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A COMPARISON OF AN EMERGENT FACTOR STRUCTURE OF THE INSOMNIA SEVERITY INDEX SET AGAINST A GLOBAL CONTEXT

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Study objectives: To identify the factor structure of the Insomnia Severity Index (ISI) and test it against competing international measurement models. Methods: A cross- sectional study survey with a randomly selected sample of 1,500 individuals living in Jordan. The ISI was administered and a response rate of 84% (n = 1,260) obtained. Both exploratory and confirmatory factor analysis were used to examine competing theoretical measurement models. Results: A new emergent measurement model was identified that may help synchronize differing measurement models reported in international literature. Exploratory factor analysis results indicated a two-factor model as a reasonably sound explanation of the data. However, this model is challenged by results from a confirmatory factor analysis. Conclusions: These findings expand the evidence base that the ISI is a reliable instrument to detect severity of insomnia in the population. Our model helps synthesize previous approaches to measurement reported in the international literature

Key words: Insomnia Severity Index; Psychometric properties; Factor structure; Jordan; Assessment.

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Insomnia is recognized as a global public health issue (Choueiry, Salamoun, Jabbour, El Osta, Hajj, & Rabbaa Khabbaz, 2016; Li, Wu, Gan, Qu, & Lu, 2016). The current American Psychiatric Association's (2013) *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*), definition of insomnia includes:

- Unhappiness with the quality or quantity of sleep, which can include trouble falling asleep, staying asleep, or waking up early and being unable to get back to sleep;
- The sleep disturbance causes significant distress or impairment in functioning, such as within the individual's working or personal life, behaviorally or emotionally;

- Difficulty sleeping occurs at least three times a week and is present for at least three months;
- The problem occurs despite ample opportunity to sleep;
- The difficulty cannot be better explained by other physical, mental, or sleep-wake disorders;
- The problem cannot be attributed to substance use or medication.

The condition has been associated with many physical and psychological conditions (Ancoli-Isreal, Ayalon, & Salzman, 2008; Jespersen, Koenig, Jennum, & Vuust, 2015). For example, it can lead to depression and anxiety (LeBlanc et al., 2009; Wong & Fielding, 2011), addiction disorder (Shibley, Malcolm, & Veatch, 2008), inattention problems, poor quality of life, and overall functioning (Léger, Scheuermaier, Philip, Paillard, & Guilleminault, 2001; Léger et al., 2014). Physically it has been associated with increased risk of stroke, obesity, diabetes, and hypertension (Fernandez-Mendoza, & Vgontzas, 2013; National Institute of Health, 2005) and decreased immune functioning (Besedovsky, Lange, & Born, 2012). In a meta-analysis of perspective studies conducted by Cappuccio, D'Elia, Strazzullo, and Miller (2010) insomnia was associated with greater risk of death. Insomnia is also reported to affect occupational function and social relations and is associated with higher work absenteeism (Bolge, Doan, Kannan, & Baran, 2009) and increased risk of accidents (Kessler et al., 2012), and therefore represents a condition with great costs for both the individual and society (Léger & Bayon, 2010; Wickwire, Shaya, & Scharf, 2016).

Epidemiological studies have reported a wide range of prevalence rates (Chung et al., 2015). For example, de Souza Lopes, Rodrigues Robaina, and Rotenberg (2012), estimated that between 10-15% of the population suffer from insomnia regularly, and a further 25-30% report transient or occasional insomnia. Prevalence rates of insomnia among the general population in developed countries are reported to be 23% in Japan and 56% in the United States (Léger, Poursain, Neubauer, & Uchiyama, 2008). Roth et al. (2011) in America surveyed 10,094 participants, using the Brief Insomnia Questionnaire (BIQ). This study found insomnia prevalence estimates of 22.1%, whilst in South America prevalence rates are estimated at 14.3% of the population (Rocha, Guerra, & Lima-Costa, 2002) increasing to 35.4% among females (Marchi, Reimão, Tognola, & Cordeiro, 2004). However, the World Health Organization survey of 24,434 women and 19,051 men, drawn from across eight countries in Africa and Asia, found that 16% of the participants reported extreme sleep problems with prevalence varying significantly across regions ranging from 3.9% to 40% (Stranges, Tigbe, Gómez-Olivé, Thorogood, & Kandala, 2012). In Europe, Ohayon and Roth (2001) in a cross-sectional survey study with a representative sample of 24,600 participants drawn from France, United Kingdom, Germany, Italy, Portugal, and Spain, found a 10.1% prevalence for difficulty in going to sleep and a further 22.2% for maintaining sleep, with a frequency of three or more times a week.

