RESEARCH ARTICLE

Insomnia Prevalence and Mental Health Correlates Among 18,646 Users of an Internet-Based Cognitive-Behavioural Therapy Website: Archival Real-World Data From the United States, 2017–2019

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Abstract

Sleep problems were examined in archival data from 18,646 users of a commercial service that provided online health risk screening, educational resources, and self-guided computerized therapy lessons for insomnia and other mental health disorders. The sample was split between college students and working adults and represents a growing modern segment of adults who voluntarily seek out digital support for common behavioral issues. The goals were to explore the prevalence and possible correlates of insomnia among this unique sample. The cognitive behavioral-based therapy from this service has evidence of its clinical effectiveness and value to users in past research. Results revealed that 36% of all users were at risk for a clinical insomnia disorder. The severity of insomnia was significantly (all $p < .001$) associated with the severity of depression ($r = .65$; 43% clinical); anxiety ($r = .54$; 40% clinical); stress ($r = .54$; 25% clinical); social phobia ($r = .34$; 27% clinical); and general health status ($r = -.26$; 15% clinical). Younger age was weakly associated with insomnia ($r = -.14$; avg. 32 years; range 18-83), while both gender ($r = -.05$; 76% female) and race ($r = .00$; 81% White) were unrelated to insomnia. Insomnia was associated with lower work performance and greater work absenteeism ($r = -.30$; $r = .17$, respectively). The conclusions are that insomnia was commonly experienced, often comorbid with other common mental health conditions, and linked to work performance problems. Thus, online self-help health services should screen for multiple disorders, including insomnia, rather than focusing on specific disorders.

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Statement of Significance

This study examines real-world data from a commercial internet-based therapy and education service in the United States. It has self-guided cognitive behavioral therapy programs that support insomnia, anxiety/stress, depression, and social phobia. Part of the starting process at the website included research-validated risk screening assessments for

these factors. About 1 in every 3 of over 18,000 adults who started using this service had clinical-level insomnia. As expected, sleep problems were correlated with all of the other behavioral factors and also with poorer work performance. Sleep problems were mostly unrelated to user demographic factors. This study emphasizes the importance of including an assessment for the risk of insomnia in digital health applications for mental health.

1. Introduction

Insomnia is characterized by difficulty in starting or staying asleep[1][2][3]. According to the Diagnostic and Statistical Manual of Mental Disorders[4], insomnia is defined by difficulty in falling asleep, staying asleep, or early morning awakenings more than three times per week for more than three months, and is associated with patient-reported poor sleep and daytime dysfunction. Insomnia can be a situational, recurrent, or persistent problem. In addition, insomnia can present throughout one's lifespan, and it can often be chronic.

1.1. *Literature Review*

Large epidemiologic studies vary in different countries regarding how many people report experiencing insomnia symptoms and have clinically severe insomnia or related sleep disorders[5][6]. In the US, 23% of adults had excessive sleepiness when asked in the National Comorbidity Survey Replication dataset from 2001 to 2003[7]. One review found a 22% population prevalence of insomnia across 13 studies between 1994 and 2017 from nine different countries[8]. Another recent study of over 57,000 people from 13 countries found a range in the prevalence of short-term insomnia from 2% to 26%[9].

The prevalence and clinical presentation of insomnia tend to have only weak associations with demographic and social context factors. Most studies tend to find insomnia more common among women than men[7][10], with this gender difference occurring in adolescence[10] and in middle and older age populations[11]. Different racial and ethnic groups have some variation in insomnia, with minorities and more socio-economically distressed groups having higher rates of insomnia[7][12][13].

Sleep is a fundamental component of a person's health[14][15][16]. People with insomnia tend to have higher healthcare treatment costs than those without sleep problems[17], and this is documented across different age groups[18] and insurance market segments from employees[19][20] to retirees[21]. One of the reasons why disturbances in sleep patterns are a risk factor for various physical and psychological illnesses is the comorbidity between medical and mental health conditions involving insomnia[7][22][23][24][25]. This overlap between insomnia and mental health conditions is most common for depression and anxiety disorders[26][27][28][29], but it also has been found with social phobia[30][31]. Other studies have associated insomnia with general stress[32][33][34][35], particularly in healthcare settings[36].

In addition, there is a large literature connecting sleep problems and insomnia disorder among employees to a range of work performance factors and work-related costs borne by employers. Many studies have found insomnia to be associated with increased work absenteeism and presenteeism[37][38][39][40][41][42][43][44][45]. Insomnia among employees

is also associated with workplace accidents[46][47]. The healthcare and workplace costs associated with insomnia combine to create a significant economic burden for businesses[16][38][40][48] and for society in general[49].

Using digital health self-care services to address mental health issues is becoming more popular[50][51][52]. For example, a 2023 review of stress management smartphone apps identified 2,044 specific tools, of which only 123 had evidence of their effectiveness to evaluate[53]. While most of these technological programs focus on specific disorders for education or self-treatment goals - such as depression[54] - the comorbidity of multiple behavioral health risk factors often is not assessed. Insomnia is one disorder that frequently is not assessed on commercial digital websites or apps that support mental health issues generally. For example, a review in 2022 found that only 3 of 33 evaluation studies of mental health digital interventions included sleep[55]. In another review from 2023, only 1 of 17 studies of digital interventions for healthy behaviors included sleep[56]. While promising, the cognitive behavioral approach (CBT) for digital self-treatment of insomnia has only limited empirical evidence[57][58]. A review published in 2023 was only able to find 6 evaluation studies during a 10-year search period that focused on iCBT and were included in the review, and although all of them found positive results for users, half of these studies had a risk of bias as the authors were linked to the commercial services[59].

1.2. *Overview of Study*

The opportunity for the present study was to use an archival data set of 18,646 users of a commercial service in the United States that provided online health risk screening, educational resources, and self-guided computerized therapy lessons for insomnia and for three other behavioral health disorders during the years 2017 to 2019. The internet-based cognitive behavioral therapy (iCBT) from this service has evidence in past research supporting its clinical effectiveness and value to users[60][61]. The current study analyzed the preliminary comprehensive risk screening results data and other select items from optional surveys of college students or employees conducted 30 days after program use.

The goals were to explore the prevalence and possible correlates of insomnia. Based on the literature review, it was expected to find insomnia to be strongly associated with the behavioral health disorders of depression, anxiety, social phobia, and stress, and to a lesser extent with perceived general health status. The available demographic factors in this sample included age, gender, and race – although only small associations with insomnia were expected. A subset of employee users also had reported on their work productivity and absenteeism, with expectations of finding that insomnia would be linked to both work factors.

The questions explored in this study examined possible relationships between insomnia and other factors among the users of the internet therapy website service:

- RQ1: What is the range of symptom severity and clinical risk status for insomnia?
- RQ2: How does the percentage of users at risk for insomnia compare to the percentage of users at risk for other behavioral health factors?
- RQ3: What is the level of comorbidity of clinical risk for insomnia with clinical risk status for other behavioral health factors (depression, anxiety, stress, social anxiety, and general perceived health)?

- RQ4: Is the level of symptom severity for insomnia associated with background factors of the user, including gender, age, race, year in school (if in college), or level of education?
- RQ5: Is the level of symptom severity for insomnia associated with work performance factors of the employee users, including hours of absenteeism, job performance, and hours of combined lost productive time at work?

2. Methods

2.1. *Archival Data*

This study is a re-analysis of data from previously published studies of employees[60] and of post-secondary students[61] who had voluntarily used an online therapy website provided by a commercial vendor. Users were made aware of the service as a benefit open to all employees or students through a variety of worksite or on-campus digital and interpersonal promotional practices. There was no direct cost to the participants in this study, as access to the website with the programs was sponsored by each of the employers or by the schools. Users participated voluntarily and were not paid for using the online tools. The study period spanned two years, from November of 2017 through October of 2019. The study design was a single-group cross-sectional comparison of volunteer participants who completed various self-report measures at up to three different longitudinal opportunities (at first access to the website; at first use of one of four internet CBT programs; and at follow-up after use).

2.2. *Inclusion Criteria*

The following three criteria were established to select users appropriate to the study goals: (1) Users had to be from a customer of the service in either the higher education market segment (i.e., a college or university) or a specific employer; (2) completed the insomnia symptom severity measure (either at first use in the comprehensive assessment or at the first use of the Insomnia iCBT therapy program); and (3) completed at least one other measure of interest as a possible correlate variable (i.e., demographics, health risks, work or college factors). Application of these criteria yielded a valid sample of 18,646 unique users.

2.3. *Program Use and Timing of Data Collection*

The first step for the users when at the website was to complete a Comprehensive Assessment (CA) of five behavioral health risks. The CA had measures of anxiety, depression, insomnia, social phobia, and stress. This was followed by an opportunity to register to use the service. Registration to use the service was completed by only about half of those who took the CA (54.3%, 10117/18646). Those who registered could then use one (or more) of the four computerized therapy programs: Insomnia, Depression; Stress Anxiety & Worry, or Social Anxiety Disorder. Each of these programs had eight structured programs designed to be used in order from first to last. The clinical risk measure appropriate for each iCBT program was completed at each of the lessons. After program use stopped, a follow-up survey was conducted that had measures for service satisfaction and outcomes and profile factors for either school or work contexts. Details about the

clinical content and use of each of these four programs were described in two previous research studies[60][61]. The data source for scores at the Pre period for the measures of insomnia, anxiety, depression, social phobia, and stress was either the user's score from the preliminary Comprehensive Assessment (CA) or their score from the first lesson of the relevant program, if the user had not completed the CA. For this study sample, almost all participants completed the CA (99.9%, *n* = 18460/18646).

All registered users of the service were sent an email and invited to complete a self-report survey about their experiences. Modest financial incentives were provided for users who participated in a follow-up survey. Note that offering incentives for survey completion was a routine component of the business operations and not a procedure unique to the research study. Only 4 out of every 100 participants in the total study sample completed the follow-up survey (3.8%, 708/18464).

2.4. *Measures*

All measures are described in detail in the two previously published source studies of employees[60] and of post-secondary students[61].

2.4.1. Demographic Factors

Everyone in the sample was from the Midwest region of the United States. The users' age and gender were asked at the time of the registration for the program after the CA. The item for age asked: *What is your age? (fill in a number of years old).* The item for gender asked: *What is your gender? Female, Male or prefer to self-describe (fill in blank).*See Table 1 for the age and gender profile in this sample. The race of the user was not included in program registration but was asked about on the follow-up survey for users of any of the iCBT programs. The race item asked: *What is your race or ethnicity?* The results from 708 users showed the following racial profile for the study sample: 81%*White or Caucasian* (*n* = 567); 7% *Asian American* (*n* = 48); 3% *Black or African American* (*n* = 25); 2% *Native American* (*n* = 15); 2% *Hispanic or Latino American* (*n* = 14); and 5% with "Other/No answer" (*n* = 39).

