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Predicting mental health risk in academic communities through digital technology usage patterns: the mediating role of sleep quality

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ABSTRACT

The increasing reliance on digital technology in academic environments has transformed learning, teaching, and communication. However, excessive digital technology usage may negatively affect psychological well-being. This study examined whether digital technology usage predicts mental health risk in academic communities, with sleep quality investigated as a mediating factor. A quantitative cross-sectional study was conducted among 165 academic staff members and postgraduate students. Digital technology usage, sleep quality, depression, anxiety, and perceived stress were assessed using standardized measures. Data were analyzed using correlation, regression, and mediation analyses. The findings showed that greater digital technology usage significantly predicted higher levels of depression, anxiety, perceived stress, and poorer sleep quality. Sleep quality partially mediated the relationship between digital technology usage and depression, while fully mediating its relationships with anxiety and perceived stress. These findings indicate that sleep quality is an important mechanism through which digital technology usage influences psychological well-being. The study highlights the value of monitoring digital technology usage and promoting healthy sleep habits as practical strategies for reducing mental health risks and supporting psychological well-being in technology-intensive academic environments.

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1. INTRODUCTION

The rapid advancement of digital technology has fundamentally transformed academic environments, reshaping learning, teaching, communication, and research activities. Digital platforms have enhanced accessibility and efficiency in higher education; however, their extensive and often continuous use has also introduced behavioral challenges, including prolonged screen exposure, digital multitasking, cognitive overload, and digital fatigue [1]-[4]. These patterns of digital engagement may adversely affect psychological well-being, highlighting the importance of understanding how digital technology usage influences mental health within academic communities. A growing body of research suggests that excessive engagement with digital technologies is associated with adverse psychological outcomes, including increased levels of depression, anxiety, and perceived stress, particularly among university populations [5], [6]. These effects often appear in subclinical forms, meaning that individuals may experience reduced well-being and impaired functioning without meeting the criteria for clinical diagnosis. Such outcomes are particularly

critical in academic environments, where cognitive performance and mental resilience are essential. One of the key mechanisms that may explain the relationship between digital technology use and psychological outcomes is sleep quality. Previous studies have demonstrated that nighttime digital engagement, especially prolonged screen exposure before sleep, can disrupt circadian rhythms and negatively affect sleep patterns [7], [8]. Poor sleep quality has been consistently linked to increased emotional distress, impaired cognitive functioning, and reduced academic performance [9]. Accordingly, sleep may play a mediating role in the relationship between technology use and mental health outcomes. Despite the increasing importance of digital technology in academic life, several important research gaps remain. Existing studies have largely examined general internet use or social media exposure, while few have treated structured academic-related digital technology usage as a primary predictive factor. Moreover, although sleep quality has been widely associated with psychological well-being, its mediating role in the relationship between digital technology usage and mental health has received limited investigation within integrated analytical frameworks. This study contributes to the existing literature in several ways. First, it positions digital technology usage patterns as primary predictive variables rather than secondary or control factors. Second, it integrates digital behavior, sleep quality, and mental health outcomes within a unified analytical framework. Third, it examines the mediating role of sleep quality in explaining the relationship between digital technology usage and psychological outcomes. Finally, by including both academic staff and postgraduate students, the study extends the applicability of existing evidence across broader academic communities and provides a predictive perspective that may support future digital well-being assessment and intervention strategies.

Despite the widespread integration of digital technology in higher education, its role as a primary determinant of psychological outcomes remains insufficiently explored. Existing research has predominantly focused on general indicators such as overall screen time or social media usage, while structured academic-related digital behavior such as engagement with e-learning platforms, academic multitasking, and extended work-related connectivity has received comparatively limited attention [10]. Furthermore, many studies treat digital technology use as a secondary or control variable rather than positioning it as a central explanatory factor. This approach limits the ability to fully understand how specific patterns of digital interaction contribute to psychological outcomes within academic environments. In addition, previous research often relies on descriptive or bivariate analysis, with limited application of analytical models that examine predictive relationships between digital behavior and mental health outcomes. Another critical limitation in the literature is the underrepresentation of academic staff populations, as most studies focus primarily on students. This restricts the generalizability of findings across academic communities, where both students and staff are exposed to intensive and continuous digital engagement. Importantly, although sleep quality has been identified as a key factor in psychological well-being, its role as a mediating mechanism linking digital technology usage and mental health outcomes has not been sufficiently examined within integrated analytical frameworks. This creates a gap in understanding the underlying processes through which digital behavior influences psychological functioning. To address these limitations, the present study positions digital technology usage patterns as primary predictive variables and applies a structured analytical approach to examine their relationship with mental health outcomes. In addition, the study incorporates sleep quality as a mediating factor, providing a more comprehensive understanding of the mechanisms linking digital behavior and psychological risk in academic environments.

