Project Report on Digital Phenotyping for Student Stress Detection

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**Digital Phenotyping for Early Detection of Student Stress**

**1. Problem Definition**

Student stress and mental health challenges are widespread. Surveys indicate that up to 75% of college students report feeling overwhelmed by stress, with one in five experiencing stress-related suicidal thoughts[frontiersin.org](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full#:~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this). Chronic academic and family stress can lead to depression and significantly impair learning outcomes[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/#:~:text=between%20stress%2C%20depression%2C%20and%20academic,parents%2C%20educators%2C%20and%20other%20stakeholders). Left unaddressed, persistent stress can escalate into serious mental health issues and drop in academic performance. Early identification of rising stress levels is therefore critical.

Digital phenotyping offers a novel approach: it continuously collects data from personal devices (e.g. smartphones) to quantify behavior and mood[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/#:~:text=Defined%20as%20using%20data%20from,4%E2%80%936). By passively sensing indicators such as sleep, mobility, and social activity, a digital phenotyping system can detect subtle changes before students become critically distressed[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/#:~:text=Digital%20phenotyping%20generally%20involves%20constant,the%20phone%20recording%20that%20a). Nearly all young adults (≈96% of U.S. 18–29-year-olds) own smartphones[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/#:~:text=The%20ubiquity%20of%20smartphones%20allows,Some%20studies%20made%20an), making mobile sensing highly feasible. Thus, using smartphones to monitor behavioral patterns provides a scalable way to flag early signs of stress. This proactive monitoring could trigger timely support or interventions, potentially mitigating the impact of stress on student well-being and performance[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/#:~:text=between%20stress%2C%20depression%2C%20and%20academic,parents%2C%20educators%2C%20and%20other%20stakeholders).

**2. Literature Review**

**Digital Phenotyping & Stress Detection.** Digital phenotyping is defined as “moment-by-moment quantification of the individual-level human phenotype in situ using data from personal digital devices”[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=Digital%20phenotyping%20is%20%E2%80%9Cthe%20moment,In). In mental health research, smartphone-based sensing has been used to infer stress, anxiety, and depression from behavioral markers[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=We%20categorized%20the%20studies%20into,number%20of%20interactions%20and%20response)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In). For example, a systematic review found that passive smartphone sensors (GPS, accelerometer, microphone, etc.) can reveal meaningful patterns: stressed individuals tend to visit fewer places, exhibit reduced physical activity, have irregular sleep, and spend more time on their phones[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In). Such studies often employ machine learning to correlate sensor features (e.g. mobility trajectories, speech patterns, sleep duration) with standardized stress and mood questionnaires[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=prediction%3B%20most%20others%20%28n%3D8%2C%2020,activity%2C%20sleep%2C%20social%20interaction%2C%20and). Overall, the evidence indicates that mobile sensing is effective at identifying behavioral signatures of stress and mild depression[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=and%20mild%20depression%20in%20nonclinical,stress%2C%20anxiety%2C%20and%20mild%20depression).

**Mobile Sensing Modalities.** Research highlights a hybrid data approach. *Active* data (self-reports through surveys or EMAs) captures subjective mood, while *passive* data (automatic sensor logging) captures objective behavior[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=atypical%20patterns%20in%20daily%20activities,to%20more%20accurately%20detect%20and)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=enormous%20amounts%20,technique%20for%20assessing%20mental%20health). In practice, combining both yields better stress inference than either alone[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=Most%20studies%20combine%20active%20and,technique%20for%20assessing%20mental%20health). For example, a student might receive periodic prompts to rate stress, supplementing constant background logging of location, steps, and screen usage. Wearable devices (smartwatches, fitness bands) can add physiological signals (heart rate variability, skin conductance) for finer stress cues[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/#:~:text=Devices%3A%20Wearables)[nature.com](https://www.nature.com/articles/s41746-018-0075-8#:~:text=Digital%20phenotyping%20uses%20smartphone%20and,its%20possible%20ethical%2C%20legal%2C%20and). Together, these multi-modal data allow rich feature extraction.

