Basic psychological need experiences, fatigue, and sleep in individuals with unexplained chronic fatigue

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Abstract
Grounded in self-determination theory, this study tested the hypothesis that the satisfaction and frustration of the psychological needs for autonomy, competence, and relatedness would relate to fatigue and subjective and objective sleep parameters, with stress and negative sleep cognitions playing an explanatory role in these associations. During a stay at a sleep laboratory in Belgium, individuals with unexplained chronic fatigue ($N = 160; 78\%$ female) underwent polysomnography and completed a questionnaire at 3 different points in time (i.e., after arrival in the sleep lab, before bedtime, and the following morning) that assessed their need-based experiences and stress during the previous week, fatigue during the preceding day, and sleep-related cognitions and sleep during the previous night. Results indicated that need frustration related to higher stress, which in turn, related to higher evening fatigue. Need frustration also related to poorer subjective sleep quality and shorter sleep duration, as indicated by both subjective and objective shorter total sleep time and subjective (but not objective) longer sleep latency. These associations were accounted for by stress and negative sleep cognitions. These findings suggest that health care professionals working with individuals with unexplained chronic fatigue may consider focusing on basic psychological needs within their therapeutic approach.

KEYWORDS
basic psychological needs, fatigue, polysomnography, self-determination theory, sleep, stress

1 | INTRODUCTION

Fatigue is a common complaint among the general population. As a subjective experience, it manifests through feelings of tiredness, weakness, or exhaustion (Shahid, Shen, & Shapiro, 2010). Although fatigue is often attributed to a primary sleep disorder, psychiatric illness, or medical condition, in many individuals, a definite cause cannot be determined. If such unexplained fatigue persists for more than 6 months, the term “chronic fatigue” is used (Fukuda et al., 1994). Unexplained chronic fatigue (UCF) has been shown to co-occur with a broad range of conditions including depression, anxiety, and sleep disorders (Janssens, Zijlema, Joustra, & Rosmalen, 2015; Mariman, Delesie et al., 2013a). Between 87% and 95% of individuals with UCF report unrefreshing sleep despite adequate sleep duration (Mariman, Delesie et al., 2013a; Mariman, Vogelaers et al., 2013b). In light of this heterogeneity observed in individuals with UCF, there is a need to identify transdiagnostic predictors of fatigue and poor sleep among these individuals (e.g., Egan, Wade, & Shafran, 2011). In this study, we adopted a theory-driven approach by considering psychological predictors of fatigue and sleep from an established psychological framework, namely, self-determination theory (SDT; Deci & Ryan, 2000).

2 | SELF-DETERMINATION THEORY: BASIC PSYCHOLOGICAL NEEDS

We adopted SDT as a framework for examining predictors of fatigue and sleep within individuals with UCF because it specifies three universal and inherent psychological needs that it claims are essential for well-being and optimal functioning: the need for autonomy refers to experiencing a sense of volition and self-endorsement in one’s activities, the need for competence involves feeling capable and effective in achieving desired outcomes, and the need for relatedness...
reflects one’s proclivity for strong interpersonal relationships (Deci & Ryan, 2000). According to SDT, the satisfaction of these needs is critical for individuals to flourish and experience psychological and physical well-being, whereas the active frustration of these needs is said to elicit maladaptive or even pathological functioning. The notion of need frustration deserves attention in its own right because the mere absence of need satisfaction does not necessarily denote the presence of need frustration. Indeed, for psychological needs to be frustrated, a more active undermining or thwarting is required (Bartholomew, Ntoumanis, Ryan, Bosch, & Thogersen-Ntoumani, 2011; Vansteenkiste & Ryan, 2013). Autonomy frustration involves feeling pressured to think, feel, or act a certain way, competence frustration refers to experiencing feelings of failure and inadequacy, and relatedness frustration involves feeling excluded or socially isolated.

Previous research has extensively documented an association between psychological need satisfaction and adaptive outcomes such as higher well-being (e.g., life satisfaction and self-esteem; Deci & Ryan, 2000; Vansteenkiste & Ryan, 2013), higher subjective energy (e.g., higher vitality; Ryan & Deci, 2008), and more salutary physical outcomes such as higher quality and quantity of sleep (Campbell et al., 2015). However, more recently, research has increasingly begun to examine the costs associated with psychological need frustration. For example, studies have demonstrated that when psychological needs are frustrated, individuals are more likely to report disordered eating behaviour (e.g., Versstuyf, Vansteenkiste, Soenens, Boone, & Mouratidis, 2013), depressive symptoms, and exhaustion (e.g., Bartholomew et al., 2011). Together, these studies suggest that although low psychological need satisfaction has the potential to hinder individuals’ growth and well-being, psychological need frustration can be especially harmful and uniquely predictive of ill-being (e.g., exhaustion and depressive symptoms) over and above a lack of need satisfaction (e.g., Bartholomew et al., 2011; Chen et al., 2015).

Importantly, in addition to the claim that these psychological needs play a fundamental role in both adaptive and maladaptive functioning, SDT also conceives of these psychological needs as being universal. Specifically, SDT claims that these needs have the potential to either promote or impede human flourishing among all individuals regardless of their age, cultural background, or even clinical status. A number of studies have provided support for this universality claim. For example, one recent study showed need satisfaction to relate positively to well-being (e.g., life satisfaction and vitality) and need frustration to relate positively to ill-being (e.g., depressive symptoms) across four diverse cultures (i.e., Belgium, China, Peru, and the USA; Chen et al., 2015). Apart from being relevant across distinct cultures, the benefits of need satisfaction have also been shown to extend to clinical populations including adolescents with severe emotional and behavioural problems (e.g., Savard, Joussemet, Pelletier, & Mageau, 2013) and people living with HIV (Campbell et al., 2016a). However, despite previous findings demonstrating that psychological need-based experiences relate to subjective energy and sleep, research is yet to examine whether these previously identified associations generalize to individuals with UCF.

