Review

Measuring Perceived Stress in Healthy Adults in Daily Life: Scoping Review of Smartphone-Based Self-Assessment

Toon Colman[1], MSc; Tom Van Daele[1,2], PhD; Bert Bonroy[3], PhD; Jean-Marie Aerts[4], PhD; Glen Debard[3], PhD; Jasper Gielen[4], PhD; Romy Sels[3], MSc; Catharina Nina Van Oost[4], MSc; Maria Faurholt-Jepsen[5,6], MD, DMSc; Nele A J De Witte[1], PhD

[1]Psychology & Technology, Centre of Expertise Care and Well-being, Thomas More University of Applied Sciences, Antwerp, Belgium

[2]Centre for Technological Innovation, Mental Health and Education, Queen's University Belfast, Belfast, Northern Ireland, United Kingdom

[3]Mobilab & Care, Centre of Expertise Care and Well-being, Thomas More University of Applied Sciences, Geel, Belgium

[4]Department of Biosystems, Research group M3-BIORES, KU Leuven, Leuven, Belgium

[5]Copenhagen Affective Disorder Research Center (CADIC), Psychiatric Center Copenhagen, Frederiksberg, Denmark

[6]Department of Clinical Medicine, Faculty of Health and Medical Sciences, University of Copenhagen, Copenhagen, Denmark

Corresponding Author:
Toon Colman, MSc
Psychology & Technology, Centre of Expertise Care and Well-being
Thomas More University of Applied Sciences
Molenstraat 8
Antwerp, 2018
Belgium
Phone: 32 32410824
Email: toon.colman@thomasmore.be

Abstract

Background: Smartphone-based self-assessment methods, such as ecological momentary assessment (EMA), are increasingly used to measure perceived stress in research and emerging clinical applications. However, the proliferation of studies and methods has made it difficult for researchers and practitioners to maintain an overview and make informed methodological choices. An updated synthesis of smartphone-based self-report methods is therefore needed.

Objective: This scoping review aims to systematically map smartphone-based methods for assessing self-reported perceived stress in healthy adults during daily life, to describe measurement characteristics and methodological choices, and to narratively examine the extent to which validity and reliability evidence are reported.

Methods: Following PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines, we searched a total of 7 databases: Web of Science, Embase, MEDLINE, PubMed, IEEE Xplore, ACM, and PsycInfo. Eligible studies assessed general perceived stress in healthy adults using smartphone-based self-report measures in daily life. Screening was conducted independently by at least 2 reviewers at the abstract and full-text levels. Methodological characteristics of stress measurement were extracted and summarized descriptively.

Results: From 8777 deduplicated records, 108 studies met all eligibility criteria. Publication frequency increased notably over the review period. Most studies used observational designs, with EMA-style prompting schedules. Stress was typically assessed using very brief measures: most instruments (84/114, 74%) consisted of a single item, most commonly answered using a Likert-type scale or a visual analog scale. Measurement frequency ranged from once per week to multiple prompts per day, with intensive approaches (≥3 prompts per day) being most common. Despite the prevalence of these instruments, only a minority of studies reported validity or reliability measures. When provided, evidence typically consisted of correlations with established stress questionnaires or affective measures. A small subset conducted elaborate psychometric analyses or validation of instruments.

Conclusions: Smartphone-based stress assessment is widespread but methodologically heterogeneous. This review provides an updated methodological overview to support researchers in selecting or developing robust smartphone-based measures of perceived stress. Only a small minority of studies reported formal psychometric evaluations, highlighting the need for more systematic validation of smartphone-based stress assessment.

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KEYWORDS

smartphone; ecological momentary assessment; psychological stress; self-report; mobile apps; surveys and questionnaires

Introduction

Background

Stress is a multifaceted psychological and physiological response that plays a central role in mental and physical health. According to Cohen et al [1], stress can be described as the process in which "environmental demands tax or exceed the adaptive capacity of an organism, resulting in psychological and biological changes that may place persons at risk for disease." Chronic stress, without sufficient recovery, is indeed associated with numerous adverse outcomes, including infectious disease [2], cardiovascular disease [3], and depression [4], as well as substantial economic costs [5]. Hence, improving stress monitoring and interventions can have a substantial personal and societal impact.

Being a complex response, stress involves changes in autonomic nervous system activity, behavior, and subjective mood. Physiologically, it is associated with decreases in heart rate variability (HRV) [6], increases in electrodermal activity [7], and the release of stress-related hormones such as cortisol [8]. Equally important, however, is the psychological response: the subjective experience of feeling stressed, occurring when individuals perceive that demands exceed their resources [9]. Physiological and psychological stress measures are related, but they capture distinct processes on different timescales and, therefore, their correlation is often modest [10]. Physiological responses are also not stress-specific and are influenced by contextual variables, such as physical movement or high-arousal positive emotions [11]. Therefore, the accurate measurement of self-reported perceived stress (or subjective stress) remains crucial.