**Ethical and Privacy Considerations.** Prior reviews emphasize the ethical challenges of digital phenotyping[nature.com](https://www.nature.com/articles/s41746-018-0075-8#:~:text=Digital%20phenotyping%20uses%20smartphone%20and,its%20possible%20ethical%2C%20legal%2C%20and)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC8367187/#:~:text=same%20time%2C%20mental%20health%20applications,protection%2C%20consent%2C%20bias%2C%20and%20accountability). The technique inherently involves sensitive personal data (movements, communications, health status), so strict privacy safeguards are required. Authorities recommend transparency, informed consent, data protection, and accountability as core principles[nature.com](https://www.nature.com/articles/s41746-018-0075-8#:~:text=Digital%20phenotyping%20uses%20smartphone%20and,its%20possible%20ethical%2C%20legal%2C%20and)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC8367187/#:~:text=same%20time%2C%20mental%20health%20applications,protection%2C%20consent%2C%20bias%2C%20and%20accountability). Any student-focused stress app must anonymize or encrypt data and explicitly allow opt-in/opt-out for each sensor stream. Developers must also be mindful of algorithmic bias and clearly communicate how predictions are made. Ethical data handling is therefore integral, aligning with guidelines for mobile health research and institutional review practices.

**3. Existing Systems**

Several systems have explored mobile stress monitoring. On the research side, Dartmouth’s **StudentLife** project developed one of the first smartphone apps to sense student behavior and stress[studentlife.cs.dartmouth.edu](https://studentlife.cs.dartmouth.edu/#:~:text=,good%20they%20felt%20about%20themselves). Over a 10-week term, StudentLife automatically tracked participants’ sleep, activity, conversations, location (e.g. time in class or dorm), and even self-reported stress levels[studentlife.cs.dartmouth.edu](https://studentlife.cs.dartmouth.edu/#:~:text=,good%20they%20felt%20about%20themselves). Analyses of this dataset revealed how academic workload influences mood and health over a semester. Similarly, the Australian **Vibe Up** app collected passive data (accelerometer, gyroscope, step count, etc.) from ~400 students along with stress surveys[frontiersin.org](https://www.frontiersin.org/journals/psychiatry/articles/10.3389/fpsyt.2024.1422027/full#:~:text=study%20also%20completed%20survey,study%20period%2C%20and%20completed%20screening). Vibe Up used machine learning on these mobile data to classify stress severity, demonstrating that passive sensing alone could distinguish high-stress users.

In contrast, many commercial wellness apps focus on relaxation or journaling rather than prediction. For instance, mood-tracking apps (e.g. T2 Mood Tracker, Daylio) rely on voluntary entries, and meditation apps (Calm, Headspace) provide interventions but don’t monitor stress continuously. Some wearable ecosystems (e.g. Samsung Health, Fitbit) offer instant stress scores (via heart rate or breathing metrics) but lack long-term predictive models. A notable research platform is **mindLAMP** (LAMP Platform), an open-source system integrating active surveys and sensor streams for psychiatric studies. Its modular design (mobile app + cloud data center + analytics) illustrates how digital phenotyping tools can be built for patient care and research.

**Strengths and Gaps:** These systems show the feasibility of mobile stress sensing, but gaps remain. Research prototypes often require high participant engagement and standardized study phones, which limit real-world scalability. Commercial apps rarely integrate passive data fully, so real-time stress prediction is scarce. Most existing work focuses on short-term studies; fewer systems continually monitor across semesters. There is also a need for user-friendly feedback: many systems collect data but do not provide actionable alerts or coping suggestions to the user. In summary, current solutions underscore both the promise of sensor-based stress monitoring and the need for integrated, scalable platforms that combine passive and active data in a privacy-preserving way.

**4. Proposed System**

Our envisioned system is a cross-platform mobile app (built in **Flutter**[github.com](https://github.com/flutter#:~:text=Flutter%20is%20an%20open%20source,from%20all%20around%20the%20world)) that continuously assesses student stress. The key objectives are to collect hybrid data and provide early alerts. Using Flutter ensures a single codebase for Android and iOS, while Firebase will power secure cloud storage and real-time syncing[firebase.google.com](https://firebase.google.com/#:~:text=Prototype%2C%20build%20%26%20run%20modern%2C,throughout%20your%20app%20development%20lifecycle). The app will gather *passive* data such as GPS/location, accelerometer (activity/mobility), screen time/app usage, ambient noise levels, and (where available) wearable vitals (via Apple HealthKit or Google Fit). Periodically, it will prompt the user with *active* inputs (brief stress or mood surveys).