Previous research provides some indirect evidence for the hypothesized role of need-based experiences in the fatigue and poor sleep in individuals with UCF. For example, substantial occupational disability occurs in individuals with UCF that likely thwarts psychological needs. Up to 50% of individuals with UCF report being unemployed and of those who remain employed, many have to change jobs, work fewer hours, and receive less pay due to their illness (Assefi, Coy, Uslan, Smith, & Buchwald, 2003). This inability to work may engender competence and autonomy frustration as these individuals likely feel unable to carry out valued everyday activities (i.e., going to work) and feel pressured by their condition to either not work or work less. Further, previous findings indicate that individuals with work disability (i.e., who work less than 50% and receive disability pension) report poorer sleep quality than those who return to work after long-term sick leave (Oyefaten, Midtgarden, Maeland, Eriksen, & Magnusson, 2014). In addition to occupational disability, individuals with UCF often report social isolation and lack of social support from family and friends (Drachler et al., 2009), which is indicative of the frustration of their need for relatedness. The long search for a diagnosis often results in individuals feeling frightened, angry, and alone. With no explanation for their condition, individuals with UCF often experience disbelief and a lack of empathy from their direct environment (Drachler et al., 2009). Support and understanding from family and friends is, however, considered vital, and lack of social support has been identified as a perpetuating factor of fatigue severity and functional impairment (Prins et al., 2004). Although these previous studies among UCF populations did not directly assess basic psychological needs using SDT-based measures, they provide some indirect evidence for the hypothesized association between need-based experiences and fatigue and sleep within this clinical group.

3 | INTERVENING MECHANISMS: SYMPTOMS OF STRESS AND NEGATIVE SLEEP COGNITIONS

In light of the evidence suggesting that need-based experiences may relate to fatigue and sleep in individuals with UCF, the question arises as to which explanatory processes may account for these hypothesized associations. In this study, we propose that symptoms of stress, such as nervous arousal, difficulty relaxing, agitation and irritability (Lovibond & Lovibond, 2004), and negative sleep-related thoughts (e.g., ruminating about the consequences of not getting enough sleep), are likely to play an intervening role in the hypothesized association between need satisfaction and frustration and fatigue and sleep. We propose symptoms of stress and negative sleep-related cognitions as potential explanatory processes because need frustration has previously been shown to engender both stress (e.g., Campbell et al., 2016a; Weinstein & Ryan, 2011) and dysfunctional cognitions such as worrying and rumination (Van der Kaap-Deeder, Vansteenkiste, Van Petegem, Raes, & Soenens, 2016b).

Moreover, previous research has extensively documented associations between both stress (e.g., Valerio, Kim, & Sexton-Radek, 2016) and negative sleep cognitions (e.g., Wood, Joseph, Lloyd, & Atkins, 2009) and poorer sleep outcomes. Indeed, a recent prospective
6-day diary study in 27 individuals with chronic fatigue syndrome (CFS)\(^1\) showed that somatic arousal and negative presleep cognitions predicted poorer subjective sleep quality and poorer subjective sleep efficiency. Much like symptoms of stress, somatic arousal which is referred to as the experience of a jittery, nervous feeling in the body, was found to predict perceiving sleep to be unrefreshing, a common complaint among individuals with UCF (Russell, Wearden, Fairclough, Emsley, & Kyle, 2016).

Although the root of these pre-sleep arousals was not examined, we propose that they may be at least partly grounded in need frustration. For example, need frustration resulting from being unable to work and feeling socially excluded is likely to give rise to symptoms of stress (e.g., tension and overarousal). During the day, these symptoms of stress are likely to erode energy levels thereby engendering fatigue; whereas at night, symptoms of stress may feed into negative cognitions when trying to fall asleep that in turn may negatively impact on quality and quantity of sleep. In line with this, a short-term longitudinal study among university students showed that increases in psychological need frustration related to increases in daytime dysfunction and poor sleep quality and reductions in sleep quantity through (i.e., accounted for by) increases in stress, suggesting that stress represents a critical explanatory mechanism (Campbell, Vansteenkiste, Soenens, & Beyers, 2016b). Furthermore, Lopez et al. (2011) found that individuals with CFS who followed a group-based cognitive behavioural stress management intervention reported significant decreases in perceived stress and improvements in fatigue and unrefreshing sleep compared to baseline and compared to individuals who received psychoeducation. This intervention may have reduced stress through increasing patients’ basic psychological need satisfaction as it focused on modifying individuals’ outlook, coping strategies, and improvement of social support perceptions. However, the intervening role of both stress and negative sleep cognitions in the relation between psychological need frustration and fatigue and sleep in individuals with UCF has not yet been examined.

### 4 | PRESENT STUDY

The global objective of this cross-sectional study was to test an integrative model in a large sample of individuals referred to a tertiary care centre for investigation of UCF. As shown in Figure 1, we examined the relation between psychological need experiences (i.e., their satisfaction and frustration) and both fatigue and quality and quantity of sleep, while considering the explanatory role of stress and negative sleep cognitions in these associations. Indeed, theoretical models of insomnia and previous empirical studies have consistently argued and found evidence for the role of stress in contributing to negative pre-sleep cognitions that in turn have been shown to relate to poorer sleep outcomes (e.g., Espie, Broomfield, MacMahon, Macphee, & Taylor, 2006; Morin, Rodrigue, & Ivers, 2003). Hence, we sought to investigate whether stress and negative sleep cognitions would play a similar role among UCF patients by examining their intervening role in the relation between need-based experiences and the fatigue and sleep outcomes.