The aim of this study is to examine whether digital technology usage patterns can predict mental health risk in academic communities, with particular emphasis on the mediating role of sleep quality. This study seeks to achieve the following objectives:

- To assess levels of digital technology usage among academic staff and postgraduate students.
- To assess levels of depression, anxiety, perceived stress, and sleep quality within academic communities.
- To examine the relationships between digital technology usage patterns and psychological outcomes.
- To determine whether digital technology usage patterns can significantly predict mental health outcomes.
- To investigate the mediating role of sleep quality in the relationship between digital technology usage and mental health indicators.

This study addresses the following research questions:

- That are the dominant digital technology usage patterns in academic communities?
- Is there a significant relationship between digital technology usage and mental health outcomes?
- To what extent can digital technology usage patterns predict depression, anxiety, and perceived stress?
- Does sleep quality mediate the relationship between digital technology usage and psychological outcomes?

Digital technology has become a fundamental component of modern academic environments, supporting learning, teaching, communication, and research activities. The widespread adoption of learning management systems, online collaboration tools, and virtual classrooms has significantly increased reliance

on digital platforms within higher education institutions [1]. As a result, academic populations are exposed to sustained and intensive patterns of digital engagement that extend beyond traditional educational settings. From an information technology (IT) perspective, digital usage is not limited to access or availability, but includes patterns of interaction such as duration, frequency, timing, and intensity of use. These patterns are critical in understanding how digital systems influence user behavior and overall well-being [2]. In academic contexts, individuals often engage in prolonged screen exposure, continuous connectivity, and multitasking across multiple platforms, which may contribute to cognitive overload and reduced recovery time.

Technostress refers to the stress experienced by individuals due to the use of digital technologies and the demands associated with them. In academic environments, technostress may arise from factors such as excessive information flow, constant notifications, and the need to manage multiple digital platforms simultaneously [11], [3]. Empirical studies have demonstrated that technology overload is associated with increased psychological strain, emotional exhaustion, and reduced productivity [12]. The rapid transition toward digitally intensive academic environments has further intensified these challenges, making technostress a critical factor influencing well-being in higher education [13]. These findings suggest that the way individuals interact with digital systems plays a crucial role in shaping psychological outcomes. Recent evidence further indicates that technostress not only impairs psychological well-being but also negatively affects learning quality and academic performance. Moreover, institutional support and digital resilience have been shown to mitigate these adverse effects in higher education settings [14].

Mental health issues, including depression, anxiety, and perceived stress, are increasingly prevalent among academic populations. Previous studies have reported higher levels of psychological distress among university students and academic staff compared to the general population [15]. These outcomes are often associated with academic workload, performance pressure, and limited opportunities for psychological recovery. Importantly, many individuals experience subclinical symptoms that do not meet diagnostic thresholds but still negatively affect cognitive functioning, academic performance, and overall well-being [16]. In this context, identifying contributing factors such as digital behavior is essential for understanding and managing mental health risks within academic environments.

Sleep quality is a critical determinant of both psychological and cognitive functioning. Poor sleep has been consistently associated with increased emotional distress, reduced concentration, and impaired performance [9]. In recent years, digital technology usage-particularly during nighttime has been identified as a significant factor affecting sleep patterns. Exposure to screens before bedtime can disrupt circadian rhythms by suppressing melatonin production, leading to delayed sleep onset and reduced sleep quality [7], [8], [17]. In academic settings, late-night digital engagement related to study or work responsibilities may further exacerbate sleep disturbances, particularly when smartphones are used at bedtime [18].