Table 1. Profile of demographic and context factors with tests for associations with insomnia symptom severity.

Risk Factor	Profile	Insomnia clinical risk status = Yes	Association with insomnia clinical risk
Insomnia	% (*n* of 18,646)		
Minimal	32.3 (6,021)		
Mild	31.3 (5,834)		
Moderate	23.5 (4,387)		
Severe	12.9 (2,404)		
Clinical risk status	**36.4** (6,791)		
Depression	% (*n* of 18,474)	% (*n* of group)	
Minimal	27.4 (5,061)	5.8 (295)	
Mild	29.5 (5,446)	28.0 (1,526)	$X^2(4,18474) = 4885.51$
Moderate	22.4 (4,126)	50.4 (2,091)	$p < .001$

Moderately severe	13.6 (2,520)	68.3 (1,721)	***r* = .51 large effect**
Severe	7.0 (1,301)	82.9 (1,078)	
Clinical risk status	**43.0** (7,947)		
Anxiety	% (*n* of 18,476)	% (*n* of group)	
Low	29.1 (5,061)	11.6 (625)	
Mild	30.8 (5,446)	31.7 (1,807)	$X^2(3,18476) = 3145.00$
Moderate	22.3 (4,126)	50.7 (2,092)	$p < .001$
High	17.8 (1,301)	66.6 (2,188)	***r* = .41 large effect**
Clinical risk status	**29.4** (5,427)		
Stress	% (*n* of 18,460)	% (*n* of group)	
Low	17.5 (3234)	8.7 (281)	
Moderate	57.9 (10,695)	33.4 (3,571)	$X^2(2,18460) = 2489.61$
High	24.5 (4,531)	62.9 (2,849)	$p < .001$
Clinical risk status	**24.5** (4,531)		***r* = .36 large effect**
Social Phobia	% (*n* of 18,469)	% (*n* of group)	
Minimal	50.8 (9,391)	25.6 (2,402)	
Mild	22.4 (4,129)	40.4 (1,669)	$X^2(4,18469) = 1158.78$
Moderate	14.2 (2,630)	49.8 (1,309)	$p < .001$
Severe	8.6 (1,582)	54.1 (856)	***r* = .25 medium effect**
Very severe	4.0 (737)	63.6 (469)	
Clinical risk status	**26.8** (4,949)		
General Health Status	% (*n* of 708)	% (*n* of group)	
Excellent	7.2 (51)	23.5 (12)	
Very good	33.6 (238)	29.8 (71)	$X^2(4,708) = 27.77$
Good	44.6 (316)	43.4 (137)	$p < .001$
Fair	13.4 (95)	54.7 (52)	***r* = -.20 medium effect**
Poor	1.1 (8)	62.5 (5)	
Clinical risk status	**14.5** (103)		

Note: Total N = 18,646. M = mean. SD = standard deviation. Sample size varies as relevant for valid data on both factors.

2.4.2. Level of Education

On the follow-up survey, program users in the higher education market reported their year in college (from freshman to graduate school; see Table 1). On the follow-up survey for employees, the following item asked about education (*N* = 340), “What is your highest level of educational attainment?”, with options of: *Some high school* (*n* = 2); *some college courses* (*n* = 51); *completed high school* or GED (*n* = 12); 2-*year associate degree or technical college degree* (*n* = 47); 4-year college degree (*n* = 165); *master’s level graduate degree* (*n* = 57); or *doctoral level graduate degree* (*n* = 6). These

two sources for educational attainment were combined into one variable for the full sample with relevant data (see Table 1).

2.4.3. Clinical Measures

Each of the clinical risk measures was a published, reliable, and validated scale from the scientific literature. For all of the clinical outcome measures, the analyses for the Pre score used the outcome score from either the CA or, if that was not available, then the score from the first lesson of iCBT completed. Most of the clinical measures of symptom severity had a significant ($p < .001$) test-retest correlation within person from the first and last available assessment: Insomnia $r = .70$, $n = 433$; depression $r = .59$, $n = 214$; anxiety $r = .42$, $n = 122$; and social phobia $r = .67$, $n = 125$.

Insomnia. A self-report scale of symptoms of sleep disturbance and insomnia was used in the study. The Medical Outcomes Study (MOS) Sleep Scale[62] has been shown to have adequate levels of reliability and validity[63]. The 6-item short version of the MOS used item numbers 4, 5, 7, 8, 9, and 12 from the original full 12-item scale. The instructions for the measure state: "How often during the past week did you...." The items include: (4) *get enough sleep to feel rested upon waking in the morning*?; (5) *awaken short of breath or with a headache*?; (7) *have trouble falling asleep?;* (8) *awaken during your sleep time and have trouble falling asleep again*?; (9) *have trouble staying awake during the day?*; and (12) *get the amount of sleep you needed?*In the preliminary CA, the instructions for this scale used the "past 4 weeks" reference for recall of sleep-related symptoms, whereas in each of the iCBT lessons of the program, the instructions asked about sleep during the "past week." The 6 items were rated on a 1 to 6 scale and weighted (1 = 0, 2 = 20, 3 = 40, 4 = 60, 5 = 80, 6 = 100). The items were summed to create a total score. The four levels of severity included: Minimal (0-29), Mild (30-43), Moderate (44-60), and Severe (61-100). Clinical status for insomnia was defined as a score of 44 or greater.

Depression. The Patient Health Questionnaire 9-item scale (PHQ-9) was used to assess self-reported symptoms of depression[64][65]. The instructions state: "Over the last 2 weeks, how often have you been bothered by any of the following problems?" Sample items include: *Little interest or pleasure in doing things*; and *Feeling down, depressed, or hopeless*. Items were rated on a 0-3 scale: 0 = not at all; 1 = several days; 2 = more days than not; 3 = nearly every day. Scores on the 9 items were summed. Severity levels included: Minimal (0-4), Mild (5-9), Moderate (10-14), Moderately Severe (15-19), and Severe (20-27). Clinical status for depression was defined as scores of 10 or higher.

Anxiety. The Generalized Anxiety Disorders 7-item scale (GAD-7) was used to assess self-reported symptoms of anxiety[66][67][68]. Sample items include: (a) *Feeling nervous, anxious or on edge*; (b) *Not being able to stop or control worrying*. The instructions stated: "Over the last 2 weeks, how often have you been bothered by any of the following problems?" Items were rated on a 0-3 scale. Items are rated on a 0-3 scale: 0 = not at all; 1 = several days; 2 = more days than not; 3 = nearly every day. Ratings on the items were summed and scores categorized as follows: Low (0-4), Mild (5-9), Moderate (10-14) and Severe (15-21). Clinical status for anxiety was defined as a score of 10 or greater.

Social Phobia. The Social Phobia Inventory (SPIN) was used to assess self-reported symptoms of social anxiety[69]. The SPIN has been shown in past research to have adequate levels of reliability and validity[70]. The instructions state: "Select

the answer that best describes how much the following problems have bothered you during the past week." Sample items include: *Fear of parties and social events*; and *Avoid talking to strangers*. Scores on the 17 items are rated on a 0-4 scale: 0 = not at all; 1 = a little bit; 2 = somewhat; 3 = very much; or 4 extremely. Scores were summed and categorized into five levels of severity: Minimal 0-18; Mild 19-30; Moderate 31-40; Severe 41-50; and Very Severe 51-68. Clinical status for social anxiety was defined as scores of 31 or higher.

Stress. The Perceived Stress Scale (PSS) assesses one's evaluation of stressful situations in the previous one month[71][72][73]. This study used the shorter 10-item version of the scale, with four of the items being reverse scored. Sample items include: *how often have you been upset because of something that happened unexpectedly?*; *how often have you felt nervous and "stressed"*? The 0 to 4 rating options for experiences in the past month included: 0 = Never; 1 = almost never; 2 = sometimes; 3 = fairly often; 4 = very often. After reverse scoring, the ratings were summed and ranged from 0 to 40. Level of stress was categorized as: Low (0-13); Moderate (14-26), or High (27-40). Clinical status for stress was defined as scores of 27 or greater. This measure was not repeated within any of the 8 lessons of the Stress Anxiety & Worry program and thus was only available if the participant completed the CA before starting the online program.

General Health Status. The perceived health item is widely used in health care research[74][75][76][77]. It asks: *In general, my health is*: Poor (1), Fair (2), Good (3), Very Good (4) or Excellent (5). At-risk status was defined as a rating of Poor or Fair. Among those who used the program and completed the optional follow-up survey, a retrospective recall method used instructions of: "Please answer the question for the period of the month BEFORE you first used [the service]."

2.4.4. Work Measures

The size of the employer where the user worked was archival data extracted from the customer database of the service provider (see Table 1). On the follow-up survey, individual program users in the employer market reported on their work schedule, hours of absenteeism, and their level of work productivity.

Work Schedule. The question: *About how many hours does your employer expect you to work in a typical 7-day week? (If it varies, estimate the average.)* was used to measure the work schedule, with a fill-in-the-blank for the number of hours scheduled. Answers ranged from 5 hours to 75 hours, with an average of 41 and a median of 40. This data was used for calculating the hours of lost productive time (LPT; see below).

Work Absenteeism Hours. A single item on hours of missed work was adapted for this study from the single item on the Health and Productivity Questionnaire (HPQ), which was developed by the World Health Organization and Harvard University[78]: *This item concerns your level of absenteeism from work. During the past 4 weeks, how many times did you miss an entire day of work because of issues with your physical or emotional health? And also, how many times did you miss part of a workday (arrived late or left early) because of your physical or emotional health?* A fill-in-the-blank option was used to count the total number of missed workdays. To also get the pre-use data for this outcome, this was repeated with instructions of: *During the 4-week period BEFORE you first used Learn to Live, how many times did you miss an entire day of work because of issues with your physical or emotional health? And also, how many times did you miss part*

of a workday (arrived late or left early) because of your physical or emotional health? These responses also used a fill-in-the-blank format for the total number of missed workdays estimated before using the program. Work absence at the start of use was highly correlated with within-person work absence at the follow-up, $r = .63$, $p < .001$, $n = 321$. The analyses used the data from the "before use" variable.

Work Productivity. Work productivity was assessed using an adapted version of the single item on job performance from the HPQ[78] which asked: *This question concerns your level of productivity on-the-job. How would you rate your overall job performance on the days you worked during the past 4 weeks? Please use the rating scale of 0 to 10, where 0 is the worst performance and 10 is the top performance.* To get the pre-program use data for this outcome, the question was repeated with instructions: *Please answer the same question for the period BEFORE you first used [the service]: How would you rate your overall job performance on the days you worked during the 4-week period before you first used [the service]?* The level of productivity was highly correlated within-person from the start of use to the follow-up, $r = .74$, $p < .001$, $n = 321$. The analyses used the data for this measure from the retrospective "before use" variable.