A unique feature is the **hybrid sensing pipeline**. Data ingestion modules will capture sensor streams in the background; simultaneously, user responses and context (calendar schedules, deadlines) will be logged. All data are timestamped and sent to Firebase, where our backend will perform feature extraction (e.g. daily distance traveled, sleep inferred from phone inactivity, communication patterns). A machine learning stress-inference model then analyzes these features to estimate stress level in real time. When elevated stress is detected, the app can notify the student or counselor and recommend coping strategies. This approach leverages the full spectrum of digital phenotyping – combining self-report with ubiquitous sensing for richer context[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=Most%20studies%20combine%20active%20and,technique%20for%20assessing%20mental%20health)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In).

Technologically, we utilize Flutter’s plugin ecosystem for sensor access and UI, and Firebase’s suite (Authentication, Firestore, Cloud Functions) to handle data securely[github.com](https://github.com/flutter#:~:text=Flutter%20is%20an%20open%20source,from%20all%20around%20the%20world)[firebase.google.com](https://firebase.google.com/#:~:text=Prototype%2C%20build%20%26%20run%20modern%2C,throughout%20your%20app%20development%20lifecycle). We will also integrate HealthKit (iOS) and Google Fit (Android) APIs to import existing health metrics (e.g. heart rate variability). In summary, the app aims to provide a seamless interface: students run it on their phones, it quietly logs data day and night, and delivers personalized stress insights to help them stay healthy and succeed academically.

**5. Knowledge Gained**

Throughout this project, we have acquired familiarity with key tools and concepts:

* **Flutter and Dart:** An open-source UI toolkit for building natively compiled applications from a single codebase[github.com](https://github.com/flutter#:~:text=Flutter%20is%20an%20open%20source,from%20all%20around%20the%20world). We learned Flutter fundamentals for crafting cross-platform interfaces and using packages for sensors and state management.
* **Firebase Platform:** Google’s mobile/web app development platform that offers real-time databases, user authentication, and cloud functions for scalable backends[firebase.google.com](https://firebase.google.com/#:~:text=Prototype%2C%20build%20%26%20run%20modern%2C,throughout%20your%20app%20development%20lifecycle). We studied Firestore for data storage and Cloud Messaging for notifications.
* **Mobile Sensing APIs:** Integration of device capabilities via packages (e.g. sensors\_plus for accelerometer/GPS, flutter\_health/google\_fit) and handling permissions. We also explored HealthKit (Apple) and Google Fit to incorporate step counts and heart rate data.
* **Machine Learning & Analytics:** Coursework in machine learning (Coursera/edX) has helped us plan how to preprocess sensor data and train models (e.g. classification) for stress inference. We reviewed libraries like TensorFlow Lite for on-device inference.
* **Digital Phenotyping Literature:** We studied academic sources on digital phenotyping, stress detection algorithms, and ethics in digital health (e.g. JMIR and Nature articles[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[nature.com](https://www.nature.com/articles/s41746-018-0075-8#:~:text=Digital%20phenotyping%20uses%20smartphone%20and,its%20possible%20ethical%2C%20legal%2C%20and)). Online courses on data privacy and ethical AI informed our approach to responsible data handling.
* **Concepts:** Key learned concepts include ecological momentary assessment (EMA), feature extraction from time-series data, and the importance of balancing user engagement with passive data collection.

Additionally, tutorials and community examples (e.g. sample Flutter sensor apps, Firebase documentation) have guided our architecture design. By combining these skills—cross-platform mobile development, cloud services, mobile health sensing, and ML—we are well-prepared to implement the proposed digital phenotyping solution.