Several studies have identified significant associations between digital technology usage and psychological outcomes. Research indicates that excessive screen time and continuous digital engagement are linked to higher levels of depression, anxiety, and perceived stress [5], [6]. Additionally, academic-related digital workload has been shown to contribute to emotional exhaustion and reduced well-being [3]. However, many of these studies rely on descriptive or correlational approaches, limiting their ability to explain underlying mechanisms or predictive relationships. Furthermore, digital technology is often treated as a background variable rather than a primary predictor, reducing its analytical importance within research models.

Despite the growing body of research, several limitations remain. First, most studies focus on general digital usage rather than structured academic-related technology behavior. Second, there is limited application of analytical frameworks that examine predictive relationships between digital behavior and mental health outcomes. Third, academic staff populations are often underrepresented, with a strong emphasis on student samples. Additionally, while sleep quality has been recognized as an important factor, its role as a mediating mechanism within integrated analytical models has not been sufficiently explored. These limitations highlight the need for studies that adopt a more structured and predictive approach to understanding the relationship between digital technology usage and psychological outcomes.

The existing literature demonstrates a clear association between digital technology usage and psychological well-being within academic environments. However, gaps remain in terms of predictive modeling, integration of behavioral and psychological variables, and the examination of mediating mechanisms such as sleep quality. Addressing these gaps requires an IT-oriented analytical approach that positions digital usage patterns as measurable predictors of mental health risk.

2. METHOD

2.1. Study design

This study adopts a quantitative cross-sectional design to examine the relationship between digital technology usage patterns and mental health outcomes within academic communities. In addition to traditional statistical analysis, the study applies a predictive analytical perspective by positioning digital

usage patterns as independent variables used to estimate mental health risk indicators. This design is appropriate for identifying associations and predictive relationships among multiple variables without manipulating the study environment. The analytical framework integrates behavioral data (digital usage), psychological indicators, and sleep quality within a unified model.

2.2. Study population and participants

The study sample consisted of 165 participants drawn from an academic environment, including academic staff and postgraduate students. These groups were selected due to their continuous exposure to digital technologies in academic activities such as teaching, learning, and communication. Participants were recruited using a voluntary response approach within an academic setting. To ensure privacy and reduce response bias, institutional identifiers were not disclosed.

2.3. Eligibility criteria

Participants were eligible if they were actively engaged in academic activities and regularly used digital devices for academic purposes. Individuals with previously diagnosed psychiatric disorders or those undergoing psychological treatment were excluded to maintain a focus on general psychological patterns rather than clinical conditions.

2.4. Data collection procedure

Data were collected through a structured online questionnaire. Participants voluntarily completed the survey after providing electronic informed consent. The questionnaire assessed digital technology usage, psychological outcomes, and sleep quality. All responses were anonymous and treated confidentially.

2.5. Research instruments

Digital technology usage was assessed using a structured digital technology usage scale developed for this study to measure academic-related digital behavior. The scale was developed to capture common patterns of academic-related digital technology use, including screen exposure, academic multitasking, nighttime device use, digital dependency, and perceived digital fatigue. The scale assessed the frequency and patterns of participants' academic-related digital technology usage across common academic digital activities. The instrument assessed overall patterns of digital technology usage through a five-point Likert scale ranging from strongly disagree to strongly agree. The scale demonstrated acceptable internal consistency (Cronbach's $\alpha = 0.752$).

Psychological outcomes were measured using validated instruments:

- Depression: patient health questionnaire (PHQ-9)
- Anxiety: generalized anxiety disorder scale (GAD-7)
- Perceived stress: perceived stress scale (PSS) [19]

These instruments are widely used in non-clinical populations and provide reliable measures of psychological distress. Sleep quality was assessed using the Pittsburgh sleep quality index (PSQI), which measures sleep patterns and disturbances over the previous month. Higher scores indicate poorer sleep quality.

2.6. Data analysis

Data were analyzed using SPSS version 26. The analysis included descriptive statistics, reliability analysis, Pearson correlation analysis, regression analysis, and mediation analysis. Mediation was evaluated using a regression-based approach with 5,000 nonparametric bootstrap resamples and 95% confidence intervals. The indirect effect was considered statistically significant when the bootstrap confidence interval did not include zero. Statistical significance was established at $p < 0.05$.

2.7. Analytical framework

The analytical framework treated digital technology usage as the independent variable, sleep quality as the mediating variable, and depression, anxiety, and perceived stress as the dependent variables. This framework enabled the examination of both direct and indirect predictive relationships.

