CHRONIC INSOMNIA AND HEALTHCARE UTILIZATION IN YOUNG ADULTS

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Chronic insomnia is a highly prevalent disorder in general and young adult populations, and contributes a significant economic burden on society. Previous studies have shown healthcare utilization (HCU) is significantly higher for people with insomnia than people without insomnia. One limitation with previous research is accurate measurement of HCU in people with insomnia is difficult due to a high co-morbidity of medical and mental health problems as well as varying operational definitions of insomnia. Assessing HCU in people with insomnia can be improved by applying research diagnostic criteria (RDC) for insomnia, using a population with low rates of co-morbid medical/mental health problems, and measuring HCU with subjective, objective, and predictive methods. The current study found young adults with chronic insomnia had greater HCU than normal sleepers, specifically on number of medications, and chronic disease score (CDS) estimates of total healthcare costs, outpatient costs, and predicted number of primary care visits. The presence of a medical and/or mental health problem acted as a moderating variable between chronic insomnia and HCU. Simple effects testing found young adults with chronic insomnia and a medical/mental health problem had the greatest HCU followed by normal sleepers with a medical/mental health problem, chronic insomnia, and normal sleepers. Exploratory analyses found young adults with chronic insomnia had a greater likelihood of emergency room visits and overnight hospital admissions. More efforts for early identification and intervention of insomnia are necessary to help reduce costs associated with chronic insomnia co-morbid with medical and/or mental health problems.

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INTRODUCTION

Insomnia is a highly prevalent disorder in both the general (4% - 13%) and in young adult (2% - 17%) populations. The estimated annual direct costs of insomnia in the United States range from $14 to $21 billion with annual total costs ranging from $77 to $241 billion. Unfortunately, it is difficult to determine which portions of healthcare utilization (HCU) and healthcare costs are directly attributable to insomnia because of the high comorbidity with other disorders (e.g., medical and psychiatric) as well as varying operational definitions of insomnia found in previous research. A more accurate assessment of the relationship between chronic insomnia and HCU can be accomplished by using a population with low rates of comorbidities, applying research diagnostic criteria (RDC) for insomnia, and assessing HCU more comprehensively. To date, no studies have investigated HCU in a young adult sample with chronic insomnia. College students represent a large percentage of young adults, are a relatively healthy population, yet still have a similar prevalence of chronic insomnia as middle-aged and older adults. Providing healthcare for college students represents a huge expense for universities. Any study that can identify modifiable risk factors (i.e., sleep disturbance) for increased HCU should be important in improving health and reducing HCU of young adults.

Prevalence of Insomnia in the General Population

A seminal study by Ford and Kamerow (1989) established that insomnia is a highly prevalent disorder in adults—10.2%. Since 1989, epidemiology studies have found varying rates of insomnia in the general population, depending on the definition of insomnia used. Prevalence rates as high as 25% - 48% (Mallon, Broman, & Hetta, 2000; Quera-Salva, Orluc, Goldenberg, & Guilleminault, 1991) have been reported, although these studies were limited by a very liberal definition of insomnia that lacked specific criteria such as severity, frequency, or duration of

symptoms (Ohayon, 2002). Over the past 20 years, the operational definition of insomnia has become more standardized, with most definitions of insomnia in recent research using a combination of severity, frequency, and duration of symptoms, as well as a self-report of sleep dissatisfaction, and presence of daytime complaints due to disrupted sleep. These criteria coincide with recently developed quantitative criteria (Lichstein, Durrence, Taylor, Bush, & Riedel, 2003) and RDC (Edinger et al., 2004). A review by Ohayon (2002) showed that the studies using both presence of insomnia symptoms and a daytime complaint found prevalence rates closer to that of Ford and Kamerow (1989)—8.5% - 13% (Hetta, Broman, & Mallon, 1999; Ohayon, 2001). Using the quantitative criteria and RDC allows for better comparison of results across studies and more accurate identification of people with insomnia.

Prevalence of Insomnia in Young Adults

Insomnia is prevalent in young adults, however varying prevalence rates exist ranging from 2% - 17% (Breslau, Roth, Rosenthal, & Andreski, 1996; Buysse et al., 2008; Johnson, Roth, Schultz, & Breslau, 2006; Leger, Guilleminault, Dreyfus, Delahaye, & Paillard, 2000; Roberts, Roberts, & Chan, 2008). In 1996, Breslau and colleagues published a large epidemiology study of young adults (age 21-30) and found the prevalence of insomnia symptoms was 17%. Their definition of insomnia was focused on symptom frequency and duration: difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), or early morning awakenings (EMA) nearly every day for at least two weeks. Using a similar definition of insomnia as Breslau et al. (1996) —1 month duration rather than 2 weeks—Leger et al. (2000) found a similar prevalence rate as the Breslau et al. study—13.2% in a sample of 18 - 24 year-olds. The most rigorous study to date, performed by Ohayon and Roberts (2001), compared *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV; American Psychiatric

Association, 2000) criteria and *International Classification of Sleep Disorders* (ICSD; American Sleep Disorders Association, 2005) criteria for insomnia disorders in a sample of adolescents and young adults (15 - 24). Like the studies by Breslau et al. (1996) and Leger et al. (2000), insomnia symptoms were much more prevalent than an insomnia diagnosis. Approximately 14% of the samples had DIS or DMS, and only 3% met criteria for *DSM-IV* primary insomnia, 1.5% met criteria for *ICSD* psychophysiological insomnia, and 1.0% met criteria for *ICSD* idiopathic insomnia (Ohayon & Roberts, 2001).

Economic Impact of Insomnia

The economic impact of insomnia is considerable. The direct costs of insomnia have been estimated from $14 to $21 billion (Daley, Morin, LeBlanc, Gregoire, & Savard, 2009; Walsh & Engelhardt, 1999). However, costs of insomnia are often difficult to compare across studies. Measurements of direct costs vary but often include: physician visits, prescription medication, over-the-counter (OTC) medication (Daley et al., 2009; Walsh & Engelhardt, 1999), transportation, and alcohol as a sleep aid (Daley et al., 2009). Daley et al. (2009) noted that their estimation of direct costs may be low since prescription drugs in Canada—the location of their study—are almost exclusively generic and therefore less expensive than in countries like the United States where brand names drugs are more common.

The total costs (direct + indirect costs) of insomnia are substantially larger than the direct costs. In 1994, Stoller calculated the total costs of insomnia to be $93 to $108 billion. This included lost productivity ($41 billion), direct medical costs of treatment ($15.4 billion), insomnia-related depression ($1 billion), insomnia-related alcohol abuse ($8.5 - $11.6 billion), and accidents ($17.4 - $27.9 billion). The recent study by Daley et al. (2009) found total costs of insomnia, in the province of Quebec, to be approximately $6.1 billion (US$). Extrapolated to the

total population of the United States (307.5 million, 2009 estimate) insomnia total costs would be approximately $241 billion (US$). Total costs included in the Daley et al. (2009) study were physician consultations, transportation, prescription and OTC medications, alcohol as a sleep aid, absences at work, and lost productivity. At the individual level, total costs were $4675 for people with insomnia syndrome, $1336 for people with insomnia symptoms, and $393 for good sleepers (Daley et al., 2009).

Insomnia's Impact on HCU

Numerous studies have found that people with sleep disruption, insomnia disorder, or insomnia symptoms consistently have greater HCU and healthcare costs than good sleepers (Kapur et al., 2002; Kuppermann et al., 1995; Leger, Guilleminault, Bader, Levy, & Paillard, 2002; Novak, Mucsi, Shapiro, Rethelyi, & Kopp, 2004; Simon & VonKorff, 1997). One study found that patients with moderate to severe insomnia had, on average, more than double the physician visits per year than good sleepers—12.87 vs. 5.25, respectively (Weyerer & Dilling, 1991). A study by Kales et al. (1984) found that people with chronic insomnia were hospitalized almost twice as often (2.7 vs. 1.4) compared to a control group with no insomnia. Average 6-month healthcare costs were approximately $1,400 greater for people with insomnia ($4,755) than people without insomnia ($3,381; Ozminkowski, Wang, & Walsh, 2007). However, costs related to reduced productivity, transportation, use of alcohol, and use of OTC products were excluded from the analysis, suggesting that the results underestimated the total cost of insomnia (Ozminkowski et al., 2007).