Lost Productive Time Hours. The single metric of hours of LPT concept is based on the work of the American Productivity Audit Project[79]. For example, this metric starts with considering the maximum number of hours that an employee is scheduled to work in a month (i.e., the 160-hr standard full-time schedule for the US). From this schedule, next we subtract the hours of absence (e.g., 10 hours), which leaves 150 hours worked from the total schedule. Next, the work productivity 0 to 10 rating results are used to estimate how much of the time while at work was productive. The 0 to 10 rating reflects the full range of low to high work productivity, and, when multiplied by 10, it becomes a metric of 0% to 100% of work time. A rating of 6 corresponds to a 60% level of work productivity. Unproductive time is the difference between 100% and the productivity level. To get the number of hours of unproductive time, multiply the actual hours worked by the level of unproductivity. This amount of unproductive time is combined with the number of hours of absence from work to yield the total LPT result. This calculation is repeated for both the pre- and post-use periods. The hours of LPT at the start of use and at the follow-up were highly correlated within person, $r = .75$, $p. < .001$, $n = 321$. The analyses used the data for this measure from before the use of the program. An example calculation:

- Step 1: 160 hours scheduled to work in a month
- Step 2: 10 hours absent from work
- Step 3: 150 hours of work
- Step 4: 60% level of productivity while working (rating of 6 on 0-10 scale)
- Step 5: 40% level of work unproductivity (100% minus above %)
- Step 6: 60 hours of work unproductivity (150 X 40% = presenteeism hours)
- Step 7: 70 hours of combined lost productive time (10 absenteeism + 60 presenteeism) 70)

2.5. *Data Analysis*

All analyses were conducted in SPSS Version 27. Descriptive and inferential tests were performed as appropriate to the data and the research questions. Details on specific analyses are presented in the Results section.

2.6. *Statistical Power and Effect Sizes*

With such a large sample size, the level of statistical power[80] to detect a small size effect in repeated measures tests at $p < .05$ chance level was very high at .99. Thus, high levels of statistical power increased the ability to declare even very small differences found as being "significant" at beyond chance levels (i.e., $p < .05$). Thus, a commonly used interpretative tool within the social sciences of comparing the statistical effect sizes of certain results was adopted for the study. Following Gignac and Szodorai's meta-analysis review of research results in psychology studies[81], various metrics of statistical effect size (Cohen's *d*, partial eta squared η_p^2) were converted into a single effect size of the standardized correlation coefficient (*r*) with *r* of .30 or higher indicating a large effect, *r* of .20 to .29 a medium size effect, *r* of .10 to .19 as a small size effect, and *r* less than .10 to be a trivial difference even if significant beyond a chance level.

3. Results

The study findings are presented in four parts, beginning with the prevalence rate for insomnia symptoms and clinical disorder status in this large sample. The second part is the results for insomnia and behavioral health disorders. The third part explores the differences in insomnia for age, gender, and race of the service users. The final part focuses on how insomnia is associated with work factors.

3.1. *Insomnia*

What was the range in severity of insomnia? Figure 1 and Table 2 show the profile of the study sample for the severity of experiencing symptoms of insomnia. The full range of scores possible on the severity measure, from 0 to 100, was evident in the sample. Slightly less than a third of the total sample had the lowest level of insomnia symptoms in the minimal category. Almost another third of the total sample were classified as having only a mild level of insomnia symptoms. About a fourth of the sample had moderate insomnia, and 13% had severe insomnia, with some at or close to the maximum score possible on the scale. When these last two higher-level groups were combined, about a third of people (36%) in the study were classified as being at risk for a clinical level of sleep disturbance and insomnia (see Figure 1). The conclusion is that among the people who choose to seek support from this self-care website for one or more of four common behavioral health issues, having sleep problems was indeed one of the issues relevant to a large portion of this population, with some of these people at a very severe level.

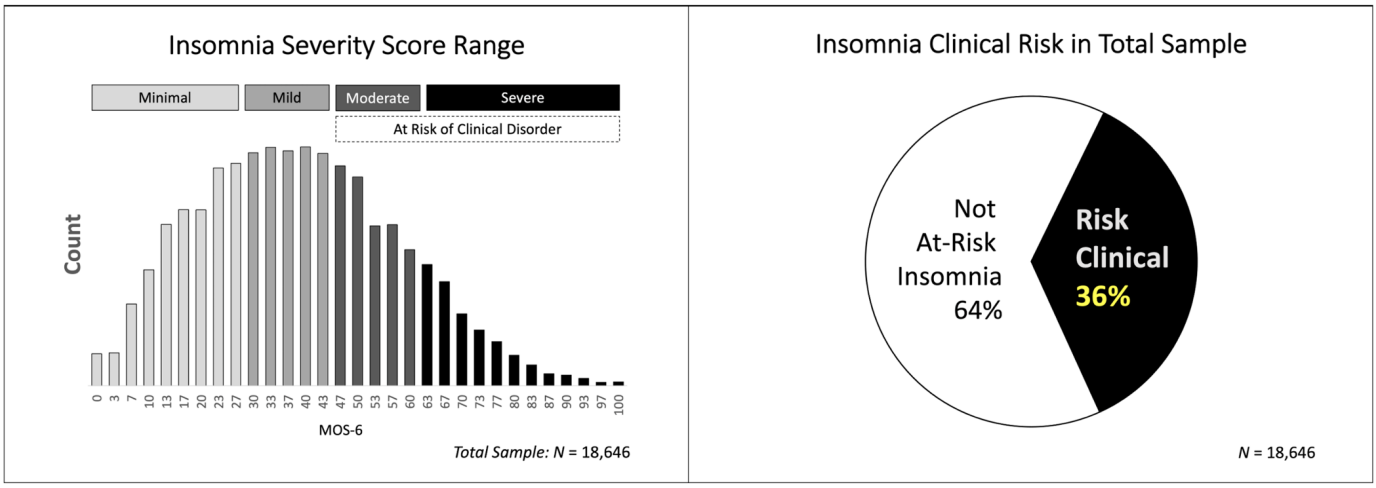

Figure 1. (left) Frequency distribution of scores on the MOS-6 measure of severity of insomnia symptoms in the total sample; **(right)** Percentage of users at clinical risk status for insomnia in the total sample.

3.2. *Insomnia and Behavioral Health Disorders*

How prevalent were the various behavioral health risk factors? Table 2 also shows the profile of the study sample on five other behavioral health risk factors and the statistical results for how each factor was associated with insomnia. As shown in Figure 2, each of the health factors had a wide range of representation from low to high severity levels.

Table 2. Profile of behavioral health risk factors with tests for associations with insomnia symptom severity.

Health Factors		*M* (SD) Range	% at risk clinical disorder	Health Factors				
				2	3	4	5	6
1	**Insomnia**	38.73 (19.11) 0-100	36.4%	**.65** (18,474)	**.54** (18,476)	**.34** (18,469)	**.54** (18,460)	**-.26** (708)
2	**Depression**	9.13 (6.21) 0-27	43.1%	1.00				
3	**Anxiety**	8.46 (5.72) 0-21	40.1%	**.73** (18,468)	1.00			
4	**Social phobia**	20.89 (15.07) 0-68	26.8%	**.53** (18,460)	**.53** (18,466)	1.00		
5	**Stress**	20.93 (7.51) 0-40	24.5%	**.75** (18,460)	**.77** (18,460)	**.51** (18,460)	1.00	
6	**General health**	3.32 (0.84) 1-5	14.5%	**-.37** (667)	**-.24** (688)	**-.22** (664)	**-.34** (663)	1.00

Note: M = mean. SD = standard deviation. Range = minimum to maximum scores. Cells in the table have Pearson r coefficient (n sample size). All correlations are significant at p < .001. Sample size varies as relevant for valid data on both factors.