This study builds on previous research in three significant ways. First, by investigating whether the previously identified association between psychological need experiences and fatigue and sleep within a nonclinical population (i.e., Campbell et al., 2015) extends to the clinical population of UCF. Second, we sought to account for the processes underlying these associations, thereby examining both stress and negative sleep cognitions as intervening mechanisms in the relation between basic psychological needs, fatigue, and the sleep outcomes. Finally, we assessed a variety of sleep outcomes (i.e., sleep latency, total sleep time, and wake after sleep onset) not only subjectively but also objectively using sleep parameters derived from polysomnography (PSG). This allowed us to avoid the well-known problem of shared method variance in case of the use of a single informant. To further reduce the bias of shared method variance, we assessed the study variables at different points in time. It seemed especially critical to circumvent the issue of shared method variance in this sample because previous research suggests that individuals with UCF are likely to have a biased perception of their sleep, as is evidenced by moderate correlations between their self-reported and objectively recorded sleep (e.g., Creti et al., 2010). This biased perception is perhaps because individuals with UCF may attribute their fatigue to perceived deficits in their sleep. As a result, their fatigue may cause them to become increasingly attentive to and biased towards their sleep, potentially leading to the observed discrepancies between subjective and objective sleep measures.

Although we assessed both need-satisfying and need-frustrating experiences, congruent with past work (Bartholomew et al., 2011; Van der Kaap-Deeder, Vansteenkiste, Soenens, & Mabbe, 2016a) and theorizing (Vansteenkiste & Ryan, 2013), we expected higher psychological need frustration, rather than low need satisfaction, to be especially related to higher stress (Hypothesis 1). In turn, we expected stress to be positively related to both fatigue (Hypothesis 2) and negative sleep cognitions (Hypothesis 3). Finally, we expected that negative sleep cognitions in turn would relate to poorer sleep quality (Hypothesis 4a) and to reduced sleep quantity (Hypothesis 4b), as indexed by reduced total sleep time, higher sleep latency, and more frequent awakenings after sleep onset.

### 5 | METHODS

#### 5.1 | Participants and procedure

All participants were recruited between July 2015 and March 2016 at time of referral to the tertiary care centre for further clinical investigation of UCF at Ghent University Hospital. The major presenting complaint was severe chronic fatigue with a negative impact on daytime functioning, for which no apparent explanation could be found by conventional medical evaluation in primary and/or secondary care settings. All participants had complaints of UCF for a minimum of 6 months before being referred to the centre. Assessment of UCF at

\(^1\)CFS is diagnosed through multidisciplinary assessment by a medical professional usually according to the Fukuda et al. (1994) criteria. Although individuals with UCF in this study had complaints of fatigue for a minimum of 6 months, they had not yet undergone multidisciplinary assessment to receive a clinical diagnosis.
the centre involves internal medical assessment, psychodiagnostic screening, rehabilitation assessment, and PSG combined with a multiple sleep latency test.

Participants were eligible for inclusion if their chronic fatigue had persisted for longer than 6 months, if they were at least 18 years old and Dutch speaking. Upon recruitment, participants were informed that they would be required to complete three online questionnaires during their stay at the sleep laboratory for diagnostic PSG. The first questionnaire was completed soon after arrival in the sleep lab and assessed their psychological functioning during the preceding week (i.e., psychological need satisfaction and stress; Time 1). The second questionnaire was completed just before bedtime and assessed fatigue during the preceding day (i.e., Time 2). The third questionnaire was completed upon awakening the following morning and assessed subjective sleep outcomes from the preceding night (i.e., Time 3). The questionnaires were completed on laptops provided in the sleep lab. Paper versions were also made available for participants who preferred to complete a hardcopy version. Signed informed consent was provided by all participants, and the study was approved by the institutional ethical review board of the University Hospital Ghent, Belgium.

The final sample consisted of 160 adults (78.1% female; Mage = 39.63 years, SD = 11.10). Of the 160 participants, 135 (85.38%) completed all three self-report assessments. Little’s missing completely at random was nonsignificant, $\chi^2(55) = 68.99, p > .05$, indicating that the data were likely to be missing at random. As a result, full information maximum likelihood was used to handle missing data in the structural equation models (Little & Rubin, 1987). Following multidisciplinary assessment of UCF at the centre, participants received the following diagnoses: 17 (10.6%) CFS without comorbidity, 14 (8.7%) CFS with comorbidity, 13 (8.1%) primary sleep disorder, 40 (24.8%) psychiatric disorder, 23 (14.3%) combination of psychiatric and sleep disorder, and 16 (3.7%) burnout. Thirty-eight participants (23.6%) were categorized as "other," which meant either that their diagnosis did not fall into one of the above categories or that their diagnosis was still unknown after multidisciplinary assessment. Fifty-one (31.9%) participants reported being single, and 109 (68.1%) participants were either married or cohabiting. Seven participants (4.3%) had completed a primary education, 88 (55%) had completed secondary education, and 64 (40%) had completed a higher form of education. Fifty-seven percent of the sample reported depressive symptoms but were not diagnosed as having a depressive disorder, and 93 (58%) participants were unemployed at the time of their participation in the study.

