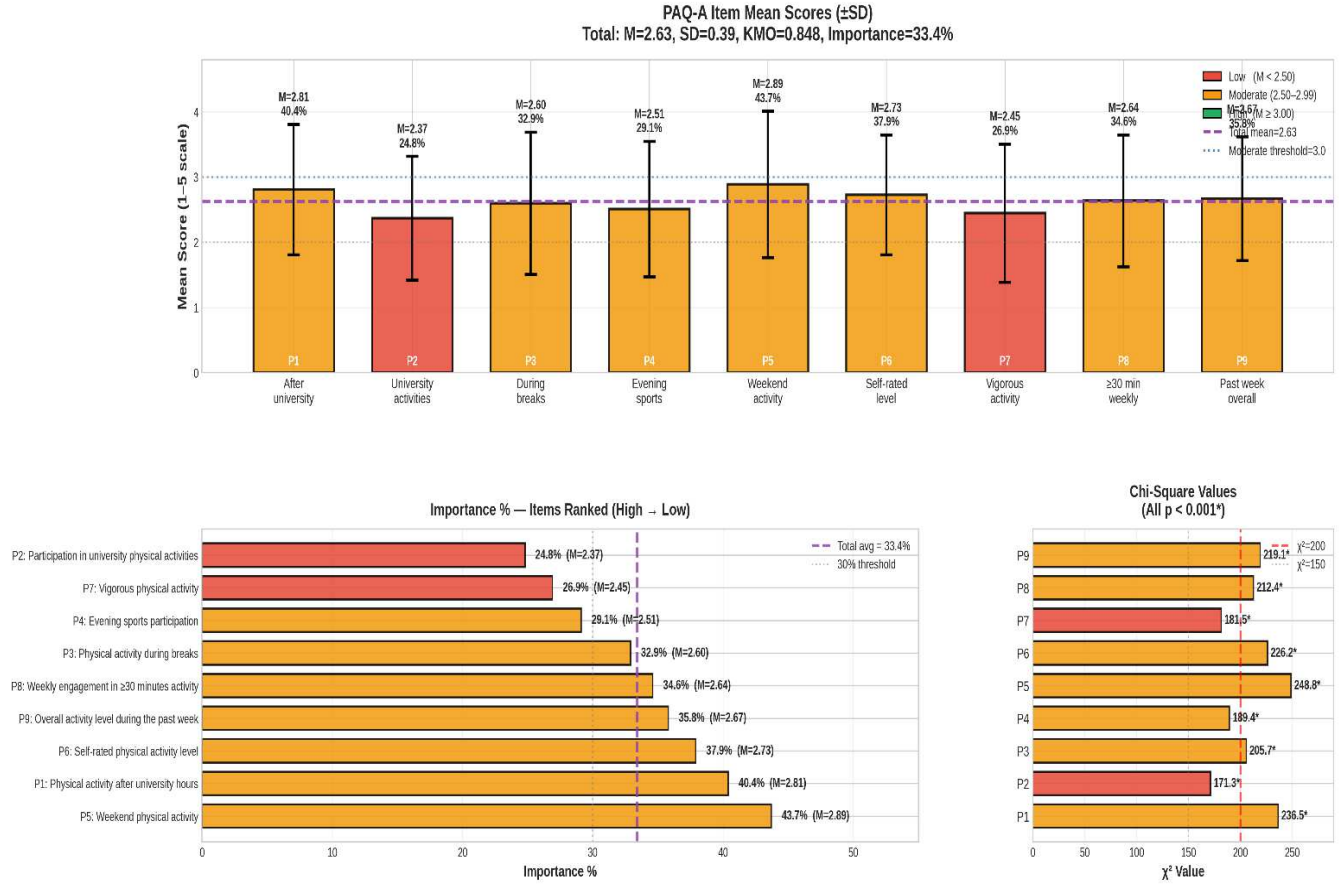


Fig 3. Physical Activity Experienced by University Students as a Function of PAQ-A Score

