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Distinguishing between frequency and intensity of health-related symptoms from diary assessments

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ABSTRACT

Objective: This study investigated the utility of distinguishing between the frequency and intensity of self-reported symptoms using diary-based assessments in a representative sample of U.S. residents.

Methods: Data from the 2010 American Time Use Survey were analyzed, in which 12,000 respondents provided a diary about the prior day and rated their pain, tiredness, stress, and sadness for three of the day's episodes. A "two-part" latent variable modeling strategy was applied to estimate the frequency (propensity of its presence) and intensity (mean level when present) of each symptom from the diary ratings. Regression analyses comparing differences in symptom frequency and intensity across demographic factors (gender, age, income, education) were conducted to evaluate the utility of the distinction.

Results: Frequency and intensity measures were reliably estimated from 3 daily episodes, were moderately intercorrelated for each symptom domain (*rs* .39 to .60), and were differentially associated with demographic factors. Gender differences were evident only in symptom intensity, not frequency, with women reporting more intense symptoms. Comparisons by age showed pronounced declines in the frequency of tiredness and stress in older age, with no age-differences in the intensity of these symptoms. Higher socioeconomic status was associated with a lower intensity of pain, tiredness, stress, and sadness, but a higher frequency of tiredness and stress.

Conclusion: A useful distinction between symptom frequency and intensity may be made from diary-based assessments. It reveals demographic differences that are otherwise obscured and enables a more detailed characterization of health-related experiences in people's daily life.

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Introduction

Interest in self-reported somatic and affective symptoms is high in research, clinical, and health policy settings. Knowledge about health-related symptoms is important for evaluating health care and treatment, for understanding health disparities, and for tracking population trends in health and wellbeing over time [1,2]. To date, two characteristics of symptom experience – their frequency and their intensity – have often been overlooked or simply combined into single measures, in part, because there has been limited empirical study of the distinction [3]. The question addressed here is whether symptom frequency and intensity should be viewed and can be measured as distinctive health outcomes.

There are compelling conceptual arguments for separating the frequency and intensity of symptom experiences. A person could have symptoms of pain, fatigue, or emotional distress at *mild* levels yet very *often*, whereas another person could have symptoms at *high* levels but only *occasionally*, as in the case of symptom flares. The overall symptom severity (i.e., its average magnitude across time) could be very similar for both people, despite pronounced differences in the composition of symptom frequency and intensity. Discriminating these patterns could have implications for practice and research, perhaps suggesting different mechanisms and indicating different treatment strategies [3,4].

Despite its theoretical appeal, the frequency–intensity distinction has received little empirical justification in past research on self-reported somatic symptoms. Chang et al. [3] compared retrospective self-report ratings of fatigue using a frequency (none of the time–all of the time) or intensity (not at all–very much) response format and found that the two produced largely corresponding scale scores (correlation of .86). Similarly, scales that ask participants to rate either the frequency (not at all–almost always) or intensity (not at all–extremely) of posttraumatic stress disorder symptoms have been found to yield highly overlapping information (correlation of .93) [5]. Based on these findings, it has been argued that the concepts are virtually redundant and that there is little use in querying frequency and intensity of somatic symptoms separately [3–5].

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Importantly, however, these studies examined retrospective questionnaires, where respondents were asked to summarize their symptoms over several days (e.g., the past 7 days)[3]. Recall ratings can be impacted by memory biases [6], and contextual factors can influence how people use and interpret frequency and intensity response scales in retrospective self-reports [7]. Symptom diaries, such as ecological momentary assessment (EMA) and the Day Reconstruction method (DRM), mitigate or eliminate the effects of recall bias [6,8]. In addition, by collecting experience ratings across multiple moments or episodes, outcome measures that summarize these experiences are created by the researcher and not implicitly by the respondents. In other words, measures of symptom frequency and intensity can be directly computed from the diary data instead of relying on the participant's ability to meaningfully map their experiences onto a response scale that queries either frequency or intensity [9].

The purpose of this study was to investigate whether symptom diaries allow for a reliable and useful distinction between the frequency and intensity of health-related outcomes. Data from a nationally representative sample of over 12,000 individuals collected by the 2010 American Time Use Survey (ATUS, http://www.bls.gov/tus/) were utilized. Similar to the DRM, respondents were interviewed about the prior day, provided a “chunking” of the day into distinct episodes, and rated their pain, tiredness, sadness, and stress for 3 selected episodes. We conceptualized the frequency of a symptom as the proportion of episodes in which it was endorsed as present, and its intensity as the average level of the symptom when it was present, consistent with prior related literature examining basic components of affect [10–12].