5.2 | Measures

5.2.1 | Time 1—After arrival at the sleep lab

5.2.1.1 | Basic psychological need satisfaction and need frustration scale

The satisfaction and frustration of basic psychological needs was assessed using the basic psychological need satisfaction and need frustration scale (Chen et al., 2015). Participants rated whether they felt their needs for autonomy (e.g., "I felt that my choices reflected who I really am" or "I felt forced to do many things that I didn’t choose to do"), competence (e.g., "I felt confident that I could do things well" or "I had serious doubts about whether I could do things well"), and relatedness (e.g., "I felt connected with people who care for me and whom I care for" or "I felt excluded from the group that I want to belong to") were satisfied or frustrated during the preceding week on a 5-point scale ranging from 1 (Not at all true) to 5 (Very true). The scale consists of 24 items, eight items per need, four of which tap into need satisfaction and four of which tap into need frustration. A confirmatory factor analysis (CFA) with robust maximum likelihood estimation was performed to evaluate the fit of a 6-factor model that differentiated between the satisfaction and frustration of each of the three needs. The lower order CFA with the four satisfaction and four frustration items loading onto the satisfaction and frustration of the corresponding need yielded a good fit, $\chi^2/df = 1.52$, comparative fit index

FIGURE 1 | Hypothesized model

Week-related measures

Day-related measures

<table>
<thead>
<tr>
<th>Upon arrival</th>
<th>Upon arrival</th>
<th>Before sleep</th>
<th>Morning</th>
<th>Morning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need satisfaction</td>
<td>Fatigue</td>
<td>Negative sleep cognitions</td>
<td>Sleep latency</td>
<td>Total sleep time</td>
</tr>
<tr>
<td>Need frustration</td>
<td>Stress</td>
<td>Subjective sleep quality</td>
<td>Subjective and Objective</td>
<td></td>
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</tbody>
</table>

Note: H = hypothesis
(CFI) = .93, standardized root mean square residual (SRMR) = .07, root mean square error of approximation (RMSEA) = .06. The factor loadings of all items were satisfactory and ranged between .66 and .87. The higher order CFA with the three need satisfactions and three need frustrations loading onto a need satisfaction and need frustration composite also had a good fit, $\chi^2/df = 1.54$, CFI = .92, SRMR = .07, RMSEA = .06, with a minimum loading of .58. Two composite scores were created by averaging the 12 items that assessed need satisfaction ($\alpha = .87$) and the 12 items that assessed need frustration ($\alpha = .88$).

### 5.2.1.2 Stress

Symptoms of stress were assessed using the stress subscale from the short-form version of the Depression Anxiety and Stress Scale (Lovibond & Lovibond, 2004). The subscale consists of seven items that measure symptoms of stress (e.g., "I tended to over-react to situations," "I felt that I was using a lot of nervous energy," and "I found myself getting agitated") during the past week. The items were rated on a 4-point scale, ranging from 0 (Not applicable at all) to 3 (Very much so). Cronbach’s $\alpha$ in this sample was .91. This seven item stress subscale has been shown to have good internal consistency in nonclinical (e.g., Henry & Crawford, 2005; Willemsen, Markey, Declercq, & Vanheule, 2011) and clinical samples (e.g., Antony, Bieling, Cox, Enns, & Swinson, 1998). Previous studies have demonstrated this scale to be related to a variety of variables in the expected directions, underscoring its construct validity. Specifically, it has been shown to be positively related to anxiety, depression, and negative affect and negatively related to positive affect (Crawford & Henry, 2003; Henry & Crawford, 2005). Furthermore, it has also been linked to poorer emotional self-regulation and lower mindfulness (Lyvers, Makin, Toms, Thorberg, & Samios, 2014).

### 5.2.2 Time 2—Before bedtime

#### 5.2.2.1 Fatigue

Symptoms of fatigue were assessed using the lassitude subscale from the Inventory of Depression and Anxiety Symptoms (Watson et al., 2007). The subscale consists of six items that were adapted so that they assessed symptoms of fatigue during the past day (e.g., "Today I felt exhausted"). Items were answered on a 5-point scale ranging from 1 (Not at all) to 5 (Very much so). Cronbach’s $\alpha$ was .81.

### 5.2.3 Time 3—Upon awakening the following morning

#### 5.2.3.1 Negative sleep cognitions

Negative sleep cognitions whilst trying to fall asleep or get back to sleep were measured in the morning using the five negative sleep-related items (e.g., "If I don't get to sleep soon, I will feel very tired tomorrow") from the self-statement test: 60+ (SST: 60+; Fichten et al., 1998). The items were rated on a 5-point scale ranging from 1 (Not applicable at all) to 5 (Very much so). Cronbach’s $\alpha$ was .76.

#### 5.2.3.2 Subjective total sleep time

Subjective total sleep time was calculated from four open-ended questions from the Pittsburgh Sleep Diary (Monk et al., 1994) that were completed in the morning. Specifically, total sleep time was calculated from items assessing bedtime, the number of minutes it took to fall asleep (i.e., sleep latency), the number of minutes spent awake during the night after initially falling asleep (i.e., wake after sleep onset), and the final wake time. First, total time in bed was calculated using the bedtime and the final wake time. Next, the total sleep time was calculated by subtracting sleep latency and wake after sleep onset from the total time in bed.

#### 5.2.3.3 Subjective sleep quality

Subjective sleep quality was also measured in the morning using two visual analogue scales (VAS) that assessed the quality of the previous night’s sleep (i.e., “How was the quality of your sleep last night?”) and whether the previous night’s sleep was experienced as restorative (i.e., “How restorative was your sleep?”). Both VAS’s were rated on a score from 0 (i.e., “Very bad” or “Not at all restorative”) to 100 (i.e., “Very good” or “Completely restorative”). A composite score of subjective sleep quality was created by averaging the scores on these two VAS scales ($\alpha = .73$).