2.8. Ethical considerations

The study was conducted in accordance with accepted ethical standards for research involving human participants. Participation was voluntary, and informed consent was obtained electronically. No personally identifiable information was collected, and all data were treated confidentially.

3. RESULTS AND DISCUSSION

3.1. Result

3.1.1. Demographic characteristics

The study included a total of 165 participants, all of whom provided complete responses. The demographic characteristics of the sample are presented in Table 1. As shown in Table 1, male participants constituted 66.1% of the sample, while females accounted for 33.9%. The majority of participants were academic staff (85.5%), followed by postgraduate students (8.5%) and administrative staff (6.1%). This distribution reflects a predominantly professional academic population. Participants were drawn from multiple academic disciplines, including IT and medical sciences (each 28.5%), engineering (12.1%), psychiatry (14.5%), and other fields (13.9%). The mean age of participants was 40.78 years (SD = 8.81), indicating a mature and experienced academic sample. These characteristics enhance the relevance of the findings within academic environments.

Table 1. Demographic characteristics ($N = 165$)

Variable	Category	n	%
Gender	Male	109	66.1
	Female	56	33.9
Academic role	Academic staff	141	85.5
	Administrative staff	10	6.1
	Postgraduate student	14	8.5
Academic field	Computer science / IT	4	2.4
	Engineering	20	12.1
	IT	47	28.5
	Medical sciences	47	28.5
	Psychiatry	24	14.5
	Other	23	13.9
Age (years)	Mean ± SD	40.78 ± 8.81	-

3.1.2. Reliability analysis

Prior to conducting inferential analyses, reliability analysis was performed to assess the internal consistency of all study instruments using Cronbach's alpha. The results are presented in Table 2. As shown in Table 2, all scales demonstrated acceptable to excellent reliability. The PHQ-9 depression scale showed excellent internal consistency ($\alpha = 0.930$), indicating a high level of measurement stability. The digital technology usage scale (DTUS) showed acceptable reliability ($\alpha = 0.752$), while the GAD-7, PSS, and sleep quality scale also demonstrated acceptable internal consistency values (all $\alpha > 0.70$). These results confirm that the instruments used in this study are reliable and suitable for further statistical analysis.

Table 2. Reliability statistics

Scale	Number of items	Cronbach's alpha
DTUS	10	0.752
Depression (PHQ-9)	9	0.930
Anxiety (GAD-7)	7	0.801
PSS	10	0.743
Sleep quality	4	0.724

3.1.3. Descriptive statistics

Descriptive statistics were calculated to summarize the central tendency and variability of the main study variables. The results are presented in Table 3. Participants reported moderate to high levels of digital technology usage (M = 36.48, SD = 6.08), indicating substantial engagement with digital systems in academic settings. Psychological variables, including depression (M = 29.63), anxiety (M = 22.14), and perceived stress (M = 36.61), showed considerable variability across participants, suggesting differences in psychological experiences within the sample. Sleep quality scores (M = 12.67, SD = 3.92) also varied, indicating that sleep disturbances are present among members of the academic community. Overall, these descriptive findings provide initial evidence of variability in both digital behavior and psychological outcomes.

Table 3. Descriptive statistics of main variables

Variable	Minimum	Maximum	Mean	Std. deviation
DTUS_total	21.00	50.00	36.48	6.08
PHQ_total	1.00	45.00	29.63	9.60
GAD_total	0.00	32.00	22.14	6.08
PSS_total	26.00	47.00	36.61	4.17
Sleep_total	2.00	20.00	12.67	3.92

3.1.4. Correlation analysis

Pearson correlation analysis was conducted to examine the relationships between digital technology usage, sleep quality, and psychological outcomes. The results are presented in Table 4. As shown in Table 4, digital technology usage was positively and significantly correlated with depression (r = 0.377, p < 0.01), anxiety (r = 0.296, p < 0.01), perceived stress (r = 0.281, p < 0.01), and sleep disturbances (r = 0.302, p < 0.01). These findings indicate that higher levels of digital engagement are associated with increased psychological distress and poorer sleep quality. Additionally, strong correlations were observed between sleep quality and psychological outcomes, particularly depression (r = 0.858) and anxiety (r = 0.849), suggesting that sleep plays a central role in mental health within academic environments.