Prevalence studies show insomnia is more common among older adults (Kamel & Gammack, 2006; Kim, Uchiama, Okawa, Liu, & Ogihara, 2000), females (Zhang & Wing 2006), those who take medication, and among those with a presence of concurrent mental health issues (Lee, Baker, Newton, & Ancoli-Israel, 2008), being of lower education, not living with a partner, and poorer quality of life impacted on insomnia levels (Stranges et al., 2012). Studies that examined the association between marital status and insomnia generally report a higher prevalence in separated/divorced or widowed individuals (Li, Wing, Ho, & Fong 2002; Rocha et al., 2002; Xiang et al., 2008) when compared to single or married people. However, findings from demographic research is not straightforward; for example, whilst Kamel and Gammack (2006) and Kim et al. (2000) reported age as a significant factor in insomnia, several scholars (Lee et al., 2008; Suzuki, Miyamoto, & Hirata, 2017) argue that it may be due to other factors such as concurrent medical and psychological conditions and the use of medications to treat them.

De Souza Lopes et al. (2012), in an examination of the measurement of insomnia stated that the variability in prevalence rates across the world may be attributed to the clinical definitions used to define

insomnia and the measurement tool used to rate it. This led to a call for standardization of both definition and measurement, in order to facilitate comparability globally and a better understanding of contributing factors. Accurate identification of insomnia symptoms is crucial to foster accurate, timely diagnosis, and effective management of insomnia (Gagnon, Bélanger, Ivers, & Morin, 2013).

Self-report instruments such as Insomnia Severity Index (ISI) provide a measure of the key symptoms of clinical insomnia (Moscou-Jackson, Allen, Smith, & Haywood Jr, 2016) and this index has been aligned with the *DSM-5* classification (Gagnon et al., 2013). The index comprises seven items that measure perceived insomnia over a two-week period and examines severity of symptoms, impact on the individual, and overall satisfaction with quality and quantity of sleep. However it does not inlcude measures of explanatory causes (physical or medication), nor frequency (incidence per week), nor duration (last three months) of insomnia.

A review of the literature identified 21 key papers relevant to the psychometric properties and examination of the factor structure of the ISI (see Table 1). On examination of the papers' statistical properties relating to reliability and validity, the ISI is an effective tool in identifying people with insomnia and its relation to insomnia- related conditions. It has been shown to have strong internal and external validity. Cronbach's alpha scores of the total items show strong internal consistency across a number of studies involving varied clinical and nonclinical populations (Boysan, Güleç, Beşiroğlu, & Kalafat, 2010; Fernandez-Mendoza et al., 2013; Kaufmann et al., 2017; Sadeghniiat-Haghighi, Montazeri, Khajeh-Mehrizi, Nedjat, & Aminian, 2014; Sierra, Guillén-Serrano, & Santos-Iglesias, 2008; Veqar & Hussain, 2017). It has been shown to have strong discriminant validity in identifying a clinical population of insomnia patients across countries, conditions, and settings (Gagnon et al., 2013; Morin, Belleville, Bélanger, & Ivers, 2011; Moscou-Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014; Veqar & Hussain, 2017; Wong et al., 2017; Yazdi, Sadeghniiat-Haghighi, Zohal, & Elmizadeh, 2012); convergent validity (Boysan et al., 2010; Chung, Kan, & Yeung, 2011; Fernandez-Mendoza et al., 2013; Kaufmann et al., 2017; Morin et al., 2011; Moscou-Jackson et al., 2016; Yu 2010) and test-retest (Chahoud, Chahine, Salameh, & Sauleau, 2017); criterion-related validity (Sadeghniiat-Haghighi et al., 2014), and concurrent validity (Bastien, Vallières, & Morin, 2001; Castronovo et al., 2016; Chung et al., 2015; Gerber et al., 2016; Moscou-Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014).