#### 5.2.3.4 Objective sleep parameters

Objective sleep parameters were assessed by PSG. PSG was recorded and manually scored in 30-s epochs by an experienced PSG technologist, according to the 2007 scoring manual of the American Academy of Sleep Medicine (Iber, Ancoli-Israel, Chesson, & Quan, 2007). Sleep parameters derived from PSG included total sleep time, which gives an objective indication of the total time in minutes that each participant was actually asleep, sleep latency, which provides an objective measure of the number of minutes it took each participant to fall asleep after going to bed, and wake after sleep onset, which provides an objective indication of the number of minutes that each participant spent awake throughout the night after initially falling asleep.

### 5.3 Statistical analyses

To examine the intervening role of stress and negative sleep cognitions in the relation between basic psychological needs, fatigue and subjective and objective sleep outcomes path models were tested (with manifest variables) using Mplus7. Model fit was assessed using the $\chi^2$ test, the CFI, the SRMR, and the RMSEA. An acceptable fit was indicated by $\chi^2/df$ ratio of 2 or below, CFI values of .90 or above, and SRMR and RMSEA values of around .08 or below (Hu & Bentler, 1999; Kline, 2005). After inspection of the relation between patients’ characteristics and the study variables, two variables (i.e., number of comorbidities and age) were controlled for in the integrated models (see Subsection 6.1). In testing the role of basic psychological needs, we followed a stepwise procedure by first testing the unique contribution of a composite score of need satisfaction and need frustration and then breaking down the composite score into its subcomponents so as to examine the unique contribution of the three separate needs (i.e., for autonomy, competence, and relatedness). In each step, two models were tested, one that examined relations with the subjective sleep outcomes and one that examined relations with the objective sleep outcomes. In all models, the intervening role of stress and negative sleep cognitions was examined by tests of indirect effects (MacKinnon, Lockwood, & Williams, 2004). These indirect
effects were tested using bootstrapping (1,000 draws) to account for potential deviations from multivariate normality.

6 | RESULTS

6.1 | Preliminary analyses

6.1.1 | Background characteristics

The relation between the participants’ background characteristics and the study variables was examined using a multivariate analysis of covariance with gender, education level, and employment status as fixed factors, age and number of comorbidities as covariates, and all study variables as dependent variables. Although none of these background variables yielded a significant multivariate effect, subsequent univariate analysis of variances revealed several significant relations between the background characteristics and the study variables. Age was negatively related to objective total sleep time, $F(1, 95) = 12.02$, $p < .001$, $\eta^2 = .11$, and positively related to objective wake after sleep onset, $F(1, 95) = 11.29$, $p < .001$, $\eta^2 = .11$. Number of comorbidities was positively related to objective, $F(1, 95) = 5.79$, $p < .05$, $\eta^2 = .06$, and subjective, $F(1, 95) = 8.02$, $p < .01$, $\eta^2 = .08$, wake after sleep onset, objective, $F(1, 95) = 9.38$, $p < .01$, $\eta^2 = .09$, and subjective, $F(1, 95) = 6.50$, $p < .05$, $\eta^2 = .06$, sleep latency, and negatively related to objective, $F(1, 95) = 9.02$, $p < .01$, $\eta^2 = .09$, and subjective, $F(1, 95) = 7.78$, $p < .01$, $\eta^2 = .08$, total sleep time and subjective sleep quality, $F(1, 95) = 5.05$, $p < .05$, $\eta^2 = .05$. These significant relations between age and number of comorbidities (i.e., none, one, or two) and the study variables were controlled for in the subsequent integrative models.

6.1.2 | Descriptive statistics and correlations

The means, standard deviations, and correlations between all the study variables are shown in Table 1. Need satisfaction and need frustration were related to stress, fatigue, and negative sleep cognitions in the expected directions but were unrelated to the subjective and objective sleep parameters. Stress was positively related to fatigue and negative sleep cognitions and was negatively related to subjective sleep quality but unrelated to the other sleep parameters. Negative sleep cognitions were related to the four subjective sleep indicators in the expected directions but were unrelated to the three objective sleep parameters. Finally, subjective total sleep time, sleep latency, and wake after sleep onset were moderately correlated with their respective objective indicators. Paired sample $t$ tests indicated that the mean difference between subjective and objective total sleep time was not significant, $t(133) = 1.65$, ns; whereas, the mean difference in subjective and objective sleep latency, $t(124) = 2.79$, $p < .01$, and wake after sleep onset was significant, $t(110) = -7.86$, $p < .001$, yet in the opposite direction. Participants overestimated their sleep latency by 9.31 min and underestimated their wake after sleep onset by 40.82 min on average.

6.1.3 | Testing the proposed model

In line with the timing of the assessment of the different constructs, an integrated model was tested in which paths were added from the need composite variables (i.e., need satisfaction and need frustration) to stress, from stress to fatigue and negative sleep cognitions and, lastly, from negative sleep cognitions to the subjective sleep outcomes (i.e., subjective total sleep time, subjective sleep latency, and subjective sleep quality), which were allowed to correlate. The final model, $\chi^2(17) = 16.42$, $p = .49$, $\chi^2/df = .97$, $CFI = 1.00$, $SRMR = .05$, $RMSEA = .00$, is shown in Figure 2 (see the first coefficients reported). Results indicated that need frustration was uniquely positively related to stress, which in turn, was positively related to fatigue and negative sleep cognitions. Negative sleep cognitions were, in turn, negatively related to subjective total sleep time and subjective sleep quality and positively related to subjective sleep latency. Next, direct paths were

