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The Meaning and Measurement of Work Fatigue: Development and Evaluation of the Three-Dimensional Work Fatigue Inventory (3D-WFI)

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Abstract

Although work fatigue represents an important construct in several substantive areas, prior conceptual definitions and measures have been inadequate in a number of ways. The goals of the present study were to develop a conceptual definition and outline the desirable characteristics of a work fatigue measure; briefly examine several prior measures of work fatigue-related constructs; and develop and evaluate a new measure of work fatigue. The Three-Dimensional Work Fatigue Inventory (3D-WFI) provides separate and commensurate assessments of physical, mental, and emotional work fatigue. Results from a pilot study (N = 207) and a broader evaluative study of U.S. wage and salary workers (N = 2,477) suggest that the 3D-WFI is psychometrically sound and evinces a meaningful pattern of relations with variables that comprise the nomological network of work fatigue. As with all new measures, additional research is required to evaluate fully the utility of the 3D-WFI in research on work fatigue.

Keywords

Work fatigue; exhaustion; job burnout; conservation of resources (COR) theory; job demands-resources model; work stress

Interest in the causes and outcomes of work fatigue can be seen in a large and growing multi-disciplinary literature.[1] This interest has grown in recent decades because work fatigue is viewed as an important personal and work-related outcome that can connect working conditions to employee health, work attitudes, safety, and performance. For example, work exhaustion is a central element in models of job burnout (e.g., Demerouti, Bakker, Vardkakou, & Kantas, 2003; Maslach, Jackson, & Leiter, 1996; Shirom, 2011). Work fatigue also plays a prominent role in the job demands-resources model (JD-R; e.g., Bakker & Demerouti, 2007) and conservation of resources (COR) theory (Hobfoll, 1989; Shirom, 2011). Collectively, these theoretical models postulate that exposure to job demands/stressors deplete energetic resources resulting in increased levels of work fatigue,

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[1]Because the terms fatigue, exhaustion, weariness, and tiredness are typically used interchangeably, the term fatigue generally will be used in the text to represent these and related terms in order to avoid confusion and because the term fatigue has a longer and broader history of use. The other terms will be used, where appropriate, when referring to a construct in a specific conceptual model or to a prior measure that uses one of the other terms in its name.

whereas exposure to job resources protect or renew various energies resulting in lower levels of work fatigue. The resulting work fatigue subsequently influences a number of personal (physical, mental, and behavioral health; inability to relax) and organizational (job attitudes; attendance and turnover; poor performance; work injuries) outcomes.

Despite the theoretical importance and personal/organizational relevance of work fatigue, Winwood, Winefield, Dawson, and Lushington (2005) noted that an adequate definition of work fatigue has not been developed, and this has impeded the development of measurement tools (Winwood et al., 2005). These problems undermine our ability to conduct research on work fatigue and to draw conclusions that could serve as a guide to policy (Australian Safety and Compensation Council, 2006). Therefore, the main goal of this study is to develop and provide an initial evaluation of a multidimensional measure of work fatigue. Toward this end, we begin by developing a conceptual definition of work fatigue, identify desirable characteristics of a work fatigue measure, and briefly examine several prior measures of work fatigue-related constructs. We then present the goals and findings of a pilot study and a broader national validation study aimed at developing and evaluating the Three-Dimensional Work Fatigue Inventory (3D-WFI).

What is Work Fatigue?

In order to identify the central features of work fatigue, we consulted earlier conceptual and empirical research on fatigue, whether or not it was work-related. Looking across the various sources, three features were identified. The first feature of work fatigue is that it involves both extreme tiredness (i.e., lack of energy) and reduced functional capacity. Reduced functional capacity reflects a decrease in the capacity and/or motivation to respond to certain stimuli or engage in certain types of activities or behaviors. For example, Pillsbury (1922, p. 541) stated “By fatigue we mean a reduction in the capacity for doing work which comes as a result of work.” Ricci, Chee, Lorandeau, and Berger (2007, p. 1) defined fatigue as “a feeling of weariness, tiredness, or lack of energy.” Bokesem and Tops (2008, p. 126) stated that mental fatigue is experienced “after or during prolonged periods of cognitive activity” and involves “tiredness or even exhaustion, an aversion to continue with the present activity, and a decrease in the level of commitment to the task at hand.” Stasi, Abriani, Beccaglia, Terzoli, and Amadori (2003, p. 1787) noted that “fatigue is the state of weariness after a period of exertion, mental or physical, characterized by a decreased capacity for work and reduced efficiency to respond to stimuli.” Maslach and Jackson (1981, p. 101) stated that emotional exhaustion involves “feelings of being emotionally overextended and exhausted by one's work.” So, although variation exists across definitions in terms of a focus on extreme tiredness versus reduced functional capacity, they collectively suggest that the experience of work fatigue is represented by both aspects. Including both aspects in a definition of work fatigue helps to differentiate it from a normal and benign sense of tiredness that might result from engaging in activities that use some physical, mental, or emotional resources.

The second feature of work fatigue is that the experience of extreme tiredness and reduced functional capacity can occur with respect to each of three types of energetic resources—physical (involving muscular movement), mental (involving cognitive processing), and

emotional (involving expression and regulation of emotions). As seen in the definitions above and in the research literature dating back at least 90 years (e.g., Pillsbury, 1922), a distinction frequently has been drawn between physical fatigue resulting from depletion of muscular energy and mental fatigue resulting from depletion of cognitive energy. More recently, there has been a growth in service sector jobs and the extent to which individuals are required to work in teams. These changes require more intensive interpersonal interactions among employees and between employees and various organizational outsiders. Therefore, growing attention has focused on emotional fatigue, resulting from depletion of emotional energy, in addition to physical and mental fatigue (e.g., Australian Safety and Compensation Council, 2006; Maslach & Jackson, 1981; Shirom & Melamed, 2006).

The third feature of work fatigue is that it is temporally tied to the workday. That is, work fatigue is experienced during the workday (e.g., Demerouti et al., 2003; Kristensen, Borritz, Villadsen, & Christensen, 2005a; Maslach et al., 1996; Melamed et al., 2006). Although work fatigue is expected to be the outcome of various job demands and resources, it also may result from nonwork factors, such as enduring dispositional characteristics (e.g., personality; chronic disease) and demands originating outside the workplace that deplete energetic resources during the workday (e.g., dealing with chronic family problems at work).

Based on the discussion above, the following *general* definition of work fatigue is proposed:[2]

> **Work fatigue** represents extreme tiredness and reduced functional capacity that is experienced during and at the end of the workday.

Taking into account the three separate energy resources, the following *resource-specific* definitions of work fatigue are proposed:

> **Physical work fatigue** represents extreme physical tiredness and reduced capacity to engage in physical activity that is experienced during and at the end of the workday.
>
> **Mental work fatigue** represents extreme mental tiredness and reduced capacity to engage in cognitive activity that is experienced during and at the end of the workday.
>
> **Emotional work fatigue** represents extreme emotional tiredness and reduced capacity to engage in emotional activity that is experienced during and at the end of the workday.

Desirable Characteristics in a Work Fatigue Measure

Based on the above definitions and discussion, a measure of work fatigue should be multidimensional, separately assessing physical, mental, and emotional dimensions of work fatigue. The items for each type of work fatigue need to assess extreme tiredness and

[2]Work fatigue represents a condition that has an onset when energy depletion becomes too great and it has an offset when the energetic demands end and energy is restored through rest. Therefore, depending on the length of time between the onset and offset of work fatigue (i.e., duration of an episode), it can be experienced as an acute or chronic condition. Even if the acute/state experience of work fatigue resolves shortly after the end of every workday, if it occurs frequently over an extended period of time, it may be viewed as a chronic/trait condition. So work fatigue can be assessed as an acute/state condition (e.g., the experience of fatigue at the present moment) or a chronic/trait condition (e.g., the experience of work fatigue over the past 12 months). Although the acute/state versus chronic/trait distinction in the experience of work fatigue is relevant to the assessment of work fatigue, it is not directly relevant to defining the condition of work fatigue per se.

reduced functional capacity, and capture fatigue experienced during and at the end of the workday. To the extent that a measure of work fatigue is multidimensional, it can be anticipated that researchers will be interested in three general types of comparisons. One type is comparing the levels of different types of work fatigue within a group of workers or the levels of the same type of work fatigue across groups of workers. A second, and related, type of comparison involves work fatigue as an outcome. It might be useful to compare the strength of relations involving a specific predictor to the three types of work fatigue. A third type of comparison involves work fatigue as a predictor or cause. In this case, it might be informative to compare the strength of relations between the three types of work fatigue and some outcome.

For maximally interpretable comparisons of the types just described, it would be desirable for the measures of the three types of work fatigue to be fully commensurate. Drawing from the literature on person-environment fit (e.g., Edwards & Shipp, 2007) and integrative data analysis (e.g., Hussong, Curran, & Bauer, 2013), fully commensurate measures have two characteristics. The first characteristic is *conceptual equivalence*, which means the different types of work fatigue are described in the same terms, have the same number of items, and have the same conceptual meaning. More specifically, the wording of the three sets of items used to assess physical, mental, and emotional work fatigue, respectively, should be parallel in construction, differing only in reference to a specific energy resource (see Appendix). The second characteristic is *metric equivalence*, which means the measures of physical, mental, and emotional work fatigue need to employ the same metric or response scale.

