

Phone Unlocks and Anxiety: A Digital Phenotyping Approach – Cross-Sectional Study

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Abstract

Background:

This study explores the relationship between smartphone usage behavior and mental health scores among MBBS students, utilizing a digital phenotyping framework. With increasing reliance on digital devices, behavioral data such as unlock patterns can offer insight into emotional well-being.

Objective:

To examine the association between smartphone usage behavior and mental health symptoms among MBBS students using a digital phenotyping approach

Materials and Methods:

A cross-sectional observational study was conducted among 93 MBBS students. Data were obtained using validated self-report instruments — GAD-7, PHQ-9, and PHQ-15 — along with active retrieval of stored 14-day unlock history from participants' devices, assisted by the research team. Pearson correlation coefficients were computed to examine associations between digital behavior and mental health indices.

Results:

Participants (77 male, 16 female; mean age 21.0 ± 2.1 years) recorded an average of 2000 ± 600 total unlocks in 14 days. A significant positive correlation was observed between Total Unlocks and GAD-7 scores ($r = 0.55$, $p < 0.001$), indicating that higher unlocking frequency is linked to increased anxiety symptoms. A weaker yet notable correlation was found between Total Unlocks and PHQ-9 scores ($r = 0.35$, $p = 0.004$), suggesting a modest association between smartphone use and depressive symptoms. The relationship between Total Unlocks and PHQ-15 scores ($r = 0.31$, $p = 0.08$) was not statistically significant.

Conclusion:

These findings reaffirm that digital interaction metrics, particularly unlock frequency, may serve as potential behavioral indicators of psychological distress. However, the weaker association with PHQ-9 underscores that depressive symptoms may manifest less consistently in digital behavior compared to anxiety, and may require follow-up or longitudinal assessment to ascertain the pattern.

Recommendation:

Future research utilizing prospective multi-center designs with expanded cohorts is essential to corroborate device unlock tracking as a valid digital biomarker for anxiety symptoms, while evaluating its predictive performance, practical implementation in clinical workflows, and associated ethical considerations.

Keywords: Digital Phenotyping, Smartphone use, Smartphone unlocking, Screen time, Anxiety, Depression, Digital Biomarkers

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Introduction

Interest in digital phenotyping — the use of data from smartphones and wearables to infer behavioral and emotional states — has increased substantially in recent years. Such technology captures continuous data on activity, communication, and device interaction patterns, reflecting how individuals function in real-world environments.

Smartphones today collect extensive passive data such as screen time, call frequency, unlock counts, and even light and motion sensor readings. These behavioral traces can reveal subtle fluctuations in stress, mood, and cognitive engagement.

Earlier work demonstrated strong correlations between digital metrics and affective symptoms such as anxiety and depression [1–4]. Yet, many prior studies have been limited by small samples or overrepresentation of depressive symptoms, overlooking anxiety's distinctive behavioral footprint. This expanded dataset aimed to provide stronger statistical evidence and examine whether correlations between smartphone interaction and psychological distress persist when sample size and variability increase.

Materials and Methods

Study Design

A cross-sectional observational study was conducted to examine the correlation between digital behavior metrics and mental health scores among MBBS students. Digital behavior data were collected on a single day using an active retrieval method: participants, assisted by the research team, accessed and recorded their device's built-in 14-day unlock history (Digital Wellbeing for Android; Screen Time for iOS). Participants provided self-reported responses on standardized mental health scales and actively retrieved their own digital behavior data from device settings. The

total number of daily phone unlocks was considered the primary digital indicator. For Android users, unlock counts were obtained via **Settings** → **Digital Wellbeing and Parental Controls**, and for iPhone users, via **Settings** → **Screen Time**

Study Setting

This investigation was carried out at North DMC Medical College & Hindu Rao Hospital, a tertiary care teaching facility in Delhi, India. The target sample comprised undergraduate medical students pursuing their MBBS degree at the institute. Data collection spanned 12 months, running from September 2023 through August 2024.

Sample Size Justification

The α -level was fixed at 0.05 and β at 0.20 (power = 80%). Assuming a medium effect size ($r = 0.3$) based on earlier digital phenotyping studies, the sample size requirement was computed as:

$$N = ((Z\alpha + Z\beta) / (0.5 \times \ln((1 + r) / (1 - r))))^2 + 3$$

Substituting $Z\alpha = 1.96$, $Z\beta = 0.84$, and $r = 0.3$, the minimum required sample size was 85. To enhance reliability and representativeness, 93 participants were recruited.