**TABLE 1** Correlations between all study variables

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<th>Variables (units)</th>
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<th>10</th>
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<th>12</th>
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<tbody>
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<td>Need satisfaction (1–5)</td>
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<td>-.73**</td>
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<tr>
<td>Need frustration (1–5)</td>
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<td></td>
<td>-.19**</td>
<td>.21**</td>
<td>.24**</td>
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<td>Stress (0–3)</td>
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<td>-.56**</td>
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<td>Fatigue (1–5)</td>
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<td>-.22*</td>
<td>.25**</td>
<td>.34**</td>
<td>.13</td>
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<td>Negative sleep cognitions (1–5)</td>
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<td>-.16</td>
<td>-.20*</td>
<td>-.20*</td>
<td>-.27**</td>
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<td>Subjective sleep quality (1–100)</td>
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<td>.15</td>
<td>-.16</td>
<td>-.20*</td>
<td>-.20*</td>
<td>-.27**</td>
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<td>Subjective total sleep time (min)</td>
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<td>.02</td>
<td>.07</td>
<td>-.21*</td>
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<td>-.04</td>
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<tr>
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<td>.02</td>
<td>-.02</td>
<td>-.05</td>
<td>.20*</td>
<td>-.25**</td>
<td>-.74**</td>
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<tr>
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<td>.08</td>
<td>.01</td>
<td>.10</td>
<td>-.14</td>
<td>.08</td>
<td>.42**</td>
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<tr>
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<td>.04</td>
<td>-.06</td>
<td>-.02</td>
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<td>-.10</td>
<td>-.25**</td>
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<tr>
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<td>-.09</td>
<td>-.00</td>
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<td>.12</td>
<td>-.10</td>
<td>-.40**</td>
<td>.32**</td>
<td>.46**</td>
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<td>.27**</td>
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Mean

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<th>40.30</th>
<th>389.79</th>
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<td>119.70</td>
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<td>55.56</td>
<td>61.66</td>
<td>27.41</td>
<td>50.83</td>
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Note. SD = standard deviation, WASO = wake after sleep onset.

*p < .05.

**p < .01.
gradually added in between the predictor and outcome variables that were significantly related (see Table 1). Specifically, direct paths were added between the two need composite scores and fatigue and negative sleep cognitions and between stress and subjective sleep quality. However, these paths were removed from the model because they did not lead to an improved model fit. The indirect association between need frustration and fatigue via stress was significant, \( \beta = .11, p < .05 \), 95% CI \([-0.02, 0.19]\). Further, the indirect association between need frustration and subjective sleep quality, \( \beta = -0.04, p < .05 \), 95% CI \([-0.08, 0.00]\), and subjective sleep latency, \( \beta = 0.05, p < .01 \), 95% CI \([0.02, 0.08]\), via stress and negative sleep cognitions was also significant. These results indicated that stress completely accounted for the association between need frustration and fatigue, whereas need frustration had an indirect association with subjective quality and quantity of sleep through (i.e., accounted for by) stress and negative sleep cognitions.

Next, in a second model, subjective total sleep time and subjective sleep latency were replaced by their respective objective indicators derived from PSG. Similar to the first model, all dependent variables (i.e., objective total sleep time, objective sleep latency, and subjective sleep quality) were allowed to correlate. The final model, \( \chi^2(22) = 27.30, p = .20, \chi^2/df = 1.24, CFI = .97, SRMR = .05, RMSEA = .04 \), is shown in Figure 2 (see the second coefficients reported in the figure). The results of this model were similar to the first model with one exception, namely, the relation between negative sleep cognitions and objective sleep latency which was nonsignificant. Again, direct paths were gradually added in between the predictor and outcome variables that were significantly related (see Table 1). Similar to the previous model, direct paths were added between the two need composite scores and fatigue and negative sleep cognitions and between stress and subjective sleep quality. However, these paths were dropped from the model because they did not lead to an improved model fit. Similar to the first model tested, all indirect associations between need frustration and the outcomes were significant, range 95% CI \([-0.08, 0.19]\), apart from the indirect association between need frustration and objective sleep latency via stress and negative sleep cognitions (\( \beta = 0.01, ns \)). Because objective total sleep time and objective wake after sleep onset were highly correlated (\( r = -0.96, p < .01 \)), we could not include them simultaneously in the same model as dependent variables. For this reason, we opted not to include wake after sleep onset in the final integrative models. Instead, we tested two models (i.e., one including only subjective sleep outcomes and one including only objective sleep outcomes) in which we examined the relation between the psychological predictors and wake after sleep onset. Specifically, in the model including only the subjective sleep outcomes, we replaced subjective total sleep time with subjective wake after sleep onset, and in the model including only objective sleep outcomes, we replaced objective total sleep time with objective wake after sleep onset. These models produced similar results to the previous models and indicated that negative sleep cognitions were significantly related to higher subjective wake after sleep onset (\( \beta = 0.17, p < .05 \)) but were unrelated to objective wake after sleep onset (\( \beta = 0.10, ns \)). In both of these models, the indirect association between need frustration and subjective wake after sleep onset (\( \beta = 0.03, ns \)) and between need frustration and objective wake after sleep onset (\( \beta = 0.02, ns \)) was not significant.

Finally, we examined the unique role of the three individual need frustrations (i.e., autonomy, competence, and relatedness frustration) in the prediction of the outcomes in the main integrative models. The results of the model including the subjective, \( \chi^2(22) = 23.01, p = .40, \chi^2/df = 1.05, CFI = .99, SRMR = .05, RMSEA = .02 \), and objective, \( \chi^2(27) = 31.29, p = .26, \chi^2/df = 1.16, CFI = .97, SRMR = .05, RMSEA = .03 \), sleep outcomes revealed that each of the individual
need frustrations were uniquely and positively related to stress. All of the other relations between the study variables were similar to the previous models (see Figure 3). The indirect association between autonomy frustration and fatigue, $\beta = .07, p < .05, 95\% \text{ CI } [.009, .121])$ via stress was significant as well as the indirect association between autonomy frustration and subjective sleep quality, $\beta = -.03, p < .05, 95\% \text{ CI } [-.053, -.004])$, subjective total sleep time, $\beta = -.02, p < .05, 95\% \text{ CI } [-.039, -.005])$, and subjective sleep latency, $\beta = .03, p < .05, 95\% \text{ CI } [.010, .050])$ via stress and negative sleep cognitions. Further the indirect association between relatedness frustration, $\beta = .02, p < .05, 95\% \text{ CI } [.002, .035]$, and subjective sleep latency via stress and negative sleep cognitions was also significant. All other indirect associations between competence and relatedness frustration and the outcomes did not reach significance.