Prior Work Fatigue-Related Measures

As shown in Table 1, several measures exist that assess work fatigue, or some aspect of it, such as extreme tiredness (e.g., exhaustion). Although these measures were not developed to provide a broad multidimensional assessment of work fatigue, as defined earlier, it is useful nonetheless to determine the extent to which their underlying conceptual definitions and items represent work fatigue or exhaustion (for a more detailed evaluation, see Supplementary Material File 1). Collectively, these measures exhibit a number of shortcomings. First, some measures appear to have been developed in the absence of a conceptual definition (MBI exhaustion measure; OFER acute work fatigue measure), and where a definition existed, it may not have actually defined the underlying construct of fatigue or exhaustion (OLBI exhaustion measure, CBI measures, BM measures of mental and emotional exhaustion). Second, an evaluation of items in each measure shows that almost all of them contain items representing constructs other than work fatigue or exhaustion. Third, some measures that purportedly assessed a specific type of work fatigue or exhaustion primarily assessed overall work fatigue or exhaustion instead (MBI emotional exhaustion measure, BM physical exhaustion measures, SMBQ physical fatigue measure). Finally, of the six measures in Table 1, the one that comes closest to a broad assessment of work fatigue is the SMBQ. However, the items assessing physical work fatigue better assess overall work fatigue, and none of the three SMBQ measures contain items assessing both extreme tiredness and reduced functional capacity.

Overview of Measure Development

An examination of prior measures suggests that a practical need exists for a new multidimensional measure of work fatigue that incorporates the desired measurement characteristics outlined earlier. Therefore, we developed the Three-Dimensional Work Fatigue Inventory (3D-WFI) following several general steps and practices for scale development and evaluation derived from a variety of sources (e.g., DeVellis, 1991; Edwards & Shipp, 2007; Hinkin, 1998; Hussong et al., 2013; Worthington & Whittaker, 2006). Step 1 was to review the literature in order to develop a detailed conceptual definition of work fatigue and to assess the need for a new instrument. The results of this step were provided earlier. Step 2 was to generate a set of items and instructions, and Step 3 was to provide an initial evaluation of the measure using a pilot study. These two steps are described below under Study 1. Step 4 was to provide a confirmatory test of the factor structure and other psychometric properties of the measure using an independent and much larger sample, and Step 5 was to provide initial data on the measure' sconstruct validity. These two steps are described under Study 2.

Study 1

Overview

After developing general and resource-specific definitions of work fatigue, identifying the desirable characteristics of a work fatigue measure, and examining prior measures, it was decided to develop a new set of items and a detailed instructional set. Hinkin (1998) refers to this as the deductive approach to measure development because a strong conceptual definition provides adequate information to generate a set of items, as well as an instructional set. The initial set of instructions and items was drafted by Author 1. These materials were subsequently revised by Author 2, which were again revised by Author 1. Several iterative cycles of revisions occurred until both Authors 1 and 2 were satisfied that the instructions and items were adequate and ready to be pilot tested. That is, the instructions and items had a high level of fidelity to the proposed definitions and captured the desirable measurement characteristics identified earlier. Midway during this process, the instructions and items were sent to an outside content expert, whose comments were incorporated into the measurement development process.

Taking into account the multidimensionality of the overall measure, it was desirable that the number of items developed for each type of work fatigue adequately capture the construct but that the total number of items was not excessive. Therefore, we developed 18 items—six items for each type of work fatigue, and within each type, three items assessing the extreme tiredness aspect and three items assessing the reduced functional capacity aspect of work fatigue. After the instructions and 18 items were developed, the 3D-WFI was included in a pilot study to provide an initial examination of its factor structure to determine if any of the items required revision before conducting a larger evaluative study and to provide an initial examination of the internal consistency reliability for each of the three measures.[3]

Participants and Procedure

The goal of the pilot study was to evaluate a broader interviewer-administered survey instrument, evaluate the data collection procedures, and to train interviewers for Study 2. The survey instrument contained the 18-item 3D-WFI described earlier and shown in the Appendix. The population from which the study participants were sampled was all noninstitutionalized adults aged 18 to 65 who were employed in the civilian labor force and residing in households in the 48 contiguous United States and the District of Columbia. Data were collected primarily by eight extensively trained interviewers using computer-assisted telephone interviewing (CATI) stations from September, 2008 to February, 2009. On average, the interview lasted 55 minutes and participants were paid $25.00 for their time. For the pilot study, 207 interviews were conducted.

Sixty-two percent of the participants were women. Regarding race/ethnicity, 75% were White, 11% were Black, 6% were Hispanic, and 8% were of other racial/ethnic makeup. The average age of participants was 44 years. In terms of highest level of education, 2% did not graduate from high school; 17% graduated from high school or obtained a GED; 3% attended trade, technical, or vocational training beyond high school; 23% attended some college; 11% received an Associate's degree; 23% received a Bachelor's degree; 3% attended some graduate school; 14% received a Master's degree; and 4% received a doctoral level degree. The participants worked on average 40 hours per week and held their job for an average of 5 years.

Results

Factor analysis—To explore the factor structure of the 3D-WFI items, a principle axis exploratory factor analysis was conducted. Oblique (Promax) rotation was used because the anticipated three factors, one for each type of fatigue, were expected to be positively correlated. Exploratory factor analysis was used with the pilot study data because other factor structures were possible and to identify items that loaded highly on multiple factors. Hinkin (1998) suggested a number of criteria that should be met in an exploratory factor analysis. First, any item representing a specific type of work fatigue that correlates less than .40 with all other items representing the same dimension of work fatigue can be eliminated. Second, a carefully developed set of items should result in the same number of

[3]A content adequacy study to determine if the 18 fatigue items were conceptually consistent with the relevant definitions of physical, mental, and emotional work fatigue was not conducted after they were developed. At the request of an anonymous reviewer, we conducted a content adequacy study during the manuscript review process. The items were rated by 21 PhD-level researchers, specializing in sociology and various areas of psychology (e.g., biological, clinical, developmental, and social), who had no affiliation with the present research project. Using an approach suggested by Anderson and Gerbing (1991), each rater received a written set of conceptual definitions for physical, mental, and emotional work fatigue. They also received a rating form that provided a column with the 18 work fatigue items in random order. On the rating form, there were four additional columns labeled *Physical Work Fatigue*, *Mental Work Fatigue*, *Emotional Work Fatigue*, and *Item Assesses Something Else*. The raters were asked to read the conceptual definitions and then, for each item, place a check mark in the appropriate column indicating whether the item was consistent with a specific type of work fatigue or something else. The results revealed that none of the 18 items were classified as assessing something other than work fatigue. The substantive agreement (SA) index, which represents the proportion of raters who assigned an item to its intended construct can range from 0 to 1.0, with higher scores representing higher SA. The SA scores were 1.0 for sixteen items and .95 for two items. The substantive validity (SV) index, which represents the extent to which raters assign an item to its intended construct more than to any other construct, can range from -1 .0 to 1.0. Higher positive scores represent higher levels of substantive validity. A binomial test can be conducted to see if an item significantly assesses the intended construct more than the other constructs. Anderson and Gerbing (1991) suggested testing an item's SV score against the conservative null hypothesis that SV = .5. The SV index was 1.0 for 16 items ($Z = 4.12$, $p < .001$) and .90 for two items ($Z = 3.67$, $p < .001$). Therefore, each of the items exhibited a high level of content adequacy.

factors identified by both the Kaiser and scree criteria. Third, the total item variance explained by the retained factors should be high, with 60% as a minimal target. Finally, the items should have "an appropriate loading of greater than .40 and/or a loading twice as strong on the appropriate factor than on any other factor" (p. 112). Worthington and Whittaker (2006) suggested deleting an item if it has a cross-factor loading "less than .15 difference from the item's highest factor loading" (p. 823).

An examination of the inter-item correlations showed that no items needed to be dropped. The smallest correlation was .62 among the physical work fatigue items, .67 among the mental work fatigue items, and .72 among the emotional work fatigue items. Both the scree plot and the number of eigenvalues greater than 1 suggested retaining three factors. The three retained factors explained 78% of the total item variance. The factor pattern loadings are shown in Table 2. Factor 1 represented physical work fatigue, Factor 2 represented mental work fatigue, and Factor 3 represented emotional work fatigue. Each item loaded highly on its intended factor and none required deleting or modification based on the item retention criteria mentioned earlier. Finally, the work fatigue factors were positively correlated: r = .58 between physical and mental work fatigue; r = .55 between physical and emotional work fatigue; and r = .74 between mental and emotional work fatigue.

Reliability—Internal consistency reliability (coefficient alpha) was estimated for each of the three dimensions of work fatigue. The coefficient alphas were .94 for physical work fatigue, .95 for mental work fatigue, and .96 for emotional work fatigue.

Discussion

The results of this pilot study supported the factor structure and psychometric properties of the 3D-WFI. A large proportion of total item variance was explained by the three factors, and all of the items loaded highly on their intended factors with no evidence of notable cross-loading. The reliability of all three measures was uniformly high (.94 to .96), and greatly exceeded the minimum desired reliability of .70 (Hinkin, 1998). Therefore, a larger study is warranted to provide a confirmatory test of the 3D-WFI's psychometric properties and an examination of the measure's construct validity.

Study 2

Overview

The goal of this study was to begin examining the construct validity of the 3D-WFI. The construct validation process entailed consideration of two types of information (Borsboom, Mallenbergh, & van Heerden, 2004; Ghiselli, Campbell, & Zedeck, 1981; Newton & Shaw, 2013). The first type of information is related to the psychometric properties of the 3D-WFI. We will test the fit of the hypothesized three-factor structure of the work fatigue items and compare it to the fit of a one factor model and a two-factor model. Also, the reliability of the three work fatigue measures will be estimated. The second type of information is related to the nomological network of the 3D-WFI; that is, exploring variables thought to be related (convergent-related evidence for construct validity) and unrelated (discriminant-related evidence for construct validity) to the three types of work fatigue. In terms of the

nomological network, two sets of variables will be examined. The first set of variables includes work and personality characteristics thought to be (a) predictive of all three types of work fatigue, (b) differentially predictive of the three types of work fatigue, or (c) unrelated to the three types of work fatigue. The second set of variables represent potential outcomes of work fatigue. The specific hypotheses are developed below.