Limitations of Previous Insomnia and HCU Research

It is clear that insomnia contributes to increased HCU and healthcare costs. However, it is difficult to know how much of the increased HCU is from insomnia or from medical and

psychiatric disorders commonly comorbid with insomnia. Simon and VonKorff (1997) noted that, "Attempts to disentangle these relationships encounter difficulty at both the measurement or operational level and at a more basic conceptual level" (p. 1421).

Large portions of the costs of insomnia are likely attributable to medical and psychiatric disorders comorbid with insomnia since people with insomnia have significantly more comorbid psychiatric and medical disorders than people without insomnia (Taylor, Lichstein, Durrence, Riedel, & Bush, 2005; Taylor et al., 2007). For instance, 40% - 57% of people with insomnia have a comorbid psychiatric disorder (Ford & Kamerow, 1989; McCall, 2001; Skaer, Robinson, Sclar, & Galin, 1999). People with insomnia are significantly more likely to have major depressive disorder, an anxiety disorder, substance abuse/dependence, and to commit suicide (Roberts, Shema, Kaplan, & Strawbridge, 2000; Taylor et al., 2005; Taylor, Lichstein, & Durrence, 2003; Wojnar et al., 2009). Taylor et al. (2005) found that approximately 20% of people with insomnia met criteria for clinical depression or anxiety while only 3% of people without insomnia met criteria for clinical depression or anxiety. In a community-based sample, people with chronic insomnia had higher rates than people without insomnia for heart disease (22% vs. 10%), hypertension (43% vs. 19%), chronic pain (50% vs. 18%), and gastrointestinal (34% vs. 9%), neurological (7% vs. 1%), urinary (20% vs. 10%), and breathing problems (25% vs. 6%; Taylor et al., 2007).

Research has shown that the medical and psychiatric disorders commonly comorbid with insomnia, not surprisingly, have a significant economic impact as well (DeVol & Bedroussian, 2007; Druss et al., 2001). Thus, comparing a group with more comorbid disorders (i.e., people with insomnia) to a group with less comorbid disorders (i.e., people without insomnia) would naturally result in the former group having higher HCU and healthcare costs than the latter

group. One solution to this problem is through statistical control of medical and psychiatric disorders, but some studies failed to do even this. Weyerer and Dilling (1991) failed to control for either comorbid medical or psychiatric disorders, and two other studies (Kapur et al., 2002; Leger et al., 2002) controlled only for psychiatric disorders.

Several studies did statistically control for both comorbid medical and psychiatric disorders and still found significant differences between those with and without insomnia (Hatoum, Kong, Kania, Wong, & Mendelson, 1998; Kuppermann et al., 1995; Novak et al., 2004; Ozminkowski et al., 2007; Simon & VonKorff, 1997). Only one study (Simon & VonKorff, 1997) found that after statistical control of medical and psychiatric comorbidities (i.e., analysis of covariance [ANCOVA]) healthcare cost differences were no longer significant between those with and without insomnia (Simon & VonKorff, 1997). Controlling for individuals with comorbid medical and psychiatric disorders allows for a better examination of the relationship between insomnia and HCU. Medical problems and psychiatric disorders act as confounds for studying insomnia and HCU, where increased HCU and healthcare costs may be due to comorbid disorders more so than insomnia itself.

However, statistical control for comorbid disorders through ANCOVA may be inappropriate (Miller & Chapman, 2001). ANCOVA was not developed to be a statistical means of controlling for a covariate (e.g., comorbid medical and psychiatric disorders) on which the groups are significantly different (Miller & Chapman, 2001). Pre-existing group differences (e.g., comorbid disorders) are common in psychopathology research since random assignment cannot occur. Therefore statistical control (i.e., ANCOVA) is common to avoid interpretation problems due to group differences (Miller & Chapman, 2001). ANCOVA is only appropriate when groups do not differ on the covariate and when including the covariate merely removes

variance that is unrelated to the grouping variable (e.g., insomnia; Miller & Chapman, 2001). Simon and VonKorff (1997) recognized that adjusting for covariates (i.e., comorbid disorders) may be inappropriate when the variables of interest (i.e., insomnia, medical and psychiatric disorders) are on the same causal path. Consequently, the adjusted comparisons of healthcare costs between people with and without insomnia should be considered conservative estimates (Simon & VonKorff, 1997).

One solution for control of comorbid disorders would be to study a sample of people with insomnia and without insomnia, where both groups have low or at least equal rates of comorbid medical and psychiatric disorders. Research has shown, that in contrast to the general population (Taylor et al., 2007), young adults with insomnia do not have a higher proportion of comorbid medical disorders than young adults without insomnia (Bramoweth et al., 2008). This was not true for psychiatric disorders. While young adults with insomnia have increased rates of psychiatric disorders than young adults without insomnia (Breslau et al., 1996; Roane & Taylor, 2008), their rates are still lower than adults (Taylor et al., 2005). Studying a healthier population (i.e., young adults) will allow for a better measure of HCU and healthcare costs attributable to chronic insomnia alone.

In addition to the confounding effects of comorbid disorders, another limitation of previous insomnia and HCU studies is that definitions of insomnia vary considerably. It is difficult to compare results across studies and fully understand the impact of insomnia on HCU. Insomnia definitions ranged from too vague to too narrow. Several studies provided no symptom severity, frequency, or duration criteria (Kapur et al., 2002; Kuppermann et al., 1995), only symptom severity criteria (Hatoum, Kania, Kong, Wong, & Mendelson, 1998), or only symptom duration criteria (Weyerer & Dilling, 1991). Other studies used an operational

definition of insomnia that was too restrictive (Leger et al., 2002; Novak et al., 2004; Simon & VonKorff, 1997). For instance, two studies (Leger et al., 2002; Novak et al., 2004) based their definition of insomnia on International Classification of Diseases (ICD; World Health Organization, 2003) criteria, which assumes at least two insomnia complaints (i.e., difficulty initiating sleep [DIS], difficulty maintaining sleep [DMS], early morning awakenings [EMA], non-restorative sleep), at least three times per week, for at least one month. This is more restrictive than *DSM-IV* criteria and the more recently developed quantitative criteria (Lichstein et al., 2003) and RDC (Edinger et al., 2004), which only require one insomnia complaint. Simon and VonKorff (1997) used a structured interview (Composite International Diagnostic Interview; Robins et al., 1988) to assess for insomnia. However, they used very severe cutoff scores (i.e., DIS $\geq$ 2 hours, DMS $\geq$ 1 hour, EMA $\geq$ 2 hours). The studies by Novak et al. (2004), Leger et al. (2002), and Simon and VonKorff (1997) likely underestimate the prevalence of chronic insomnia and therefore do not accurately measure HCU in a chronic insomnia population. These studies eliminated participants with clinically significant insomnia symptoms that did not meet the authors' "severe" criteria. In one of largest and most statistically well controlled studies of insomnia and HCU, Ozminkowski et al. (2007) defined insomnia using healthcare claims, either an ICD insomnia diagnostic code (i.e., 307.41, 307.42, 780.52) or use of a prescription medication for insomnia. Only symptom duration ($\geq$ 6 months) was used for inclusion, no symptom severity or frequency criteria were required for a diagnosis (Ozminkowski et al., 2007). It is highly probable that many cases of insomnia were missed by the clinicians in this study, clinicians who may have little experience diagnosing insomnia with accepted definitions (e.g., RDC). Surveys conducted in the primary care setting show that physicians overlook 60% - 64% of patients with severe insomnia (Sateia, Doghramji, Hauri, & Morin, 2000).

Using a liberal definition of insomnia risks diagnosing individuals, or including individuals in a study, with non-chronic insomnia, including: insomnia as an acute stress response, transient insomnia, insomnia secondary to a medical or psychiatric disorder, and insomnia due to an occult sleep disorder (e.g., restless leg syndrome, periodic limb movements). This could attenuate the differences that exist between people with actual chronic insomnia and those without insomnia. Conversely, using overly conservative definitions of insomnia can result in only the most severe cases being diagnosed with insomnia, which could overestimate the differences between people with and without insomnia. Using a standardized operational definition for insomnia (i.e., RDC and quantitative criteria for chronic insomnia) will help to better identify chronic insomnia, good sleepers, and those in between, which will lead to more reliable and valid estimates of HCU.