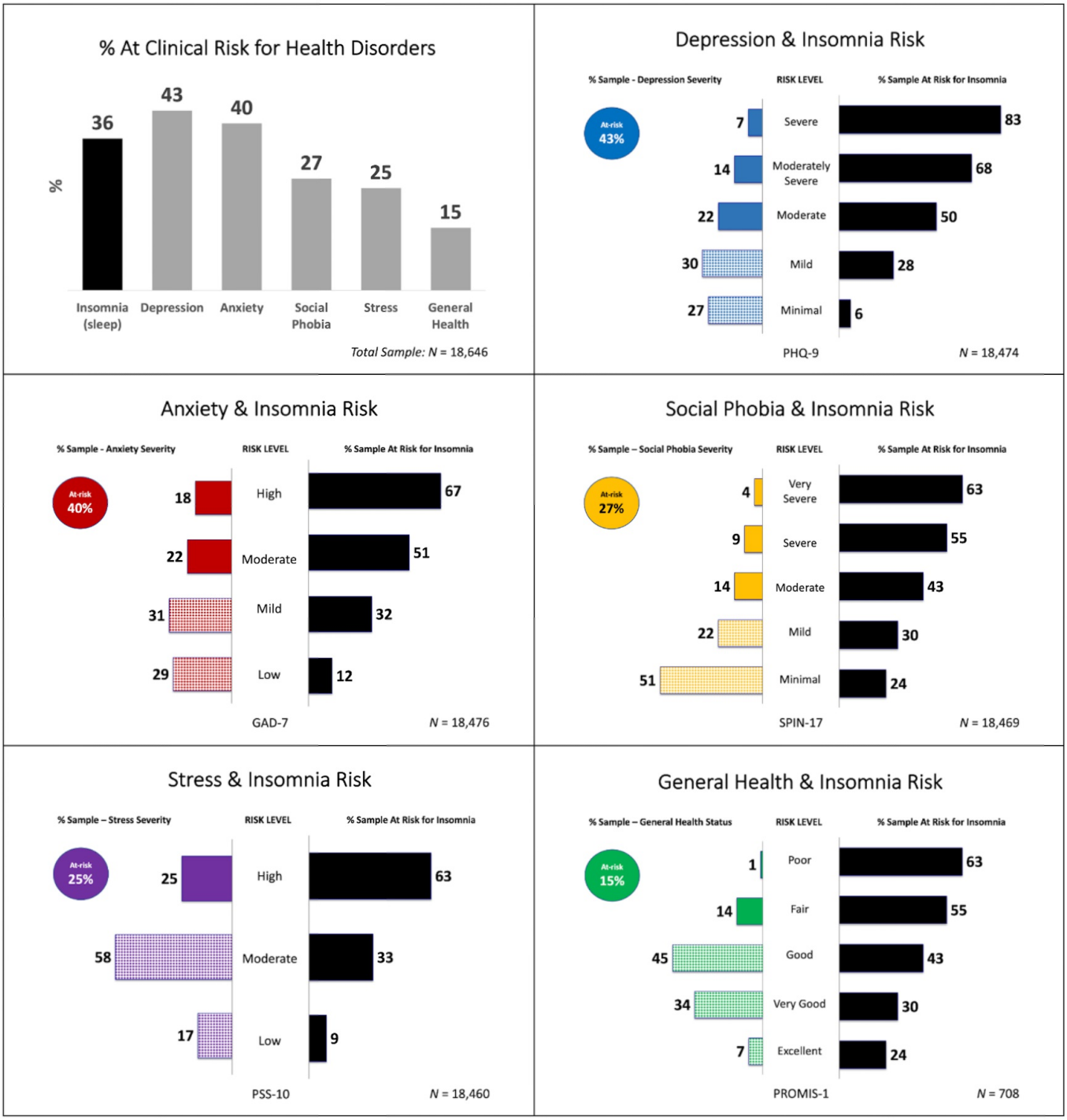

Figure 2. (a) Percentage of users at clinical risk status in the total sample for six health disorders; **(b)** Distribution of users at different levels of severity of symptoms of depression (left) and percentage of users at clinical risk status for insomnia by each level of depression (right); **(c)** Distribution of users at different levels of severity of symptoms of anxiety (left) and percentage of users at clinical risk status for insomnia by each level of anxiety (right); **(d)** Distribution of users at different levels of severity of symptoms of social phobia (left) and percentage of users at clinical risk status for insomnia by each level of social phobia (right); **(e)** Distribution of users at different levels of severity of symptoms of stress (left) and percentage of users at clinical risk status for insomnia by each level of stress (right); **(f)** Distribution of users at different levels of general health status (left) and percentage of users at clinical risk status for insomnia by each level of health status (right).

Risk Prevalence. Of the six health factors, clinical risk status on insomnia was the third most prevalent disorder.

Depression was the most common, with 43% of the sample being at risk, followed closely by anxiety at 40%, insomnia was next at 36%, and about a fourth were at risk for social phobia (27%) or for stress (25%). Only 15% of the sample reported having poor or fair overall health status. These at-risk rates are also shown in Figure 2.

Total Number of Risks. For the five risks assessed at the start of use, the typical participant had 1.71 total factors (SD = 1.68) that reached the clinical level of severity, but the range was from none to all that were included in the online screening. More specifically, 36.1% (n = 6,662) of users had zero of these factors that were at a clinical risk level, 17.4% (n = 3,206) had one risk factor, 13.7% (n = 2,522) had two risk factors, 12.9% (n = 2,384) had three risk factors, 12.5% (n = 2,300) had four risk factors, and 7.5% (n = 1,386) had all five disorders. For the subset of the participants who used one of the iCBT programs and completed the follow-up survey that included the general health status item (n = 708), the average participant had 1.88 (SD = 1.71) total factors at risk of the six possible.

Correlations Between Different Risk Factors. How interrelated were the various behavioral health risk factors? The overlap of the clinical severity level of insomnia and the clinical severity of the other five health disorders was examined next. Correlations were calculated between each measure in the full sample (see the top row of Table 3). Three of the disorders all had strong associations with insomnia, including depression (r = .65), anxiety (r = .54), and stress (r = .54). Insomnia was also positively correlated with social phobia (r = .34) and with worse overall health status (r = -.24).

Comorbidity of Insomnia and Different Risk Factors. This comorbidity was explored more directly in other tests that examined the percentage of participants who were at risk for clinical insomnia by the different risk levels of each of the other five behavioral risk factors (see Table 2). The level of comorbidity is also displayed visually in Figure 3. The percentage of people at clinical risk for insomnia increased dramatically from only 6% to 82% within each depression risk group. The percentage of people at clinical risk for insomnia increased dramatically from only 12% to 67% within each anxiety risk group. The percentage of people also being at clinical risk for insomnia increased dramatically from only 9% to 63% within each stress risk group. The percentage of people also being at clinical risk for insomnia increased from 26% to 64% within each social phobia risk group. The percentage of people also being at clinical risk for insomnia increased dramatically from only 24% to 63% within each general health risk group.

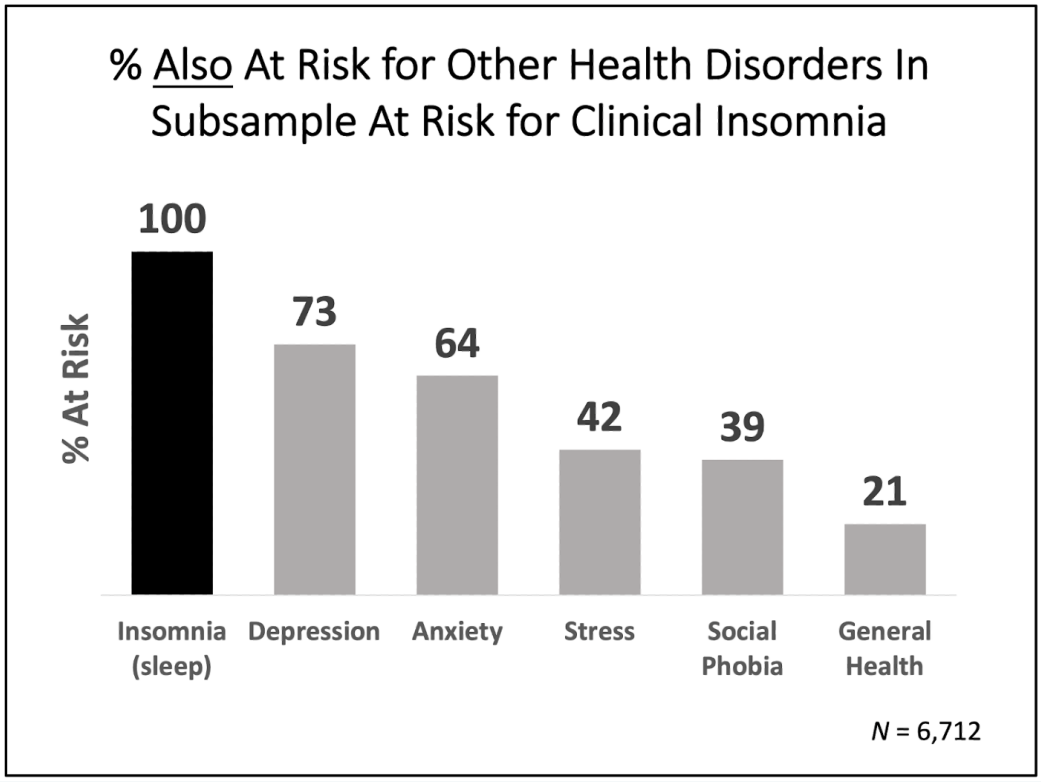

Figure 3. Comorbidity of clinical insomnia with clinical risk status on five other health disorders: Subsample of those at risk for insomnia.

Correlations Between Different Risk Factors. As expected, as shown in the lower part of Table 3, all six of these behavioral health factors were themselves also significantly inter-correlated (*r* ranged from .77 to -.22). Thus, there was substantial overlap between each of the psychological risk factors and general health status.

Table 3. Profile of demographic and context factors with tests for associations with insomnia symptom severity.

Factor	Profile	Insomnia *M* (SD)	Association with severity of insomnia symptoms
Context	% (*n* of 18,646)		*F*(1,18645) = 304.13 *p* < .001 ***r* = .13 small effect**
College	49.4 (9,209)	41.18 (18.73)	
Employer	50.6 (9,437)	36.34 (19.18)	
Adjusted for age	% (*n* of 10,109)	M_{adj} (SE)	*F*(1,10106) = 16.38 *p* < .001 ***r* = .04 trivial effect**
College	44.7 (4,523)	40.63 (0.32)	
Employer	55.3 (5,586)	38.74 (0.28)	
Age (years)	% (*n* of 9,980)		*F*(4,9975) = 41.86 *p* < .001
18-29 years	50.9 (5,076)	41.67 (18.49)	
30-39 years	20.6 (2,059)	38.58 (18.89)	

40-49 years	13.6 (1,359)	37.31 (18.26)	***r* = -.13 small effect**
50-59 years	11.2 (1,120)	35.61 (18.01)	
60-83 years	3.7 (366)	34.86 (17.73)	
M (SD) range 18-83	32.82 (12.98)		
Gender	% (*n* of 10,117)		
Female	73.5 (7,440)	40.28 (18.46)	*F*(2,10116) = 32.78
Male	25.3 (2,560)	37.28 (18.71)	*p* < .001
Gender diverse	1.2 (117)	46.32 (21.17)	***r* = -.05 trivial effect**
Race	% (*n* of 708)		*F*(1,707) = 0.01
White	81.1 (567)	39.92 (18.49)	*p* = .97 ns
Other than White	19.9 (141)	39.78 (17.07)	***r* = .00 no effect**
Education level	% (*n* of 708)		
Some college or student	15.8 (112)	42.58 (18.69)	*F*(2,707) = 2.17
Undergraduate degree	53.1 (376)	40.06 (18.15)	*p* = .11 ns
Graduate degree	31.1 (220)	38.22 (17.94)	***r* = -.08 no effect**
College year	% (*n* of 368)		
Freshman	16.3 (60)	39.93 (18.02)	
Sophomore	14.9 (55)	41.98 (18.37)	
Junior	13.0 (48)	45.31 (19.05)	*F*(4,367) = 1.66
Senior	13.0 (48)	42.44 (15.08)	*p* = .16 ns
Graduate school	42.7 (157)	38.45 (17.66)	***r* = -.06 no effect**
Employer size	% (*n* of 5,591)		
< 1,000 employees	5.0 (281)	36.68 (17.42)	
1,000 – 2,999	5.1 (283)	37.49 (20.25)	
3,000 – 9,999	14.5 (809)	40.05 (19.56)	*F*(1,5590) = 4.32
10,000 – 49,9999	39.0 (2,183)	37.41 (18.59)	*p* = .002
50,000 +	36.4 (2,035)	36.96 (18.24)	***r* = .02 trivial effect**

Note: Total N = 18,646. M = mean. SD = standard deviation. Sample size varies as relevant for valid data on both factors.

3.3. *Insomnia and Demographic Factors*

Table 1 shows the demographic profile of the study sample and the statistical results for how each of these factors was associated with the severity of insomnia symptoms. Note that the demographic factors of age and gender were available for about 10,000 of the 18,646 program users in the aggregated sample.

Insomnia and Age. Age ranged from 18 to 83 years, with an average of 32 years. Age had a small-sized statistical effect on the severity of insomnia symptoms when tested as mean scores on the MOS-6 (see Table 1). This same pattern occurred for a chi-square test comparing the percentage of users who were at risk or not for insomnia disorder by the same five groups based on age decades, $X^2(4,9980) = 90.37$, $p < .001$, $r = -.09$, a very small-sized effect. The youngest age group of those under 30 (which was half of the sample with age data recorded) had the greatest percentage of users at risk for clinical insomnia disorder, with 42%, and there was a linear decrease in this percentage at risk for insomnia as the users got older, with only 27% at risk among those aged 60 years or older (see Figure 4).

