

Critical Reviews

Ecological Momentary Assessment Methodology in Chronic Pain Research: A Systematic Review



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Abstract: Self-reported pain intensity assessments are central to chronic pain research. Ecological momentary assessment (EMA) methodologies are uniquely positioned to collect these data, and are indeed being used in the field. However, EMA protocols are complex, and many decisions are necessary in the design of EMA research studies. A systematic literature review identified 105 articles drawing from 62 quantitative EMA research projects examining pain intensity in adult chronic pain patients. Study characteristics were tabulated to summarize and describe the use of EMA, with an emphasis placed on various dimensions of decision-making involved in executing EMA methodologies. Most identified studies considered within-person relationships between pain and other variables, and a few examined interventions on chronic pain. There was a trend toward the use of smartphones as EMA data collection devices more recently, and completion rates were not reported in nearly one third of studies. Pain intensity items varied widely with respect to number of scale points, anchor labels, and length of reporting period; most used numeric rating scales. Recommendations are provided for reporting to improve reproducibility, comparability, and interpretation of results, and for opportunities to clarify the importance of design decisions.

Perspective: *Studies that use EMA methodologies to assess pain intensity are heterogeneous. Aspects of protocol design, including data input modality and pain item construction, have the potential to influence the data collected. Thorough reporting on design features and completion rates therefore facilitates reproducibility, comparability, and interpretation of study results.*

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Key words: *Ecological momentary assessment, experience sampling, electronic diaries, self-report, chronic pain.*

Pain intensity represents the primary outcome in most clinical trials of pain disorders and is nearly universally assessed in chronic pain research.^{32,79} Chronic pain affects over 11% of the population of the

United States,⁹⁰ and there is an undisputed need for the accurate and reliable assessment of pain. Although alternatives to self-reported pain intensity (eg, observation of pain behaviors⁶⁴) have previously been considered, self-reports presently constitute the gold standard of pain assessment because they are able to reflect the subjectivity inherent in the pain experience.³²

Within the family of self-report methodologies, ecological momentary assessment (EMA) is uniquely positioned to assess a patient's pain experience with high precision. EMA involves momentary data collection in participants' natural environments at multiple points in time, and its advantages follow from 3 central aspects.¹¹² First, momentary measurement reduces recall biases by capturing present pain experiences rather than

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pain beliefs or summary ratings based on memory. Second, EMA occurs in patients' natural environments and social contexts, thus increasing the ecological validity of the assessment. Third, multiple repeated assessments occur over time, providing potentially fine-grained information about pain experiences. Whereas pain research is often based on cross-sectional snapshots, EMA methodologies provide rich data that facilitate the examination of short-term shifts, temporal dynamics, and the effects of specific contexts on the pain experience. In addition, ecological momentary interventions, also known as just-in-time adaptive interventions, become possible with EMA.^{57,91}

The importance ascribed to the advantages of EMA by organizations that drive protocol design for chronic pain research (eg, the Food and Drug Administration,¹⁰⁸ the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials³²), along with the increased availability of associated technologies, has naturally translated into an increase in the use of EMA in pain research. Nevertheless, it remains a specialized approach, and knowledge of its implementation is still relatively fragmented.

It is a central tenet of research design that the way in which data are collected influences the type of data collected. In a study comprised of a single assessment, the collection of pain intensity data upon waking from one group and in the middle of the day from another group would certainly be relevant to the interpretation of results. EMA methodology can similarly introduce bias, and, because of its complexity, can harbor many potential means of doing so. For example, contextual factors (eg, location, social environment) may be associated with pain, which makes it important to consider the timing and frequency of EMA sampling.¹²⁸ If sampling times are too sparse, the design may brush over symptom exacerbations or contextual influences may be overlooked, whereas too frequent sampling may be burdensome and may negatively affect data quality. Similarly, reporting decisions, such as whether compliance with momentary pain assessments is reported before or after exclusion of dropouts, can affect the appearance of study results. The importance of the various design and reporting decisions that are implicated in EMA studies necessitates detailed and comprehensive documentation.

This systematic review aims to summarize and describe the use of EMA in chronic pain research while emphasizing the various domains of decision-making involved in EMA methodologies. Because there is large variation among studies, this review is primarily descriptive. The main purpose was to examine characteristics pertaining to study populations and sampling procedures, the rationale for using EMA, data input modalities, pain assessment instrumentation, EMA completion rates, and statistical reporting. We recommend thorough reporting with respect to these domains to improve reproducibility, understanding of comparability across studies, and accuracy of interpretation of study results; we also note opportunities for future research to clarify the importance of design decisions.

Methods

Search Strategy

A systematic literature search was conducted through PubMed and Web of Science databases with the following search terms: [("ecological momentary assessment" or "experience sampling" or "electronic diary" or "electronic diaries" or "electronic interview" or "electronic interviews" or "interactive voice response" or "intensive diaries" or "ambulatory monitoring" or "ambulatory assessment") and "pain"]. The goal of the search was to include studies that specifically reference EMA methodologies, and we recognize the possibility that articles presenting dynamic data without specifically referring to the methodologies used to obtain the data were unintentionally excluded from the review. The search was conducted in October 2016 and therefore includes only articles published before that point; no other restrictions were placed on publication date.

This review focuses on quantitative EMA studies of pain intensity in adult chronic pain patients. As such, any studies that: 1) did not present empirical data, 2) did not measure pain intensity with EMA, 3) did not consider a chronic (noncancer) pain sample, or 4) did not consider a sample of adults, as well as any 5) case or qualitative studies, were excluded from the review. EMA involves the contemporary assessment of variables in participants' natural environments; therefore, studies asking participants to recall pain experienced across the past day, as is typical in daily diary studies, as well as laboratory studies taking place outside of participants' natural environments (eg, studies of procedural pain), were excluded. Paper as well as electronic methods of EMA data collection were acceptable for inclusion. Pain items were required to be specific to pain intensity (excluding, eg, pain quality) and dichotomous pain variables describing the presence or absence of pain were not in and of themselves considered to be pain intensity items. Further, patient populations for whom the pain history, mechanisms, or treatment strategies would take on different forms (eg, acute pain, cancer pain, children)^{50,143} were also excluded. There were no other disease or design restrictions, and methodological, observational, feasibility, and intervention studies were all deemed relevant and therefore included.

The search identified 685 unique articles, and 11 articles were additionally identified through other sources (eg, by consulting the reference lists of articles identified by the database search). Articles were considered for inclusion in a 2-step process (Fig 1): first, the abstract of each article was reviewed, and any that met the exclusion criteria were removed from the sample; second, full-text versions of all remaining publications were examined, and articles were again excluded on the basis of the aforementioned exclusion criteria. A total of 105 articles drawing from 62 unique research projects were included in the present review.

Extraction of Study Characteristics

We extracted and tabulated study characteristics from each of the articles (Table 1). If an article referenced

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