Nomological Network: Predictor Relations

Job demands—Models of job burnout, the JD-R model, and COR theory generally describe an energy depletion process beginning with exposure to job demands requiring sustained physical, cognitive, or emotional effort, which then results in work fatigue (e.g., Bakker & Demerouti, 2007; Demerouti et al. 2003; Hobfoll, 1989; Maslach et al. 1996; Shirom, 2011). Although empirical research has documented a relation between measures of overall work demands and past measures of emotional work exhaustion (e.g., Alarcon, 2011; Lee & Ashforth, 1996), no studies have explored the potential differential relations of specific job demands to specific types of work fatigue. Such research would make a useful contribution to the work fatigue literature, as well as further validate the distinction between the three types of work fatigue. Although it is possible that physical, mental, and emotional job demands may be each associated with all three types of work fatigue, it is expected that the strongest relation for each type of job demand will involve resource-congruent work fatigue. Therefore, the following hypotheses are proposed:

Hypothesis 1. Physical job demands will be positively related to physical work fatigue, and will exhibit a weaker positive relation to mental and emotional work fatigue.

Hypothesis 2. Mental job demands will be positively related to mental work fatigue, and will exhibit a weaker positive relation to physical and emotional work fatigue.

Hypothesis 3. Emotional job demands will be positively related to emotional work fatigue, and will exhibit a weaker positive relation to physical and mental work fatigue.

Prior empirical research also has found a positive relation between two more general role demands—role conflict and role ambiguity—and past measures of emotional work exhaustion (e.g., Alarcon, 2011; Lee & Ashforth, 1996). However, we anticipate that these two role demands will be differentially related to the three types of work fatigue. Because neither role conflict nor role ambiguity would be expected to deplete physical resources, we expect that neither stressor will be related to physical work fatigue. In contrast, both types of role demands may deplete mental resources resulting from mental effort aimed at resolving conflict and trying to determine what is expected at work. Both types of role demands also may deplete emotional resources due to distress resulting from exposure to conflicting work demands and uncertainty regarding one's role expectations and responsibilities. Therefore, the following hypotheses are proposed:

Hypothesis 4. Role conflict will be positively related to mental and emotional work fatigue but will be unrelated to physical work fatigue.

Hypothesis 5. Role ambiguity will be positively related to mental and emotional work fatigue but will be unrelated to physical work fatigue.

Job resources—As mentioned earlier, job burnout models, the JD-R model, and COR theory collectively suggest that a negative relation exists between job resources and work fatigue because job resources may protect or renew various energies. One of the most commonly explored job resources has been job autonomy, with two recent meta-analyses finding a negative relation between job autonomy and past measures of emotional work exhaustion (Alarcon, 2011; Park, Jacob, Wagner, & Baiden, 2013). Although past research has only explored the relation between job autonomy and emotional work fatigue, it is possible that having control over how one's job is structured and conducted also may be predictive of lower levels of physical and mental fatigue. Therefore, the following hypothesis is proposed:

> ***Hypothesis 6***. Job autonomy will be negatively related to physical, mental, and emotional work fatigue.

Other work characteristics—In addition to exploring the relations of job demands and job resources to work fatigue, it is useful to show that other work characteristics exist that are generally unrelated to work fatigue because they do not play a central role in energetic resource depletion or restoration. In the present study, these other work characteristics represent job interdependence, promotion opportunity, and friendship formation. Jobs differ in the extent to which they are interdependent or mechanistically connected to one another. Morgeson and Humphrey (2006) noted that workers can experience two types of interdependence. Initiated interdependence represents the extent to which a person needs to complete his or her work before another person is able to complete their work. Received interdependence represents the extent to which a person's ability to complete his or her work is dependent on others completing their work. Neither type of interdependence is expected to deplete physical or emotional resources. To the extent that both types of interdependence may require some planning and coordination on the part of a given employee, there may be some depletion in mental resources. Therefore, the following hypotheses are proposed:

> ***Hypothesis 7***. Initiated interdependence will be positively related to mental work fatigue, but will be unrelated to physical and emotional work fatigue.

> ***Hypothesis 8***. Received interdependence will be positively related to mental work fatigue, but will be unrelated to physical and emotional work fatigue.

Jobs also differ in the extent to which there is potential for promotion. However, relative to a high level of promotion opportunity, a low level is not likely to deplete physical and mental resources. Also, to the extent that the level of promotion opportunity is a stable feature of a job and is generally known before or at the time of accepting a job, it is not likely that a low level of promotion opportunity will be emotionally depleting. Therefore, the following hypothesis is proposed:

> ***Hypothesis 9***. Lack of promotion opportunity will be unrelated to physical, mental, and emotional work fatigue.

A meta-analysis by Lee and Ashforth (1996) found that the size of the relation between having friends at work and past measures of emotional work exhaustion was near zero and nonsignificant. This lack of relation may result from the fact that work friendships can have

both positive (social support) and negative (conflict) consequences that balance out, resulting in a null relation to emotional work fatigue. This lack of relation may also extend to physical and mental work fatigue because friendship formation per se is not likely to deplete or replenish the associated energetic resources. Therefore, the following hypothesis is proposed:

> ***Hypothesis 10***. Workplace friendship formation will be unrelated to physical, mental, and emotional work fatigue.

Personality—Prior research supports relations between two personality traits and emotional work exhaustion. The first trait is negative emotionality (also referred to as neuroticism or negative affectivity) and represents a general dispositional tendency to experience negative emotions. Two meta-analyses found a positive relation between negative emotionality and prior measures of emotional work exhaustion (Alarcon, Eschleman, & Bowling, 2009; Swider & Zimmerman, 2010). This relation may exist because chronically experiencing and managing negative emotions may deplete emotional resources. Further, although the relation may not be as strong, negative emotionality also may be related to physical and mental fatigue. The reason is that compared to individuals with low levels of negative emotionality, those with high levels may be more likely to self-select into demanding jobs (e.g., Spector, Zapf, Chen, & Frese, 2000), or they may set high goals for themselves and may be more likely to develop inefficient methods for solving problems (e.g., Bakker, Van Der Zee, Lewig, & Dollard, 2006). Therefore, the following hypothesis is proposed:

> ***Hypothesis 11***. Negative emotionality will be positively related to physical, mental, and emotional work fatigue.

The second trait is positive emotionality (also referred to as extraversion and positive affectivity) and represents a general dispositional tendency to experience positive emotions and to seek out stimulation and the company of others. Two meta-analyses found a negative relation between positive emotionality and past measures of emotional work exhaustion (Alarcon et al., 2009; Swider & Zimmerman, 2010). This relationship may exist because chronically experiencing positive emotions may protect or renew emotional resources. Although the relation may not be as strong, positive emotionality also may be related to physical and mental fatigue. The reason is that compared to individuals with low levels of positive emotionality, those with high levels may be more likely to develop supportive workplace networks, be less likely to set unrealistic goals, and be more likely to develop more efficient methods for solving problems (e.g., Bakker et al., 2006). Therefore, the following hypothesis is proposed:

> ***Hypothesis 12***. Positive emotionality will be negatively related to physical, mental, and emotional work fatigue.

Finally, it is useful to demonstrate that not all personality traits are related to work fatigue. One such trait is social inhibition, which refers to the dispositional tendency to avoid participating in social situations and to inhibit self-expression (Denollet, 2005). It is not expected that a tendency to avoid social situations will deplete physical, mental, and emotional resources. Therefore, the following hypothesis is proposed:

Hypothesis 13. Social inhibition will be unrelated to physical, mental, and emotional work fatigue.

Nomological Network: Outcome Relations

Based on job burnout models, the JD-R model, and COR theory, the frequent experience of work fatigue is expected to be physically and psychologically damaging, thereby leading to poor employee health, an inability to relax or recover after work, and negative work-related attitudes (e.g., Bakker & Demerouti, 2007; Demerouti et al. 2003; Hobfoll, 1989; Maslach et al. 1996; Shirom, 2011). Supporting these expectations, meta-analytic studies have found that prior measures of emotional work exhaustion were negatively related to job satisfaction and organizational commitment and positively related to turnover intentions (e.g., Alarcon, 2011; Cropanzano, Rupp, & Byrne, 2006; Lee & Ashforth, 1996). Research also shows that overall work exhaustion was positively related to an inability to relax or detach after work (Sonnentag & Fritz, 2007) and negatively related to mental health (e.g., Huang, Du, Chen, Yang, & Huang, 2011; van Daalen, Willemsen, Sanders, & van Veldhoven, 2009) and physical health (e.g., Deery, Iverson, & Walsh, 2002; Melamed, Shirom, Toker, Berlinger, & Shapira, 2006). Although most research has focused on the relation of overall work exhaustion to personal and work outcomes, exploring the independent relations of the three types work fatigue to these outcomes would be useful and extend past research. Therefore, the following hypotheses are proposed:

Hypothesis 14. Physical work fatigue will be negatively related to physical health, mental health, job satisfaction, and organizational commitment, and positively related to an inability to relax after work and turnover intentions.

Hypothesis 15. Mental work fatigue will be negatively related to physical health, mental health, job satisfaction, and organizational commitment, and positively related to an inability to relax after work and turnover intentions.

Hypothesis 16. Emotional work fatigue will be negatively related to physical health, mental health, job satisfaction, and organizational commitment, and positively related to an inability to relax after work and turnover intentions.

Method

Study design—There were 2,975 U.S. workers who took part in the National Survey of Work Stress and Health. The study population and general procedures for this telephone survey were describe in Study 1. However, for this main study, data were collected by 29 trained interviewers from December 2008 to May 2012. Of all selected eligible individuals, 47% participated in the study. On average, the interview lasted 55 minutes and participants were paid $25.00 for their time. Of the 2,975 study participants, the present analyses were restricted to the 2,477 wage and salary workers (i.e., owner/operators were not included) who had complete data on all of the variables used in this report.