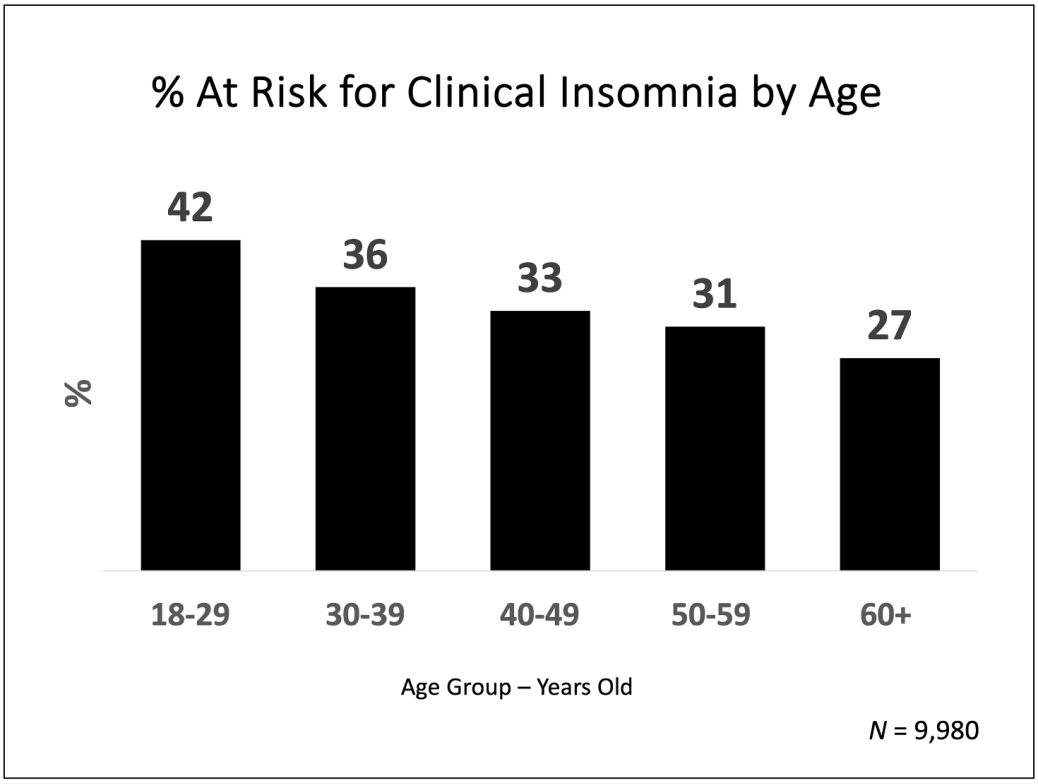

Figure 4. Percentage of users in different age groups who were at risk for clinical insomnia disorder.

Insomnia and Other Background Factors. The other available demographic factors of gender ($r = -.05$) and race ($r = .00$) were not associated with insomnia severity. The level of education attained ($r = -.06$) and the year in college (for current students; $r = -.06$) also were not associated with insomnia severity. The context of having about half of the total sample being college students and the other half being employees accounted for only a trivial difference in insomnia severity when also controlling for age ($r = .04$), which differed substantially between these two samples (college $M = 24$ years < employees $M = 40$ years). Among the employee subsample, the size of the employer was not associated with insomnia severity ($r = .02$).

Health Risks and Demographic Factors. How are the other health factors associated with demographic factors? Table 4 shows the correlations of all six health disorders with age, gender, and race in the full sample with valid data. As with insomnia, each of the other psychological factors was inversely related to age, such that greater severity of depression, anxiety, social phobia, and stress was more common among younger age than older age participants ($r = -.14$ to $-.33$).

Gender had only trivial-sized associations with health risks (with females having slightly more severe symptoms than males; but all $r < .10$). Race had no meaningful associations with any of the behavioral health disorders but was associated with general health status, such that participants of White race had slightly better overall health than those of other races; however, this also was a small-sized statistical effect ($r = .15$).

Table 4. Associations between behavioral health risk factors and age, gender and race.

Health Factors	Demographic Factors		
	Age	Gender	Race
Insomnia	**-.14*** (9,980)	.07* (10,000)	.00 (708)
Depression	**-.28*** (9,811)	.03* (9,830)	-.07 (667)
Anxiety	**-.33*** (9,812)	.08* (9,832)	-.07 (668)
Social phobia	**-.28*** (9,806)	.05* (9,825)	-.08* (664)
Stress	**-.32*** (9,797)	.09* (9,825)	-.06 (663)
General health status[a]	.05 (367)	-.02 (361)	**.15*** (368)

*Note: Pearson r coefficient (n sample size). Sample size varies as relevant for valid data on both factors. Age in years. Gender coded as Female = 1 and Male or Other = 0. Race coded as White = 1 and Non-White = 0. Results in **bold** if at least a small size statistical effect.*

[a] *higher scores indicate better health.*

** p < .05.*

3.4. *Insomnia and Work*

How is insomnia associated with work performance factors? Table 5 shows the work profile among the subsample of employee users of the iCBT service and the statistical results for how each of these factors was associated with the severity of insomnia symptoms.

Table 5. Profile of work performance factors in study sample and tests for associations with insomnia: Employed sample.

Factor	*M* (SD) Range	Insomnia symptom severity				Statistical test
		Minimal (*n* = 99)	Mild (*n* = 104)	Moderate (*n* = 74)	Severe (*n* = 44)	
Work productivity rating	6.79 (1.84) 0-10	7.35 (1.64)	6.91 (1.65)	6.47 (1,79)	5.80 (2.29)	*F*(3,320) = 8.85 *p* < .001 ***r* = -.28 medium effect**
Work absenteeism hours	6.36 (9.83) 0-48	4.08 (8.37)	6.62 (9.45)	8.27 (10.68)	7.64 (11.47)	*F*(3,320) = 3.03 *p* = .03 ***r* = .17 small effect**
Work presenteeism hours	49.86 (29.03) 0-144	42.39 (26.64)	49.29 (17.01)	53.83 (29.78)	62.99 (36.27)	*F*(3,320) = 5.69 *p* < .001 ***r* = .23 medium effect**
Combined hours of lost productive work time (LPT)	56.21 (32.27) 0-158	46.47 (28.55)	55.91 (29.01)	61.10 (32.18)	70.62 (40.57)	*F*(3,320) = 6.86 *p* < .001 ***r* = .25 medium effect**

Note: Total N = 321 employees in follow-up survey after iCBT program use. M = mean. SD = standard deviation. Range = minimum to maximum scores. Average work schedule for 4 weeks was 156.8 hours (39.2 per week).

Level of work productivity averaged a 6.8 rating on the 0 to 10 scale. This is lower than the 8.5 level found in past research for the typical worker in the US using the same rating scale[71]. Work productivity had a medium-sized statistical effect for its association with the severity of insomnia symptoms when tested as mean scores on the MOS-6 ($r = .28$), with lower work performance associated with higher insomnia severity. Hours of work absence had a small-sized statistical effect with the severity of insomnia symptoms when tested as mean scores ($r = .17$), with more hours of missed work associated with higher insomnia severity. Hours of estimated work presenteeism and combined lost work productive time (absenteeism and presenteeism) both had medium-sized statistical effects with the severity of insomnia symptoms when tested as mean scores ($r = .23$ and.25, respectively), with more hours of presenteeism while working and more hours of total lost productive work time associated with greater severity of insomnia.

Figure 5 shows the self-reported hours of absenteeism, the estimated hours of presenteeism, and for employees in groups made by the four levels of severity of insomnia. This figure also includes the LPT hours for the typical employee in the US who was not seeking behavioral health support[71]. Several points are relevant from these results. First, the

average employee who was seeking psychological education and support from a self-help website had a much higher level of LPT hours than did the typical employee norm. Indeed, the average employee in the study sample had more than twice the hours of LPT in the past month compared to norms for this metric: Study $M = 56.2$ (SD = 32.4) *vs.* 26.6 norm, $t(320) = 16.43, p < .001, d = .92$. Second, the LPT was derived almost entirely from the impact of presenteeism problems while working compared to being absent from work (*M* hours = 49.9 presenteeism *vs.* 6.4 absenteeism; 89% of total LPT hours *vs.* 11%; respectively). Third, increased LPT was significantly associated with increased severity of insomnia: the Minimal insomnia group had 46.5 hours of LPT; the Mild insomnia group had 55.9 hours; the Moderate insomnia group had 61.1 hours; and the Severe insomnia group had 70.6 hours. Another simpler test comparing the hours of LPT between two groups of pre-clinical employees ($n = 203$) and clinical status employees ($n = 118$) on insomnia found a significant and medium effect size difference. The clinical group of users on average had more LPT hours, $M = 64.65$ (SD = 35.68) than the pre-clinical group of users, $M = 51.30$ (SD = 29.11), $t(319) = -3.60, p < .001, r = .20$.

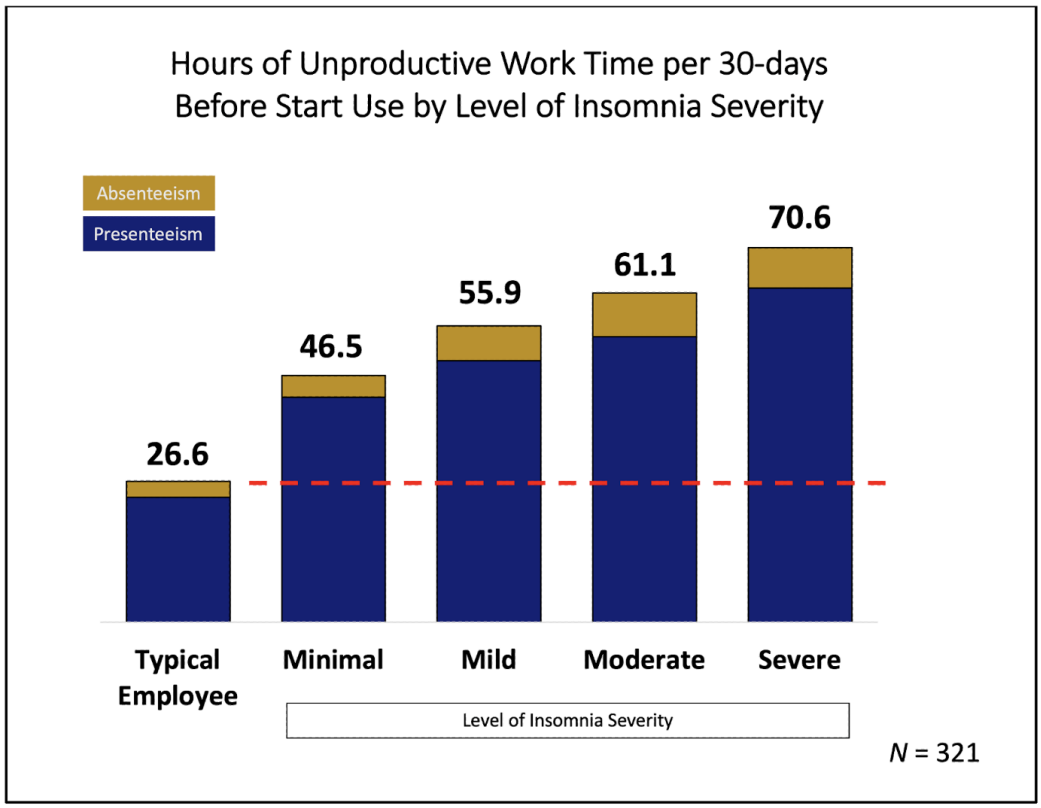

Figure 5. Hours of LPT per person by level of insomnia severity in employee follow-up sample and for the typical employee in U.S. norm data.