**6. Architectural Framework**

Our system architecture comprises several layers:

* **Mobile Frontend (Flutter App):** The user-facing component running on the student’s phone. It handles UI screens (login, stress survey prompts, dashboard), and continuously collects sensor data. Key modules include a *Sensor Manager* (capturing accelerometer, GPS, microphone levels, etc.) and an *EMA Scheduler* (triggering user surveys at set intervals). This frontend communicates with the cloud backend over secure HTTPS/Firebase channels.
* **Data Ingestion and Storage:** Collected data are uploaded to Firebase. We use Firestore (NoSQL) to store raw sensor streams and user responses. Authentication ensures only authorized access. Firebase’s real-time syncing allows low-latency data flow for near-real-time analysis.
* **Feature Extraction and Backend Processing:** A cloud component retrieves raw data (using Firebase Functions or a backend server) to compute meaningful features. For example, a nightly job might aggregate the day’s step count, compute sleep duration from phone inactivity, or tally hours spent in study locations. These features are stored in a processed dataset.
* **Stress Inference Engine:** The core analytical module applies a machine learning model (e.g. a trained classifier) to the feature set to predict current stress level. This could run on a cloud server (using Python/TensorFlow) or on-device for privacy. The model leverages patterns identified in the literature (e.g. reduced mobility or increased late-night phone use as stress indicators[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)).
* **User Feedback and Intervention:** Predicted stress levels feed into the app’s UI. If stress crosses a threshold, the app may generate notifications, display coping resources, or connect the student to campus counseling. All components are illustrated in the simplified architecture below:
* **(Figure: System Architecture)** *Although not shown here, the architecture includes the mobile app, cloud database (Firebase), data processing pipelines, and ML inference module. Sensors feed into the app, which sends data to the cloud; the backend processes features and returns stress assessments to the app.*

In this framework, data flows seamlessly from **sensors → mobile app → cloud storage → feature processing → stress model → app feedback**. Security and privacy controls (data encryption in transit and at rest, user consent checks) are integrated at each stage. By structuring the system in modular layers (data ingestion, processing, inference, and UI), we ensure scalability and maintainability.

**7. Project Implementation**

At present, we have begun prototyping the system. The Flutter project’s basic UI scaffolding is in place: key screens (user login, consent form, dashboard) have been implemented. Firebase services have been configured, including user authentication and a Firestore database schema for storing sensor and survey data. We have integrated Flutter plugins to access device sensors: for example, the geolocator plugin to capture GPS coordinates and sensors\_plus for accelerometer/gyroscope readings.

Concurrently, we designed the overall data flow. Using mock data, we tested uploading to Firestore and retrieving it for analysis. We created initial Dart classes to represent data entities (e.g. SensorRecord, SurveyResponse) and set up listeners to stream data to the backend. The architecture design (as above) has been validated by setting up Firebase Cloud Functions stubs that can process incoming data.

Finally, preliminary experiments confirm our setup works: the app successfully logs user location and motion data to Firebase, and reads/writes from the database. We also drafted the machine learning pipeline in Python: feature extraction scripts can parse timestamped logs, and a simple stress classification model (using a linear SVM) is being trained on synthetic data to test connectivity. In summary, the core infrastructure is operational, enabling us to move forward with refining features and analytics.

**8. Results**

Initial tests demonstrate successful integration of the main components. We have verified that the Flutter app can **connect to Firebase**, authenticate users, and **store sensor data** in the cloud. For example, accelerometer readings and GPS samples were recorded in Firestore with correct timestamps. UI modules for login and data display are functional, and the app responds to lifecycle events (pausing/resuming sensing correctly).

On the sensor side, motion and location services are active: we have confirmed that step counts and location changes are logged when the device moves. Screen time and app usage data are also being captured. We tested a simple feature extraction routine (e.g. counting total steps per hour) on the ingested data, which produced expected values.

Although a finalized stress prediction model is still in development, our early machine learning experiments show promise: using a small synthetic dataset, a prototype classifier was able to distinguish “low” vs. “high” stress patterns based on mobility features. Importantly, the **end-to-end data pipeline** works: data flows from the phone into the database, is processed by our scripts, and the results (stress scores) can be fed back to the app for visualization. These results confirm that the planned system components are viable and correctly interconnected.

**9. Conclusion and Future Work**

In this research/design phase, we have defined a mobile-based framework for early stress detection in students and built the foundational software infrastructure. The cross-platform app (Flutter) and Firebase backend are operational, and basic sensor-data collection and storage have been demonstrated. Our architectural design aligns with best practices in digital phenotyping, combining passive sensing and user input to capture student behavior comprehensively.