Participants

Initially, 96 medical undergraduates underwent eligibility screening. Written informed consent was obtained from all participants before enrolment. Three students were excluded due to ongoing psychiatric treatment: two for anxiety disorders and one for depressive disorder. No participants were excluded for using multiple mobile devices, and no post-enrolment dropouts occurred. The final analytical sample comprised 93 participants.

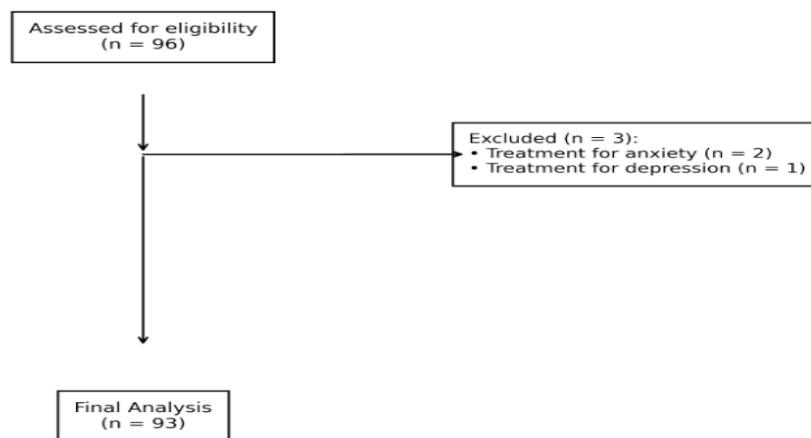


Figure 1. Participant flow diagram

Measures

1. GAD-7: Assessed anxiety severity (0–21).
2. PHQ-9: Measured depressive symptoms (0–27).
3. PHQ-15: Evaluated somatic symptoms (0–30).
4. Total Unlocks: Retrieved actively by participants from device system analytics, reflecting the preceding 14 days.

Statistical Analysis

Descriptive statistics were calculated for age, gender, and digital metrics. Pearson's correlation was used to explore associations between Total Unlocks and each psychological measure. A two-tailed $p < 0.05$ denoted statistical significance.

Results

The study comprised 93 participants (77 male, 16 female), with a mean age of 21.0 ± 2.1 years. The average number of Total Unlocks over 14 days was 2000 ± 600 , equating to

roughly 143 Phone unlocks per day. Anxiety symptoms demonstrated the strongest association with unlock frequency. The depressive symptom correlation weakened compared to the previous cohort, suggesting that depression-related digital engagement patterns may fluctuate and require longitudinal tracking to clarify causality.

Most students had mild anxiety symptoms (50, 53.8%), followed by minimal anxiety (21, 22.6%), moderate anxiety (19, 20.4%), and severe anxiety (3, 3.2%). Overall, 22 students (23.6%) had moderate-to-severe anxiety symptoms. These categories indicate symptom severity and do not establish a clinical diagnosis.

Most students had minimal depressive symptoms (40, 43.0%), followed by mild (33, 35.5%), moderate (17, 18.3%), and moderately severe symptoms (3, 3.2%). No students had severe symptoms (0, 0%). Overall, 20 students (21.5%) had moderate-to-moderately severe depressive symptoms.

Table 1. Sociodemographic Characteristics of the Study Participants (N = 93)

Characteristic	n (%)
Age group (years)	
16–20	37 (39.8%)
21–26	56 (60.2%)
Gender	
Male	77 (82.8%)
Female	16 (17.2%)
Total	93 (100%)

The study cohort exhibited an average age of 21.13 ± 2.65 years, with the majority falling between 21 and 26 years old (56, 60.2%) and the remainder aged 16 to 20 years (37, 39.8%). Male participants accounted for the largest proportion (77, 82.8%), while female participants comprised 17.2% (16).

Table 2. Correlation Between Smartphone Unlock Frequency and Psychological Symptom Scores Among MBBS Students (N = 93)

Measure	Pearson's r	p-value	Significance
GAD-7	0.55	< 0.001	Significant
PHQ-9	0.35	0.004	Weak-moderate significant
PHQ-15	0.31	0.08	Not significant

Smartphone unlock frequency showed a significant positive correlation with anxiety (GAD-7) and depression (PHQ-9) scores, with a stronger association for anxiety. The reported association with somatic symptoms was statistically nonsignificant.