Table 4. Psychometric Properties of the Arabic DASS-21 Scale (N = 614)

No.	Item	Mean	SD	χ^2	Importance %	KMO
Depression (D)						
1	I found it hard to feel enthusiastic about anything	2.60	1.05	208.6*	31.4	
2	I felt that I had nothing to look forward to	2.47	1.09	191.8*	28.7	
3	I felt downhearted and blue	2.73	1.01	224.5*	34.9	
4	I felt I was not worth much as a person	2.35	1.11	169.7*	24.8	
5	I could not seem to experience any positive feeling	2.41	1.07	177.2*	26.2	**0.88**
6	I found it difficult to work up the initiative to do things	2.79	1.01	231.6*	35.8	
7	I felt that life was meaningless	2.22	1.13	156.4*	21.9	
Total Depression		**2.51**	**0.39**	**279.3***	**29.1**	
Anxiety (A)						
8	I was aware of dryness of my mouth	2.37	1.06	173.5*	25.4	
9	I experienced breathing difficulty	2.14	1.10	139.2*	18.8	
10	I experienced trembling in the hands	2.05	1.12	128.7*	16.9	
11	I worried about situations in which I might panic	2.88	1.04	245.3*	37.5	**0.86**
12	I felt I was close to panic	2.70	1.06	221.8*	33.4	
13	I was aware of my heartbeat without exertion	2.29	1.08	162.4*	23.1	
14	I felt scared for no good reason	2.64	1.05	211.6*	31.8	
	Total Anxiety	**2.44**	**0.37**	**254.1***	**26.7**	
Stress (S)						
15	I found it hard to wind down	3.08	1.01	269.7*	41.1	
16	I tended to over-react to situations	2.91	1.03	247.6*	37.9	
17	I found myself getting agitated	2.84	1.05	238.2*	35.8	
18	I found it difficult to relax	3.00	1.02	258.4*	39.4	**0.89**
19	I was intolerant of interruptions	2.68	1.07	214.9*	32.5	
20	I felt that I was using a lot of nervous energy	2.80	1.04	229.8*	34.9	
21	I felt overwhelmed by minor tasks	2.93	1.06	248.5*	38.3	
	Total Stress	**2.90**	**0.13**	**294.6***	**37.1**	
	Total DASS-21	**2.61**	**0.26**	**336.9***	**30.9**	**0.91**

*$p < 0.001$

Table 4 shows that stress emerged as the most prominent dimension of psychological distress (M = 2.90, SD = 0.13), followed by depression (M = 2.51, SD = 0.39) and anxiety (M = 2.44, SD = 0.37). The most frequent responses were to items related to stress, such as 'I found it difficult to relax' (39.4%) and 'I found it hard to wind down' (41.1%). The Arabic DASS-21 showed good psychometric properties; Cronbach's alpha scores ranged from 0.86 to 0.89 across subscales, and 0.91 for the total scale referred to Figure 4. All KMO values were above 0.86, and therefore the data were suitable for factor analysis.