Several questionnaires assess perceived stress, including the Perceived Stress Scale (PSS) [12], the stress subscale of the Depression Anxiety Stress Scales (DASS) [13], and the Kessler Psychological Distress Scale (K10) [14]. Although these retrospective measures are widely used and psychometrically supported [15-17], they are limited by recall bias and low temporal resolution: they cannot capture rapid fluctuations in stress throughout daily life [18]. Ecological momentary assessment (EMA), also termed the experience sampling method (ESM), addresses these limitations by collecting repeated real-time reports of thoughts, emotions, and behaviors in natural environments, enhancing ecological validity and reducing recall-related bias [18]. With the widespread use of smartphones, EMA has become more feasible and scalable, expanding the possibilities for high-resolution monitoring of perceived stress [19-22]. Smartphone-based EMA methods have also been used to measure stress in patient populations, demonstrating the opportunities in clinical contexts [23]. Examples of populations that have been studied include patients with HIV [24] or tinnitus [25].

EMA and similar methods allow researchers and practitioners to collect self-reported stress data in real time, but several methodological challenges remain. EMA protocols rely on brief assessments that are administered repeatedly, often multiple times per day. To minimize participant burden and increase compliance, single-item measures or abbreviated versions of existing questionnaires are often used [20]. While the validity and reliability of brief EMA measures are generally supported, results vary across participants, topics, and studies [26,27]. In addition, when traditional (retrospective) questionnaires are shortened and adapted to a momentary assessment context, they may not automatically retain their psychometric properties [28]. The validity and reliability of EMA stress measures are a multifaceted problem. First, validity can be examined by studying whether the EMA measure correlates with a validated questionnaire, such as the PSS (convergent validity), and by investigating whether it correlates as theoretically expected with distinct but related constructs, such as positive and negative affect (criterion and discriminant validity) [28,29]. Second, the reliability of EMA measures can be investigated using multilevel approaches, as there is variability not only between participants but also within participants (due to repeated measurements) [28,29].

A systematic review by Þórarinsdóttir et al [20] showed that by 2016, smartphone-based self-assessment of stress had already proliferated, driven by widespread smartphone availability and growing interest in personalized health monitoring. Their review revealed heterogeneity in methodological choices such as scale type, number of items, and sampling frequency, and highlighted that many studies relied on unvalidated brief instruments. Consequently, to date, important questions remain regarding the validity and reliability of these measures.

Study Objectives

It is likely that over the past decade, since the review by Þórarinsdóttir et al [20], the scientific literature on smartphone-based self-assessment of stress has grown even more steeply, and more validated approaches have been developed. The lack of a recent comprehensive overview of smartphone-based methods for assessing perceived stress poses challenges for researchers seeking to make informed methodological decisions.

Thus, the present scoping review systematically maps the methods used to measure self-reported perceived stress via smartphones in healthy adults during daily life. Here, we focus on general perceived (or subjective) stress, as opposed to stress associated with specific events or domains, such as stress related to traumatic life events. Because the field is characterized by considerable methodological diversity in instrument content, response formats, sampling schedules, and implementation strategies, a systematic review is currently not feasible. Instead, a scoping review is the most appropriate way to map the existing evidence base. We aim to update the findings of Þórarinsdóttir

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et al [20] by synthesizing the methodological characteristics of recent approaches and exploring the extent to which their validity and reliability have been studied.

Specifically, this review addressed the following research questions:

1. Which smartphone-based self-report methods have been used to assess perceived stress in healthy adults during daily life since 2016?
2. What are the methodological characteristics of smartphone-based stress assessment, including study characteristics (eg, study duration, sample size, population, and assessment context) and measurement characteristics (eg, item phrasing, number of items, response format, measurement frequency, and prompting method)?
3. What evidence regarding the validity and reliability of these instruments has been reported?

Methods

Review Framework and Protocol Registration

This scoping review was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 statement [30] and the PRISMA extension for Scoping Reviews (PRISMA-ScR) [31]. The tip sheets accompanying the PRISMA-ScR statement were also consulted. The PRISMA-ScR checklist can be found in Multimedia Appendix 1 [31]. The protocol was developed following the methodological guidelines of the Joanna Briggs Institute Scoping Review Methodology Group [32] and was preregistered on OSF Registries [33]. Compared with the preregistered protocol, only 2 minor deviations occurred. First, the ACM Guide to Computing Literature was searched instead of the ACM Full Text Collection. Because the ACM Guide to Computing Literature includes all records from the ACM Full Text Collection as well as additional records, this modification resulted in a more comprehensive search. Second, although participant age was extracted from included studies as planned, age data were not synthesized using descriptive statistics. Age was reported inconsistently across studies, with some reporting means and SDs, others reporting medians, and others reporting age ranges only. Because these data could not be summarized in a consistent manner across studies, age was not included in the final quantitative summary.