Rationale for the Current Study

The goals of this study were to accurately measure the prevalence of chronic insomnia in young adults (i.e., college students) with low rates of confounding variables (e.g., medical and psychiatric disorders) and obtain different measures of HCU including self-report, direct costs, and chronic disease score (CDS; Clark et al., 1995) in order to examine differences in HCU between young adults with chronic insomnia and normal sleepers. Using college students is advantageous because they represent a large percentage of the young adult population (69%; Bureau of Labor Statistics, 2009), they are a relatively healthy population free of many chronic health conditions and psychiatric disorders (negating the need for the somewhat dubious practice of statistical control), and yet still have a similar prevalence of chronic insomnia as middle-aged and older-adults. In addition, the effect of insomnia on HCU is valuable information for academic institutions, because providing healthcare for college students represents a huge

expense for universities. A college student sample allows easy access to both subjective HCU data (self-report) as well as objective HCU data (direct cost data from university health center).

Additionally, this study will help answer a question posed by the National Institutes of Health (NIH) State of the Science Statement on Manifestations and Management of Chronic Insomnia (2005): "What are the consequences, morbidities, comorbidities, and public burden associated with chronic insomnia?" Finally, we hope this study will help develop new research questions and identify future directions for insomnia-related research, another NIH directed goal.

Hypotheses

Primary Hypothesis

The main hypothesis is that young adults with chronic insomnia will have greater self-reports of physician visits, mental health visits (e.g., psychologist, psychiatrist, other mental health clinician), greater direct costs at the UNT Health and Wellness Center than young adults without chronic insomnia (i.e., normal sleepers), medication usage (prescription and OTC), and greater CDS on all three levels (i.e., total costs, outpatient costs, and number of primary care visits). Additionally, we expect the presence of a medical problem and/or mental health problem to act as a moderator between insomnia status and HCU (i.e., medical and mental health problems combined into one dichotomous variable).

Exploratory Hypothesis

Young adults with chronic insomnia will have greater self-reports of other subtypes of HCU than young adults without chronic insomnia that have not been explored in the literature. These variables include visits to a physical therapist/rehabilitative practitioner, visits to an emergency room, and hospital admissions.

METHOD

Participants

This study recruited undergraduate students from the University of North Texas (UNT) through the Department of Psychology's research participant pool (SONA system). Since the focus of the study was young adults, participants were excluded if younger than 18 or older than 35 years old. Data from participants not included in this study were retained and used for other projects. The sample (N = 1010) was 72.0% female, 24.5% male, and 3.5% did not specify gender; the mean age was 20.07 years (SD = 2.56). The race/ethnicity of the sample was 66.3% Caucasian, 12.9% African American, 10.7% Hispanic, 5.6% Asian/Pacific Islander, and 4.5% other; this breakdown was similar to the ethnicity of UNT's student body. The academic rank of the sample was 37.4% freshmen, 25.1% sophomore, 17.2% junior, 13.3% senior, 0.6% Other, and 6.3% missing. The sample's average level of parental education was 14.42 years (SD = 2.69) for mothers and 14.68 years (SD = 2.89) for fathers.

Procedure

The University of North Texas – Sleep and Health Research Lab (UNT-SHRL) collected data during the 2006-2007 academic year, following approval from the Institutional Review Board. Students in psychology courses earned extra credit for completing a questionnaire packet and a week-long sleep diary. Students accessed the consent form and questionnaire online, through the Department of Psychology's undergraduate research participant pool website (SONA system). Participants printed the survey, signed the consent form, and then filled out all questionnaires and the week-long sleep diary. During both fall and spring semesters, data collection ended prior to the start of finals week so that sleep diaries were not influenced by a

change in sleep schedules during the exam period. When participants completed the questionnaire and sleep diary they returned all materials to the UNT-SHRL.

Materials

Sleep Diary

Sleep diaries are the cheapest, most efficient, and most commonly used clinical and research measure of subjective sleep. However, these measures are almost never used in epidemiological studies of sleep, in preference for the easier to administer single-time point retrospective estimates of sleep. Research has found that sleep diaries are better than single-time point retrospective estimates of typical sleep (Coursey, Frankel, Gaarder, & Mott, 1980), and there is adequate agreement between sleep diaries and the "gold standard" objective measure of sleep, polysomnography ($\kappa = 0.49 – 0.63$; Gehrman, Edinger, Means, & Husain, 2003). Sleep diaries asked participants to give details about their sleep each night over the course of a week, including: bedtime, wake time, sleep onset latency (SOL), nighttime awakenings (NWAK), wake after sleep onset (WASO), time awake prior to arising (TWAK), estimated total sleep time, nap time, and sleep quality.

Insomnia Severity Index (ISI)

The ISI is a 7-item self-report measure that assesses perceived severity of insomnia (Bastien et al., 2001). Each item uses a 5-point Likert scale ranging from 0 to 4 with higher scores indicating greater severity of insomnia symptoms. The items are summed to produce a total score (range 0 – 28). The ISI has good internal consistency (Cronbach's alpha = 0.74 – 0.76) with item-total correlations ranging from $r = 0.32 – 0.71$ (all ps < 0.01; Bastien, Vallieres, & Morin, 2001). Correlations between ISI items and corresponding variables on sleep diaries

were modest (all *p*s < 0.01): sleep onset latency (r = 0.38), time awake after sleep onset (r = 0.35), and early morning awakenings (r = 0.35; Bastien et al., 2001).

Quick Inventory of Depressive Symptomatology (QIDS)

The QIDS is a 16-item self-report questionnaire that assesses nine symptom domains of depression: sleep disturbance, psychomotor disturbance, changes in weight, depressed mood, decreased interest, decreased energy, worthlessness and guilt, concentration and decision making, and suicidal ideation (Rush et al., 2003). Each item is rated 0 to 3 and the total score has a range of 0 – 27. Initial validation studies found the QIDS has good internal consistency (Cronbach's alpha = 0.81 – 0.90; Rush et al., 2003). Using a cutoff score of 6, with higher scores indicating clinically significant depression, the QIDS has a sensitivity of 79% and a specificity of 81% (Rush et al., 2003). The QIDS is highly correlated with the Hamilton Rating Scale for Depression (Hamilton, 1960), r = .72, and the Inventory of Depressive Symptomatology (Rush, Gullion, Basco, Jarrett, & Trivedi, 1996), r = .82 (Rush et al., 2003).

State-Trait Anxiety Inventory, trait scale, form Y (STAI)

The trait scale of the STAI consists of 20 items where participants rate how they generally feel (Spielberger et al., 1983). This scale measures general feelings of apprehension, tension, and increased autonomic activity. This type of anxiety is seen as a relatively stable personality trait. Each item is rated on a 4-point Likert-type scale ranging from 1 (*almost never*) to 4 (*almost always*). Items are summed to produce a total score (range 20 – 80). The internal consistency for the STAI ranged from 0.72 to 0.96 and the test-retest reliability ranged from 0.82 to 0.94 (Barnes, Harp, & Jung, 2002).

Epworth Sleepiness Scale (ESS)

The ESS is an 8-item self-report measure in which participants rate their probability of

falling asleep in hypothetical everyday situations, such as sitting quietly after a lunch without alcohol or watching TV (Johns, 1991). Items are rated on a 4-point Likert-type scale ranging from 0 (*would never doze*) to 3 (*high chance of dozing*). The item scores are summed to produce a total score (range 0 – 24). Scores > 10 indicate significant daytime sleepiness and those > 15 indicate pathological sleepiness (Johns, 1991). The ESS has good test–retest reliability (r = 0.82), and shows satisfactory internal consistency in patients with sleep disorders (Cronbach's alpha = 0.88) and adequate internal consistency in patients without sleep disorders (Cronbach's alpha = 0.73; Johns, 1992). The mean correlation coefficient between ESS scores and sleep latency scores on the multiple sleep latency test (an objective measure of daytime sleepiness in which a low sleep latency score is indicative of sleepiness) is r = -0.3 (Johns, 2000). The ESS has high sensitivity (93.5%) and high specificity (100%) for correctly classifying significant daytime sleepiness when using a cutoff score of 10 (Johns, 2000).

Multidimensional Fatigue Inventory (MFI-20)

The MFI is a 20-item self-report measure that assesses five dimensions of fatigue: general fatigue, physical fatigue, mental fatigue, reduced motivation, and reduced activity (Smets et al., 1995). Each item uses a 5-point Likert-type scale ranging from *yes, that is true* to *no, that is not true*. Item responses are scored 1 – 5 and items within each dimension are summed to produce a scale score (range 4 – 20). The initial validation studies conducted with groups of medical and psychology students show the five scales of the MFI have adequate to good internal consistency (Cronbach's alpha = 0.66 – 0.93; Smets, 1995). The MFI scales also show adequate to good convergent validity with a 100 mm visual analogue scale of fatigue (rs = 0.23 – 0.77; Smets et al., 1995).