4. Discussion

This study used an applied context to try to better understand the risk for insomnia disorder and its correlates. The study has real-world validity because the data came from a large sample of over 18,000 people who voluntarily used an online service that offered education, risk assessment, and self-care programs for insomnia and three other behavioral health conditions (depression, stress and anxiety, and social phobia). These risks, along with overall health status, were all

assessed with research-validated and widely used self-report assessment tools. Contrary to the more limited measurement range obtained in other studies using only clinical treatment samples, this study featured people who represented the full range of severity from pre-clinical to clinical levels for each of the health-related factors. Such research design conditions are good for conducting tests of the possible associations between insomnia and these other common behavioral health risks.

4.1. *Review of Primary Findings*

The primary findings were that insomnia was strongly and positively associated - with large-sized statistical effects - with depression, anxiety, and stress. Insomnia was positively associated with social phobia and negatively associated with general health status (both medium-sized statistical effects). Other tests within the group of participants with a clinical level of insomnia also revealed substantial comorbidity between insomnia and each of these other mental health disorders. Thus, insomnia and sleep problems are more complex in their clinical presentation and often involve multiple other mental health conditions. One practical implication is that clinical support programs for people with insomnia should include risk screenings for multiple other behavioral health conditions and then engage in multi-component treatment processes as needed. Across all the study sample, the high degree of correlations between insomnia, depression, anxiety, stress, and social phobia also replicates past research (average $r = .59$), as does the inverse and weaker associations between the more psychological conditions and the perceived general health factor (average $r = -.29$). These findings underscore that the psychological nature of insomnia is stronger than its impact on physical health.

Although based on a much smaller sample size, the findings linking insomnia and work performance could be of interest to employers and occupational health psychology scholars. Consistent with other past research[41][44][77][82], presenteeism is much more of an issue than absenteeism for those with more clinical levels of insomnia. It is somewhat new to document the overlap between work productivity and insomnia, as how depression and anxiety affect work productivity and absence has been studied far more often[41][45][60][76][77][82].

4.2. *Background Factors*

The study also has practical validity as the sample represented a broad range of different employers and institutions of higher education located in a multi-state region of the U.S. The demographic profile of the study sample had substantial variability for age, gender, and education level. In contrast, the racial mix was mostly White, with only about 1 in every 5 people in the sample being of a different race, but this mix generally matched the racial profile of the larger local populations. Only one of these context and demographic factors had any meaningful associations with insomnia. Age had an inverse linear relationship such that insomnia was greatest among those in the younger age groups and decreased as people got older, yet the reader should keep in mind that this result was a small size statistical effect. The year in college or the status of undergraduate or graduate school educational context also was unrelated to the severity of insomnia. The conclusion is that basic demographic, college year, and employer size factors had only weak or no relationship with insomnia in this study sample. Age, however, was more strongly associated with all four of the other behavioral health

disorders in this sample (all inverse relationships) than it was associated with insomnia. Yet, age was not associated with perceived overall health status. Finding that age was negatively associated with insomnia is the opposite direction of much of the literature, which often finds insomnia increases with age[1][2][3][4][5][6][7].

4.3. *Implications for Prevention and Treatment with Online Self Care Tools*

Past research documents a variety of therapies and clinical treatments available for insomnia[1][2][3]. These include prescription medications and psychotherapy approaches[83][84][85]. Studies conducted in the United States indicate that about 10% of the adult population use over-the-counter medication and 13% use alcohol to try to improve their sleep[86]. Cognitive behavioral therapy for insomnia has been shown to lower rates of depression recurrence[87][88].

This sample of help seekers had higher rates of insomnia, depression, anxiety, and social phobia than are usually found in the general society. Thus, they were appropriately accessing the service to learn more about these conditions and to maybe take action to use digital therapy tools for one or more conditions of most interest. However, the data showed that only about half of those who anonymously took the initial screening decided to formally register for the program to use one of the treatment modules (54.3%, n = 10,117 of 18,646 total). The percentage of people who registered to potentially use one of the treatment programs had 1.8 total risks on average (of 5 possible) and 47% of this group had zero risks. That is only slightly higher than the 1.6 risks (of 5 possible) and 52% of this group with zero risks among those who stopped participating after taking the initial online comprehensive assessment and did not register. The lack of differences in severity level between the registered and non-registrant groups suggests that personal choice played a role in the decision to try the self-care iCBT tools.

More specifically, positive therapeutic outcomes were found in the two previous research studies conducted on the use of the lessons of iCBT for this insomnia program. The study of employees[60] and the study of college students[61] both found significant reductions in the severity of insomnia symptoms for the at-risk users of this online self-guided program for insomnia. Thus, inexpensive and always available Internet-based therapy tools, such as the one involved in this study, could be more widely adopted as a resource to help people self-treat their insomnia problems. Based on the comprehensive screening data in this study, about 1 in every 3 participants had none of the five health factors at a clinical risk level. An implication of this finding is the appeal of using the educational opportunities offered by this kind of online automated service for prevention goals among non-clinical populations rather than just focusing on the value of the clinical treatment iCBT modules for people at risk for insomnia or other behavioral health disorders.

4.4. *Limitations*

Like all applied social science research, the present study has some limitations. It is a cross-sectional study design with an archival sample created by one service provider. The measures used to collect the data were all self-report. The sample sizes vary from the full sample for the behavioral health disorder measures to about half of the starting sample for the demographic factors of age and sex and a much smaller sample for the variables of race, health status, and work performance. The timing of this study during 2017-2019 occurred before the COVID-19 global pandemic. Thus, any

effects on the factors examined in this study are unknown for the more current era[89][90]. For example, a review study of 83 studies conducted during the COVID-19 pandemic of samples of health care workers found associations between measures of insomnia and anxiety, depression, and stress[91].

4.5. *Conclusions*

This study provided a unique look at how insomnia is experienced among a very large convenience sample of Americans who were using an online service seeking educational and therapeutic support for insomnia and for other behavioral health conditions. The key conclusions are that sleep problems are commonly experienced, often comorbid with other common mental health conditions, linked to work performance problems, but were not associated much with demographic factors. This level of insomnia clinical risk of about 1 in every 3 people in this sample falls in the middle between the other studies in the literature on insomnia and sleep problems that tend to find lower rates in the general population or substantially higher rates among those receiving clinical treatment.

Statements and Declarations

Supplementary Materials: None.

Funding: This research received no external funding.

Institutional Review Board Statement: Ethical review and approval were waived for this study due to the use of archival data. The privacy of users was protected by having all program and survey data de-identified before being shared with the independent consultant who conducted the analyses. This context is like other applied studies of commercial service online program data[60][61][76][77]. The use and analysis of archival operational data in this manner is consistent with the published ethical guidelines of the American Psychological Association[92].

Informed Consent Statement: Participant consent was waived because this was an applied study of archival anonymized data collected from the routine use of the service; additional informed consent from individual participants beyond their initial consent agreement in the terms of use to access the service was not needed.

Data Availability Statement: The raw data are unavailable due to the proprietary nature of the applied study design involving a commercial service provider.

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Conflicts of Interest: The author declares no conflict of interest. The author is an independent research scholar and consultant who received no financial support for preparing this research manuscript. However, the author was compensated by this service provider in the past for writing the two earlier published studies that analyzed other parts of

this same data set[59][60].

References

1. [a, b, c]*Sateia MJ, Doghramji K, Hauri PJ, Morin CM. Evaluation of chronic insomnia. An American Academy of Sleep Medicine review. Sleep. 2000;23(2):243-308. PMID: 10737342.*
2. [a, b, c]*Morin CM, LeBlanc M, Daley M, Grégoire JP, Mérette C. Epidemiology of insomnia: Prevalence, self-help treatments, consultations, and determinants of help-seeking behaviors. Sleep Med. 2006;7(2):123-130. doi:10.1016/j.sleep.2005.08.008.*
3. [a, b, c]*Ohayon MM, Reynolds CF III. Epidemiological and clinical relevance of insomnia diagnosis algorithms according to the DSM-IV and the International Classification of Sleep Disorders (ICSD). Sleep Med. 2009;10(9):952-960. doi:10.1016/j.sleep.2009.07.008.*
4. [a, b]*American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5®). American Psychiatric Publications: Washington, DC, 2013.*
5. [a, b]*Chaput J-P, Yau J, Rao DP, Morin CM. Prevalence of insomnia for Canadians aged 6 to 79. Public Health Reports. 2018;29:16–20.*
6. [a, b]*Morin CM, Jarrin DC, Ivers H, Mérette C, LeBlanc M, Savard J. Incidence, persistence, and remission rates of insomnia over 5 years. JAMA Netw Open. 2020;3:e2018782.*
7. [a, b, c, d, e]*Kolla BP, He JP, Mansukhani MP, Frye MA, Merikangas K. Excessive sleepiness and associated symptoms in the US adult population: Prevalence, correlates, and comorbidity. Sleep Health. 2020;6(1):79-87. doi:10.1016/j.sleh.2019.09.004.*
8. [^]*Zeng LN, Zong QQ, Yang Y, et al. Gender difference in the prevalence of insomnia: A meta-analysis of observational studies. Frontiers in Psychiatry. 2020;11:577429. doi:10.3389/fpsyt.2020.577429.*
9. [^]*Aernout E, Benradia I, Hazo JB, Sy A, Askevis-Leherpeux F, Sebbane D, Roelandt JL. International study of the prevalence and factors associated with insomnia in the general population. Sleep Med. 2021;82:186-192. doi:10.1016/j.sleep.2021.03.028.*
10. [a, b]*Zhang J, Chan NY, Lam SP, et al. Emergence of sex differences in insomnia symptoms in adolescents: A large-scale school-based study. Sleep. 2016;39:1563–1570. doi:10.5665/sleep.6022.*
11. [^]*Sivertsen B, Pallesen S, Friborg O, Nilsen KB, Bakke ØK, Goll JB, Hopstock LA. Sleep patterns and insomnia in a large population-based study of middle-aged and older adults: The Tromsø study 2015–2016. J Sleep Res. 2021;30(1):e13095. doi:10.1111/JSR.13095.*
12. [^]*Adenekan B, Pandey A, McKenzie S, Zizi F, Casimir GJ, Jean-Louis G. Sleep in America: Role of racial/ethnic differences. Sleep Med Rev. 2013;17(4):255–262. doi:10.1016/j.smrv.2012.07.002.*
13. [^]*Jackson CL, Powell-Wiley TM, Gaston SA, Andrews MR, Tamura K, Ramos A. Racial/ethnic disparities in sleep health and potential interventions among women in the United States. J Women's Health. 2020;29(3):435-342. doi:10.1089/jwh.2020.8329.*