Eligibility Criteria

Following the population, concept, and context framework of the Joanna Briggs Institute [34], studies were eligible when they targeted healthy adults (population), assessed general perceived stress (concept), and used a smartphone-based self-assessment method administered during daily life (context). The population of healthy adults was defined as individuals aged 18 years or older without diagnosed physical or mental health conditions and without indications of unhealthy living circumstances (eg, homelessness), as outlined in the World Health Organization Housing and Health Guidelines [35]. To update the earlier review by Þórarinsdóttir et al [20], only records published between January 1, 2016, and the search date of June 14, 2024, were considered.

Studies were excluded if they met any of the following criteria: (1) wrong publication type (eg, nonempirical report such as a protocol or not written in English), (2) wrong population (eg, minors, unhealthy adults, or unhealthy housing conditions), (3) no measurement of general perceived stress levels in daily life (eg, stress not quantified, not general but specific stress, or not in daily life), (4) not a smartphone-based assessment (eg, stress not measured on a smartphone), (5) duplicate data (eg, in multiple publications reporting the same dataset, only the most complete version was retained, ie, the study with the most participants or the longest duration if sample size was equal), and (6) missing data on one or more of the main variables, preventing extraction of core characteristics (eg, stress item phrasing or sampling frequency).

Information Sources and Search Strategy

We searched generalist and domain-specific databases in psychology and technology. Searches were conducted in Web of Science Core Collection (via the Clarivate Web of Science platform), Embase and MEDLINE (via Embase), PubMed (via PubMed), PsycInfo (via Ovid), IEEE Xplore Digital Library (via IEEE Xplore), and the ACM Guide to Computing Literature (via ACM Digital Library). Because PubMed also includes all MEDLINE-indexed records, there was overlap between the searches conducted through Embase and PubMed, which was addressed during the deduplication process. However, PubMed also includes records that are not (yet) indexed in MEDLINE, thereby increasing the sensitivity of the search strategy.

No gray literature (eg, master's theses) was included because the review aimed to identify smartphone-based stress assessment methods that were described in sufficient methodological detail to allow extraction of key measurement characteristics and any available evidence regarding validity or reliability. No supplementary reference list searching, citation tracking, hand-searching, or expert consultation was performed.

The general search query was *(Stress* OR psychological stress OR emotional stress) AND (smartphone* OR "cell phone*" OR cellphone* OR "cellular phone*" OR mobile phone* OR iPhone* OR iOS OR Android OR mobile application* OR mobile app OR mobile apps OR ecological momentary assessment* OR experience sampling method* OR ESM OR EMA)*. Some databases required adaptation of the query to accommodate their specific search fields and operators. Prior to finalizing the strategy, we piloted the search string in all databases and refined it iteratively to maximize sensitivity (inclusion of all relevant studies) while maintaining sufficient specificity (limiting irrelevant results).

As an example, the full search strategy for PubMed was to enter the following search query in the basic search field: *(Stress*[Title/Abstract] OR "psychological stress"[Title/Abstract:~5] OR "emotional stress"[Title/Abstract:~5]) AND (smartphone*[Title/Abstract] OR "cell phone"[Title/Abstract:~5] OR "cell phones"[Title/Abstract:~5] OR cellphone*[Title/Abstract] OR "cellular phone"[Title/Abstract:~5] OR "cellular phones"[Title/Abstract:~5] OR "mobile phone"[Title/Abstract: ~5] OR "mobile phones"[Title/Abstract:~5] OR iPhone*[Title/Abstract] OR iOS[Title/Abstract] OR Android[Title/Abstract] OR "mobile*

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application"[Title/Abstract:~5] OR "mobile applications"[Title/Abstract: ~5] OR "mobile app"[Title/Abstract:~5] OR "mobile apps"[Title/Abstract:~5] OR "ecological momentary assessment"[Title/Abstract] OR "experience sampling method*"[Title/Abstract] OR ESM[Title/Abstract] OR EMA[Title/Abstract])*. After conducting the search, the publication date filter was set from January 1, 2016, to June 14, 2024. All other database-specific search queries are available in the preregistered protocol [33].

Screening and Selection Process

For the screening and selection of studies, all retrieved records were imported into Rayyan (Rayyan Systems, Inc) [36] for deduplication and screening. After removing duplicate entries, the remaining unique records were first screened at the abstract level using the predefined inclusion and exclusion criteria. Abstract screening was conducted independently by 2 reviewers, who were blinded to each other's decisions. Records deemed potentially eligible proceeded to full-text screening, which was carried out using the same blinded dual-reviewer procedure. After both the abstract and full-text stages, any conflicts between reviewers were resolved through discussion until consensus was reached. Reviewers had an academic and professional background in psychology.