Sampling weights—For all analyses, the participants are weighted so the sample more closely represents the target population defined earlier (e.g., Korn & Graubard, 1999; Levy & Lemeshow, 1999). The sampling weights account for differences in selection probabilities

across participants, adjust for differential nonresponse, and are poststratified to population totals. Poststratification adjusts for known differences between the sample and population on key variables that may be due to sampling error, undercoverage, or nonresponse.

Participant characteristics—The respondent (i.e., population) characteristics are described with weighted means and percentages. Of the participants, 52% were male. Furthermore, 69% were White, 13% were Black, 9% were Hispanic, and 9% were of other racial/ethnic makeup. The average age of the participants was 40 years. In terms of highest level of education, 0.3% did not attend high school; 4.3% attended high school but did not graduate; 18.7% graduated from high school or obtained a GED; 3.1% attended trade, technical, or vocational training beyond high school; 20.2% attended some college; 9.2% received an Associate's degree; 22.6% received a Bachelor's degree; 3.0% attended some graduate school; 14.3% received a Master's degree; and 4.3% received a doctoral level degree. The participants worked on average 40 hours per week and held their present job for an average of 5 years.

Measures: Descriptive statistics for and correlations among the 22 study variables are provided in Supplemental Material File 2. Each of the variables is described below.

Work fatigue: The 18 item 3D-WFI was used to assess physical, mental, and emotional work fatigue (See Appendix).

Job demands: Physical job demands was assessed with four items—three items were taken from Morgeson and Humphrey (2006) and one item was developed for this study. An example item is “During the past 12 months, how often did your job require a lot of muscular strength?” Mental job demands was assessed with three items—one item was taken from Morgeson and Humphrey (2006), one item was taken from Hurrell and McLaney (1988), and one item was developed for this study. An example item is “During the past 12 months, how often did your job require you to engage in a large amount of thinking?” Emotional job demands was assessed with three items adapted from the Copenhagen Psychosocial Questionnaire (Kristensen, Hannerz, Høgh, & Borg, 2005b). An example item is “During the past 12 months, how often was your work emotionally demanding?” All job demand items used a five point frequency response scale ranging from (0) *never* to (4) *everyday*. Internal consistency reliability was .94 for physical demands, .83 for mental demands, and .77 for emotional demands.

Role demands: Role conflict was assessed with three items—two items from Peterson et al. (1994) and one item from House, Schuler, and Levanoni (1983). An example item is “I often have to deal with conflicting demands at work.” Role ambiguity was assessed with four items developed by House et al. (1983). An example item is “I know exactly what is expected of me at work.” All role demand items used a four point response scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .86 for role conflict and .82 for role ambiguity.

Job autonomy: This construct was assessed with six items adapted from Morgeson and Humphrey (2006). Example items are “I can make my own decisions about how to schedule

my work," and "I can make decisions about what methods I use to complete my work." All items used a four point response scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .86.

Job interdependence: Two dimensions of job interdependence—initiated and received interdependence—were each assessed with three items developed by Morgeson and Humphrey (2006). An example item for initiated interdependence is "Unless my job gets done, other jobs cannot be completed," and an example for received interdependence is "My job cannot be done unless others do their work." All items used a four point response scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .88 for initiated interdependence and .83 for received interdependence.

Lack of promotion opportunity: This construct was assessed with three items developed for this study. An example item is "There is little chance for promotion on my job." All items used a four point response scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .85.

Friendship formation: This construct was assessed with three items developed for this study. An example item is "I have formed strong friendships at work." All items used a four point response scale ranging from (1) *strongly disagree* to (4*) strongly agree*. Internal consistency reliability was .90.

Personality: Negative emotionality was assessed with seven items developed by Denollet (2005). An example item is "I take a gloomy view of things." Positive emotionality was assessed with six items developed by Tellegen (1982). An example item is "Most days I have moments of real fun or joy." Social inhibition was assessed with seven items developed by Denollet (2005). An example item is "I would rather keep other people at a distance." All items used a four point response scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .84 for negative emotionality, .87 for positive emotionality, and .83 for social inhibition.

Physical and mental health: Based on approaches commonly used in epidemiological and public health research, Frone (2007) developed four items that distinguished between physical and mental (i.e., emotional) health and represented both absolute and relative ratings. For example, physical health was assessed with the following two items: "In general, would you say your physical health is poor, fair, good, very good, or excellent?" and "In general, compared to most (men/women) of your age, is your physical health much worse, somewhat worse, about the same, somewhat better, or much better?" Mental health was assessed with a commensurate set of items. Internal consistency reliability was .74 for physical health and .79 for mental health.

Inability to relax: This construct was assessed with the following single item: "During the past 12 months, how often did you find it difficult to unwind and relax after you leave work?" The five point frequency response scale ranged from (0) *never* to (4) *everyday*.

Job attitudes: Job satisfaction was assessed with three items developed by Cammann, Fichman, Jenkins, and Klesh (1983). An example item is "All in all, I am satisfied with my job." Organizational commitment was assessed with three items developed by Meyer and Allen (1997). An example item is "This organization has a great deal of personal meaning to me." Turnover intentions were assessed with three items adapted from Spector, Dwyer, and Jex (1988) and Cammann et al. (1983). An example item is "I am seriously thinking about quitting my job." All job attitude items used a four-point scale ranging from (1) *strongly disagree* to (4) *strongly agree*. Internal consistency reliability was .91 for job satisfaction, .88 for organizational commitment, and .84 for turnover intentions.

Results

Psychometric evaluation—Confirmatory factor analysis (CFA) was conducted to test the hypothesized factor structure of the 3D-WFI. The CFAs were conducted using Mplus software (Version 7.2, Muthén & Muthén, 2012). In addition to allowing the use of sampling weights, the robust maximum likelihood estimator in Mplus provides correct standard errors and handles potential nonnormal data (Muthén & Muthén, 2012). Four CFA models were tested—Model 1: a one factor model; Model 2: a correlated two-factor model (physical and psychological [mental and emotional] work fatigue); Model 3a: a correlated three factor model (physical, mental and emotional work fatigue); and Model 3b: a correlated three factor model with 18 design-driven correlations among error terms. The design-driven correlated error terms in Model 3b involved pairs of error terms for the six sets of commensurate items. For instance, the error terms for Items 1, 7, and 13 were allowed to covary (see the Appendix for the items). It is reasonable to expect that commensurately worded items may share similar sources of measurement error. Further, Cole, Ciesla, and Steiger (2007) argued and demonstrated that the inclusion of design-driven correlated errors terms is appropriate, and failing to include them can inappropriately harm model fit and lead to misleading results. Finally, to determine if a specific factor model provided acceptable fit to the data, the following criteria were used: comparative fit index (CFI) and Tucker-Lewis Index (TLI) ≥ .95, root mean square error of approximation (RMSEA) < .06, and standardized root mean square residual (SRMR) < .08 (Hu & Bentler, 1989).

The model fit results are shown in Table 3. As can be seen, a one-factor model (Model 1) did not fit the data: χ^2 (135, N = 2,477) = 5,892.49, p < .001; CFI = .62; TLI = .57; RMSEA = .131; and SRMR = .12. A correlated two-factor model (Model 2; physical and psychological work fatigue) fit substantially better than the one-factor model ($\Delta\chi^2$ [1, N = 2,477] = 291.95, p < .001), though its overall fit was not acceptable: χ^2 (134, N = 2,477) = 3,639.27, p <.001; CFI = .77; TLI = .74; RMSEA = .103; and SRMR = .08. A correlated three-factor model (Model 3a; physical, mental, and emotional work fatigue) fit substantially better than the correlated two-factor model ($\Delta\chi^2$ [2, N = 2,477] = 294.16, p < .001) and achieved adequate levels of overall fit: χ^2 (132, N = 2,477) = 963.68, p <.001; CFI = .95; TLI = .94; RMSEA = .050; and SRMR = .04. Finally, as anticipated, a correlated three-factor model with the 18 design-driven correlations among error terms (Model 3b) fit better than the correlated three factor model without correlated error terms ($\Delta\chi^2$ [18, N = 2,477] = 289.91, p < .001). The overall model fit of the hypothesized three-factor model with

correlated errors (Model 3b) was acceptable: χ^2 (114, N = 2,477) = 687.54, p < .001; CFI = .96; TLI = .95; RMSEA = .045; and SRMR = .03. Finally, of the overall reduction in model χ^2 from Model 1 to Model 3b ($\Delta\chi^2$ = 5,204.95), almost all of the reduction (95%) was due to the hypothesized three-factor structure among the items, with a relatively small additional reduction (5%) due to the design-driven correlated errors.

Further supporting the hypothesized factor structure, Table 4 shows the standardized loadings for Models 3a and 3b. Each item had a large and significant (all *p*s < .001) standardized loading on its respective work fatigue factor, and introducing the correlated errors in Model 3b had no impact on the factor loadings. Also, the correlations among the work fatigue factors were unaffected by freeing the correlated error terms and were identical in Models 3a and 3b: .63 (p < .001) between physical and mental work fatigue, .56 (p < .001) between physical and emotional work fatigue, and .70 (p < .001) between mental and emotional work fatigue. Finally, the internal consistency reliability estimates were .94 for physical work fatigue, .95 for mental work fatigue, and .95 for emotional work fatigue.