Operational Definitions

Young Adults

The definition of young adulthood varies throughout the scientific literature. Within insomnia research, studies of young adults have included individuals age 19-24 (Ohayon & Roberts, 2008), 20-28 (Angst et al., 1989), and 21-30 (Breslau et al., 1996). One developmental health text categorized individuals 22-34 as young adults (Merluzzi & Nairn, 1999). For this sample to be representative of young adults, individuals age 18-35 were included in the study.

Chronic Insomnia

The operational definition of insomnia used in this study is a combination of quantitative criteria (Lichstein et al., 2003) and research diagnostic criteria (RDC; Edinger et al., 2004)) for insomnia. First, a participant must have an insomnia complaint, measured two ways. One, a 'yes' response to the question in the health survey, "Do you currently have/experience: Insomnia (trouble falling asleep, staying asleep, early morning awakenings)?" Two, a response of ≥ 2 on questions 1a and/or 1b of the Insomnia Severity Index (ISI; Bastien et al., 2001), which indicates moderate to severe difficulty falling asleep (ISI 1a) or difficulty staying asleep (ISI 1b) in the past two weeks.

Second, a participant must meet severity, frequency, and duration criteria for insomnia (see Table 1). Severity of insomnia (i.e., sleep onset latency [SOL] and/or wake after sleep onset [WASO]) must be greater than 30 minutes (determined by sleep diary). The frequency of severity symptoms (i.e., SOL, WASO, or combination ≥ 30 minutes) must occur at least three times per week (determined by sleep diary). The duration of symptoms must be present for 6 months or longer (based on self-report).

Third, participants must have a daytime complaint. Daytime complaints were indicated through multiple self-report psychosocial measures. A response on question 3 of the ISI (Bastien et al., 2001) ≥ 2 indicates moderate to severe interference in daily functioning due to the sleep problem. A score on the Epworth Sleepiness Scale (ESS; Johns, 1991) ≥ 7.4 is one standard deviation above the ESS mean in a sample of normal sleepers (Johns & Hocking, 1997) and is the same cutoff used by Lichstein et al. (2003). The presence of fatigue was also indicative of daytime complaint. The Multidimensional Fatigue Inventory (MFI-20; Smets, Garssen, Bonke, & De Haes, 1995) was used to determine five types of fatigue (i.e., general fatigue, physical fatigue, mental fatigue, reduced motivation, and reduced activity). Since little normative data is available on the MFI-20, a score one standard deviation above this sample's mean will be used as a cutoff score for each subscale and any subscale greater than the cutoff was used to indicate presence of daytime complaint. Presence of one or more daytime complaints based on the above criteria combined with an insomnia complaint and adequate severity, frequency, and duration criteria will indicate minimal quantitative criteria (Lichstein et al., 2003).

Finally, for the participant to have chronic insomnia in this study, they must also meet criteria set forth in the RDC for an insomnia disorder (Edinger et al., 2004; see Table 2).

Medical Problems

Participants were asked to report past and/or current medical problems. The medical problems listed included: heart disease (e.g., irregular heartbeat, heart attack); cancer; AIDS/HIV; high blood pressure; neurological (e.g., seizures, Huntington's, multiple sclerosis); breathing (e.g., chronic obstructive pulmonary disease [COPD], asthma, emphysema); urinary (e.g., recurring urinary tract infections, kidney stones); diabetes (e.g., type I/II, gestational); chronic pain (e.g., back pain, fibromyalgia, arthritis); gastrointestinal (e.g., ulcers, irritable

bowel, Crohn's); autoimmune (e.g., lupus, Guillain-Barre, psoriasis); endocrine (e.g., hypo/hyper thyroid, adrenal), migraines/chronic headaches; sexually transmitted diseases; and other. For each medical problem, participants were asked to write in the specific problem, the date of onset, how long the problem had lasted (years and months), and if the problem was current. Participants were considered to have a medical problem if any of the above problems were current at the time of the study.

Mental Health Problems

Participants reported symptoms of depression and anxiety using two self-report measures, the Quick Inventory of Depressive Symptomatology (QIDS) and the State-Trait Anxiety Inventory, trait scale (STAI), respectively. A score ≥ 11 on the QIDS was indicative of moderate to severe symptoms of depression. Since the primary independent variable of this study is chronic insomnia and sleep disturbance is a component of the QIDS total score, the sleep questions were removed from the total score of the QIDS. This modification was intended to better distinguish young adults with chronic insomnia with symptoms of moderate to severe depression without inflated scores due to already present insomnia symptoms. Participants needed a score ≥ 11, after removing the sleep questions, to meet criteria for moderate to severe symptoms of depression (Rush et al., 2003). A score ≥ 59 on the STAI (two standard deviations above a normative mean) was considered indicative of clinical symptoms of anxiety. No sleep related questions were part of the STAI.

Healthcare Utilization (HCU)

HCU was measured in three ways. First, participants reported their use of health-related services over the past six months. Services included physician visits, emergency room visits, visits to a psychologist, psychiatrist, or other mental health care clinician, visits to a physical

therapist or other rehabilitative practitioner, number of times admitted to the hospital, and total days spent in the hospital.

Second, participants reported current (i.e., past week) medications including prescription, OTC, and any nutritional products (e.g., vitamins). Participants were asked the purpose for taking the medications, frequency, duration, dose, and time of day. Medication usage will be used in two ways. First as an ordinal count to compare participants with and without chronic insomnia and second medications will be used to calculate a chronic disease score (CDS; Clark et al., 1995).

The CDS is an algorithm that uses gender, age, and a history of prescription drugs to predict healthcare costs and HCU (Clark et al., 1995). Weights are given to different medication classes that represent different chronic diseases. Each medication variable is associated with an outcome of outpatient care costs, primary care visits, and total costs based on regression models. Medications are classified by American Hospital Formulary System (AHFS) category numbers. Additionally, gender and 10-year age groups are weighted and associated with the three CDS outcomes. The CDS is calculated as CDS = intercept + gender + age group + medication 1 + medication 2 + medication 3 + . . . + medication n. CDS represents costs in dollars (Clark et al., 1995). This calculation is repeated for total costs, outpatient costs, and number of primary care visits, with each category receiving different weights based on the chronic disease. CDS variables represent 6 months of HCU.

Finally, HCU was measured through direct costs accumulated at the UNT Student Health and Wellness Center. A separate release form was signed by participants to obtain this information.

RESULTS

Missing Data

Missing data was minimal (< 5%) and since the sample size was large (N = 1010) and missing data appeared to be missing at random, missing data was excluded from analyses using pairwise deletion as recommended by Tabachnik and Fidell (2007).

Power Analysis

The program G*Power 3.1.2 (Faul, Erdfelder, Lang, & Buchner, 2007) was used to calculate necessary groups sizes to find a Cohen's d effect size of 0.5 with $p < .05$. Using a two-tailed design and a group allocation ratio of 1:9 (based on 10% prevalence of chronic insomnia in the population [Ford & Kamerow, 1989]), sample sizes of 35 and 317 were recommended for the chronic insomnia and normal sleeper groups, respectively. Actual sample sizes of the groups used in the study were chronic insomnia = 88 (8.7%) and normal sleepers = 580 (57.4%); 342 (33.9%) had transient or subclinical symptoms of insomnia.

Participants

A chi-square goodness-of-fit test indicated more females than males in the sample, χ^2 (1, n = 975) = 237.29, $p < .001$. A chi-square test of independence showed that significantly more females had chronic insomnia than males, χ^2 (1, n = 644) = 4.05, p = .044, φ = .079, odds ratio (OR) = 1.84 (95% confidence interval [CI]: 1.01-3.37). Please see Table 3 for frequencies of participants' parental income, Table 4 for frequency of medical and mental health problems, and Table 5 for frequency of healthcare utilization (HCU).