The ISI has proven reliability: test-retest reliability (Chung et al., 2011; Veqar & Hussain, 2017), sensitivity to change (Bastien et al., 2001), and moderate correlation with sleep diary and polysomnography measures (Bastien et al., 2001, Chung et al., 2011; Sadeghniiat-Haghighi et al., 2014). It has been used with international populations and translated into numerous languages (see Table 1; Bastien et al., 2001; Blais, Gendron, Mimeault, & Morin, 1997; Chahoud et al., 2017; Gerber et al., 2016; Savard, Savard, Simard, & Ivers, 2005; Yang, Morin, Schaefer, & Wallenstein, 2009) and across populations, for example, adolescents (Gerber et al., 2016) and older people (Chung et al., 2011); and has been used to study insomina with various clinical conditions such as cancer (Savard et al., 2004), chronic pain (Dragioti, Wiklund, Alföldi, & Gerdle, 2015), sickle cell disease (Moscou-Jackson et al., 2016), and traumatic brain injury (Moscou-Jackson et al., 2016).

However inconsistencies in factor structure with variability across country, settings, and populations have been noted (see Table 1). Even within studies (Fernandez-Mendoza et al., 2013), a variable (one- or three-) factor structure was evident. The constituent items contained in both the two- and three-factor models show a relatively stable factor structure with Items 1-3 loading on "severity of insomnia" and

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TABLE 1
Psychometric properties and factor structure of the ISI

Study	Country	Setting	Population	Factor structure
Bastien Vallières, & Morin (2001)	Canada	French	*N* = 145 insomnia patients	Three-factor model
Savard et al. (2004)	USA	English	*N* = 1,670 cancer patients	Two-factor model
Sierra, Guillén-Serrano, & Santos-Iglesias (2008)	Spain	Spanish	*N* = 230 older people	One-factor model
Yu (2010)	China	Chinese	*N* = 585 older people	Two-factor model
Boysan, Güleç, Beşiroğlu, & Kalafat (2010	Turkey	Turkish	Clinical (*n* = 34) and nonclinical (*n* = 258)	Two-factor model
Chung, Kan, & Yeung (2011)	China	Chinese	*N* = 1516 adolescents	Two-factor model
Morin, Belleville, Bélanger, & Ivers (2011)	Canada	English	*N* = 959 survey; clinical (*n* = 183) and non-clinical (*n* = 62)	One-factor model
Lahan & Gupta (2011)	India	Hindi	Clinical (*n* = 45) and nonclinical (*n* = 20)	One-factor model
Fernandez-Mendoza et al. (2013)	Spain	Spanish	*N* = 500 nonclinical	One- and three-factor model
Sadeghniiat-Haghighi, Montazeri, Khajeh-Mehrizi, Nedjat, & Aminian (2014)	Iran	Persian	*N* = 1,037 Insomnia patient	Two-factor model
Cho, Song, & Morin (2014)	Korea	Korean	*N* = 614 insomnia patients	One-factor model
Ahmed (2014)	Saudi Arabia	Arabic	*N* = 83 nonclinical	One-factor model
Dragioti, Wiklund, Alföldi, & Gerdle (2015)	Sweden	Swedish	*N* = 836 chronic pain patients	One-factor model with items removed
Castronovo et al. (2016)	Italy	Italian	*N* = 272 insomnia patients	Three-factor model
Gerber et al. (2016)	Switzerland	German	*N* = 1,475 youth; 862 university students; *n* = 533 adults	One-factor model
Moscou-Jackson, Allen, Smith, & Haywood (2016)	USA	English	*N* = 263 sickle cell disease	Two-factor model
Chahoud, Chahine, Salameh, & Sauleau (2017)	Lebanon	French/ English	*N* = 104 students	Two-factor model in English and three-factor model in French
Kaufmann et al. (2017)	USA	English	*N* = 83 traumatic brain injury	One-factor model
Veqar & Hussain (2017)	India	Indian	*N* = 25 nonclinical	One-factor model
Byrne, Bullock, & Murray (2017)	USA	English	*N* = 462 insomnia patients (youth)	Two-factor model
Dieck, Morin, & Backhaus (2018)	Germany	German	Clinical (*n* = 416) and nonclinical (*n* = 284)	One-factor model

Items 5-7 on "impact of insomnia" (Bastien et al., 2001; Castronovo et al., 2016; Chung et al., 2015; Moscou -Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014).