Nomological network—To provide a more conservative and nuanced exploration of the relations between the three types of work fatigue with the various predictor and outcome variables, we report linear regression analyses (the full correlation matrix is presented in Supplemental Material File 2). For the predictor relations, each type of work fatigue was regressed on all 13 predictor variables simultaneously. For the outcome relations, each outcome was regressed on the three types of work fatigue simultaneously. Because the three measures of work fatigue were fully commensurate, unstandardized regression coefficients were used to explore (a) differences in the strength of each predictor relation across the three types of work fatigue, and (b) differences in the strength of the relations between the three types of work fatigue to a given outcome variable (e.g., Willet, Singer, & Martin, 1998). Stata software (Version 13, Stata Corporation, 2013) was used to conduct the linear regressions and cross-equation and cross-variable comparisons of coefficients because it allowed for the use of sampling weights and provided correct robust standard errors.

Predictors: The relations between the predictor variables and each type of work fatigue, as well as the results for tests of cross-equation differences in the coefficients for each predictor, are reported in Table 5. Looking at the three job demands variables, the results supported Hypothesis 1 because physical job demands were significantly and positively related to physical work fatigue (**b** = .20, p < .001) and exhibited significantly weaker relations to mental work fatigue (**b** = -.02, *ns*) and emotional work fatigue (**b** = .04, p < .05). Supporting Hypothesis 2, mental job demands were significantly and positively related to mental work fatigue (**b** = .21, p < .001) and exhibited significantly weaker relations to physical work fatigue (**b** = .06, *ns*) and emotional work fatigue (**b** = .05, p < .05). Finally, Hypothesis 3 was partially supported because emotional job demands were significantly and positively related to emotional work fatigue (**b** = .27, p < .001). However, inconsistent with Hypothesis 3, emotional demands also exhibited the same magnitude of relation to physical work fatigue (**b** = .22, p < .001) and mental work fatigue (**b** = .22, p < .001).

Turning to the two role demands, Hypothesis 4 was supported because role conflict was positively related to both mental work fatigue (**b** = .09, p < .05) and emotional work fatigue

(**b** = .11, $p < .001$) and was unrelated to physical work fatigue (**b** = .04, *ns*). In contrast, Hypothesis 5 was partially supported because role ambiguity was positively related to mental work fatigue (**b** = .12, $p < .05$) and was unrelated to physical work fatigue (**b** = .04, *ns*). However, inconsistent with Hypothesis 5, role ambiguity was unrelated to emotional work fatigue (**b** = .09, *ns*).

The results show that Hypothesis 6 was partially supported because job autonomy was significantly and negatively related to physical work fatigue (**b** = -.18, $p < .001$) and mental work fatigue (**b** = -.13, $p < .05$). However, inconsistent with the hypothesis, job autonomy was unrelated to emotional work fatigue (**b** = -.06, *ns*). The results also revealed that the relation of job autonomy to physical and mental work fatigue did not differ significantly in size.

With regard to job interdependence, the results in Table 5 partially supported Hypotheses 7 and 8 because initiated and received interdependence were each unrelated to physical work fatigue (initiated interdependence: **b** = -.04, *ns*; received interdependence: **b** = .01, *ns*) and emotional work fatigue (initiated interdependence: **b** = -.03, *ns*; received interdependence: **b** = .01, *ns*). However, inconsistent with these hypotheses, initiated and received interdependence also were unrelated to mental work fatigue (initiated interdependence: **b** = -.01, *ns*; received interdependence: **b** = .06, *ns*).

The results supported Hypothesis 9 because lack of promotion opportunity was unrelated to physical work fatigue (**b** = .01, *ns*), mental work fatigue (**b** = -.01, *ns*), and emotional work fatigue (**b** = -.01, *ns*). Similarly, Hypothesis 10 was supported because friendship formation was unrelated to physical work fatigue (**b** = .00, *ns*), mental work fatigue (**b** = .03, *ns*), and emotional work fatigue (**b** = -.06, *ns*).

Finally, turning to the three personality variables, the results supported Hypothesis 11 because negative emotionality was significantly and positively related to physical work fatigue (**b** = .33, $p < .001$), mental work fatigue (**b** = .40, $p < .001$), and emotional work fatigue (**b** = .56, $p < .001$). Moreover, the results showed that the relation of negative emotionality to emotional work fatigue was significantly stronger than its relation to either physical or mental work fatigue, with the latter two relations not differing in size. Supporting Hypothesis 12, positive emotionality was significantly and negatively related to physical work fatigue (**b** = -.21, $p < .001$), mental work fatigue (**b** = -.18, $p < .01$), and emotional work fatigue (**b** = -.18, $p < .001$). In addition, these three relations did not differ in size. Supporting Hypothesis 13, social inhibition was unrelated to physical work fatigue (**b** = -.02, *ns*), mental work fatigue (**b** = .00, *ns*), and emotional work fatigue (**b** = -.01, *ns*).

Outcomes: As shown in Table 6, Hypothesis 14 was largely supported because physical work fatigue was uniquely related in the predicted direction to five of the six outcome variables: physical health (**b** = -.16, $p < .001$), mental health (**b** = -.09, $p < .001$), inability to relax after work (**b** = .15, $p < .001$), organization commitment (**b** = -.09, $p < .01$), and turnover intentions (**b** = .09, $p < .01$). Hypothesis 15 was largely unsupported because mental fatigue was significantly and positively related only to an inability to relax after work (**b** = .26, $p < .001$). Finally, Hypothesis 16 was largely supported because emotional work

fatigue was uniquely related in the predicted direction to five of the six outcome variables: mental health (**b** = -.19, $p < .001$), inability to relax after work (**b** = .23, $p < .001$), job satisfaction (**b** = -.20, $p < .001$), organization commitment (**b** = -.10, $p < .05$), and turnover intentions (**b** = .17, $p < .001$).

Discussion

The CFA results support the psychometric properties of the 3D-WFI. The three hypothesized factors were identified and each item loaded highly on its respective factor, thereby discriminating between physical, mental, and emotional work fatigue. Internal consistency reliability for the set of items assessing each type of work fatigue was uniformly high.

The findings also provide convergent and discriminant evidence for the construct validity of the 3D-WFI. Extending past research, the results show a meaningful pattern of relations between specific types of job demands and work fatigue. Physical and mental job demands primarily predicted physical and mental work fatigue, respectively. Although emotional demands predicted higher levels of emotional work fatigue, they also predicted higher levels of physical and mental work fatigue. This pattern of results suggest that emotional job demands may be more broadly depleting of all energetic resources than physical and mental job demands.

This study also extends prior research by showing that role demands displayed a meaningful pattern of relations to the three types of work fatigue. The fact that role conflict and role ambiguity, as expected, were unrelated to physical fatigue and positively related to mental fatigue represents new findings. Consistent with prior research, role conflict was positively related to emotional work fatigue. However, role ambiguity was not related to emotional fatigue. The present regression analyses suggests that the relationship between role ambiguity and emotional work exhaustion reported in prior meta-analyses may be spurious, which is also consistent with the fact that the zero-order correlation between emotional work exhaustion and role conflict reported in these meta-analyses was larger than the correlation involving role ambiguity (e.g., Alarcon, 2011; Lee & Ashforth, 1996).

The results provide further support for a negative relation between job resources and work fatigue. Job autonomy was negatively related to physical and mental work fatigue, but was unrelated to emotional work fatigue. However, prior meta-analyses documented a negative relation between job autonomy and emotional work exhaustion (Lee & Ashforth, 1996; Alarcon, 2011). Our evaluation of prior work fatigue measures and our failure to find this relation in the present study collectively suggests that past support for a relation between job autonomy and emotional work exhaustion may have resulted from failing to control for job autonomy's relation to other predictor variables and/or construct contamination in the prior measures of emotional exhaustion. The most commonly used emotional exhaustion measure from the MBI has items representing overall work fatigue, which includes physical and mental work fatigue, as well as other constructs that might correlate with job autonomy (see Table 1 and Supplemental File 1).

Several work characteristics were not expected to relate to work fatigue because they do not play a key role in the depletion of energetic resources. The results showed that initiated and received job interdependence, lack of promotion opportunity, and friendship formation had nonsignificant and near-zero relations to all three types of fatigue. These results, in conjunction with those for job demands, role demands, and job autonomy, suggest that only work conditions that either deplete or protect/renew energetic resources may be related to work fatigue.

The present results also extend prior research on personality and work fatigue. Consistent with prior meta-analyses, negative emotionality was positively related and positive emotionality was negatively related to emotional work fatigue. In addition, both personality variables were related in the predicted direction to physical and mental work fatigue. Although negative emotionality was related to all three types of work fatigue, its strongest relation was to emotional work fatigue. Positive emotionality had a similar negative relation to each type of work fatigue. Further, the results reveal that not all personality variables are predictive of work fatigue. Specifically, social inhibition was unrelated to all three types of work fatigue.

Finally, the present results extend prior research on the relation of work fatigue to employee health and work attitudes by showing a number of unique patterns. First, physical and emotional work fatigue were each independently and consistently related to most outcome variables assessed in this study, and mental fatigue was independently related to only one of the outcome variables.[4] Second, only physical work fatigue uniquely predicted lower levels of physical health. Third, both physical and emotional fatigue predicted lower levels of mental (i.e., emotional) health and organizational commitment and higher levels of turnover intentions. However, emotional work fatigue had a stronger relation to mental health than physical work fatigue. Fourth, only emotional work fatigue was related to lower levels of job satisfaction. Finally, all three types of work fatigue were positively related to an inability to relax after work. Overall, these results suggest that physical and emotional fatigue may be more important than mental fatigue for most of the outcome variables assessed in this study.