Primary Analyses

Correlation Analyses of HCU Dependent Variables

Pearson product-moment correlations were run between the dependent variables: physician visits, mental health visits, direct costs at the University of North Texas (UNT) Health and Wellness Center, number of medications, chronic disease score (CDS) total costs, CDS outpatient costs, and CDS number of primary care visits. Three correlations were performed, one that included both the chronic insomnia and normal sleeper groups, and one each for chronic insomnia alone and normal sleepers alone. Numerous significant relationships were found in each of the three correlation analyses. Number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits were all highly inter-correlated (rs = .62 - .97, ps < .01). This high inter-correlation was due to the CDS algorithm, which is based on medication usage (see method section for more information). In general, the more medications used by a participant, the higher their CDS. The three algorithms place different weights on the medications which results in the three different CDS values. See Tables 6, 7, and 8 for complete correlation results.

Linear Regression of Insomnia Severity on HCU Dependent Variables

To assess for the influence of a continuous insomnia construct on HCU, a series of linear regressions were performed to evaluate the prediction of HCU from insomnia severity. Insomnia severity was measured using the Insomnia Severity Index (ISI), a psychometrically sound measure that uses a continuous scale that ranges from no symptoms of insomnia to severe clinical symptoms of insomnia (see materials for more information). Correlations between the predictor variable (ISI) and the HCU dependent variables ranged from r = .095 - .24 (all ps <

.01). Variance accounted for (R^2) ranged from 1% - 6% (all *p*s < .01). See Table 9 for complete results of the linear regression analyses.

HCU: Chronic Insomnia vs. Normal Sleepers

A one-way between groups multivariate analysis of variance (MANOVA) was performed to evaluate the difference in HCU between young adults with chronic insomnia and young adults who were normal sleepers. The combined dependent variable included: physician visits, mental health visits, direct costs at the UNT Health and Wellness Center, number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits. There was a statistically significant difference between the groups on the combined dependent HCU variable, Wilks' $\Lambda = .92$, $F(7, 649) = 8.27$, $p < .001$, partial $\eta^2 = .082$. Follow-up univariate one-way analyses of variance (ANOVA) were performed to determine which HCU variables were significantly different. Preliminary assumption testing was conducted and homogeneity of variance was violated. Since the two groups were heterogeneous and the group sizes were unequal, the Welch test was applied to the ANOVAs to provide a more robust test of mean comparisons. Using $p < .05$ on the Welch test, the chronic insomnia group had significantly greater HCU than normal sleepers on number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits (all *p*s < .001). No significant differences were found between the groups on physician visits, mental health visits, and direct health care costs (Table 10).

As a validity check, the two groups were compared using an independent samples *t*-test. Since the assumption of homogeneity of variance for each of the dependent variables was violated, the equal variances not assumed *p* valued was used to determine significance on each comparison. Additionally, to protect against increased type I error from multiple comparisons, a

Bonferroni correction was applied to the *t*-test. The new *p*-value of .007 ($p = .05/7$ dependent variables) was used to determine statistical significance. The results remained the same—the chronic insomnia group remained significantly greater than normal sleepers on number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits (all *p*s < .001, Table 11).

As an additional, more conservative, validity check and to further protect against errors related to non-normally distributed data and heterogeneity of variance, a non-parametric analysis was performed. A Mann-Whitney U test converted the continuous HCU dependent variables into ranks, removing the influence of non-normal distributions, and compared the groups on the medians instead of the means. Similar to the ANOVAs and *t*-test, the Mann-Whitney U revealed that young adults with chronic insomnia were significantly greater on number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits than the normal sleeper group (all *p*s < .001; see Table 12).

Influence of a Medical and/or Mental Health Problem on HCU

Comparing the two groups on current medical and mental health problems resulted in several significant differences. Using chi-square tests of independence, a significantly greater proportion of young adults with chronic insomnia had hypertension, pulmonary problems, chronic pain, gastrointestinal problems, migraine headaches, "other" medical disorders, and clinical symptoms of depression and anxiety than normal sleepers (all *p*s < .05, Table 13).

The group differences found above were consistent with the evidence found in the literature that people with insomnia have higher comorbid medical and mental health problems than people without insomnia. To measure the influence of a medical and/or mental health problem on HCU, a dichotomous variable was created to represent the presence of at least one of

the following: a) a current medical problem (self-report), b) symptoms of depression (Quick Inventory of Depressive Symptomatology [QIDS] ≥ 11), and c) symptoms of anxiety (State-Trait Anxiety Inventory [STAI] ≥ 59). This dichotomous variable was entered into a MANOVA as a second factor to test for an interaction effect (i.e., moderation effect [Baron & Kenny, 1986]) with insomnia status (i.e., chronic insomnia or normal sleepers). A Factorial MANOVA showed a significant interaction effect on the combined HCU dependent variables, Wilks' $\Lambda = .97$, $F(7, 647) = 3.38$, $p = .001$, partial $\eta^2 = .035$. Follow-up factorial ANOVAs identified that mental health visits, number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits all had significant interaction effects (all *p*s < .05) between insomnia status and presence of a medical and/or mental health problem.

Simple effects tests were performed for significant factorial ANOVAs to determine differences between the interaction variables—insomnia status by medical/mental health problems. Number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits were significant at $p < .05$ using a Welch test (*p*s < .001). A significant difference was not found for mental health visits using a Welch test ($p = .12$). Games-Howell post-hoc testing on the significantly different variables found that participants with comorbid chronic insomnia had greater number of medications than normal sleepers with a medical/mental health problem, chronic insomnia, and normal sleepers. Normal sleepers with a medical/mental health problem had greater medication use than normal sleepers without a medical/mental health problem. On CDS total costs, CDS outpatient costs, and CDS number of primary care visits participants with comorbid chronic insomnia were greater than normal sleepers with a medical/mental health problem, chronic insomnia, and normal sleepers. Also, normal sleepers with a medical/mental health problem had greater CDS (all three) than the chronic insomnia and

normal sleeper groups. When a medical/mental health problem was not present, no differences occurred between chronic insomnia and normal sleeper groups. All differences were significant at $p < .01$ (Table 14).

Exploratory Analyses

MANOVAs

All HCU dependent variables had significantly positively skewed distributions with medians and modes clustered near zero. While not true outliers (the data were extreme but accurate), the values on the far right of the distribution were more influential than if the data were normally distributed. To help reduce the influence of these extreme data points, values greater than two standard deviations above the mean on each dependent variable were removed from analyses to help reduce the positive skewness of the distributions. New sample sizes for the groups were chronic insomnia = 70 and normal sleepers = 536, both remained large enough to retain adequate power.

A one-way MANOVA found a significant difference between participants with chronic insomnia and normal sleepers on the combined HCU dependent variable, Wilks' $\Lambda = .96$, $F(7, 598) = 3.33$, $p = .002$, partial $\eta^2 = .037$. Follow-up univariate one-way ANOVAs using the Welch test were performed to determine which HCU variables were significantly different. Using $p < .05$ on the Welch test, the chronic insomnia group continued to have significantly greater HCU than normal sleepers on number of medications, CDS total costs, CDS outpatient costs, and CDS number of primary care visits (all ps $< .001$). The Welch test found no significant differences between the groups on physician visits, mental health visits, and direct health care costs. A factorial MANOVA was performed to determine if an interaction effect

existed between insomnia status and presence of a medical/mental health problem after extreme values were removed. The interaction effect was not statistically significant ($p = .57$).

χ^2 Analyses and Fisher's Exact Tests

HCU variables with low expected prevalence rates were compared on insomnia status (chronic insomnia or normal sleepers). Chi-square tests for independence were conducted to determine a relationship between insomnia status and visits to physical therapy/rehabilitation, the ER, and hospital admissions. A Fisher's exact test was used for analyses with cell sizes less than five to avoid loss of power in chi-square analyses.

Physical therapy/rehabilitation. A Fisher's exact test indicated no significant relationship between physical therapy/rehabilitation visits and insomnia status. Similar results occurred after excluding participants with extreme values.

ER. A chi-square analysis indicated that participants with chronic insomnia (20.7%) were significantly more likely to have an ER visit than normal sleepers (8.4%), χ^2 (1, $n = 661$) = 12.77, $p < .001$, $\varphi = .14$, OR = 2.86 (95% CI: 1.57 - 5.19). Similar results occurred after excluding participants with extreme values ($p = .02$, $\varphi = .092$, OR = 2.23, 95% CI: 1.12 - 4.45).

Hospital admissions. A chi-square analysis indicated that participants with chronic insomnia (9.2%) were significantly more likely to have been admitted to the hospital for at least one night than normal sleepers (1.2%), χ^2 (1, $n = 657$) = 21.48, $p < .001$, $\varphi = .18$, OR = 8.15 (95% CI: 2.88 – 23.07). Fisher's exact tests showed similar results after excluding participants with extreme values ($p = .006$, $\varphi = .14$, OR = 9.50, 95% CI: 2.09 - 43.24).