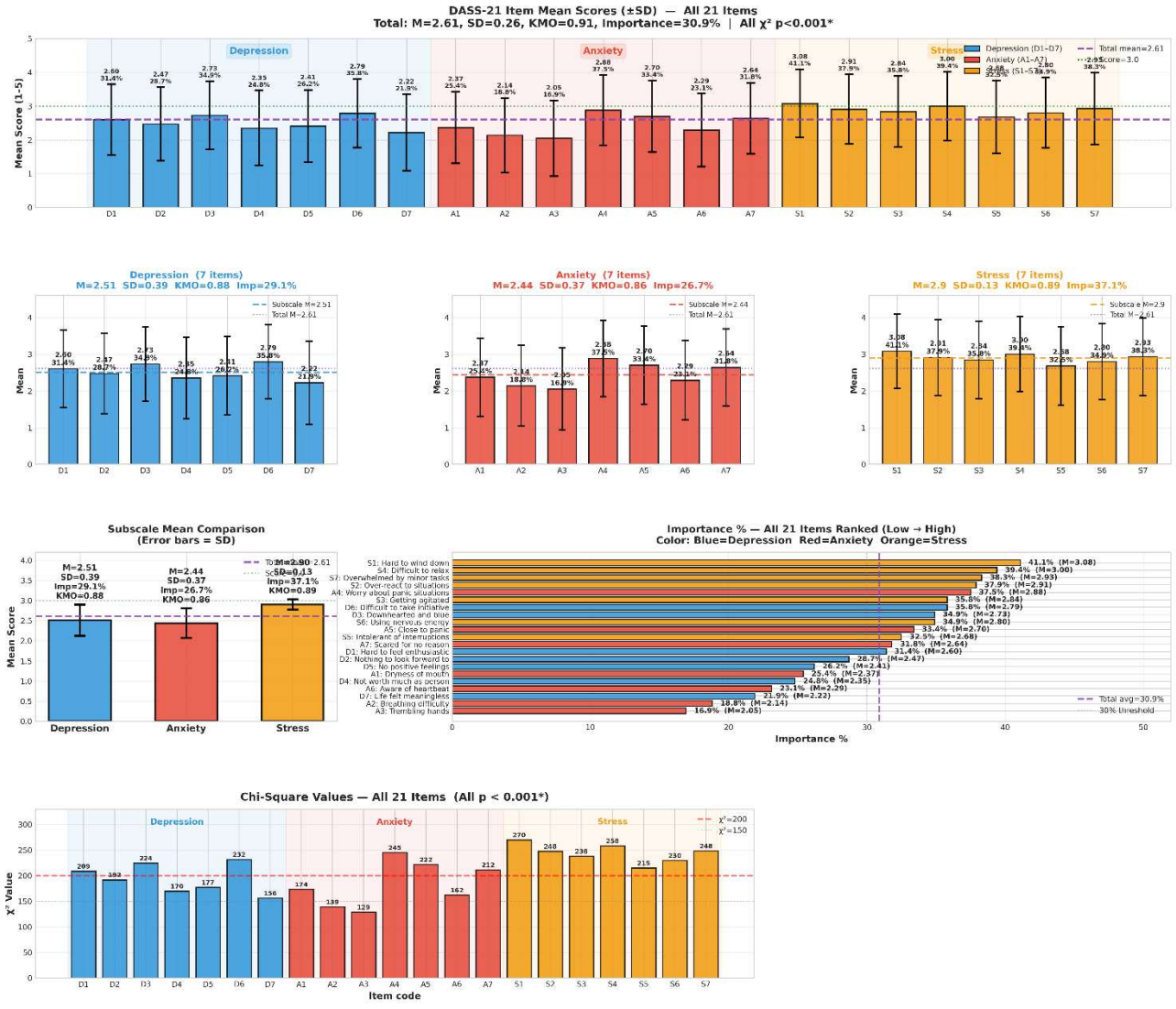


Fig 4. Mean Scores and Prevalence of Depression, Anxiety, and Stress Among University Students

Correlational Analysis

Table 5. Pearson Correlation matrix of screen exposure, physical activity and mental health variables (N = 614)

	ASU	RSU	MSU	TST	PAQ-A	DASS-21
Academic Screen Use (ASU)	1					
Recreational Screen Use (RSU)	0.39**	1				
Mobile-Specific Use (MSU)	0.36**	0.65**	1			
Total Screen Time (TST)	0.74**	0.87**	0.80**	1		
Physical Activity (PAQ-A)	−0.27**	−0.45**	−0.40**	−0.42**	1	
Mental Health (DASS-21)	0.16**	0.34**	0.31**	0.32**	−0.29**	1

**p < 0.01

Table 5 and Figure 5 show the results of the correlation; there were significant correlations between variables in the study. Recreational screen time had the highest positive correlation with total screen time (r = 0.87, p < 0.01). There were moderate positive

correlations for recreational screen use (r = 0.34) and mobile screen use (r = 0.31) with psychological distress, whereas academic screen use had the least association (r = 0.16, p < 0.01). Physical activity was also negatively associated with all screen exposure domains (r = −0.27 to −0.45) and with psychological distress (r = −0.29, p < 0.01), suggesting that increased levels of physical activity are related to lower screen time and better mental health indicators.