General Discussion

Work fatigue is an important construct in several conceptual models and areas of research in occupational health psychology. Despite the importance of this construct, relatively little attention had been paid to its conceptualization and measurement. Therefore, the central goals of this study were to develop a more comprehensive, multidimensional conceptual

[4]A reviewer was concerned that mental fatigue might not have been related to most of the outcome variables due to collinearity among the three work fatigue measures. It is generally suggested that collinearity does not become a problem until the variance inflation factor (VIF) for a variable reaches 10, with some suggesting more conservative cut-offs of 4 or 5 (e.g., O'Brien, 2007). The VIFs were 1.7 for physical fatigue, 2.0 for emotional fatigue, and 2.2 for mental fatigue. These values were well below even conservative cut-off values. The primary concern with collinearity is that a variable used to predict an outcome may fail to achieve statistical significance because of inflation in its standard error (SE). However, the potential influence of collinearity needs to be considered in conjunction with other factors that affect the SE (precision) of a regression coefficient (e.g., Kennedy, 2003; O'Brien, 2007). Among these other factors, the best correction for collinearity is to obtain larger samples. The sample size in Study 2 (N=2,477) is sufficiently large to compensate for the VIFs observed with the fatigue variables. Another way to reduce the effects of collinearity, which may be associated with larger samples, is to ensure adequate variation in the predictor variables (i.e., reduce range restriction). Because of the broad sample, the observed scores on each of the three dimensions of fatigue covered the entire five-point range with adequate numbers of individuals distributed across this range of scores.

definition and a psychometrically sound multi-dimensional measure of work fatigue. The results of Studies 1 and 2 provide initial support for the psychometric quality and construct validity of the Three-Dimensional Work Fatigue Inventory (3D-WFI).

Two general conclusions can be reached from the present research. First, work fatigue is a multidimensional construct representing the depletion of physical, mental, and emotional resources, which is characterized by extreme tiredness and reduced functional capacity. Second, to develop a more precise understanding of the potential causes and outcomes of work fatigue, research should attend to all three types of work fatigue. In contrast to past research that primarily assessed either overall work exhaustion (see Table 1 and Supplemental File 1), Study 2 explored nomological relations involving physical, mental, and emotional work fatigue. The results supported a number of hypotheses involving predictor variables that should and should not be related to the specific types of work fatigue. The results also provided a more nuanced understanding of the relation of the three types of work fatigue to a number of outcome variables.

Strengths and Limitations

The present results should be interpreted within the context of the strengths and limitations of this research. The primary strength of Study 2 was that it used a broad probability sample of employed adults in the U.S. Compared to most convenience samples, the present sample was large thereby providing adequate statistical power to detect the hypothesized effects and providing more accurate effect sizes (Ioannidis, 2008). This strength notwithstanding, because the present study collected data from a single source and was cross-sectional in design, method variance may have inflated some relations and causal conclusions cannot be drawn regarding the predictor and outcome relations reported. However, the differential pattern of observed relations among the nomological relations is inconsistent with appreciable method bias.

Implication for Theory and Future Research

Although the present findings support the construct validity of the 3D-WFI, further research is needed with additional predictor and outcome variables. As noted by Messick (1995, p. 741), “validity is an evolving property and validation a continuing process.” The present predictor and outcome relations also need to be replicated and extended using longitudinal research designs. Given our evaluation of prior measures of work fatigue, past research involving emotional work exhaustion in particular, and work fatigue more generally, should be revisited. It is possible that measurement contamination in prior measures of work fatigue may have affected the relations to various predictor and outcome variables. Additional multivariate research involving the putative predictors and outcomes of physical, mental, and emotional fatigue may foster refinements in job burnout theories, the JD-R model and COR theory.

Several additional directions for future research on work fatigue exist. First, in addition to health outcomes and job attitudes, more research should explore the relations between work fatigue and behavioral health and work outcomes. A meta-analysis by Swider and Zimmerman (2010) reported significant relations between past measures of emotional work

exhaustion and several behavioral outcomes: absenteeism, turnover, and job performance. However, given the issues identified with past measures of emotional work exhaustion, it may be that these relations involve physical or mental work fatigue rather than emotional work fatigue. The 3D-WFI could be used to explore whether or not behavioral work outcomes may be differentially affected by the three types of work fatigue. In contrast to the health and job attitude outcomes used in this study, mental and physical work fatigue may play a more prominent role than emotional fatigue in poor job performance and workplace safety outcomes depending on the occupation being considered. Research also should explore the possible relations of work fatigue to important behavioral health outcomes. The chronic depletion of energetic resources may foster dysfunctional behavioral health outcomes, such as increases in smoking and alcohol use and decreases in exercise.

Second, research should explore both between-person and within-person relations between the three types of work fatigue and various predictor and outcome variables. The 3D-WFI assesses the frequency of exposure to work fatigue during the past year. The scores for the three types of work fatigue capture between-persons variation in the frequency of experiencing work fatigue during this reporting period, ranging from never experiencing fatigue through infrequent exposure (i.e., less than monthly exposure) through frequent exposure (i.e., everyday). Future between-persons research could explore predictor and outcome relations while using shorter reporting periods for work fatigue. Also the 3D-WFI might be adapted to explore within-person predictor and outcome relations over time. Third, moderators of the relations involving the predictors and outcomes of work fatigue should be explored. Finally, future research could explore interventions aimed at reducing work fatigue. It may be that some interventions have targeted effects on the different types of work fatigue.

Conclusions

Despite interest in work fatigue that dates back several decades, no comprehensive definition and self-report measure had been developed. The present study developed a multidimensional definition, as well as a valid multidimensional measure of work fatigue. The Three-Dimensional Work Fatigue Index (3D-WFI) can facilitate future research on work fatigue as a detrimental personal outcome, and as a potential cause of a variety of dysfunctional work-related attitudes, behaviors, and outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Appendix: Three-Dimensional Work Fatigue Inventory (3D-WFI)

Interviewer-administered instructions

Many people experience a sense of extreme or excessive tiredness during and at the end of the work day. This excessive sense of tiredness is called fatigue and can involve one's physical, mental, and emotional resources. I'll begin by asking about your experience of physical fatigue, followed by your experience of mental fatigue and emotional fatigue.

Self-administered instructions

Many people experience a sense of extreme or excessive tiredness during and at the end of the work day. This excessive sense of tiredness is called fatigue and can involve one's physical, mental, and emotional resources. The questions below begin by asking about your experience of physical fatigue, followed by your experience of mental fatigue and emotional fatigue. For each question, check the box that most accurately reflects how often you experience each aspect of fatigue.

Physical fatigue involves extreme physical tiredness and an inability to engage in physical activity. During the PAST 12 MONTHS, how often did you …	**Everyday**	**At least once a week**	**At least once a month**	**Less than once a month**	**Never**
1. feel physically exhausted at the end of the workday?	☐	☐	☐	☐	☐
2. have difficulty engaging in physical activity at the end of the workday?	☐	☐	☐	☐	☐
3. feel physically worn out at the end of the workday?	☐	☐	☐	☐	☐
4. want to physically shut down at the end of the workday?	☐	☐	☐	☐	☐
5. feel physically drained at the end of the workday?	☐	☐	☐	☐	☐
6. want to avoid anything that took too much physical energy at the end of the workday?	☐	☐	☐	☐	☐
Mental fatigue involves extreme mental tiredness and an inability to think or concentrate. During the PAST 12 MONTHS, how often did you …	**Everyday**	**At least once a week**	**At least once a month**	**Less than once a month**	**Never**
7. feel mentally exhausted at the end of the workday?	☐	☐	☐	☐	☐
8. have difficulty thinking and concentrating at the end of the workday?	☐	☐	☐	☐	☐
9. feel mentally worn out at the end of the workday?	☐	☐	☐	☐	☐
10. want to mentally shut down at the end of the workday?	☐	☐	☐	☐	☐
11. feel mentally drained at the end of the workday?	☐	☐	☐	☐	☐
12. want to avoid anything that took too much mental energy at the end of the workday?	☐	☐	☐	☐	☐

Physical fatigue involves extreme physical tiredness and an inability to engage in physical activity. During the PAST 12 MONTHS, how often did you …	**Everyday**	**At least once a week**	**At least once a month**	**Less than once a month**	**Never**
Emotional fatigue involves extreme emotional tiredness and an inability to feel or show emotions. During the PAST 12 MONTHS, how often did you …	**Everyday**	**At least once a week**	**At least once a month**	**Less than once a month**	**Never**
13. feel emotionally exhausted at the end of the workday?	☐	☐	☐	☐	☐
14. have difficulty showing and dealing with emotions at the end of the workday?	☐	☐	☐	☐	☐
15. feel emotionally worn out at the end of the workday?	☐	☐	☐	☐	☐
16. want to emotionally shut down at the end of the workday?	☐	☐	☐	☐	☐
17. feel emotionally drained at the end of the workday?	☐	☐	☐	☐	☐
18. want to avoid anything that took too much emotional energy at the end of the workday?	☐	☐	☐	☐	☐

References

Alarcon GM. A meta-analysis of burnout with job demands, resources, and attitudes. Journal of Vocational Behavior. 2011; 79:549–562.

Alarcon G, Eschleman KJ, Bowling NA. Relationships between personality variables and burnout: A meta-analysis. Work & Stress. 2009; 23:244–263.

Anderson JC, Gerbing DW. Predicting the performance of measures in a confirmatory factor analysis with a pretest assessment of their substantive validities. Journal of Applied Psychology. 1991; 76:732–740.

Australian Safety and Compensation Council. Work-related fatigue: Summary of recent indicative research. 2006. Retrieved from http://www.safeworkaustralia.gov.au/sites/SWA/about/Publications/Documents/420/WorkRelated_Fatigue_Indicative_Research_2006.pdf

Bakker AB, Demerouti E. The job demands resources model: State of the art. Journal of Managerial Psychology. 2007; 22:309–328.