14. ^Grandner MA. Sleep, health, and society. Sleep Med Clin. 2017;12:1–22. doi:10.1016/j.jsmc.2016.10.012.
15. ^Olfson M, Wall M, Liu SM, Morin CM, Blanco C. Insomnia and impaired quality of life in the United States. J Clin Psychia. 2018;79(5):9151. doi:10.4088/JCP.17m12020.
16. a, b DiBonaventura M, Richard L, Kumar M, Frosythe A, Flores NM, Moline M. The association between insomnia and insomnia treatment side effects on health status, work productivity, and healthcare resource use. PLoS ONE. 2015;10(10):e0137117. doi:10.1371/journal.pone.0137117.
17. ^Olatunde K, Patton S. Association between insomnia and healthcare utilization: A scoping review of the literature. Amer J Lifestyle Med. 2023;0(0). Online first. doi:10.1177/15598276231164953.
18. ^Bramoweth AD, Taylor DJ. Chronic insomnia and health care utilization in young adults. Behav Sleep Med. 2012;10(2):106-121. doi:10.1080/15402002.2011.587067.
19. ^Anderson LH, Whitebird RR, Schultz J, McEvoy CE, Kreitzer MJ, Gross CR. Healthcare utilization and costs in persons with insomnia in a managed care population. Am J Manag Care. 2014;20(5):e157-e165. PMID: 25326930.
20. ^Burton WN, Chen CY, Schultz AB, Li X. Association between employee sleep with workplace health and economic outcomes. J Occup Environ Med. 2017;59(2):177-183. doi:10.1097/JOM.0000000000000934.
21. ^Wickwire EM, Tom SE, Scharf SM, Vadlamani A, Bulatao IG, Albrecht JS. Untreated insomnia increases all-cause health care utilization and costs among Medicare beneficiaries. Sleep. 2019;42(4):zsz007. doi:10.1093/sleep/zsz007.
22. ^Baglioni C, Battagliese G, Feige B, et al. Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. J Affect Disord. 2011;135:10–19. doi:10.1016/j.jad.2011.01.011.
23. ^Fernandez-Mendoza J, Vgontzas AN. Insomnia and its impact on physical and mental health. Cur Psychia Reports. 2013;15:1-8. doi:10.1007/s11920-013-0418-8.
24. ^Hertenstein E, Feige B, Gmeiner T, et al. Insomnia as a predictor of mental disorders: A systematic review and meta-analysis. Sleep Med Rev. 2019;43:96–105. doi:10.1016/j.smrv.2018.10.006.
25. ^Kolla BP, He JP, Mansukhani MP, Frye MA, Merikangas K. Excessive sleepiness and associated symptoms in the US adult population: Prevalence, correlates, and comorbidity. Sleep Health. 2020;6(1):79-87. doi:10.1016/j.sleh.2019.09.004.
26. ^Joshi K, Cambron-Mellott MJ, Costantino H, Pfau A, Jha MK. The real-world burden of adults with major depressive disorder with moderate or severe insomnia symptoms in the United States. J Affect Disord. 2023;323:698-706. doi:10.1016/j.jad.2022.12.005.
27. ^Cox RC, Olatunji BO. A systematic review of sleep disturbance in anxiety and related disorders. J Anxiety Disord. 2016;37:104-29. doi:10.1016/j.janxdis.2015.12.001.
28. ^Cox RC, Olatunji BO. Sleep in the anxiety-related disorders: A meta-analysis of subjective and objective research. Sleep Med Rev. 2020;51:101282. doi:10.1016/j.smrv.2020.101282.
29. ^Bragantini D, Sivertsen B, Gehrman P, Lydersen S, Güzey IC. Differences in anxiety levels among symptoms of insomnia. The HUNT study. Sleep Health. 2019;5(4):370-375. doi:10.1016/j.sleh.2019.01.002.
30. ^Stein MB, Kroft CD, Walker JR. Sleep impairment in patients with social phobia. Psychiatry Res. 1993;49(3):251–256.

doi:10.1016/0165-1781(93)90065-O.

31. ^*Raffray T, Bond TLY, Pelissolo A. Correlates of insomnia in patients with social phobia: Role of depression and anxiety. Psychiatry Res. 2011;189(2):315–317. doi:10.1016/j.psychres.2011.03.004.*
32. ^*Kashani M, Eliasson A, Vernalis M. Perceived stress correlates with disturbed sleep: A link connecting stress and cardiovascular disease. Stress. 2012;15(1):45–51. doi:10.3109/10253890.2011.578266.*
33. ^*Średniawa A, Drwiła D, Krotos A, Wojtaś D, Kostecka N, Tomasik T. Insomnia and the level of stress among students in Krakow, Poland. Trends Psychia. Psychotherapy. 2019;41:60-68. doi:10.1590/2237-6089-2017-0154.*
34. ^*Benham G. Stress and sleep in college students prior to and during the COVID-19 pandemic. Stress Health. 2021;37(3):504-515. doi:10.1002/smi.3016.*
35. ^*Chapagai S, Martyn-Nemeth P. Sleep health, acculturation, and acculturative stress in immigrants in the United States: A scoping review. J. Transcultural Nurs. 2022;33(3):398-415. doi:10.1177/10436596211072884.*
36. ^*Liu Z, Liu R, Zhang Y, Zhang R, Liang L, Wang Y, Wei Y, et al. Association between perceived stress and depression among medical students during the outbreak of COVID-19: The mediating role of insomnia. J. Affect. Disord. 2021;292:89-94. doi:10.1016/j.jad.2021.05.028.*
37. ^*Godet-Cayre V, Pelletier-Fleury N, Le Vaillant M, Dinet J, Massuel MA, Leger D. Insomnia and absenteeism at work: Who pays the cost? Sleep. 2006;29:179-184. doi:10.1093/sleep/29.2.179.*
38. [a, b]*Ozminkowski RJ, Wang S, Walsh, JK. The direct and indirect costs of untreated insomnia in adults in the United States. Sleep. 2007;30(3):263-273. doi:10.1093/sleep/30.3.263.*
39. ^*Daley M, Morin CM, LeBlanc M, Grégoire JP, Savard J. The economic burden of insomnia: Direct and indirect costs for individuals with insomnia syndrome, insomnia symptoms, and good sleepers. Sleep. 2009;32(1):55-64. PMCID: PMC2625324.*
40. [a, b]*Rosekind MR, Gregory KB, Mallis MM, Brandt SL, Seal B, Lerner D. The cost of poor sleep: Workplace productivity loss and associated costs. J. Occup. Environ. Med. 2010;52(1):91-98. doi:10.1097/JOM.0b013e3181c78c30.*
41. [a, b, c]*Gosselin E, Lemyre L, Corneil W. Presenteeism and absenteeism: Differentiated understanding of related phenomena. J. Occup. Health Psychol. 2013;18(1):75-86. doi:10.1037/a0030932.*
42. ^*Burton WN, Chen CY, Schultz AB, Li X. Association between employee sleep with workplace health and economic outcomes. J. Occup. Environ. Med. 2017;59(2):177-183. doi:10.1097/JOM.0000000000000934.*
43. ^*Litwiller B, Snyder LA, Taylor WD, Steele LM. The relationship between sleep and work: A meta-analysis. J. Applied Psychol. 2017;102(4):682-699. doi:10.1037/apl0000169.*
44. [a, b]*44 - Hafner M, Stepanek M, Taylor J, Troxel WM, Van Stolk C. Why sleep matters-the economic costs of insufficient sleep: A cross-country comparative analysis. Rand Health Qtrly. 2017;Jan.6 (4):11. PMID:28983434.*
45. [a, b]*Takami M, the NinJaSleep Study Group; Kadotani H, Nishikawa K, et al. Quality of life, depression, and productivity of city government employees in Japan: A comparison study using the Athens insomnia scale and insomnia severity index. Sleep Sci. Pract. 2018;2:4. doi:10.1186/s41606-018-0024-0.*
46. ^*Hägg SA, Torén K, Lindberg E. Role of sleep disturbances in occupational accidents among women. Scand. J. Work Environ. Health. 2015;41(4):368–376. https://www.jstor.org/stable/i24466930.*

47. ^*Leger D, Bayon V, Ohayon MM, et al. Insomnia and accidents: Cross-sectional study (EQUINOX) on sleep-related home, work and car accidents in 5293 subjects with insomnia from 10 countries. J Sleep Res. 2014;23(2):143–152. doi:10.1111/jsr.12104.*

48. ^*Barnes CM, Watson NF. Why healthy sleep is good for business. Sleep Med. Rev. 2019;47:112-118. doi:10.1016/j.smrv.2019.07.005.*

49. ^*Hillman D, Mitchell S, Streatfeild J, Burns C, Bruck D, Pezzullo L. The economic cost of inadequate sleep. Sleep. 2018;41(8):zsy083. doi:10.1093/sleep/zsy083A.*

50. ^*Bakker D, Kazantzis N, Rickwood D, Rickard N. Mental health smartphone apps: review and evidence-based recommendations for future developments. JMIR Mental Health. 2016;3(1):e4984. doi:10.2196/mental.4984.*

51. ^*Abd-Alrazaq AA, Rababeh A, Alajlani M, Bewick BM, Househ M. Effectiveness and safety of using chatbots to improve mental health: Systematic review and meta-analysis. J Medical Internet Research. 2020;22(7):e16021. doi:10.2196/16021.*

52. ^*Eisenstadt M, Liverpool S, Infanti E, Ciuvat RM, Carlsson C. Mobile apps that promote emotion regulation, positive mental health, and well-being in the general population: Systematic review and meta-analysis. JMIR Mental Health. 2021;8(11):e31170. doi:10.2196/31170.*