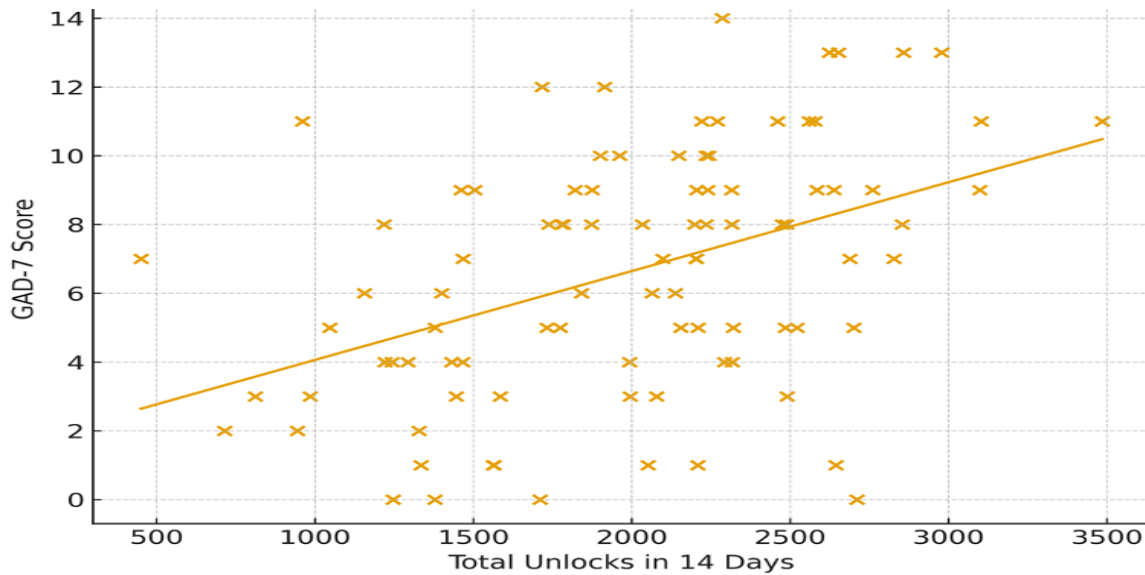


Figure 2. Correlation Between Total Smartphone Unlocks Over 14 Days and GAD-7 Anxiety Scores

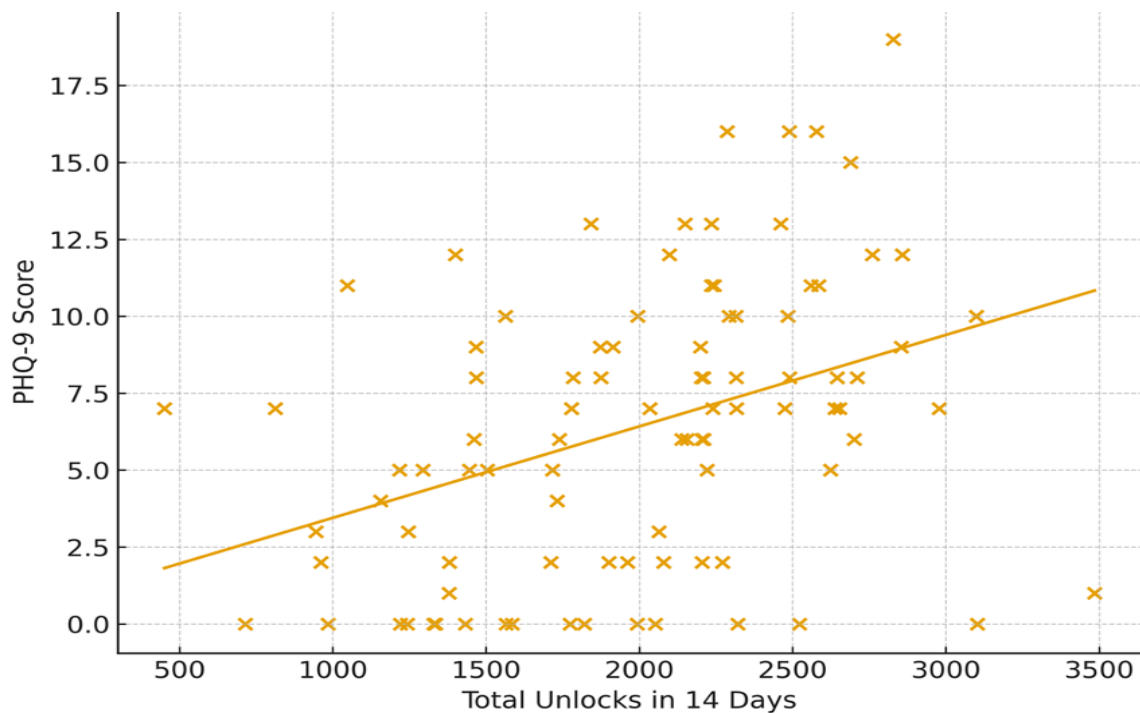


Figure 3. Correlation Between Total Smartphone Unlocks Over 14 Days and PHQ-9 Depression Scores