Table 4. Pearson correlation matrix

Variable	DTUS	PHQ	GAD	PSS	Sleep
DTUS_total	1	.377**	.296**	.281**	.302**
PHQ_total	.377**	1	.846**	.614**	.858**
GAD_total	.296**	.846**	1	.560**	.849**
PSS_total	.281**	.614**	.560**	1	.558**
Sleep_total	.302**	.858**	.849**	.558**	1

Note: p < 0.01

3.1.5. Predictive analysis

Multiple regression analysis was conducted to examine whether digital technology usage patterns predict mental health outcomes. The results are presented in Tables 5 to 8. As shown in Tables 5 to 8, digital technology usage significantly predicted depression (β = 0.377, p < 0.001), explaining 14.2% of the variance. This indicates a moderate predictive effect within behavioral research contexts. Similarly, digital technology usage significantly predicted anxiety (β = 0.296, p < 0.001), accounting for 8.8% of the variance, and perceived stress (β = 0.281, p < 0.001), explaining 7.9% of the variance. Although these effect sizes are modest, they are meaningful given the multifactorial nature of psychological outcomes. In addition, digital technology usage significantly predicted sleep quality (β = 0.302, p < 0.001), explaining 9.1% of the variance, suggesting that higher digital engagement is associated with poorer sleep.

Table 5. Regression analysis predicting depression

Predictor	B	SE	β	t	p
Constant	7.946	4.236	-	1.876	.062
DTUS_total	0.594	0.115	0.377	5.189	< .001

Table 6. Regression analysis predicting anxiety

Predictor	B	SE	β	t	p
Constant	11.339	2.767	-	4.098	< .001
DTUS_total	0.296	0.075	0.296	3.956	< .001

Table 7. Regression analysis predicting stress

Predictor	B	SE	β	t	p
Constant	29.575	1.909	-	15.495	< .001
DTUS_total	0.193	0.052	0.281	3.734	< .001

Table 8. Regression analysis predicting sleep quality

Predictor	B	SE	β	t	p
Constant	5.565	1.782	-	3.123	.002
DTUS_total	0.195	0.048	0.302	4.043	< .001

3.1.6. Mediation analysis

Mediation analysis was conducted to determine whether sleep quality mediated the relationships between digital technology usage and depression, anxiety, and perceived stress. The indirect effects were evaluated using 5,000 nonparametric bootstrap resamples with 95% confidence intervals. An indirect effect was considered statistically significant when its confidence interval did not include zero. Tables 9-12 summarize the mediation analysis results, digital technology usage significantly predicted poorer sleep quality (B = 0.195, SE = 0.048, p < 0.001). When depression was included as the outcome, sleep quality was a significant predictor of depression (B = 2.002, SE = 0.101, p < 0.001), while the direct effect of digital

technology usage remained statistically significant (B = 0.204, SE = 0.065, p = 0.002). The bootstrapped indirect effect was significant (B = 0.390, BootSE = 0.099, 95% CI [0.193, 0.588]), indicating partial mediation. For anxiety, sleep quality was a significant predictor (B = 1.296, SE = 0.067, p < 0.001), whereas the direct effect of digital technology usage became non-significant (B = 0.044, SE = 0.043, p = 0.317). The indirect effect through sleep quality was statistically significant (B = 0.252, BootSE = 0.064, 95% CI [0.131, 0.382]), supporting full mediation. Similarly, sleep quality significantly predicted perceived stress (B = 0.554, SE = 0.072, p < 0.001), while the direct effect of digital technology usage was non-significant (B = 0.085, SE = 0.046, p = 0.070). The bootstrapped indirect effect was significant (B = 0.108, BootSE = 0.033, 95% CI [0.048, 0.176]), indicating full mediation. Overall, these findings demonstrate that sleep quality represents a significant mechanism through which digital technology usage is associated with psychological outcomes.