Data Extraction

Overview

The primary aim of the extraction process was to capture the methodological characteristics of smartphone-based stress measurement. Data extraction was first piloted on a subset of 10 studies by 1 reviewer, after which the variables to be extracted were discussed with a second reviewer and refined accordingly. After finalizing the extraction approach, 1 reviewer extracted data from all included studies, after which a second independent reviewer checked the dataset. Any discrepancies or irregularities identified during this check were resolved through discussion.

Study Characteristics

To describe the characteristics of studies on smartphone-based self-assessment of stress, several variables were extracted. The main variables were (1) study population (eg, university students or employees), (2) assessment context (eg, daily life or workplace), and (3) study duration. Studies were required to report these variables to be eligible for inclusion. Additional variables that were extracted but were less essential were (1) study location, (2) study design (eg, observational cohort or interventional), and (3) number of participants. Participant age was also extracted but not retained in the final quantitative summary because of inconsistencies in reporting formats across studies.

Characteristics of Stress Self-Assessment Methods

To characterize the measurement characteristics of smartphone-based self-assessment of stress, several variables were extracted. The main variables were (1) the number of items measuring stress, (2) the stress items, (3) the method for self-assessment (eg, Likert scale or binary yes-or-no response), (4) the number of times per day that stress was measured, and (5) mobile modality and prompting method (eg, measurement via text message or app notification). Studies were required to report these variables to be eligible for inclusion. An additional variable extracted was the smartphone operating system.

Evidence on Validity and Reliability

For each included study, we documented whether evidence regarding the validity or reliability of the stress measure was reported. When available, information was extracted on the type of evidence provided, the procedures used to establish validity or reliability, and any reported psychometric indexes.

Analysis Plan

The extracted data were summarized using descriptive statistics to provide an overview of study characteristics and characteristics of smartphone-based self-assessment methods. In line with scoping review methodology, neither a formal quality assessment nor a meta-analysis was undertaken. The evidence on validity and reliability was not formally appraised but instead synthesized narratively, due to the exploratory nature of the review and the limited reporting of psychometric properties. Given the wide range of reporting practices, from no evidence to a comprehensive psychometric evaluation, it was not feasible to quantify validity and reliability evidence systematically. Therefore, we provide a narrative overview of the strategies used to establish validity and reliability in the included studies and highlight illustrative examples.

All data processing and analysis were conducted using R (version 4.3.0; R Foundation for Statistical Computing) [37], along with the packages *readxl* [38], *writexl* [39], *officer* [40], and *flextable* [41]. To enhance comparability across studies, some variables were harmonized by reducing the level of detail when appropriate, such as by binning numeric variables into categories. Study duration was converted to an estimated number of days when reported in alternative units (eg, week, month, and year), using standard conversions (7, 30, and 365 days).