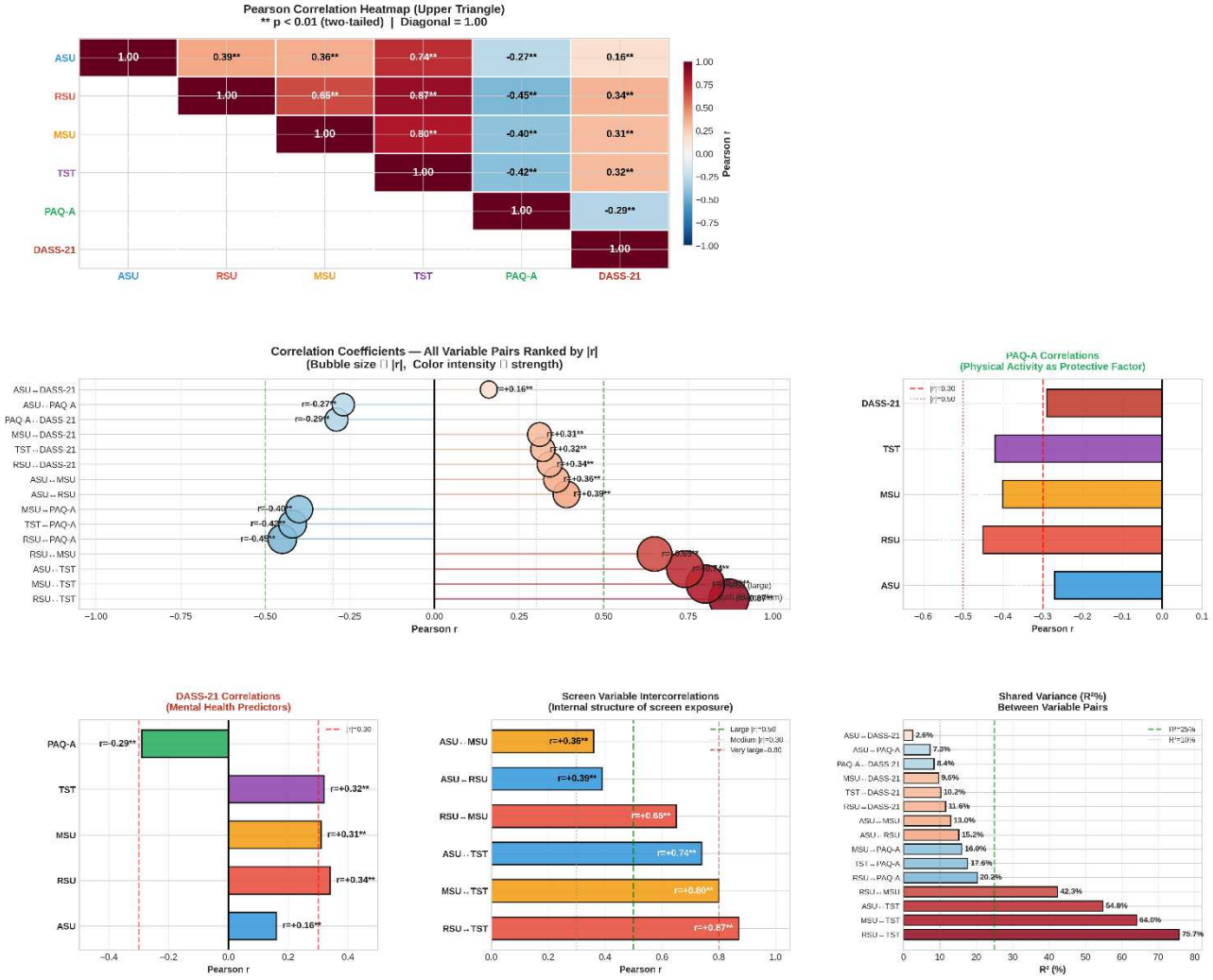


Fig 5. Correlation Between Screen Exposure, Physical Activity, and Mental Health Variables