Table 9. Mediation model (depression)

Predictor	B	SE	β	t	p
DTUS_total	0.204	0.065	0.129	3.145	.002
Sleep_total	2.002	0.101	0.819	19.894	< .001

Table 10. Mediation model (anxiety)

Predictor	B	SE	β	t	p
DTUS_total	0.044	0.043	0.044	1.005	.317
Sleep_total	1.296	0.067	0.836	19.272	< .001

Table 11. Mediation model (stress)

Predictor	B	SE	β	t	p
DTUS_total	0.085	0.046	0.124	1.825	.070
Sleep_total	0.554	0.072	0.521	7.692	< .001

Table 12. Bootstrapped indirect effects of digital technology usage on psychological outcomes through sleep quality

Outcome	Total effect	Direct effect	Indirect effect	BootSE	BootLLCI	BootULCI	Mediation
Depression	0.594	0.204	0.39	0.099	0.193	0.588	Partial
Anxiety	0.296	0.044	0.252	0.064	0.131	0.382	Full
Perceived stress	0.193	0.085	0.108	0.033	0.048	0.176	Full

Note: Indirect effects were estimated using 5,000 bootstrap resamples. BootLLCI and BootULCI represent the lower and upper limits of the 95% bootstrap confidence interval. An indirect effect is statistically significant when the confidence interval does not include zero.

3.1.7. Summary of results

Overall, digital technology usage significantly predicted depression, anxiety, perceived stress, and poorer sleep quality. The bootstrapped mediation results demonstrated significant indirect effects of digital technology usage on all three psychological outcomes through sleep quality, as none of the 95% bootstrap confidence intervals included zero. Sleep quality partially mediated the relationship between digital technology usage and depression and fully mediated its relationships with anxiety and perceived stress. These results highlight sleep quality as a key mechanism linking digital behavior to psychological well-being.

3.2. Discussion

The present study aimed to examine whether digital technology usage patterns can predict mental health risk within academic communities, with particular emphasis on the mediating role of sleep quality. The findings provide strong evidence that digital technology usage is significantly associated with depression, anxiety, perceived stress, and sleep disturbances. More importantly, the results demonstrate that digital usage patterns can serve as meaningful predictors of psychological outcomes, supporting an IT-oriented analytical perspective.

3.2.1. Digital technology usage as a predictor of mental health

The findings of this study indicate that higher levels of digital technology usage are associated with increased levels of depression, anxiety, and perceived stress. These results are consistent with previous research suggesting that intensive engagement with digital systems contributes to psychological strain and emotional exhaustion [12], [6]. However, the present study extends existing literature by moving beyond descriptive associations and positioning digital usage patterns as predictive variables. From an IT perspective, this shift is important, as it frames user interaction with digital systems not only as behavior but

as measurable input capable of explaining and predicting mental health outcomes. This analytical framing contributes to the growing field of digital well-being and technostress research. The moderate effect sizes observed in the regression models are consistent with the multifactorial nature of psychological outcomes, where multiple behavioral, social, and environmental factors interact [20]. Nevertheless, the results clearly indicate that digital technology usage represents a meaningful and measurable risk factor within academic environments.

3.2.2. The role of sleep quality in digital behavior

The study also found a significant relationship between digital technology usage and sleep quality. Participants with higher levels of digital engagement reported poorer sleep quality, supporting previous findings that prolonged screen exposure, particularly during nighttime, disrupts sleep patterns [7], [8]. This relationship can be explained through both physiological and behavioral mechanisms. Exposure to blue light from digital devices may suppress melatonin production, delaying sleep onset, while continuous engagement with digital content may increase cognitive and emotional stimulation. In academic settings, these effects may be amplified due to late-night work, continuous online communication, and lack of clear boundaries between work and rest.

3.2.3. Sleep quality as a mediating mechanism

One of the most important findings of this study is the identification of sleep quality as a mediating factor between digital technology usage and mental health outcomes. The results showed that sleep quality partially mediated the relationship between digital usage and depression, while fully mediating its relationship with anxiety and perceived stress. The statistical significance of these indirect pathways was further supported by the bootstrap analysis, as the 95% confidence intervals for the indirect effects did not include zero for depression, anxiety, or perceived stress. The partial mediation observed for depression suggests that digital technology usage influences depressive symptoms through both direct and indirect pathways. In addition to sleep disruption, factors such as digital overload, reduced social interaction, and prolonged cognitive engagement may directly contribute to depressive symptoms [21]. In contrast, the full mediation observed for anxiety and perceived stress indicates that sleep quality plays a central role in translating digital behavior into psychological outcomes. Poor sleep has been shown to impair emotional regulation, increase sensitivity to stress, and elevate anxiety levels. These findings highlight sleep as a critical mechanism linking digital behavior and mental health.