7 | DISCUSSION

This study examined whether the satisfaction and frustration of the basic psychological needs for autonomy, competence, and relatedness, as conceived within SDT, would relate to fatigue and sleep through (i.e., accounted for by) stress and negative sleep cognitions in a large sample of individuals referred with UCF. The fact that these individuals, who reported unexplained complaints of fatigue for more than 6 months, underwent PSG to shed light on their condition, created an ideal opportunity to follow them closely during a 24-hr period. This made it possible to conduct multiple self-report assessments and to examine the associations between the study variables and both subjective and objective sleep parameters. Several interesting findings emerged.

7.1 | An integrative model

Overall, the findings revealed that participants' who experienced frustration of their psychological needs during the past week reported higher evening fatigue. Perceived stress fully accounted for this association. Psychological need frustration also contributed to poorer subjective sleep quality and shorter sleep duration, as indicated by both subjective and objectively assessed total sleep time and subjective sleep latency. These relations were explained by the combined presence of higher stress and negative sleep cognitions, which played an intervening role in the need-sleep outcome association. Overall, these findings underscore the critical role of experiences of need frustration (Bartholomew et al., 2011; Vansteenkiste & Ryan, 2013). Indeed, it appeared that it was not so much a lack of need fulfilment, but rather the more active frustration of individuals' psychological needs that was related to higher symptoms of stress and the associated maladaptive pattern of fatigue and poor sleep.

The finding that stress accounted for the association between need frustration and evening fatigue is consistent with recent findings. Specifically, a recent study among university students found increases in psychological need frustration to relate to increases in daytime dysfunction (i.e., higher fatigue and lower vitality) via increases in stress (Campbell et al., 2016b). The present results provide further evidence for the explanatory role of stress in the relation between need frustration and fatigue, this time among individuals with UCF. Interestingly, extending previous findings, follow-up analyses revealed that the frustration of each of the three needs (i.e., for autonomy, competence, and relatedness) contributed uniquely to higher stress. Seemingly, when individuals feel pressured, incapable of pursuing their daily activities and isolated from important others, they are likely to
experience symptoms of stress such as tension and overarousal, which in turn, erodes energy levels and contributes to fatigue.

Apart from evening fatigue, need frustration and stress also related to more negative sleep cognitions before bedtime. In turn, these negative cognitions were associated with poorer subjective sleep quality as reported in the morning. Consistent with these findings, previous research in insomnia and nonclinical populations also found higher daily stress to relate to lower perceived sleep quality, with cognitive arousal playing an explanatory role (e.g., Morin et al., 2003; Winzeler et al., 2014). In insomnia, stressors during the day have been shown to contribute to increased anxiety at bedtime and subsequent high levels of cognitive pre-sleep arousal. It has been suggested that this pre-sleep arousal triggers selective attention to sleep-related threat cues, resulting in distortions of reality and perceptions of poorer sleep (Harvey, 2002). The present results suggest that similar mechanisms may cause a distorted perception of sleep quality in individuals with UCF.

In addition to sleep quality, higher perceived stress and subsequent negative sleep cognitions also played an intervening role in the relation between need frustration and both subjective and objective quantitative sleep outcomes, with the exception of objective sleep latency. Again, drawing from theories of insomnia, it is hypothesized that cognitive processes such as attention, perception, and erroneous beliefs may culminate in real sleep deficit (Harvey, 2002). Seemingly, individuals with UCF may also report shorter sleep duration as a result of cognitive arousal at bedtime and high levels of distress. Hence, it seems likely that cognitive processes play a similar role in UCF. Overall, the present findings suggest that in UCF psychological need frustration may spark a negative sequence of events, first by triggering stress and subsequent negative cognitive arousal, which in turn may feed into poorer sleep quality and shorter sleep duration.

7.2 Self-reported and objectively recorded sleep

The assessment of both self-reported and objectively recorded sleep outcomes produced some additional findings. First, a moderate correlation was found between the subjective and respective objective registration of all three quantitative sleep parameters (i.e., total sleep time, sleep latency, and wake after sleep onset). These correlations are of moderate effect size, which equally suggests that there is a lack of correspondence between individuals’ perception of their sleep and their actual sleep. Future research may want to examine whether the size of this noncorrespondence, which reflects a biased perception of one’s sleep, varies as a function of psychological characteristics. Furthermore, the mean-level discrepancies between the subjective and objective reports were found to vary as a function of the examined quantitative sleep outcome. Specifically, individuals with UCF overestimated their sleep latency and underestimated their wake after sleep onset. Although participants believed that it took them longer to fall asleep than the objective assessment indicated, they underestimated the number of minutes they were awake during the night after sleep onset. The diverging discrepancies for these two indicators helped explain the lack of a mean-level difference between the subjective and objective total sleep time. Similar results, both in terms of the lack of correspondence between subjective and PSG-measured sleep and in terms of mean-level differences were also reported by Creti et al. (2010) in a sample of individuals with CFS.