To evaluate the utility of the distinction, we examined the extent to which symptom frequency and intensity were differentially associated with demographic characteristics, notably, gender, age, income, and educational attainment. Insight into the prevalence of emotional and somatic symptoms across demographic groups is important for understanding of who is more likely to seek healthcare and to facilitate more cost-effective utilization of healthcare resources. However, it is important that the derived prevalence rates be as precise and informative as possible. Thus, the question we addressed here was whether separating frequency and intensity symptom components reveals demographic differences that are otherwise obscured.

Methods

Participants and procedure

Data collected as part of the US Bureau of Labor Statistics' 2010 ATUS project with addition of the NIA-supported Wellbeing Module (WBM) were used for this study. The main purpose of ATUS is to develop nationally representative estimates of how people spend their time based on a subset of households who recently completed the Current Population Survey (CPS). Respondents are interviewed over the telephone to provide a detailed time diary of the previous day. In a series of questions, the interviewer asks: “What were you doing?”; “How long did you spend [ACTIVITY]?; “What did you do next?”, starting at 4 AM of yesterday and ending at 4 AM on the interview day. Thus, episodes are defined based on the temporal sequence of yesterday's activities. In the 2010 WBM completed after the time-use interview, 3 of the episodes were randomly selected for each respondent to ask about symptoms experienced.[1] Most episodes from the ATUS time diary were eligible for the WBM questions, with the exception of episodes that were shorter than 5 min and those that were coded as sleeping, grooming (e.g., personal hygiene), and personal/private activities (e.g., intimacy), given that people may not be able or inclined to report symptoms experienced during these episodes. In addition, due to a programming error in the computer-assisted interview, the last daily episode was excluded from selection for most participants (see http://www.bls.gov/tus for sampling and interviewing procedures).

Measures

Symptoms for each of the selected episodes were rated on a unipolar 7-point scale. For pain, the question was “From 0 to 6, where a 0 means you did not feel any pain at all and a 6 means you were in severe pain, how much pain did you feel during this time?” For tiredness, sadness, and stress, the question was “From 0 to 6, where a 0 means you were not tired/sad/stressed at all and a 6 means you were very tired/sad/stressed, how tired/sad/stressed did you feel during this time?” The order of the symptom domains for each episode was assigned at random for each respondent.

Demographic characteristics gender and age were assessed during the ATUS interview. Socioeconomic status variables income and education are available from CPS interviews conducted 2–5 months prior to ATUS. There were no missing values for gender, age, and education. Family income was missing for 4% of the sample (and about 13% of non-responses for income were allocated or imputed by ATUS); response categories for income approximated a logarithmic scale of the annual dollar amount, which is the preferred metric for analyses involving income and subjective wellbeing [13]. The sample was 44% female, 80% White, and 48% married, with a mean age of 46.7 ($SD = 17.6$) years, and a median family income of $40,000–$49,999. One sixth (16%) had less than high school education and 59% at least some college. Weekdays and weekend days were sampled at a 1:1 ratio (see http://www.bls.gov/tus for detailed sampling characteristics).

Statistical methods

There were two phases of the analyses. The first was to estimate frequency and intensity from the 3 daily episodes, and results of these analyses were intended to address the reliability and overlap of the two concepts. The second phase assumes enough unique information to test differences in the association between demographic variables and the frequency and intensity measures of the outcome variables.

Two-part modeling of symptom frequency and intensity

We operationally defined the frequency of a symptom as the proportion of episodes in which it was present (i.e., a rating greater than zero) and its intensity as the average level during episodes when it was present. A “two-part” structural equation modeling [14,15] strategy was applied for this purpose. As outlined by Olsen and Schafer [14], two-part models have been developed for variables that have a proportion of responses at a single value (often zero) and a continuous distribution among the remaining responses. Zeros are assumed to be *bona fide* valid data values indicating the absence of a symptom, not proxies for negative responses in a truncated distribution. As shown in Fig. 1 (left side), the responses are recoded into two indicator variables. A dichotomous indicator distinguishes the absence of a symptom ($0 =$ not at all) from its presence at any level (greater than 0) for each episode. A continuous indicator represents the symptom level (1 to 6) if the symptom was present, and is coded missing if the symptom was absent during the episode.

It should be noted that this coding results in unbalanced (i.e., missing) data, with respondents contributing between 0 and 3 observations to the symptom intensity part. However, the missingness is determined by the value on the frequency part, which is always observed [14]. The two-part model explicitly accounts for the missing data by estimating frequency and intensity as correlated latent factors. As shown in Fig. 1 (right side), the model was specified so that the frequency factor represented the latent average of the dichotomous (presence—absence) indicators, and the intensity factor represented the latent average of the

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[1] The restriction of 3 randomly selected episodes was imposed to limit participant burden.

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