3.2.4. Implications from an IT perspective

From an IT perspective, the findings of this study emphasize the importance of considering user behavior and interaction patterns when evaluating the impact of digital systems. Rather than focusing solely on system functionality, attention should be given to how digital technologies are used in real-world contexts. The predictive framing adopted in this study suggests that digital usage data may be utilized as an early indicator of mental health risk. Recent advances in digital biomarkers further demonstrate that behavioral data collected from digital devices can support the prediction and monitoring of mental health outcomes, reinforcing the feasibility of developing predictive digital well-being systems [22], [23]. Recent research also suggests that digital resilience and technology-support interventions can reduce technostress and improve psychological well-being, highlighting the importance of integrating preventive features into future digital well-being systems [24]. Such applications may be particularly valuable in higher education institutions, where digital platforms are extensively used, and where early identification of psychological risk can improve both well-being and performance outcomes.

3.2.5. Comparison with previous studies

The findings of this study are consistent with previous research linking excessive digital engagement to increased psychological distress [5], [25]. However, unlike many earlier studies that rely on descriptive analysis, the present study adopts a predictive and mediation-based approach, providing deeper insight into the mechanisms underlying these relationships. Additionally, the inclusion of both academic staff and postgraduate students enhances the generalizability of the findings across academic communities, addressing a limitation commonly observed in student-focused studies.

3.2.6. Study limitations

Despite its contributions, this study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between variables. While predictive associations were identified, longitudinal studies are needed to confirm causality. Second, the use of self-reported data may introduce bias, including recall bias and social desirability effects. Although validated instruments were used, future research

could incorporate objective measures of digital usage and sleep patterns. Finally, the study was conducted within a specific academic context, which may limit generalizability to other populations. Future studies should examine diverse settings to validate these findings.

3.2.7. Summary of discussion

Overall, the findings of this study demonstrate that digital technology usage patterns are significant predictors of mental health outcomes in academic communities. Sleep quality plays a central mediating role, particularly in relation to anxiety and perceived stress. From an engineering perspective, these findings provide a foundation for the development of human-centered digital systems, adaptive learning platforms, and digital well-being monitoring tools that can support healthier technology usage and reduce cognitive load in academic environments.

4. CONCLUSION

This study demonstrated that digital technology usage significantly predicts depression, anxiety, perceived stress, and sleep disturbances among academic populations. The findings further showed that sleep quality plays a significant mediating role in these relationships, partially mediating the association with depression and fully mediating the associations with anxiety and perceived stress. These findings confirm that digital technology usage patterns can serve as meaningful predictors of mental health risk while highlighting sleep quality as a critical mechanism through which digital technology usage influences psychological well-being in academic environments.

From a practical perspective, these findings suggest that universities and educational institutions should promote healthy digital technology usage habits and improve sleep awareness as key strategies for supporting psychological well-being among students and academic staff. In addition, the proposed predictive framework may support the future development of digital well-being monitoring systems capable of identifying individuals at increased psychological risk and facilitating early preventive interventions.

Based on these findings, academic institutions are encouraged to promote balanced digital technology usage, particularly by reducing excessive screen exposure during late hours, and to implement sleep awareness programs that emphasize the importance of healthy sleep hygiene for psychological well-being. Institutional policies should also aim to regulate after-hours digital communication and reduce continuous connectivity demands. Furthermore, future research should focus on developing predictive digital well-being monitoring systems capable of identifying high-risk digital usage patterns and supporting early intervention. Longitudinal and multi-institutional studies involving more diverse academic populations are recommended to strengthen causal evidence, incorporate objective measures of digital technology usage and sleep behavior, and evaluate the effectiveness of digital well-being interventions in reducing psychological distress.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

ETHICAL APPROVAL

The study was conducted in accordance with applicable ethical principles for research involving human participants. Participation was voluntary, informed consent was obtained electronically from all participants before completing the questionnaire, and all responses were collected anonymously to protect participants' privacy.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, Ahmed Munadhil Abduljabar, upon reasonable request. The data contain information that could compromise the privacy of research participants and are therefore not publicly available.

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