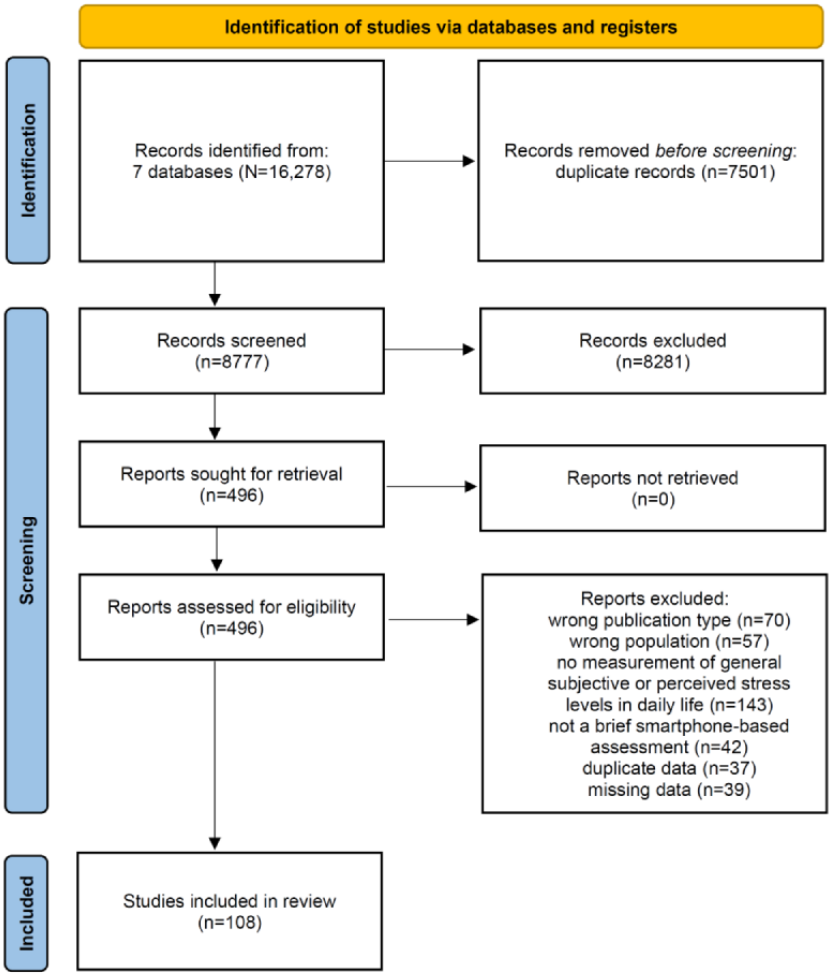
Results

Overview

After deduplication, 8777 records were screened. Of these, 496 progressed to full-text review, and 108 studies met all eligibility criteria and were included in the final synthesis. A PRISMA flow diagram of the screening and selection process is presented in Figure 1. The data table presenting all included studies can be found in Table S1 in Multimedia Appendix 2 [28,29,42-147]. The same table is included in Excel format with sorting and filtering functionalities in Multimedia Appendix 3 [28,29,42-147], to aid the closer investigation of individual studies.

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Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) diagram presenting the flow of the screening and selection process.



Study Characteristics

The 108 included studies were published between 2016 and mid-2024, with yearly publication counts of 5 (2016), 5 (2017), 2 (2018), 11 (2019), 13 (2020), 21 (2021), 17 (2022), 25 (2023), and 9 (2024). Most studies appeared in peer-reviewed journals (105/108, 97%), with a small number from conference proceedings (3/108, 3%). Geographically, the research was conducted primarily in North America (n=53) and Europe (n=38), followed by Asia (n=8), Oceania (n=3), the Middle East (n=1), South America (n=1), and multiregional studies (n=4).

Regarding study design, most publications used an observational cohort design (87/108, 81%), including longitudinal and EMA-based approaches, as well as studies that analyzed only one arm or group of an intervention. Other studies focused specifically on data collection for the development or training of machine learning models (n=7). Interventional studies were less common and included randomized (n=8), nonrandomized (n=1), and within-subject designs (n=3). Finally, 2 publications used a (multiple) n-of-1 methodology.

Although all studies involved healthy adults in daily life, the samples varied: 37 studies recruited university students, and 19 focused on working adults (of which 16 also investigated stress in the workplace). Others targeted specific subgroups, such as parents (n=8), older adults (n=2), romantic couples (n=2), or specialized populations (n=9), including pregnant women, smokers, drinkers, diet-interested individuals, meditators, and Native Americans residing on a reservation. Finally, 11 studies explicitly mentioned the COVID-19 pandemic as a context. Sample sizes varied widely, ranging from 1 to 21,923 participants, with a median value of 97 (IQR 50.25-182.50). Study duration (ie, the duration of smartphone-based stress assessment) ranged from 1 to 365 days with a median value of 14 (IQR 7-21.5).

Characteristics of Stress Self-Assessment Methods

Across all 108 studies, 114 instruments measuring perceived stress were identified. A total of 6 studies used 2 different instruments within the same protocol (eg, daily single-item EMA plus a weekly short scale). Most instruments (84/114, 74%) relied on a single-item measure. A total of 23 instruments used short scales of 2 to 4 items, and 7 used scales of 5 items or more. Note that only items specifically measuring stress were counted; often, other constructs were measured alongside stress.

The phrasing of the items (ie, the questions for the self-assessment) was grouped into 3 categories: (1) 60 out of 114 instruments measured stress in a momentary manner (eg,

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"How stressed do you feel right now?" or "At the moment, I feel stressed"), (2) 30 instruments relied on a period-based assessment (eg, "How stressful has your day been so far?" or "How stressed were you in the last 30 minutes?"), and (3) 17 instruments relied on an appraisal-based approach in the style of typical stress questionnaires (eg, "I feel that I cannot cope with the things I have to do" or "I am on top of things"). Seven instruments combined multiple of these approaches within a single scale. Regarding the response format, Likert scales (75/114, 66%) and visual analog scales (VAS; 33/114, 29%) were most common. Less frequently used formats included pictorial scales (n=2) and binary yes-or-no responses, either alone (n=1) or combined with a Likert scale or a VAS (n=3).

Across the 108 included studies, measurement frequency varied. Most studies used an intensive approach of 3 or more measurements or a variable number of measurements each day (73/108, 68%), which is typical of EMA methodology. A considerable number of studies measured stress once (n=25) or twice (n=5) per day. Finally, 5 studies used a nonintensive approach of fewer than 1 measurement per day (eg, once per week).