Examination of the variability across the factor structure models reported in the literature highlights the issue of a measure relating to the placement of an item relating to satisfaction with sleeping behavior. In the three-factor model, this item forms the central tenet of the third factor and to substantiate its existence, two methods of dealing with the third factor are introduced. Both cross factor loadings with other items are permitted (Castronovo et al., 2016) so that it contains a minimum number of items to constitute a factor — three items or more "to provide minimum coverage of the construct's theoretical domain" (Hair, Black, Babin, & Anderson, 2010, p. 676). This provides significant challenges in instrument development (Edwards & Bagozzi, 2000).

Alternatively, satisfaction is placed either on severity of insomnia (Chung et al., 2011; Yu, 2010) or impact of insomnia (Moscou-Jackson et al., 2016), or both constructs (Sadeghniiat-Haghighi et al., 2014). Examination of Table 1 shows that this variability exists across clinical and cultural settings, therefore an alternative explanation is required. One explanation may be attributed to the differences in statistical procedures and acceptable standards for fit statistics.

Given the extensive use globally of the ISI across clinical settings and samples in both physical and psychological spheres of clinical and research practice, the establishment of its factor structure is necessary. Since its introduction in 1983, the index has been widely used for clinical and research purposes (Morin, 1993) and has been translated into several languages including Chinese (Yu, 2010), Spanish (Fernandez-Mendoza et al., 2013), Hindi (Lahan & Gupta, 2011), and into Arabic (Fusha dialect; Suleiman & Yates, 2011). Suleiman and Yates recommended that the translated Arabic ISI required further testing with a later sample of both clinical and healthy Arabic populations. Therefore, the aim of this study was threefold: first, to examine the factor structure of ISI; second, to test competing measurement models of the ISI with a large sample of the Arabic general population; and finally, to examine the influence of key demographic characteristics on the emergent model.

METHOD

A large scale cross-sectional survey was conducted with a randomly selected sample of 1,500 individuals living in Amman, the capital city of Jordan. Participants were recruited and assessed using a standardized tool and key demographic characteristics recorded.

Sample

This study formed part of a larger study looking at chronic obstructive pulmonary disease (COPD) and psychological comorbidities among a nonclinical population in Jordan (Al-Smadi et al., 2017). A list of registered residents was obtained from the Amman Municipality. Inclusion criteria were: resident in Jordan, aged at least 40 years old. The list included 200,000 houses and from this sampling frame a random sample of 1,500 houses was selected and approached by professionally trained researchers. During the study, 90 individuals were found to be less than 40 years old and were excluded, and 150 individuals refused to participate without providing an explanation. Information sheets were distributed and written consent obtained. Demographical data sheets and study questionnaires were self-completed by willing partici-

pants. In total, 1,260 participants drawn from Jordan and Iraq took part, representing a response rate of 84%. Based on a potential sampling frame of 10,000 and with 95% confidence level and 50% accuracy, the sample size represents a confidence interval of 2.58. The ratio of respondents to items was 180:1, which is above the 10:1 ratio (Hair et al., 2010).

Instruments

The Insomnia Severity Index (ISI; Morin 1993) was developed based on criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric association, 1994) and the *International Classification of Sleep Disorders* (*ICSD*; American Sleep Disorders Association, 1990) but has transferred to more recent editions of the classification criteria (Gagnon et al., 2013). It has seven questions designed to measure the impact of night and daytime components of insomnia, measured over a two-week period on a 5-point scale — Items 1-3: from 0 = *none* to 4 =*very severe*; Item 4: from 0 = *very satisfied* to 4 = *very dissatisfied*; Item 5: from 0 = *not at all interfering* to 4 = *very much interfering*; Item 6: from 0 = *not at all noticeable* to 4 = *very noticeable*; Item 7: from 0 = *not at all worried* to 4 = *very much worried* (see Table 3). Higher scores indicate issues with insomnia. All items had equal weighting and scores were summed up to total scores with 0-7 = indicating no clinically significant insomnia; 8-14 = subthreshold insomnia; 15-21 = clinical insomnia (moderate severity); 22-28 = clinical insomnia (severe). Participant demographic characteristics were collected as part of the tool.

Statistical Analyses

Descriptive analyses and measures of dispersion statistics were generated for all items to help inform subsequent analysis. Inter-item correlations were generated to examine for collinearity prior to full analysis. Measures of appropriateness to conduct factor analysis were conducted using the Kaiser-Meyer-Olkin (KMO) measures of sampling adequacy and Bartlett's test of sphericity. An initial exploratory factor analysis (EFA) was conducted specifying a one- and a three-factor model. Model estimators were set as maximum likelihood extraction with oblique rotation (Geomin) as it was predicted that factors might be correlated. A theoretically derived model based on the results from the EFA was then analyzed within a confirmatory factor analysis (CFA), using the same data. The model was respecified using the modification indices provided in the statistical output until acceptable and a statistically significant relationship identified. Cronbach's α scores were generated for factors in the accepted factor model. The impact of demographic characteristics on the factor model was examined using regression.