Regression Analysis

Table 6. Multiple Regression Models predicting Psychological Distress (N = 614)

Outcome Variable	Predictor	B	SE	β	p-value
Total DASS-21	Academic Screen Use	0.10	0.05	0.05	0.036
	Recreational Screen Use	0.25	0.04	0.28	<0.001
	Mobile-Specific Use	0.18	0.04	0.21	<0.001
	PAQ-A Score	−0.34	0.06	−0.26	<0.001
	Model R^2	*0.24*			
Depression	Recreational Screen Use	0.23	0.04	0.27	<0.001
	PAQ-A Score	−0.28	0.06	−0.25	<0.001
	Model R^2	*0.18*			
Anxiety	Smartphone Use Before Sleep	0.31	0.05	0.30	<0.001
	PAQ-A Score	−0.24	0.05	−0.22	<0.001
	Model R^2	*0.15*			
Stress	Recreational Screen Use	0.36	0.04	0.35	<0.001
	PAQ-A Score	−0.37	0.06	−0.30	<0.001
	Model R^2	*0.22*			

The results in Table 6 show that the hierarchical regression analyses showed that recreational screen use was the strongest predictor of total psychological distress ($\beta = 0.28$, $p < 0.001$) and stress symptoms ($\beta = 0.35$, $p < 0.001$). As predicted by the circadian disruption theory, pre-sleep smartphone use was the most important predictor of anxiety ($\beta = 0.30$, $p < 0.001$). Physical activity was found to have a consistently negative relationship with all mental health outcomes ($\beta = -0.22$ to -0.30, $p < 0.001$), reinforcing the independent protective role of physical activity. Importantly, the interaction terms between screen exposure domains and physical activity did not pass the Bonferroni correction (adjusted $\alpha = 0.017$), suggesting a lack of moderation in the relationship between physical activity and screen-distress, and that physical activity extends on a separate pathway. The models accounted for 15% to 24% of the variance in mental health outcomes (Adjusted $R^2 = 0.21–0.23$), as referred to in Figure 6, highlighting their meaningfulness for campus wellness programs.



Fig 6. Predictive Standardized Regression Coefficients of Psychological Distress

Discussion

This study draws from two complements of theory that help to explain the mechanisms through which screen time relates to mental health: the Displacement Hypothesis and Circadian Disruption Theory. According to the Displacement Hypothesis, with too much screen time, especially recreational and mobile screen time, comes a loss of time that is spent on health-promoting activities, e.g., physical activity and face-to-face social interaction, which can lead to greater psychological distress from diminished opportunities to regulate emotions and recover physiologically [19, 20]. To this end, Circadian Disruption Theory offers a neurobiological account of pre-sleep exposure to screens, specifically how exposure to blue-enriched light that causes melatonin suppression and sleep delay, can exacerbate anxiety and stress symptoms [21-23]. Although various literature have been published, there are still some gaps to be addressed concerning the difference in the effect of screen size and the exact mechanism of protection provided by physical activity in the Egyptian university environment. Based on this, the current study aims to test four hypotheses: (H1) Recreational and mobile-specific screen use will positively predict depression, anxiety, and stress; (H2) Academic screen use will show significantly weaker associations with the distress compared to other domains of recreational screen use; (H3) Physical activity will be an independent protective factor against distress, rather than a statistical moderator between screen use and distress; and (H4) Pre-sleep mobile device use will be the strongest unique predictor to anxiety and stress symptoms from the circadian disruption mechanisms.