Most studies (83/108, 77%) administered stress assessments using a mobile app with push notifications. Another 22 studies used SMS or messaging apps to deliver survey links to an online platform (eg, Qualtrics), sometimes automated using services such as SurveySignal. One study used the smartphone timer app as a reminder, and 2 studies delivered and received assessment items directly via text message. This made it technically possible to include participants with older cell phones instead of smartphones. Some studies specified whether they supported Android (Google) devices (n=27), iOS (Apple) devices (n=2), or both (n=23).

Evidence on Validity and Reliability

Overall, relatively few studies reported robust evidence on the validity or reliability of their smartphone-based stress measures. The available evidence ranged from indirect indications of validity, through correlational assessments with external measures, to more formal psychometric evaluations.

Several studies used items adapted from existing stress questionnaires, providing indirect evidence of validity insofar as the original instruments had undergone prior validation. Most commonly, researchers adapted items from the PSS [12] (eg, [28,42-52]). Other studies drew on items from the DASS [13] (eg, [53]), the Positive and Negative Affect Schedule (PANAS) [148] (eg, [52,54]), the Psychological Stress Measure-9 (PSM-9) [149] (eg, [55,56]), or the Stress and Coping Inventory (SCI) [150] (eg, [57]). Several studies also adopted a single-item stress question developed by the American Psychological Association (APA) [151] (eg, [58,59]). However, none of these instruments were originally designed or validated to capture momentary stress. Consequently, researchers modified the time frames and, in some cases, the response formats, to approximate momentary assessment, possibly raising questions about the validity of these adapted measures for real-time stress evaluation.

A subset of studies provided evidence for convergent, criterion, or discriminant validity, typically by correlating momentary stress ratings with established questionnaires or physiological markers. This is an important step toward establishing the validity of the measurement approach. For example, Gidlow et al [60], Feneberg et al [61], and Jones et al [62] reported significant associations with the PSS, and daSilva et al [63] found similar results for their pictorial stress scale. Other instruments that were used included the PSM-9 (eg, [64]), the Achenbach Adult Self-Report (ASR) [152] (eg, [65]), and the Subcomponents of Affect Scale (SAS) [153] (eg, [66]). Þórarinsdóttir et al [67], in a study explicitly designed to assess validity, reported correlations between smartphone-based stress assessments and the PSS, Eysenck Personality Questionnaire Neuroticism (EPQ-N) [154], and the Functioning Assessment Short Test (FAST) [155]. Other studies similarly used a battery of affective or stress-related instruments (eg, [28,29,68-72]).

Studies examining associations between smartphone-based stress measures and physiological indicators produced mixed findings. For example, Gidlow et al [60] and Feneberg et al [61] did not observe significant associations with hair cortisol. Giessing et al [73] similarly reported no associations with salivary cortisol or α-amylase. In contrast, Martinez et al [74] found a small but significant association between self-reported stress and HRV, and de Vries et al [75] reported comparable findings for some participants in a multiple n-of-1 study. Gordon and Mendes [76] also found some evidence of an association with heart rate and blood pressure reactivity.

Finally, a small number of studies conducted psychometric evaluations. At the basic level, this included estimating indexes of internal consistency or reliability. For multi-item measures, reliability was estimated using Cronbach α (eg, [56]) or multilevel McDonald ω to estimate between- and within-person reliability (eg, [43,51]). Within-person reliability was also estimated using variance decomposition techniques (eg, [52]). For single-item measures, researchers sometimes calculated intraclass correlations (ICCs) to quantify the proportion of variance attributable to between-person (as opposed to within-person) differences (eg, [72,77,78]). Lower between-person ICC values suggest that moment-to-moment, within-person changes account for most of the variability, which might be preferable in EMA studies aiming to capture momentary variations in stress.

At the most advanced level, a small number of studies performed comprehensive factor-analytic assessments to examine the underlying structure of the measurement instrument. Murray et al [28] validated an EMA-adapted version of the PSS (PSS-EMA), demonstrating reliability at both within- and between-person levels and confirming the scale's factorial structure using multilevel confirmatory factor analysis. They further established convergent and criterion validity through associations with related constructs, such as stress, anxiety, depression, and negative affect. Vikoler et al [29] validated the Di-Eu-Stress State (DESS) scale, a dedicated EMA measure designed to capture both stress (distress) and eustress. Their evaluation likewise included establishing within- and between-person reliability, multilevel confirmatory factor analysis, and associations with a range of constructs, such as stress, anxiety, depressiveness, and affect.