DISCUSSION

The primary goal of this study was to evaluate differences in healthcare utilization (HCU) in a healthy population (i.e., young adults) to determine if the presence of chronic insomnia accounted for increased HCU above and beyond the presence of comorbid medical and/or mental health problems. Initial comparisons found that young adults with chronic insomnia had greater HCU than normal sleepers. However, the relationship between insomnia and HCU was moderated by medical and/or mental health problems. Significant differences only remained between those with chronic insomnia and normal sleepers when both had a current medical/mental health problem. These results suggest that while an insomnia complaint may be related to increased distress and reduced quality of life, if no comorbid disorders are present, HCU does not differ. These findings have important clinical and economic implications. Insomnia is a prevalent disorder that has an enormous economic impact on the individual and healthcare system. Insomnia is important to assess for, as a primary disorder and especially if comorbid with medical and mental health problems. If insomnia is accurately assessed for and treated, overall HCU and the direct and indirect costs related to insomnia may be reduced.

Prevalence of Chronic Insomnia

To the author's knowledge, this is the first study to use research diagnostic criteria (RDC; Edinger et al., 2004) and quantitative criteria (Lichstein et al., 2003) to find the prevalence of chronic insomnia in a young adult population. Using the combined RDC and quantitative criteria the prevalence of chronic insomnia in a young adult sample was 8.7%. This is higher than the prevalence of adults diagnosed with *DSM-IV* primary insomnia (2% - 4%; Ohayon, 2002) and consistent with other epidemiology studies with rates of 8.5% - 13% (Hetta, Broman, & Mallon, 1999; Ohayon, 2001). Compared to prevalence rates in young adult populations, the

prevalence in this study was higher than the 3% found by Ohayon and Roberts (2001) using *DSM-IV* criteria but lower than the 17% found by Breslau et al. (1996), which used less restrictive insomnia criteria than the current study's. Because RDC and quantitative criteria are intended to identify individuals with chronic insomnia, they are more conservative than many of the operational definitions used in previous epidemiology studies which did not always account for symptom severity, frequency, duration, and daytime complaints. However, RDC and quantitative criteria are not as conservative as the diagnostic manuals (e.g., *DSM-IV*, *ICSD*), which may not include all individuals with chronic insomnia and therefore underestimate the prevalence of chronic insomnia.

Chronic Insomnia and HCU

HCU is a complex construct, is measured inconsistently throughout the literature, and often includes one or more measures of self-report, direct costs (i.e., data collected from insurance companies), and predicted healthcare costs using mathematical algorithms. This study provided one of the most comprehensive assessments of HCU using a combination of measures used in previous HCU research—self-report (i.e., physician visits, mental health visits, and medications), direct costs (i.e., costs acquired at UNT Health & Wellness Center), and predicted costs and office visits based on participants' medication usage (i.e., chronic disease score [CDS]).

Number of physician visits and mental health visits were not different between the chronic insomnia and normal sleeper groups. This finding may be due to young adults being an overall healthy sample that uses less healthcare services. Additionally, it may be due to insomnia patients not seeking insomnia specific medical care (Leger, 2000). Mental health visits may not have differed due to the stigma surrounding seeking help for mental health problems,

especially in young adults. Even though direct costs at the UNT Health & Wellness Center were not significantly different for the chronic insomnia and normal sleeper groups, the predicted healthcare costs (i.e., CDS total costs and CDS outpatient costs) were significantly higher for the chronic insomnia group. Additionally, the predicted number of visits to a primary care physician was significantly greater for the chronic insomnia group. These results are consistent with the findings of previous studies using CDS to predict healthcare costs (Kapur et al., 2002; Ozminkowski et al., 2007). Insomnia, when measured on a continuum of severity instead of as a dichotomous variable, was also related to increased HCU. However, the impact was small, which is consistent with Leger's (2000) suggestion that an insomnia complaint does not lead to increased use of healthcare services and that a complaint of insomnia is usually only reported during a visit for another medical complaint. This has important clinical implications—insomnia should be better screened for during physician visits so if present it can be adequately monitored and/or treated which may help reduce HCU.

Many studies have found increased HCU in people with insomnia (Kupperman et al., 1995; Simon & VonKorff, 1997; Kapur et al., 2002; Leger et al., 2002; Novak et al., 2004; Ozminkowski et al., 2007). However, this is the first study to measure HCU in a young adult sample with chronic insomnia. Young adults with chronic insomnia had significantly greater HCU than the normal sleepers, which is consistent with the body of work previously published on insomnia and HCU, but was lower than HCU and healthcare costs found in adult populations.

Since numerous studies have found a high comorbidity between insomnia and medical and mental health problems (Taylor et al., 2005, 2007; Sarsour et al., 2010), it was necessary to account for the presence of these comorbid disorders in the analyses and how they influence HCU. Participants with comorbid insomnia were significantly greater on number of

medications, and CDS total costs, outpatient costs, and primary care visits than normal sleepers with a medical/mental health disorder. There were no differences in HCU between the groups when a medical/mental health problem was absent.

In general, these findings are consistent with previous literature on insomnia and HCU. However, it is difficult to make direct comparisons between young adults and a general adult population due to varying operational definitions of insomnia, measures of HCU, and prevalence rates of medical and mental health problems. Some of these difficulties have been reduced through development of research diagnostic criteria (Edinger et al., 2004) and quantitative criteria (Lichstein et al., 2003) for chronic insomnia as well improved methods of tracking HCU through insurance companies and using mathematical algorithms to predict healthcare costs (i.e., CDS; Clark et al., 1995). The central difference between the current study and previous studies is the differing methods of statistical analyses. When past studies did account for comorbid disorders and other confounds—although not all did—they used statistical control (e.g., analysis of covariance [ANCOVA]) or removed participants with a comorbid disorder from the analyses. As mentioned in the introduction, ANCOVA is not an appropriate method to control for covariates that differ significantly between groups (e.g., medical and mental health problems; Miller & Chapman, 2001). Removing participants from analyses often leads to underestimation or overly conservative results. In HCU research, participants that are removed from analyses are often those with the highest HCU, such as in the study by Leger et al. (2002)—participants were excluded if they met minimal criteria for *DSM-IV* depression or anxiety. Considering the impact of a mental health problem on HCU and the high comorbidity of insomnia and depression and anxiety, the results of Leger et al.'s study likely underestimates the true economic impact of

insomnia. While this limitation was noted by the authors, removing participants with depression and anxiety because of their high HCU may not have been necessary.

Exploratory analyses in the current study found that when extreme values were removed, HCU remained significantly greater for the chronic insomnia group, specifically: number of medications and CDS variables. The extreme data points did not influence the data as much as expected and this suggests that extreme data does not need to be removed when working with HCU data, and non-normal distributions do not need to be transformed (e.g., log transformed) as is sometimes done in the HCU literature (e.g., Kapur et al., 2002; Simon & VonKorff, 1997). Although one-way analyses found significant differences remained after removing extreme data, the factorial analyses found no moderation effect remained for presence of a medical/mental health problem. This suggests that more emphasis needs to be placed on individuals with the highest HCU as they appear to account for most of the interaction between insomnia and HCU even though they are only a small percentage of the sample.

Based on the findings of this study, it is recommended that future studies do not try to statistically control for naturally occurring comorbidities or exclude participants based on these comorbidities. Instead, treating comorbidities as the moderating variables they are will allow for a better understanding of the relationship between insomnia, comorbid medical and mental health problems, and HCU.

Limitations

Perhaps the biggest limiting factor of this study was the brief retrospective report of medications. As mentioned in the methods section, only one week of medication was reported, which limits the accuracy of the CDS variables, which were established using 6-months of medication data (Clark et al., 1995). An extended report of medication (e.g., 1 month, 3 months,

or 6 months) would likely provide more accurate estimated healthcare costs when using CDS algorithms, although the one-week of medication data used in this study still produced significant differences between the groups on number of medications and CDS. Also, physician visits, mental health visits, and exploratory variables were retrospective, all of which are more prone to error than prospective collection of data. Using prospective measures would improve the accuracy of HCU measures.