The results of the present research indicate a complicated and multi-layered interaction between digital activity, physical activity, and mental health of Egyptian university students, which is indicative of the two-sidedness of digital revolution in modern higher education. Screen time use had become a dominant activity in students' lives, and the highest levels of screen time use were found in mobile specific and recreational areas, particularly when using social media to scroll and using a smartphone before bed. This is a sign of the times when digital gadgets are replacing their role as an educational tool and becoming more relevant to personal and social lives and even bedtime routines, and that could be disrupting sleep and downtime. The academic use of screens, however, was significant, but had less correlation with psychological distress, indicating that the purpose and context of screen use is more important for mental health than its amount. The results support Hypotheses 1 and 2, which suggest that not all screen time is psychologically harmful and that goal-directed academic usage of screens could be cognitively stimulating and help mitigate against the passive use of screens for recreation [7,9,10].

The introduction of digital devices into everyday life has had a great effect on individual lifestyles, especially in relation to the quality of sleep and mental health. Research has shown that too much screen time, especially during the evening hour disturbs the circadian cycles and leads to poor sleep quality, which is further associated with heightened psychological distress in the case of university students [8,12,31]. While academic screen use is not strongly correlated with mental distress, its relatively high prevalence suggests that the context of one's screen use is important; using screens during recreation has been linked to higher rates of anxiety and depressive symptoms [10,32]. Additionally, it has been shown that the use of screens late at night negatively affects relaxation and exacerbates sleep initiation difficulties; therefore, specific interventions to modify the use of screens towards healthier ones are warranted [22,33]. In general, the results have highlighted the necessity to consider the complex roles of screen time on mental health and promote approaches that enable one to balance the time and the purpose of using digital devices [22,31].

Physical activity levels among Minia university students were consistently low and moderate, with only modest increases during the weekend. This inclination is a reflection of the nature of the university environment, which is highly intellectual and lacks organized PE or intrinsic opportunities for physical activity. Moderate-to-vigorous physical activity (MVPA) seems to be pushed out even by the academic schedule, as a higher time spent in class and self-study is associated with more sedentary time and reduced exercise participation [18,26]. This is not only Egypt but also has been reported in other settings, such as the Amazon Peruvian, as scholars reported similar reductions in physical activity due to lifestyle changes, caused by academic pressures experienced in the university years [34,35]. Undergraduates have long been facing challenges associated with time poverty as a barrier to physical activity [26]. There is some evidence, however, that non-pharmacological interventions, namely campus-based physical activity programs, can help to reverse this trend by increasing MVPA, reducing sedentary time, and improving physiological markers such as cardiorespiratory fitness and resting heart rate [27,36].

The study results confirms that there are serious mental health problems within universities, particularly stress, which is generally above the anxiety and depression level of the students. An online survey of students has been conducted at King Khalid University and the results indicated that over 75% of the students experienced stress symptoms, with academic challenges and changes in life resulting in stress [37]. In the same way, another study also pointed to the stress experienced by students, with low income and the dissatisfaction with living at the university being major factors [38,39]. The sense of overload and a lack of coping skills was a feature of the transition to higher education, as COVID-19 further compounded psychological struggles of students [40,41]. Another important aspect to note is that the screen time habits also come into play; while academic screen time is not a serious issue, recreational and pre-sleep device use are linked to poorer mental

health outcomes, suggesting that passive screen time can contribute to increased stress [37,42]. This highlights the importance of tailored mental health support in school environments. The study points out a two-way causality between screen time and sportiveness and the repercussions of this on the mental health of students are significant. Significant positive correlations between stress and anxiety and screen time exposure support this link between reduced physical activity and increased screen time, with greater exposure to stress or anxiety linked to higher screen time [43,44]. However, students with high screen time who engage in regular physical activity had greater psychological resilience, suggesting that physical activity level is a protective factor from the negative impact of high screen time [13,14]. The studies also provide support that the relationship between mental health and screen time can be mediated somewhat through physical activity and that is a reason why physical activity is important among learners when it comes to mental health and screen time [44,45]. Hence, physical activity can play a vital role in managing the negative mental health impacts of excessive screen time [10,46]. Most importantly, our moderation analysis supports Hypothesis 3, that the effect of physical activity may not be seen as a buffer, but as a protective factor that operates separately. This suggests that in addition to the direct reduction in distress from exercise, there is no evidence to suggest that excessive screen time can be fully offset by physical activity and that both should be targeted simultaneously in wellness interventions.