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Discussion

Main Findings

This scoping review systematically mapped 108 studies that used smartphone-based methods to assess self-reported perceived stress in healthy adults during daily life. Findings are consistent with the observations made in the earlier review by Þórarinsdóttir et al [20], particularly regarding the heterogeneity of measurement strategies, scale types, number of items, and sampling frequency. In recent years, however, both the quantity and scope of research have expanded considerably. The present review identified 108 studies, compared with the previous set of 35 studies. Most studies used observational designs with EMA-style prompting schedules, often involving 3 or more assessments per day. Across studies, stress was predominantly measured using very brief instruments, with 74% (84/114) relying on single-item measures and most using Likert scales or VAS. Single-item measures have also proven dominant in EMA research in other domains such as pain, momentary depression, and happiness [19,156-158]

Despite the widespread use of these approaches, evidence on validity and reliability was still relatively limited. Some studies adapted items from established stress or affect scales, such as the PSS or PANAS, or reported correlations with validated stress measures and related constructs. Some studies examined reliability or ICC, and the present review did retrieve a small number of recent studies on validated EMA measures, including multilevel psychometric evaluations, such as PSS-EMA [28] and a newly developed EMA stress scale [29]. These efforts signal an emerging methodological maturation, although comprehensive validation remains the exception rather than the norm.

Implications for Selecting and Evaluating Instruments

Based on the present scoping review and existing guidelines on self-assessments in daily life, several pragmatic recommendations can be made for researchers who are entering the field and selecting or developing smartphone-based stress instruments.

First, several recommendations have been proposed for EMA research in general and apply to EMA stress research as well. These include alignment between the measurement approach and the research question [159]. Specific study aims will be paramount in guiding protocol development, including timing and sampling schemes for EMA research, such as event-contingent, time-contingent, or hybrid designs [159]. When applied to the stress field, momentary items (eg, “right now”) might be preferable for capturing rapid stress fluctuations or responses to specific events, as required in high-resolution EMA designs. Period-based items (eg, “in the last 30 minutes” or “today”; also referred to as a coverage model of EMA) may be appropriate for studies focusing on larger time frames but might introduce greater recall demands or bias [160]. Appraisal-based items (eg, “I feel like I cannot cope with the things I have to do”) can strictly speaking be either momentary or period based and are mainly characterized by their alignment with traditional appraisal-based questionnaires such as the PSS, often assessing multiple dimensions of stress. App-based data collection with either a custom-developed mobile app or a readily available app, preferably on both Android and iOS, provides optimal flexibility [19].

Second, in addition to study alignment, measurement properties are relevant to consider. Single-item instruments reduce burden and facilitate intensive sampling but may limit psychometric precision. Researchers should prioritize instruments with demonstrated psychometric quality or include convergent measures (standardized stress questionnaires and affective scales) to evaluate measurement validity in their sample. The current review has shown that some single-item measures do provide satisfactory correlations with extended instruments. In addition, reliable multi-item EMA instruments were identified, such as the PSS-EMA [28] or the DESS scale [29]. When aligned with the research design, such instruments may be preferable. When appropriate, physiological indicators such as HRV (eg, measured using a wearable) can also offer complementary information to enrich the dataset with data measured at a different temporal resolution [19,21,159]. Mobile apps can enable integration with smartphone sensors and wearables but may require technical expertise, impose operating system constraints, and increase participant onboarding demands. SMS- or messaging app–based assessments enhance inclusivity, especially for participants using older devices, but offer less flexibility and integration with contextual data.

Opportunities for Improving the EMA Tradition in Stress Research

More training on the design and implementation of EMA approaches is warranted. When assessing studies, not all methodological choices appear carefully considered or prepared. Within and outside the field of stress research, many EMA measures have used novel questions without substantial prior psychometric evaluation, which implies potential problems in terms of replication and validity of the findings [156,159,160]. In addition to training on the approach itself, providing device training has been recommended to assess comprehension and promote adoption [156,160]. In line with this, transparent reporting of implementation choices supports reproducibility and informs future study design and interpretation of findings. Several reporting checklists have already been developed in related fields but could be applied to daily-life stress monitoring [19,161-163].

Because reliability is sample dependent, documenting reliability coefficients is relevant [160]. Reliability can be quantified through Cronbach α or multilevel McDonald ω for multi-item scales. The amount of variance attributed to within- and between-person differences can be quantified using ICC for single-item measures. Factor-analytic approaches provide even stronger evidence of construct validity. Alternative approaches that have been proposed to support item validity are real-time cognitive interviewing, planned missingness designs, and tests of context-dependent differential item functioning and item parameter drift [160].

Progress can also be made by further integrating smartphone-based self-report methods with physiological, behavioral, and contextual data. There is evidence for the complementary relevance of stress physiology, although

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temporal resolution is key and daily-life monitoring is challenging [8]. Wearable devices increasingly enable continuous monitoring of physiological parameters, and combining these multimodal data streams with EMA-based stress ratings offers opportunities for digital phenotyping and machine learning–based stress detection [164]. However, the validity of prediction models depends fundamentally on the quality of the EMA stress measures used as ground truth, underscoring the need for robust psychometric evaluation.