53. ^*Paganini S, Meier E, Terhorst Y, Wurst R, Hohberg V, Schultchen D, Strahler J, Wursthorn M, Baumeister H, Messner EM. Stress management apps: Systematic search and multidimensional assessment of quality and characteristics. JMIR mHealth and uHealth. 2023;11:e42415. doi:10.2196/42415.*

54. ^*Tokgöz P, Hrynyschyn R, Hafner J, Schönfeld S, Dockweiler C. Digital health interventions in prevention, relapse, and therapy of mild and moderate depression: Scoping review. JMIR Mental Health. 2021;8(4):e26268. doi:10.2196/26268.*

55. ^*Kruse CS, Betancourt JA, Gonzales M, Dickerson K, Neer M. Leveraging mobile health to manage mental health/behavioral health disorders: Systematic literature review. JMIR Mental Health. 2022;9(12):e42301. doi:10.2196/42301.*

56. ^*Sevic A, Hashemi NS, Thørrisen MM, Strømstad K, Skarpaas LS, Storm M, Brønnick KK. Effectiveness of eHealth interventions targeting employee health behaviors: Systematic review. J Med Internet Res. 2023;25:e38307. doi:10.2196/38307.*

57. ^*Oftedal S, Burrows T, Fenton S, Murawski B, Rayward AB, Duncan MJ. Feasibility and preliminary efficacy of an m-Health intervention targeting physical activity, diet, and sleep quality in shift-workers. Int J Environ Res Public Health. 2019;16(20):3810. doi:10.3390/ijerph16203810.*

58. ^*Lenker K, Bourchtein E, Paquet C, Calhoun S, Fernandez-Mendoza J. 0376 Long-term effectiveness of cognitive-behavioral therapy for insomnia: A patient-reported outcomes post-treatment study. Sleep. 2023;46(Supplement 1):A167. doi:10.1093/sleep/zsad077.0376.*

59. [a, b]*Mak M, Rahmani A. 0379 A scoping review of validation studies for commercially available CBT-I smartphone applications. Sleep. 2023;46(Supplement 1):A168. doi:10.1093/sleep/zsad077.0379.*

60. [a, b, c, d, e, f, g, h]*Attridge, M. Internet-based cognitive-behavioral therapy for employees with anxiety, depression, social*

phobia or insomnia: Clinical and work outcomes. SAGE Open. 2020;10(1). doi:10.1177/2158244020914398.

61. [a, b, c, d, e, f] *Attridge M, Morfit MC, Roseborough DJ, Jones ER. "Internet-based cognitive-behavioral therapy for college students with anxiety, depression, social anxiety or insomnia: Four single-group longitudinal studies of archival commercial data and replication of employee user study." JMIR – J. Formative Res. 2020;4(7):e17712. https://formative.jmir.org/2020/7/e17712/.*
62. [^] *Hays R, Stewart A. "Sleep measures." In Stewart AL, Ware JE, eds. Measuring Functioning and Well-being: The Medical Outcomes Study Approach. Duke University Press: Durham, NC, USA, 1992, pp. 235-259.*
63. [^] *Stewart AL, Hays RD, Ware JE. "The MOS short-form general health survey: Reliability and validity in a patient population." Med. Care. 1988;26(7):724-735. doi:10.1097/00005650-198807000-00007.*
64. [^] *Kroenke K, Spitzer RL, Williams JB. "The PHQ-9: Validity of a brief depression severity measure." J. Gen. Intern. Med. 2001;16(9):606-613. doi:10.1046/j.1525-1497.2001.016009606.x.*
65. [^] *Martin A, Rief W, Klaiberg A, Braehler E. "Validity of the brief patient health questionnaire mood scale (PHQ-9) in the general population." Gen. Hosp. Psychia. 2006;28(1):71-77. doi:10.1016/j.genhosppsych.2005.07.003.*
66. [^] *Spitzer RL, Kroenke K, Williams JB, Löwe B. "A brief measure for assessing generalized anxiety disorder: The GAD-7." Arch. Intern. Med. 2006;166(10):1092-1097. doi:10.1001/archinte.166.10.1092.*
67. [^] *Kroenke K, Spitzer RL, Williams JB, Monahan PO, Löwe B. "Anxiety disorders in primary care: Prevalence, impairment, comorbidity, and detection." Ann. Intern. Med. 2007;146(5):317-325. doi:10.7326/0003-4819-146-5-200703060-00004.*
68. [^] *Löwe B, Decker O, Müller S, Brähler E, Schellberg D, Herzog W, Herzberg, PY. "Validation and standardization of the generalized anxiety disorder screener (GAD-7) in the general population." Med. Care. 2008;46(3):266-274. doi:10.1097/MLR.0b013e318160d093.*
69. [^] *Connor KM, Davidson JR, Churchill LE, Sherwood A, Foa E, Weisler RH. "Psychometric properties of the social phobia inventory (SPIN): New self-rating scale." Br. J. Psychia. 2000;176: 379-386. doi:10.1192/bjp.176.4.379.*
70. [^] *Antony MM, Coons MJ, McCabe RE, Ashbaugh A, Swinson RP. "Psychometric properties of the Social Phobia Inventory: Further evaluation." Behav. Res. Ther. 2006;44(8):1177-1185. doi:10.1016/j.brat.2005.08.013.*
71. [a, b, c] *Cohen S, Kamarck T, Mermelstein R. "A global measure of perceived stress." J. Health Social Behav. 1983;24(4):385–396. https://psycnet.apa.org/doi/10.2307/2136404.*
72. [^] *Cohen S, Williamson G. "Perceived stress in a probability sample of the United States." In Spacapan, S, Oskamp, S., eds, The Social Psychology of Health. SAGE: Newbury Park, CA, USA, 1988, pp. 31–68.*
73. [^] *Taylor JM. "Psychometric analysis of the ten-item perceived stress scale." Psychol. Assess. 2015;27(1):90-101. doi:10.1037/a0038100.*
74. [^] *Hays RD, Bjorner J, Revicki RA, Spritzer KL, Cella D. "Development of physical and mental health summary scores from the patient reported outcomes measurement information system (PROMIS) global items." Qual Life Res. 2009;18(7):873–880. doi:10.1007/s11136-009-9496-9.*
75. [^] *Magasi S, Ryan G, Revicki D, et al. "Content validity of patient outcomes: Perspectives from a PROMIS meeting." Qual Life Res. 2011;21(5):739–746. doi:10.1007/s11136-011-9990-8.*

76. [a, b, c]*Attridge M, Dickens SP. "Onsite screening and enhanced EAP counseling improves overall health, depression, and work outcomes: Four-wave longitudinal pilot study at a community health center in Vermont." J. Workplace Behav. Health. 2021;36(4):278–308. doi:10.1080/15555240.2021.1971537.*

77. [a, b, c, d]*Attridge M, Dickens SP. "Health and work outcomes of brief counseling from an EAP in Vermont: Follow-up survey results, client satisfaction, and estimated cost savings." SAGE Open. 2022;12(1). doi:10.1177/21582440221087278.*

78. [a, b]*Kessler RC, Barber C, Beck A, et al. "The world health organization health and work performance questionnaire (HPQ)." J. Occup. Environ. Med. 2003;45(2):156–174. doi:10.1097/01.jom.0000052967.43131.51.*

79. [^]*Stewart WF, Ricci JA, Chee E, Morganstein D. "Lost productive work time costs from health conditions in the United States: Results from the American Productivity Audit." J. Occup. Environ. Med. 2003;45(12):1234-1246. doi:10.1097/01.jom.0000099999.27348.78.*

80. [^]*Cohen J. Statistical Power Analysis for the Behavioral Sciences, 2nd. ed. New York, NY, USA: Lawrence Erlbaum Associates, 1988.*

81. [^]*Gignac GE, Szodorai ET. "Effect size guidelines for individual differences researchers." Personality Individ. Differ. 2016;102:74-78. doi:10.1016/j.paid.2016.06.069.*

82. [a, b]*Morneau Shepell. Workplace Outcome Suite (WOS) Annual Report 2020: Part 1 - Decade of Data on EAP Counseling Reveals Prominence of Presenteeism. [White paper 95 pages]. Toronto, ON. 2020. Author: Attridge, M. http://hdl.handle.net/10713/13758.*

83. [^]*Morin CM, Benca, R. "Chronic insomnia." Lancet. 2012;379:1129–1141. doi:10.1016/S0140-6736(11)60750-2.*

84. [^]*Khurshid KA. "Comorbid insomnia and psychiatric disorders: An update." Innova. in Clin. Neurosc. 2018;15(3-4):28-32. PMID: 29707424.*

85. [^]*Chen TL, Chang SC, Hsieh HF, Huang CY, Chuang JH, Wang HH. "Effects of mindfulness-based stress reduction on sleep quality and mental health for insomnia patients: A meta-analysis." J. Psychosomatic Res. 2020;135:110144. doi:10.1016/j.jpsychores.2020.110144.*

86. [^]*Johnson EO, Roehrs T, Roth T, Breslau N. "Epidemiology and medication as aids to sleep in early adulthood." Sleep. 1998;21:178–186. doi:10.1093/sleep/21.2.178.*

87. [^]*Benz F, Knoop T, Ballesio A, et al. "The efficacy of cognitive and behavior therapies for insomnia on daytime symptoms: A systematic review and network meta-analysis." Clin. Psychol. Rev. 2020;80:101873. doi:10.1016/j.cpr.2020.101873.*

88. [^]*Cheng P, Kalmbach DA, Tallent G, Joseph CL, Espie CA, Drake CL. "Depression prevention via digital cognitive behavioral therapy for insomnia: A randomized controlled trial." Sleep. 2019;42:zsz150. doi:10.1093/sleep/zsz150.*

89. [^]*Lin YH, Chiang TW, Lin YL. "Increased internet searches for insomnia as an indicator of global mental health during the COVID-19 pandemic: Multinational longitudinal study." J. Med. Internet Res. 2020;22(9):e22181. https://www.jmir.org/2020/9/e22181/.*

90. [^]*Morin CM, Bjorvatn B, Chung F, et al. "Insomnia, anxiety, and depression during the COVID-19 pandemic: An*

international collaborative study." Sleep Med. 2021;87:38-45. doi:10.1016/j.sleep.2021.07.035.

91. ^*Mahmud S, Hossain S, Muyeed A, Islam MM, Mohsin M. "The global prevalence of depression, anxiety, stress, and insomnia and its changes among health professionals during COVID-19 pandemic: A rapid systematic review and meta-analysis." Heliyon. 2021;7(7):e07393. doi:10.1016/j.heliyon.2021.e07393.*

92. ^*American Psychological Association. APA Ethical Guidelines for Research, 2017. http://www.sandplay.org/pdf/APA_Ethical_Guidelines_for_Research.pdf*