Next steps include developing and validating the stress inference models. We will collect pilot data from volunteer students to label stress levels and train more robust classifiers. The UI will be refined to improve user engagement, and we will implement security measures (data encryption, GDPR-compliant consent). We also plan extensive testing of battery impact and data accuracy under real-world conditions. In the longer term, we aim to incorporate advanced features such as anomaly detection (flagging unusual behavior) and personalized intervention suggestions. Eventually, we hope to conduct a pilot study to measure how well the system predicts stress and whether it can meaningfully prompt students to seek help or adopt coping strategies.

**10. Research Article Preparation**

We intend to publish our findings in an academic venue. A manuscript will be prepared outlining the research goals, methodology, and initial results. The paper will include sections on background (student stress and digital phenotyping), system design (architecture and data collection methods), and evaluation (preliminary accuracy of stress detection). We will follow standard reporting guidelines (e.g. CONSORT for any pilot trials, or PRISMA if we include review elements) and cite relevant literature. Target venues include journals like *JMIR mHealth and uHealth* or *npj Digital Medicine*, and conferences on mobile health or educational technology. The research article will emphasize our contributions: demonstrating a cross-platform mobile system for hybrid data collection, and early evidence that digital phenotyping can support student well-being.

**Sources:** Authoritative studies and documentation were consulted to guide this project (e.g. digital phenotyping reviews[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/#:~:text=years,In)[nature.com](https://www.nature.com/articles/s41746-018-0075-8#:~:text=Digital%20phenotyping%20uses%20smartphone%20and,its%20possible%20ethical%2C%20legal%2C%20and), stress–behavior research[frontiersin.org](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full#:~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this)[pmc.ncbi.nlm.nih.gov](https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/#:~:text=between%20stress%2C%20depression%2C%20and%20academic,parents%2C%20educators%2C%20and%20other%20stakeholders), and official technology references[github.com](https://github.com/flutter#:~:text=Flutter%20is%20an%20open%20source,from%20all%20around%20the%20world)[firebase.google.com](https://firebase.google.com/#:~:text=Prototype%2C%20build%20%26%20run%20modern%2C,throughout%20your%20app%20development%20lifecycle)). All cited works appear in the text using the format specified.

Citations

[[Favicon](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full#:~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this)](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full" \l ":~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this" \t "_blank)

**[Frontiers | Academic Stress and Mental Well-Being in College Students: Correlations, Affected Groups, and COVID-19](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full" \l ":~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this" \t "_blank)**

[https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full](https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.886344/full" \l ":~:text=for%20college%20students,abuse%20disorder%2C%20begin%20during%20this" \t "_blank)

**[Family and Academic Stress and Their Impact on Students' Depression Level and Academic Performance - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/" \l ":~:text=between%20stress%2C%20depression%2C%20and%20academic,parents%2C%20educators%2C%20and%20other%20stakeholders" \t "_blank)**

[https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/](https://pmc.ncbi.nlm.nih.gov/articles/PMC9243415/" \l ":~:text=between%20stress%2C%20depression%2C%20and%20academic,parents%2C%20educators%2C%20and%20other%20stakeholders" \t "_blank)

**[Digital phenotyping for mental health of college students: a clinical review - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/" \l ":~:text=Defined%20as%20using%20data%20from,4%E2%80%936" \t "_blank)**

[https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/](https://pmc.ncbi.nlm.nih.gov/articles/PMC10231503/" \l ":~:text=Defined%20as%20using%20data%20from,4%E2%80%936" \t "_blank)

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[https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/" \l ":~:text=Digital%20phenotyping%20is%20%E2%80%9Cthe%20moment,In" \t "_blank)

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[https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/" \l ":~:text=We%20categorized%20the%20studies%20into,number%20of%20interactions%20and%20response" \t "_blank)

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[https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/" \l ":~:text=prediction%3B%20most%20others%20%28n%3D8%2C%2020,activity%2C%20sleep%2C%20social%20interaction%2C%20and" \t "_blank)

**[Digital Phenotyping for Stress, Anxiety, and Mild Depression: Systematic Literature Review - PMC](https://pmc.ncbi.nlm.nih.gov/articles/PMC11157179/" \l ":~:text=and%20mild%20depression%20in%20nonclinical,stress%2C%20anxiety%2C%20and%20mild%20depression" \t "_blank)**

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