Limitations and Future Directions

Several limitations must be acknowledged. First, this review focused on general perceived stress in healthy adults, excluding large bodies of work on domain-specific stress (eg, trauma-related stress [165] or caregiver stress [166]), as well as studies involving clinical populations, minors, or unhealthy housing conditions. The review by Yang et al [23] supported the feasibility of stress monitoring in an adult patient sample but noted challenges related to the complexity of EMA data and completion rates. The approaches documented in the current review are nevertheless relevant to the broader domain of smartphone-based stress assessment and may provide additional insights into existing methodology. Second, due to the methodological diversity of included studies, we did not conduct a formal risk of bias assessment or quantitative synthesis of validity evidence. Although frameworks such as the Patient-Reported Outcomes Measurement Information System (PROMIS) [167] could facilitate structured comparisons of psychometric quality, their application requires a narrower, more homogeneous subset of studies. Another methodological limitation is that no interrater reliability coefficient was calculated during the screening of studies. Third, because of the high number of publications and to facilitate comparison, studies with missing data on key methodological variables (eg, stress item phrasing or measurement frequency) were excluded. Although this improved the interpretability of the descriptive synthesis, it may have introduced selection bias if reporting completeness was related to certain study characteristics. Finally, many studies in this review recruited university students or white-collar workers in high-income countries. Future work should include broader demographic and cultural contexts to enhance generalizability.

Conclusions

Smartphone-based self-assessment of perceived stress in daily life has become widespread, with notable growth over the past decade. The field of research is characterized by substantial study heterogeneity, with the use of single-item EMA measures and intensive sampling schedules nevertheless being most common. Some studies provide promising evidence for the validity and reliability of smartphone-based stress instruments, and a small number conduct rigorous multilevel psychometric evaluations. Nevertheless, comprehensive validation remains relatively rare.

Together, these findings indicate that smartphone-based stress assessment has become widely used, but studies are methodologically diverse and often rely on instruments whose psychometric properties have not been adequately established. Researchers should carefully align instrument selection with their study objectives and, whenever possible, prioritize measures with demonstrated validity and reliability or report psychometric indicators such as ICCs or multilevel reliability estimates. By synthesizing existing methods and the available validity and reliability evidence, this review supports more informed instrument selection and the development of robust, evidence-based strategies for mobile stress assessment. Future work would benefit from more systematic psychometric evaluation and transparent reporting of measurement characteristics to strengthen comparability across studies.

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Data Availability

The dataset generated and analyzed in this scoping review is available in Multimedia Appendices 2 and 3.

Generative AI Use

The authors declare the use of generative AI in the research and writing process. In line with the Generative AI Delegation Taxonomy [168], the following tasks were delegated to generative AI tools under full human supervision: proofreading and editing (ie, improving sentence construction in sections). The generative AI tool used was Copilot GPT-5.2 (Microsoft). Responsibility for the final manuscript lies entirely with the authors. Generative AI tools are not listed as authors and do not bear responsibility for the final outcomes.

Authors' Contributions

Conceptualization: NAJDW (lead), TC (equal), TVD (supporting), BB (supporting)
Data curation: TC
Formal analysis: TC
Funding acquisition: BB (lead), JMA (supporting), NAJDW (supporting)
Investigation: TC (lead), NAJDW (supporting), TVD (supporting)
Methodology: TC (lead), NAJDW (supporting), TVD (supporting)

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Project administration: BB
Supervision: NAJDW
Visualization: TC (lead), NAJDW (supporting)
Writing–original draft: TC (lead), NAJDW (supporting)
Writing–review & editing: TC (lead), NAJDW (equal), TVD (supporting), RS (supporting), BB (supporting), GD (supporting), MF-J (supporting), JG (supporting), CNVO (supporting), JMA (supporting)

Conflicts of Interest

None declared.

Multimedia Appendix 1

PRISMA-ScR checklist.
[DOCX File , 80 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Data table of all included studies (Microsoft Word).
[DOCX File , 69 KB-Multimedia Appendix 2]

Multimedia Appendix 3

Data table of all included studies (Microsoft Excel).
[XLSX File (Microsoft Excel File), 41 KB-Multimedia Appendix 3]

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Abbreviations

DASS: Depression Anxiety Stress Scales
DESS: Di-Eu-Stress State
EMA: ecological momentary assessment
EPQ-N: Eysenck Personality Questionnaire Neuroticism
ESM: experience sampling method
HRV: heart rate variability
ICC: intraclass correlation coefficient
K10: Kessler Psychological Distress Scale
PANAS: Positive and Negative Affect Schedule
PRISMA-ScR: Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PSM-9: Psychological Stress Measure-9
PSS: Perceived Stress Scale
VAS: visual analog scale

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