Another limitation was the significant gender difference in the sample. Since women outnumbered men in both groups, it is not likely that the gender difference made an impact on group differences of HCU. However, since women have been found to have greater HCU than men (Koopmans & Lamers, 2007) this imbalance may have inflated the overall HCU of the sample. Gender differences were not comparisons of interest for the current study but are important investigations for future studies especially since insomnia is more common in women than men. The relative risk (RR) of insomnia for women in this study (RR = 1.72, $p < .001$, 95% confidence interval [CI]: 1.00-2.96) was similar to large meta-analyses of insomnia and gender, which found an increased RR of insomnia for women (RR = 1.41, $p < .001$, 95% CI: 1.28-1.55). In addition to further investigation of gender, insomnia, and HCU, the relationship between ethnicity, insomnia, and HCU deserves attention in future research. Any significant findings between gender and ethnicity, and insomnia, comorbid disorders, and HCU would contribute to the health disparities literature.

Regarding the moderating variable, medical problems and symptoms of depression and anxiety were based on self-reports, which can be prone to error. Clinical interviews are necessary to confirm the presence of a psychiatric problem and a detailed history is necessary to confirm which symptoms and disorders occurred first. However, clinical interviews are timely

and need to be conducted by trained individuals. In large epidemiology studies, this is not always possible hence the use of self-report and well-validated measures such as the Quick Inventory of Depressive Symptomatology (QIDS; Rush et al., 2003) and the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983).

Another limitation was that personality factors were not measured. Neuroticism has been found to be associated with increased primary care and mental health utilization (van Hemert, Bakkar, Vandenbroucke, & Valkenburg, 1993; ten Have, Oldehinkel, Vollebergh, & Ormel, 2005). Additionally, a recent review found that traits like neuroticism, internalizing, and perfectionism were associated with insomnia (van de Laar, Verbeek, Pevernagie, Aldenkamp, & Overeem, 2010). Personality factors may be another moderator between insomnia and HCU and should be included in future research.

While this study is not meant to be generalizable to an adult population, the sample may also not be generalizable to all young adults. College students represent a large percentage (i.e., 69%) of high school graduates (Bureau of Labor Statistics, 2009) but those who do not attend college may have different rates of insomnia, comorbid medical/mental health problems, and HCU. Reasons for potential differences among the non-student young adults may include more consistent work hours and lack of access to affordable healthcare (e.g., a student health center). Geographic location may also make a difference in prevalence of insomnia and HCU. This study was conducted at a large public university in the south central United States. Smaller colleges, private schools, and schools located in different geographic areas may have different rates of insomnia and HCU. Because of University of North Texas' (UNT) large enrollment (approximately 35,000) and the large sample size of the study (> 1,000), it is unlikely that the

prevalence of chronic insomnia and rates of HCU found in this study would not differ much from other colleges and universities, when using similar methods.

Strengths

While this study has limitations, its strengths include using the most valid and reliable operational definitions of chronic insomnia, a combination of HCU measures, and statistical analyses that treat comorbid disorders as moderator variables rather than trying to control for their influence. Additionally, this study helped to answer questions posed by the NIH regarding consequences, morbidities, comorbidities, and public burden associated with chronic insomnia. Consistent with previous studies of insomnia and comorbidities and insomnia and HCU, the findings of this study showed that young adults with chronic insomnia had higher medical and mental health comorbidities and when a medical and/or mental health disorder was present with chronic insomnia, HCU was significantly increased. Total medication usage and predicted total costs, outpatient healthcare costs, and number of primary care visits were greater for those with chronic insomnia than normal sleepers when a medical and/or mental health problem was present. The public burden associated with these findings was most notably the increased economic costs to the individual as well as the healthcare system.

Future Directions

The cross-sectional design of this study makes it impossible to make causal statements about HCU and the results can only be discussed in terms of associations. Future studies of insomnia and HCU would benefit from a longitudinal design to help build a more comprehensive correlational model between insomnia, comorbid medical and/or mental health problems, and HCU. An intervention study could provide more causal data by showing that individuals with chronic insomnia randomly assigned to treatment (e.g., medication, behavioral therapy) had

reduced HCU at post-treatment and follow-up than individuals with chronic insomnia not provided with treatment. Effective treatments of insomnia have been established (primary insomnia see Smith et al., 2002; comorbid insomnia see Stepanski & Rybarczyk, 2006) and implementing these treatments and tracking individuals' HCU post-treatment is an important and yet to be studied outcome measure. Additionally, the identification and treatment of insomnia can help reduce HCU since insomnia is related to lower health-related quality of life (Brostrom, Stromberg, Dahlstrom, & Fridlund, 2004; Katz & McHorney, 2005), decreased pain thresholds (Affleck, Urrows, Tennen, Higgins, & Abeles, 1996), and immune system compromise (Taylor, Lichstein, & Durrence, 2003), all of which are likely to increase HCU.

Table 1

Quantitative Criteria for Insomnia

Severity	Symptoms (i.e., SOL or WASO) $\geq$ 30 minutes
Frequency	Symptoms occur $\geq$ 3 nights/week
Duration	Symptoms have endured $\geq$ 6 months

Note. SOL = sleep onset latency; WASO = wake after sleep onset

Table 2

Research Diagnostic Criteria (RDC) for an Insomnia Disorder

A. The individual reports one or more of the following sleep related complaints

   1. difficulty initiating sleep

   2. difficulty maintaining sleep

   3. waking up too early

   4. sleep that is chronically non-restorative or poor in quality

B. The above sleep difficulty occurs despite adequate opportunity and circumstances for sleep.

C. At least one of the following forms of daytime impairment related to the nighttime sleep difficulty is reported by the individual:

   1. fatigue/malaise

   2. attention, concentration, or memory impairment

   3. social/vocational dysfunction or poor school performance

   4. mood disturbance/irritability

   5. daytime sleepiness

   6. motivation/energy/initiative reduction

   7. proneness for errors/accidents at work or while driving

   8. tension headaches, and/or gastrointestinal symptoms in response to sleep loss

   9. concerns or worries about sleep

Table 3

Frequencies of Parental Income

Income	*N*	%
< $25,000	43	4.3
$25,000 - $39,999	55	5.4
$40,000 - $59,999	91	9.0
$60,000 - $79,999	129	12.8
$80,000 - $99,999	113	11.2
$100,000 - $149,999	163	16.1
$150,000 - $199,999	55	5.4
> $200,000	56	5.5
Refused	29	2.9
Don’t know	264	26.1
Did not respond	12	1.2
Total	1010	100.0

Table 4

Frequencies of Medical Problems, Depression, and Anxiety

Problem	*N* (1010)	%
Heart	14	1.4
Cancer	0	0.0
HIV/AIDS	0	0.0
Hypertension	12	1.2
Neurological	3	0.3
Pulmonary	105	10.4
Urinary	20	2.0
Diabetes	3	0.3
Chronic pain	59	5.8
Gastrointestinal	29	2.9
Autoimmune	2	0.2
Endocrine	8	0.8
Migraine headaches	85	8.4
Sexually transmitted disease	16	1.6
Other medical problem	40	4.0
Depression (QIDS $\geq$ 11)	77	7.6
Anxiety (STAI $\geq$ 59)	43	4.3
Any medical and/or mental health problem	345	34.2

Note. QIDS = Quick Inventory of Depressive Symptomatology, total score does not include sleep related questions. STAI = State-Trait Anxiety Inventory (trait scale).

Table 5

Means and Standard Deviations of Healthcare Utilization (HCU)

Type of HCU	*M*	(*SD*)
Primary Dependent Variables		
Physician visits	1.39	(1.76)
Mental health visits	.53	(2.86)
Direct costs at UNT health & wellness center ($)	18.53	(74.93)
Medications	.98	(1.24)
CDS total costs ($)	452.99	(352.02)
CDS outpatient costs ($)	318.04	(203.33)
CDS number of primary care visits	1.15	(0.42)
Exploratory Dependent Variables		
Physical therapy/rehabilitation visits	.22	(2.01)
Emergency room visits	.12	(.40)
Hospital admissions	.045	(.66)

Table 6

Intercorrelations of HCU Dependent Variables—Chronic Insomnia and Normal Sleepers

	1.	2.	3.	4.	5.	6.	7.
1. Physician visits	--						
2. Mental health visits	.15**	--					
3. Direct costs at UNT health & wellness center	.03	-.013	--				
4. Medications	.32**	.10**	.11**	--			
5. CDS total costs	.34**	.14**	.087*	.62**	--		
6. CDS outpatient costs	.36**	.22**	.099*	.71**	.95**	--	
7. CDS # primary care visits	.33**	.15**	.11**	.71**	.89**	.96**	--

Note. $N = 657 – 668$; N varies due to missing data.