Discussion

This expanded dataset reinforces earlier findings that smartphone unlocking behavior correlates positively with anxiety (GAD-7) [5–7] and, to a lesser degree, with depressive symptoms (PHQ-9). The weaker PHQ-9 correlation ($r = 0.35$) compared to the initial 30-student pilot ($r = 0.57$) highlights how larger and more heterogeneous samples can dilute effect sizes — a pattern also seen in digital behavior research [8–9].

The observed anxiety correlation ($r = 0.55$) supports the idea that frequent phone interaction may reflect heightened vigilance, restlessness, or information-seeking behavior, traits commonly seen in anxiety. In contrast, depressive states might lead to variable engagement, where some individuals withdraw digitally while others seek online reassurance or passive scrolling.

A non-significant link with PHQ-15 ($r = 0.31$, $p = 0.08$) implies that somatic symptoms are less tied to device habits, though underlying stress physiology could still play a role. Future work may employ longitudinal tracking and machine learning models to differentiate adaptive from maladaptive digital engagement.

Generalizability

A key constraint of the present investigation involves the constrained cohort of 93 medical undergraduates, which potentially circumscribes the extrapolative scope of these outcomes to broader student cohorts or the wider community. Patterns of device engagement may diverge markedly across distinct age demographics, occupational settings, behavioral routines, and sociocultural environments. Consequently, the observed correlations—specifically regarding affective anxiety metrics—warrant cautious interpretation. Future investigations leveraging expanded, multi-site cohorts across heterogeneous populations remain imperative to substantiate external validity.

Limitations and Potential Bias

A key constraint of the present investigation involves the constrained cohort recruited from a single medical institute, which potentially circumscribes the extrapolative scope of these outcomes. Sampling bias could have been introduced by the single-site recruitment strategy and the deliberate exclusion of participants currently undergoing psychiatric care for affective or anxiety conditions. Additionally, the cross-sectional design inherently precludes establishing causal directionality, and relying on self-report psychometric scales might predispose to reporting bias. Although information bias concerning device usage was mitigated by actively retrieving objective unlock metrics directly from system analytics rather than self-estimate,

minor variations in logging mechanisms across Android and iOS platforms, alongside the inability of total unlock metrics to account for the context, intent, or duration of engagement, may introduce subtle measurement variability. Ultimately, residual confounding stemming from individual behavioral traits, academic pressures, and variable training schedules cannot be entirely excluded.

Recommendation

Future research utilizing prospective multi-center designs with expanded cohorts is essential to corroborate device unlock tracking as a valid digital biomarker for anxiety symptoms, while evaluating its predictive performance, practical implementation in clinical workflows, and associated ethical considerations.

Conclusion

This expanded digital phenotyping study ($N = 93$) confirms that smartphone unlock frequency correlates significantly with anxiety symptoms, moderately with depression, and not significantly with somatic complaints. The findings reinforce the promise of digital behavior markers in early mental health screening [10], while reminding researchers to interpret data with caution and context. Incorporating such tools into student wellness programs may enhance early detection and targeted interventions.

List of Abbreviations

- **GAD-7:** Generalized Anxiety Disorder-7
- **MBBS:** Bachelor of Medicine, Bachelor of Surgery
- **PHQ-9:** Patient Health Questionnaire-9
- **PHQ-15:** Patient Health Questionnaire-15
- **SD:** Standard Deviation
- **SPSS:** Statistical Package for the Social Sciences
- **IEC:** Institutional Ethics Committee
- **N:** Sample Size
- **r:** Pearson's Correlation Coefficient
- **p:** p-value (probability value)

Authors' contribution

Dev Rai and Sumit Jethani contributed to the concept and design of the study and supervised the project. Lokesh Parashar was responsible for collection of the data and doing the statistical analysis. Anshumali, Pankaj Kumar Verma, Himanshu Khangwal drafted the manuscript. All authors approved the final version of the manuscript.

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Ethics approval

The study was conducted after approval of the Institutional Ethics Committee of North DMC Medical College and Hindu Rao Hospital (Date: 17-06-2022 /F. No: IEC/NDMC/2022/134). This study was performed in lines with the Declaration of Helsinki.

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Conflict of interests

The authors have no relevant financial or non-financial interests to disclose.

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