Bakker AB, Van Der Zee KI, Lewig KA, Dollard MF. The relationship between the big five personality factors and burnout: A study among volunteer counselors. Journal of Social Psychology. 2006; 146:31–50. [PubMed: 16480120]

Bokesem MAS, Tops M. Mental fatigue: Costs and benefits. Brain Research Reviews. 2008; 59:125–139. [PubMed: 18652844]

Borsboom D, Mallenbergh GJ, van Heerden J. The concept of validity. Psychological Review. 2004; 111:1061–1071. [PubMed: 15482073]

Cammann, C.; Fichman, M.; Jenkins, D.; Klesh, J. Assessing the attitudes and perceptions of organizational members. In: Seashore, SE.; Lawler, EE.; Mirvis, PH., III; Cammann, C., editors. Assessing organization change. New York: Wiley; 1983. p. 71-138.

Cole DA, Ciesla JA, Steiger JH. The insidious effects of failing to include design-driven correlated residuals in latent variable covariance structure analysis. Psychological Methods. 2007; 12:381–398. [PubMed: 18179350]

Cropanzano R, Rupp DF, Byrne ZS. The relationship of emotional exhaustion to work attitudes, job performance, and organizational citizenship behaviors. Journal of Applied Psychology. 2003; 88:160–169. [PubMed: 12675403]

Deery S, Iverson R, Walsh J. Work relationships in telephone call centres: Understanding emotional exhaustion and employee withdrawal. Journal of Management Studies. 2002; 39:471–496.

Demerouti E, Bakker AB, Vardakou I, Kantas A. The convergent validity of two burnout instruments: A multitrait-multimethod analysis. European Journal of Psychological Assessment. 2003; 19:12–23.

Denollet J. DS14: Standard assessment of negative affectivity, social inhibition, and type D personality. Psychosomatic Medicine. 2005; 67:89–97. [PubMed: 15673629]

DeVellis, RF. Scale development: Theory and Applications. Newbury Park, CA: Sage; 1991.

Edwards, JR.; Shipp, AJ. The relationship between person-environment fit and outcomes: An integrative theoretical framework. In: Ostroff, C.; Judge, TA., editors. Perspectives on organizational fit. San Francisco: Jossey-Bass; 2007. p. 209-258.

Frone MR. Obesity and absenteeism among U.S. workers: Do physical health and mental health explain the relation? Journal of Workplace Behavioral Health. 2007; 22:65–79.

Ghiselli, EE.; Campbell, JP.; Zedeck, S. Measurement theory for the behavioral sciences. San Francisco: W. H. Freeman and Company; 1981.

Hinkin TR. A brief tutorial on the development of Measures for use in survey questionnaires. Organizational Research Methods. 1998; 1:104–121.

Hobfoll SE. Conservation of resources: A new attempt at conceptualizing stress. American Psychologist. 1989; 44:513–524. [PubMed: 2648906]

House RJ, Schuler RS, Levanoni E. Role conflict and ambiguity scales: Reality or artifact? Journal of Applied Psychology. 1983; 68:334–337.

Hu, Lt; Bentler, PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling. 1989; 6:1–55.

Huang YH, Du PI, Chen CH, Yang CA, Huang IC. Mediating effects of emotional exhaustion on the relationship between job demands-control model and mental health. Stress and Health. 2011; 27:e94–e109.

Hurrell JJ Jr, McLaney MA. Exposure to job stress: A new psychometric instrument. Scandinavian Journal of Work Environment Health. 1988; 14:27–28.

Hussong AM, Curran PJ, Bauer DJ. Integrative data analysis in clinical psychology research. Annual Review of Clinical Psychology. 2013; 9:61–89.

Ioannidis JPA. Why most discovered true associations are inflated. Epidemiology. 2008; 19:640–648. [PubMed: 18633328]

Kennedy, P. A guide to econometrics. 5th. Cambridge, MA: MIT Press; 2003.

Korn, E.; Graubard, B. Analysis of health surveys. New York: Wiley; 1999.

Kristensen TS, Borritz M, Villadsen E, Christensen KB. The Copenhagen burnout inventory: A new tool for the assessment of burnout. Work & Stress. 2005a; 19:192–207.

Kristensen T, Hannerz H, Høgh A, Borg V. The Copenhagen psychosocial questionnaire: A tool for the assessment and improvement of the psychosocial work environment. Scandinavian Journal of Work Environment and Health. 2005b; 31:438–449.

Lee RT, Ashforth BE. A meta-analytic examination of the correlates of the three dimensions of job burnout. Journal of Applied Psychology. 1996; 81:123–133. [PubMed: 8603909]

Levy, PS.; Lemeshow, S. Sampling of populations: Methods and applications. 3rd. New York: Wiley; 1999.

Maslach C, Jackson SE. The measurement of experienced burnout. Journal of Occupational Behaviour. 1981; 2:99–113.

Maslach, C.; Jackson, SE.; Leiter, MP. Maslach burnout inventory manual. 3rd. Menlo Park, CA: Mind Garden; 1996.

Melamed S, Shirom A, Toker S, Berlinger S, Shapira I. Burnout and risk of cardiovascular disease: Evidence, possible causal paths, and promising research directions. Psychological Bulletin. 2006; 132:327–353. [PubMed: 16719565]

Messick S. Validity of psychological assessment: Validation of inferences from persons' responses and performances as scientific inquiry into score meaning. American Psychologist. 1995; 50:741–749.

Meyer, JP.; Allen, NJ. Commitment in the workplace. Thousand Oaks, CA: Sage; 1997.

Morgeson FP, Humphrey SE. The Work Design Questionnaire (WDQ): Developing and Validating a Comprehensive Measure for Assessing Job Design and the Nature of Work. Journal of Applied Psychology. 2006; 91:1321–1339. [PubMed: 17100487]

Muthén, LK.; Muthén, BO. Mplus user's guide (Version 7). Los Angeles, CA: Muthén & Muthén; 2012.

Newton PE, Shaw SD. Standards for talking and thinking about validity. Psychological Bulletin. 2013; 18:301–319.

O'Brien RM. A caution regarding rules of thumb for variance inflation factors. Quality & Quantity. 2007; 41:673–690.

Park HI, Jacob AC, Wagner SH, Baiden M. Job control and burnout: A meta-analytic test of the conservation of resources model. Applied Psychology. 2013 Advanced online.

Peterson MF, Smith PB, Akande A, Ayestaran S, Bochner S, Callan V, et al. Sinha TN. Role conflict, ambiguity, and overload: a 21-nation study. Academy of Management Journal. 1995; 38(2):429–452.

Pillsbury, WB. The fundamentals of psychology. rev. New York: MacMillian; 1922.

Pines, A.; Aronson, E. Career burnout: causes and cures. New York: The Free Press; 1988.

Ricci JA, Chee E, Lorandeau AL, Berger C. Fatigue in the U.S. workforce: Prevalence and implications for lost productive work time. Journal of Occupational and Environmental Medicine. 2007; 49:1–10. [PubMed: 17215708]

Shirom, A. Job-related burnout: A review of major research foci and challenges. In: Quick, JC.; Tetrick, LE., editors. Handbook of occupational health psychology. 2nd. Washington, DC: American Psychological Association; 2011. p. 223-241.

Shirom A, Melamed S. A comparison of the construct validity of two burnout measures in two groups of professionals. International Journal of Stress Management. 2006; 13:176–200.

Sonnentag S, Fritz C. The recovery experience questionnaire: Development and validation of a measure for assessing recuperation and unwinding after work. Journal of Occupational Health Psychology. 2007; 12:204–221. [PubMed: 17638488]

Spector PE, Dwyer DJ, Jex SM. Relation of job stressors to affective, health, and performance outcomes: A comparison of multiple data sources. Journal of Applied Psychology. 1988; 73:11–19. [PubMed: 3350784]

Spector PE, Zapf D, Chen PY, Frese M. Why negative affectivity should not be controlled in job stress research: Don't throw out the baby with the bath water. Journal of Organizational Behavior. 2000; 21:79–95.

Stasi R, Abriani L, Beccaglia P, Terzoli E, Amadori S. Cancer-related to fatigue: Evolving concepts in evaluation and treatment. Cancer. 2003; 98:1786–1801. [PubMed: 14584059]

Stata Corporation. Stata statistical software: Release. Vol. 13. College Station, TX: StataCorp; 2013.

Swider BW, Zimmerman RD. Born to burnout: A meta-analytic path model of personality, job burnout, and work outcomes. Journal of Vocational Behavior. 2010; 76:487–506.

Tellegen, A. Brief manual for the multidimensional personality questionnaire. Unpublished manuscript, University of Minnesota; 1982.

van Daalen G, Willemsen TM, Sanders K, van Veldhoven MJPM. Emotional exhaustion and mental health problem among employees doing “people work”: The impact of job demands, job resources, and family-to-work conflict. Journal of Occupational and Environmental Health. 2009; 82:291–303.

Willet JB, Singer JD, Martin NC. The design and analysis of longitudinal studies of development and psychopathology in context: Statistical models and methodological recommendations. Development and Psychopathology. 1998; 10:395–426. [PubMed: 9635230]

Winwood PC, Lushington K, Winefield AH. Further development and validation of the occupational fatigue exhaustion/recovery (OFER) scale. Journal of Occupational and Environmental Medicine. 2006; 48:381–389. [PubMed: 16607192]

Winwood PC, Winefield AH, Dawson D, Lushington K. Development and validation of a scale to measure work-related fatigue and recovery: The occupational fatigue exhaustion/recovery (OFER) scale. Journal of Occupational and Environmental Medicine. 2005; 47:594–606. [PubMed: 15951720]

Worthington RL, Whittaker TA. Scale development research: A content analysis and recommendations for best practice. Counseling Psychology. 2006; 34:806–838.