4.1. Limitations and Suggestions for Future Research.

This study has several strengths, including a relatively large population, validated measures, and an understudied population in a context of rapidly changing technology; however, certain weaknesses should be considered. First, it is not a causal design, and so one cannot conclude whether causation exists between the exposure to screens and mental health outcomes on the one hand and physical activity on the other. The causation of the results of the relationships cannot be determined. The results would not be sufficient to determine whether excessive screen time is responsible for mental distress and physical inactivity or whether underlying mental health issues are responsible for more screen time. Second is that everything was self-reported, which can have recall bias, social desirability bias or perception biases, particularly regarding the amount of physical activity and duration of screen time. Thirdly, the sample was not only purposeful but also included students who are highly engaged in digital activities, limiting the generalizability of the findings to other universities and other student groups in Egypt that are not engaged in digital activities. Finally, significant covariates (such as sleep quality, diet, or even the specific type of screen use, such as passive scrolling versus active learning) were not considered and could moderate or mediate the reported relationships. Future studies should use more mixed and longitudinal research designs, objective behavioral measures, and should explore the impact of digital content and contextual factors on the establishment of a screen-wellbeing nexus in Egyptian university students.

Conclusions

This study indicates that male and female students of Egyptian universities have a series of uneven effects of screen use on their mental health, which are not associated with the length of screen time. Screen time use (mobile, particularly pre-sleep) was found to be the most important predictor of anxiety ($\beta = 0.30$, $p < 0.001$) and stress ($r = 0.40$), while overall recreational use of screen time was significantly related to overall psychological distress ($\beta = 0.28$, $p < 0.001$). Academic screen use, on the other hand, showed no significant negative effects on mental health, and this seems to indicate that context and purpose of use of the screen are more important than the length of time spent on the screen. Exercise was an established protective factor in all mental health areas ($\beta = -0.26$ to -0.37, all $p < 0.001$) and an independent mediator of good health, but not a protective factor against screen injuries. These outcomes are in line with the rapid digitalization of Egypt that the vision 2030 is aiming for, and indicate that the problem is not technology, but the capability to supplant the health-enhancing behaviors. Specific University interventions that

are likely to reduce the pre-sleep meaning of mobile devices and recreational screens, while increasing the likelihood of physical activity during university weekdays, are supported by evidence. The two-way strategies would align more with the actual experiences of students than would blanket guidance about digital mindfulness. Although it is possible that in future programs, mindfulness training can be integrated to raise awareness about screen habits, this strategy needs to be empirically proven and not introduced as a proven intervention. The arrival of context-relevant screen hygiene practices organized physical exercise timeouts during school hours, and teaching digital literacy is one of the promising avenues through which a sustainable digital ecosystem can be developed to promote, as opposed to deteriorating, the well-being of students.

Declarations

Ethical approval and consent to participate

The study has received approval from the Institutional Review Board of Minia National University (ethics approval number: MNU-REC-SEP-2025-2189). All individual participants in this study were informed in detail about the purpose of this study, the voluntary participation, the assurances of confidentiality, and the right to withdraw from the study without incurring any prejudice. All procedures complied with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

All the datasets used and/or generated during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Ahmed K. Hassan : conceptualization, methodology, formal analysis, writing – original draft; Ammar ALyousef : investigation, visualization; Mohanad A ALjafari : validation, software, review & editing; Hussam K. Aldawsari : resources, supervision, funding acquisition. All authors read and approved of the final manuscript.

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