*$p < .05$ level (two-tailed), **$p < .01$ level (two-tailed).

Table 7

Intercorrelations of HCU Dependent Variables—Normal Sleepers

	1.	2.	3.	4.	5.	6.	7.
1. Physician visits	--						
2. Mental health visits	.059	--					
3. Direct costs at UNT health & wellness center	.060	-.009	--				
4. Medications	.32**	.014	.071	--			
5. CDS total costs	.32**	.004	.033	.66**	--		
6. CDS outpatient costs	.34**	.026	.060	.69**	.95**	--	
7. CDS # primary care visits	.31**	.019	.072	.68**	.87**	.97**	---

Note. $N = 572 – 580$; N varies due to missing data.

*$p < .05$ level (two-tailed), **$p < .01$ level (two-tailed).

Table 8

Intercorrelations of HCU Dependent Variables—Chronic Insomnia

	1.	2.	3.	4.	5.	6.	7.
1. Physician visits	--						
2. Mental health visits	.29**	--					
3. Direct costs at UNT health & wellness center	-.071	-.039	--				
4. Medications	.31**	.23*	.17	--			
5. CDS total costs	.37**	.32**	.18	.69**	--		
6. CDS outpatient costs	.40**	.46**	.14	.72**	.94**	--	
7. CDS # primary care visits	.37**	.34**	.15	.75**	.91*	.96**	--

Note. $N = 85 – 88$; N varies due to missing data.

* $p < .05$ level (two-tailed), **$p < .01$ level (two-tailed).

Table 9

R^2 and Standardized Coefficients (β) of Linear Regression Analyses of Insomnia Severity Index on HCU Dependent Variables

Dependent Variable	R^2	β	*p*
Physician visits	.02	.14	<.001
Mental health visits	.01	.10	.003
Direct costs at UNT health & wellness center	.02	.15	<.001
Medications	.05	.22	<.001
CDS total costs	.05	.22	<.001
CDS outpatient costs	.06	.24	<.001
CDS # primary care visits	.05	.22	<.001

Table 10

One-way ANOVA of HCU Dependent Variables

	Chronic Insomnia		Normal Sleepers		Welch Test	
	M	(*SD*)	*M*	(*SD*)	Statistic	*p*
Physician visits	1.84	(2.78)	1.38	(1.67)	2.21	.141
Mental health visits	1.34	(6.19)	.47	(2.28)	1.65	.202
Direct costs at UNT health & wellness center ($)	30.68	(95.27)	16.30	(59.72)	1.89	.172
Medications	1.56	(1.50)	.80	(1.10)	20.82	<.001
CDS total costs ($)	619.65	(453.70)	407.29	(288.29)	18.17	<.001
CDS outpatient costs ($)	429.30	(285.49)	288.43	(159.85)	20.45	<.001
CDS number of primary care visits	1.36	(.54)	1.09	(.35)	20.53	<.001

Table 11

Independent Samples t-test of HCU Dependent Variables

	Chronic Insomnia		Normal Sleepers		*t*-test for Equality of Means	
	M	*(SD)*	*M*	*(SD)*	*p*	*d*
Physician visits	1.84	(2.78)	1.38	(1.67)	.141	.20
Mental health visits	1.34	(6.19)	.47	(2.29)	.202	.19
Direct costs at UNT health & wellness center ($)	30.68	(95.27)	16.30	(59.72)	.172	.18
Medications	1.56	(1.50)	.80	(1.09)	<.001	.58
CDS total costs ($)	619.65	(453.70)	407.29	(288.29)	<.001	.56
CDS outpatient costs ($)	429.30	(285.49)	288.43	(159.85)	<.001	.61
CDS number of primary care visits	1.36	(.54)	1.09	(.35)	<.001	.59

Note. Levene's test for equality of variances was significant for all dependent variables ($p < .01$) so *p* values for equal variances not assumed were used to determine statistical significance.

Table 12

Mann-Whitney U Test of HCU Dependent Variables

		Mean Rank	*Z*	Sig.
Physician visits	Normal sleepers	327.98	-.73	.465
	Chronic insomnia	343.44		
Mental health visits	Normal sleepers	327.45	-1.37	.171
	Chronic insomnia	343.15		
Direct costs at UNT health &	Normal sleepers	331.65	-1.48	.139
wellness center ($)	Chronic insomnia	353.30		
Number of medications	Normal sleepers	321.44	-4.86	<.001
	Chronic insomnia	420.59		
CDS total costs ($)	Normal sleepers	321.48	-4.88	<.001
	Chronic insomnia	420.34		
CDS outpatient costs ($)	Normal sleepers	321.16	-4.99	<.001
	Chronic insomnia	422.41		
CDS number of primary care visits	Normal sleepers	321.44	-4.89	<.001
	Chronic insomnia	420.59		

Table 13

χ^2 Tests of Medical and Mental Health Problems between Young Adults with Chronic Insomnia and Normal Sleepers

Problem	Chronic Insomnia (%)	Normal Sleepers (%)	χ^2	OR	95% CI
Hypertension	3.4	0.5	7.15*†	6.77	1.34 - 34.06
Pulmonary	22.7	8.6	16.51**	3.15	1.77 - 5.62
Chronic pain	10.2	4.1	5.96*	2.63	1.18 - 5.85
Gastrointestinal	5.7	1.9	4.64*	3.10	1.05 - 9.15
Migraine headaches	15.9	6.4	9.73**	2.76	1.43 - 5.35
Other medical problem	11.4	3.3	11.93**	3.77	1.69 - 8.39
Any medical problem	48.9	23.8	24.31**	3.06	1.93 - 4.85
Depression (QIDS ≥ 11)	13.6	6.0	6.77**	2.46	1.23 - 4.96
Anxiety (STAI ≥ 59)	11.4	2.8	15.87**	4.68	2.05 - 10.71
Any medical and/or mental health problem	56.8	28.3	28.59**	3.34	2.11 - 5.28

Note. QIDS = Quick Inventory of Depressive Symptomatology, total score does not include sleep related questions. STAI = State-Trait Anxiety Inventory (trait scale), CI = confidence interval.

* $p < .05$, ** $p < .01$, † = cell size < 5, Fisher's exact test < .05 (two-tailed) used to determine significance.

Table 14

Simple Effects Tests for the Interaction Effect between Insomnia Status and Presence of a Medical/Mental Health Problem

	CI (a)		CI-M (b)		NS (c)		NS-M (d)		insomnia*medical/ mental health problem		Post hoc
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*F*	*p*	
1.	1.00	(1.45)	2.47	(3.34)	1.14	(1.44)	1.99	(2.02)	2.23	.15	n.s.
2.	.24	(.68)	2.16	(8.12)	.35	(1.60)	.79	(3.43)	4.17	.042	n.s.
3.	21.03	(61.78)	38.01	(114.48)	13.22	(45.47)	24.09	(85.56)	.16	.69	n.s.
4.	.79	(1.09)	2.14	(1.51)	.64	(.87)	1.21	(1.45)	9.07	.003	b > a, c, d d > c
5.	368.34	(149.27)	810.64	(512.30)	350.95	(137.01)	550.20	(467.74)	12.52	<.001	b > a, c, d d > a, c

(*continued*)

Table 14 (*continued*)

	CI (a)		CI-M (b)		NS (c)		NS-M (d)		insomnia*medical/ mental health problem		Post hoc
	M	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*F*	*p*	
6.	281.37	(117.07)	541.73	(323.25)	258.53	(104.55)	364.29	(234.22)	15.15	<.001	b > a, c, d d > a, c
7.	1.09	(.28)	1.57	(.60)	1.02	(.27)	1.25	(.48)	8.77	.003	b > a, c, d d > a, c

Note. 1. Physician visits, 2. Mental health visits, 3. Direct costs at UNT health & wellness center ($), 4. Number of medications, 5. CDS total costs ($), 6. CDS outpatient costs ($), 7. CDS number of primary care visits.

CI = chronic insomnia, CI-M – chronic insomnia + medical/mental health problem, NS = normal sleeper, NS-M = normal sleeper + medical/mental health problem.

The letters in parentheses in column heads refer to the letters used for illustrating significant differences in the last column titled "Post hoc." All differences in "Post hoc" column are significant at $p < .001$ (two-tailed) on one-way ANOVAs using a Welch test.

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