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Table 1

Summary of Six Prior Work Fatigue-Related Instruments

Instrument	Maslach Burnout Inventory (MBI) Maslach et al. (1996)		Oldenburg Burnout Inventory (OLBI) Demerouti et al. 2003)	Copenhagen Burnout Inventory (CBI) Kristensen et al. (2005a)		Occupational Fatigue Exhaustion Recovery Scale (OFER) Winwood et al. (2005, 2006)		Burnout Measure (BM) Pines & Aronson (1988)			Shirom-Melamed Burnout Questionnaire (SMBQ) Melamed et al. (2006)		
Construct	**Emotional Exhaustion (original measure)**	**Exhaustion (revised measure)**	**Exhaustion**	**Work Burnout**	**Client Burnout**	**Chronic Work Fatigue**	**Acute Work Fatigue**	**Physical Exhaustion**	**Mental Exhaustion**	**Emotional Exhaustion**	**Physical Fatigue**	**Cognitive Weariness**	**Emotional Exhaustion**
Construct definition	"Feelings of being emotionally overextended and exhausted by one's work." "The emotional exhaustion scale measures the depletion of emotional energy, distinct from physical exhaustion or mental fatigue."	No definition provided, though the intent of the measure appears to be an assessment of overall work exhaustion (i.e., tiredness).	"Exhaustion is defined as a consequence of intensive physical, affective, and cognitive strain, i.e., as a long-term consequence of prolonged exposure to certain job demands."	"The degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his/her work."	"The degree of physical and psychological fatigue and exhaustion that is perceived by the person as related to his/her work with clients."	"Inefficient action patterns; declining interest, involvement and commitment; reduced concentration and motivation; and negative emotions."	None	Physical exhaustion represents the experience of "low energy, chronic fatigue, and weakness."	Mental exhaustion represents the experience of "negative attitudes toward one's self, work, and life itself."	Emotional exhaustion represents the experience of "feeling helpless, hopeless, and entrapment."	Physical fatigue refers to "feelings of tiredness and low levels of energy in carrying out daily tasks at work."	Cognitive weariness refers to "feelings of slow thinking and reduced mental agility.	Emotional exhaustion refers to "feeling that one lacks the energy needed to invest in relationships with other people at work."
Total # of items	9	5	8	7	6	5	5	7	7	7	6	5	3
Number of items assessing:													
Overall tiredness	3	3	3	5	1	0	5	6	0	0	4	0	0
Overall RFC	0	0	0	0	2	0	0	0	0	0	0	0	0
Physical tiredness	0	0	0	0	0	0	0	1	0	0	1	0	0
Physical RFC	0	0	0	0	0	0	0	0	0	0	0	0	0
Mental tiredness	0	0	0	0	0	0	0	0	0	0	0	0	0
Mental RFC	0	0	0	0	0	0	0	0	0	0	0	5	0
Emotional tiredness	1	1	1	1	0	0	0	0	0	0	0	0	0
Emotional RFC	0	0	0	0	0	0	0	0	0	0	0	0	3
Other (non-fatigue) Constructs	5	1	4	1	3	5	0	0	7	7	1	0	0

Note: RFC = Reduced functional capacity.

Table 2
Factor Pattern Loadings for the 3D-WFI (Study 1)

Factor Loadings			
Items	**Physical Work Fatigue**	**Mental Work Fatigue**	**Emotional Work Fatigue**
Item 1	**.94**	-.06	-.04
Item 2	**.83**	-.01	.05
Item 3	**.99**	-.04	-.07
Item 4	**.54**	.03	.34
Item 5	**.90**	.03	-.02
Item 6	**.65**	.19	.01
Item 7	.01	**.91**	-.02
Item 8	-.04	**.78**	.06
Item 9	.11	**.90**	-.06
Item 10	-.04	**.78**	.17
Item 11	.07	**.85**	.01
Item 12	-.06	**.79**	.20
Item 13	.01	.04	**.82**
Item 14	.04	-.02	**.92**
Item 15	.08	-.03	**.90**
Item 16	.04	.08	**.74**
Item 17	-.04	.08	**.88**
Item 18	-.11	.06	**.93**

Note: *N* = 207. See Appendix for item wording. Bolded factor loadings indicate the factor onto which the item loaded.

Table 3

Confirmatory Factor Analysis Model Fit for the 3D-WFI (Study 2)

	χ^2	df	$\Delta\chi^2$	Δdf	*p*	CFI	TLI	RMSEA (90% CI)	SRMR
Model 1: One factor	5,892.49	135			<.001	.62	.57	.131 (.128, .134)	.12
Model 2: Two factors (Physical vs. Psychological Fatigue)	3,639.27	134	291.95	1	<.001	.77	.74	.103 (.100, .106)	.08
Model 3a: Three factors	963.68	132	294.19	2	<.001	.95	.94	.050 (.047, .053)	.04
Model 3b: Three factors with design-based correlated errors	687.54	114	289.91	18	<.001	.96	.95	.045 (.042, .048)	.03

Note: *N* = 2,477. See text regarding correlated measurement errors. Two and Three factor models allowed the factors to correlate. CFI = comparative fit index; TLI = Tucker-Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. $\Delta\chi^2$= Satorra-Bentler scaled chi-square difference test for robust maximum likelihood estimation each model to the prior model.

Table 4
Item Statistics and Standardized Factor Loadings for the 3D-WFI (Study 2)

Factors	Item Mean	Item *SD*	Standardized Factor loadings	
Physical work fatigue			**Model 3a**	**Model 3b**
Item 1	1.97	1.24	.84	.84
Item 2	1.64	1.34	.81	.81
Item 3	2.04	1.29	.90	.90
Item 4	1.57	1.37	.83	.82
Item 5	1.92	1.30	.90	.90
Item 6	1.75	1.35	.83	.82
Mental work fatigue				
Item 7	1.86	1.24	.88	.88
Item 8	1.57	1.28	.86	.86
Item 9	1.91	1.28	.93	.93
Item 10	1.49	1.35	.83	.82
Item 11	1.86	1.29	.93	.93
Item 12	1.74	1.35	.83	.82
Emotional work fatigue				
Item 13	1.29	1.21	.86	.86
Item 14	1.34	1.25	.93	.93
Item 15	1.33	1.25	.92	.92
Item 16	1.01	1.17	.80	.80
Item 17	1.04	1.20	.87	.87
Item 18	1.23	1.25	.89	.88

Note: N = 2,477. See Appendix for item wording. Item scoring ranged from 0 = never to 4 = everyday. Model 3a and Model 3b represent correlated three-factor solutions without and with the design-based correlated errors, respectively. All factor loadings significant at $p < .001$.

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Table 5

Regression of Work Fatigue on Predictor Variables

	Physical Work Fatigue		Mental Work Fatigue		Emotional Work Fatigue	
Predictors	**b**	**β**	**b**	**β**	**b**	**β**
Physical job demands	.20^{***a}	.25	-.02^{b}	-.02	.04^{*c}	.05
Mental job demands	.06^{a}	.06	.21^{***b}	.20	.05^{*a}	.05
Emotional job demands	.22^{***a}	.22	.22^{***a}	.22	.27^{***a}	.29
Role conflict	.04^{a}	.03	.09^{*a}	.07	.11^{***a}	.10
Role Ambiguity	.04^{a}	.02	.12^{*a}	.06	.09^{a}	.05
Job autonomy	-.18^{***a,b}	-.10	-.13^{*b,c}	-.07	-.06^{c}	-.04
Initiated interdependence	-.04^{a}	-.03	-.01^{a}	-.01	-.03^{a}	-.02
Received interdependence	.01^{a}	.01	.06^{a}	.04	.01^{a}	.01
Lack of promotion opportunity	.01^{a}	.01	.01^{a}	.01	-.01^{a}	-.01
Friendship formation	.00^{a,b}	.00	.03^{a}	.02	-.06^{b}	-.05
Negative emotionality	.33^{***a}	.17	.40^{***a}	.20	.56^{***b}	.30
Positive emotionality	-.21^{***a}	-.11	-.18^{**a}	-.09	-.18^{***a}	-.10
Social inhibition	-.02^{a}	-.01	.00^{a}	.00	-.01^{a}	-.01
R^2	.24***		.26***		.32***	

Note: N = 2,477. **b** = unstandardized regression coefficients. **β** = standardized regression coefficients. Unstandardized coefficients *within a row* sharing a superscript are not significantly different; unstandardized coefficients *within a row* with different superscripts are significantly different ($p < .05$).

$^{*}p < .05$,

$^{**}p < .01$,

*** $p < .001$.

Table 6

Regression of Outcomes on Work Fatigue

	Physical Health		Mental Health		Inability to Relax After Work		Job Satisfaction		Organizational Commitment		Turnover Intentions	
Predictors	**b**	**β**	**b**	**β**	**b**	**β**	**b**	**β**	**b**	**β**	**b**	**β**
Physical fatigue	-.16^{***a}	-.22	-.09^{***a}	-.12	.15^{***a}	.14	-.04^{a}	-.05	-.09^{**a}	-.11	.09^{**a}	.11
Mental fatigue	-.03^{b}	-.05	-.06^{a}	-.07	.26^{***a}	.24	.03^{a}	.04	.04^{a}	.04	-.04^{b}	-.04
Emotional fatigue	-.04^{b}	-.05	-.19^{***b}	-.24	.23^{***a}	.20	-.20^{***b}	-.29	-.10^{*a}	-.12	.17^{***a,c}	.20
R^2	.08***		.15***		.26***		.09***		.03***		.06***	

Note: N = 2,477. **b** = unstandardized regression coefficients. **β** = standardized regression coefficients. Unstandardized coefficients *within a column* sharing a superscript are not significantly different; unstandardized coefficients *within a column* with different superscripts are significantly different ($p < .05$).

$^{*}p < .05$,

$^{**}p < .01$,

$^{***}p < .001$.