Perhaps individuals with UCF overestimate their sleep latency because they are more alert when trying to fall asleep and are more likely to ruminate about the consequences of not having sufficient sleep. Because individuals are especially likely to recall these negative sleep cognitions in the morning, they may overestimate their sleep latency. In addition, based on their more habitual difficulty to fall asleep (Watson et al., 2003), individuals with UCF may project this experience to the single night that they spent at the sleep lab, thereby neglecting the time it took them to fall asleep that particular night. In contrast, with respect to wake after sleep onset, individuals are likely to be in a more passive mode during their awakenings at night thereby leading them to underestimate the amount of time spent awake. These differential discrepancies between subjectively and objectively recorded sleep outcomes may help explain why the proposed integrative model including the subjective reports of the sleep parameters generalized to the objectively recorded total sleep time but not to sleep latency or wake after sleep onset. Because participants overestimated the amount of time it took them to fall asleep and underestimated the amount of time they spent awake throughout the night, the predictive power of negative sleep cognitions was reduced. Note though that the differential predictive validity of negative sleep-related cognitions in the prediction of objective sleep latency (i.e., .05, ns) relative to objective wake after sleep onset (i.e., .10, ns) and objective total sleep time (i.e., −.14, p < .05) is a matter of gradation. Additional research is needed to replicate the current pattern of findings before any firm conclusions can be drawn.

7.3 Theoretical and practical implications

The present findings build on previous research in three important ways. First, by replicating the previously identified association between psychological need experiences and fatigue and sleep outcomes in a heterogeneous group of individuals with UCF. Second, by providing further insight into the explanatory processes that underlie these associations. Specifically, the present findings yielded evidence for the intervening role of both stress and negative sleep cognitions. Third, the present findings show that psychological need experiences not only relate to self-reported sleep parameters but also relate to an objective indicator of sleep.

In light of these findings, therapeutic interventions that seek to help reduce fatigue and sleep disturbances among individuals with UCF could target psychological need experiences. A first important step would be to help individuals recognize sources of need frustration in their life and regulate their emotional response (i.e., stress and cognitive arousal) to these experiences. One way to do this may to help individuals develop a more mindful approach (Brown & Ryan, 2003), thereby helping them learn to adopt an open, nonjudgemental awareness of present moment experiences. Indeed, mindfulness has previously been shown to relate to higher need satisfaction (Campbell et al., 2016a; Campbell et al., 2015) presumably because it aids awareness of and receptivity to cues for need satisfaction. Furthermore, previous studies suggest that being mindful is related to experiencing lower fatigue and higher sleep quality (Campbell et al., 2015; Howell, Digdon, Buro, & Sheptycki, 2008).
A second step may be to help individuals achieve more need satisfaction within their own life. For example, individuals could be helped to identify and participate in daily need satisfying activities (e.g., Weinstein, Khabbaz, & Legate, 2016). A final and important third step would be to foster need satisfaction within the health care environment (e.g., Teixeira, Carraca, Markland, Silva, & Ryan, 2012). This could be achieved by providing individuals with choice and avoiding pressuring strategies (i.e., supporting the need for autonomy), by responding in a warm and empathic manner (i.e., supporting the need for relatedness) and by limiting negative feedback and providing manageable tasks (i.e., supporting the need for competence).

7.4 Limitations and future research

This study has some limitations that can be addressed in future studies. First, although the assessments took place at different points in time, the prospective design precludes the establishment of causal relationships between psychological need frustration and perceived fatigue and the sleep outcomes. For example, fatigue may not only result from stress but may also lead to stress, which in turn, may thwart psychological needs. However, the timing of the assessment of the different constructs prevented us from testing such alternative pathways. Hence, future longitudinal or experimental research is needed to examine the direction of effects. Second, fatigue was only measured in the evening and not the following morning. It would be interesting to examine whether (disturbed) sleep outcomes may be involved in the maintenance of daytime symptoms in UCF. Third, although PSG is considered the gold standard for objectively measuring sleep, a sleep recording "snapshot" measured by a single-night in an unnatural, clinical environment lacks ecological validity. Future research could try to overcome this issue by assessing sleep using both PSG and wrist actigraphy. Although wrist actigraphy may not provide as accurate an estimate of objective sleep, it can be worn at home in a naturalistic environment and may provide a valuable additional source of information. Fourth, in this study, we only assessed relations between the variables of interest and a self-report assessment of sleep quality. We are unaware of the identification of any PSG parameter that fully captures the quality of individuals’ sleep. Hence, there is a need for future studies to determine how data derived from PSG is best used to provide valid qualitative sleep indicators. Finally, our sample was highly heterogeneous and included individuals with a range of different clinical diagnoses. Future research is needed to examine whether these same mechanisms (i.e., stress and negative sleep cognitions) play a similar intervening role in the relation between need experiences and sleep parameters (i.e., both subjective and objective) in nonclinical healthy samples.

7.5 Conclusion

In conclusion, individuals with UCF who experience frustration of their basic psychological needs for autonomy, competence, and relatedness are likely to experience more symptoms of stress, which in turn, is likely to result in higher evening fatigue. In addition to evening fatigue, need frustration also related to poorer quality and quantity of sleep through (i.e., accounted for by) higher stress and negative sleep cognitions. As poor sleep may contribute to fatigue, these findings indicate the potential need for health care professionals to focus on basic psychological needs as a therapeutic approach in this patient sample, both directly by providing a need supportive health care environment (Teixeira et al., 2012) and, indirectly, by helping individuals identify ways in which they can achieve more need satisfaction within their home environment (Weinstein et al., 2016).

CONFLICT OF INTEREST

The authors have declared that they have no conflict of interest.

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