Acceptance modification criteria were applied as follows: (a) the items to first order factors were fitted initially; (b) correlated error variance permitted as all items were measuring the same unidimensional construct; (c) factor loadings above .45 to provide a strong emergent factor structure (based on sample size; Hair et al., 2010); (d) only statistically significant relationships retained to obtain a model as parsimonious as possible.

Acceptable fit statistics were set at root mean square error of approximation (RMSEA) of .05 or below, 90% confidence interval (CI) higher bracket below .08; comparative fit indices (CFI) of .95 or higher; and standardized root-mean-square residual (SRMR) below .05 (Byrne, 2013; Wang & Wang, 2012).

Ethics

Full ethical approval was sought and gained from the Jordanian national ethics board prior to commencement of the study. All principles of good clinical practice in research were adhered to throughout the study. Confidentiality and anonymity of participants' responses were ensured, and the data were securely stored.

RESULTS

From 1,500 individuals living in Amman, the capital city of Jordan, 1,260 (84%) consented to participate in the study. Table 2 summarizes the descriptive characteristics of the sample. The majority (92.9%) of participants were Jordanian, married (78.0%), aged 40-49 years (45.1%), and had a college or university degree (54.9%). There was a representative distribution of male and female respondents in the sample.

TABLE 2
Demographic characteristics of participants

Demographic	Percentage	Demographic	Percentage
Male	49.8% (*n* = 627)	Less than secondary school	8.33% (*n* = 105)
Female	50.2% (*n* = 633)	Secondary school	24.61% (*n* = 310)
		Bachelor's degree	54.92% (*n* = 692)
		Post graduate	12.14% (*n* = 153)
Jordanian	92.9% (*n* = 1,171)		
Other	7.1% (*n* = 89)		
Married	78.0% (*n* = 983)	40-49 years	45.1% (*n* = 568)
Divorced	6.0% (*n* = 76)	50- 59 years	30.7% (*n* = 387)
Widowed	7.7% (*n* = 97)	60- 69 years	15.2% (*n* = 191)
Single	8.3% (*n* = 104)	+70 years	9.0% (*n* = 114)

Measures of Distribution

Mean scores indicate a low level of severity of sleep disturbance among the seven items. As shown in Table 3, the highest scored items were "satisfied with current sleep patterns" (*M* = 1.348) and the lowest was "worried/distressed about your sleep" (*M* = 0.776). Measures of skewness and kurtosis were acceptable. Almost half (58.4%, *n* = 730) of the participants in the study reported having no difficulty with insomnia, with almost a third of participants (31.8%, *n* = 398) reporting subthreshold insomnia. A further 9.8% were clinically insomniac as 8.6% (*n* = 108) reported moderate severity of insomnia, and 1.2% (*n* = 15) severe insomnia.

Exploratory Factor Analysis

The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO = 0.894) and Bartlett test of sphericity (χ^2 = 4527, *df* = 21, *p* = .001) are acceptable values.

TABLE 3
Mean scores (*SD*), skewness, kurtosis, and factor loading of items of Insomnia Severity Index

Item	Scoring range	Mean (*SD*)	Skewness	Kurtosis
Difficulty falling asleep	0 = *None*, 4 = *Very severe*	0.918 (0.99)	0.903	–0.166
Difficulty staying asleep	0 = *None*, 4 = *Very severe*	0.927 (1.04)	0.893	–0.073
Problems waking up too early	0 = *None*, 4 = *Very severe*	1.020 (1.15)	0.924	–0.079
Satisfied with current sleep pattern	0 = *Very satisfied*, 4 = *Very dissatisfied*	1.348 (1.01)	0.514	–0.225
Noticeable to others/quality of life	0 = *Not at all noticeable* 4 = *Very much noticeable*	0.869 (0.95)	0.861	0.080
Worried/distressed	0 = *Not at all worried* 4 = *Very much worried*	0.776 (0.93)	1.067	0.580
Interfere with daily functioning	0 = *Not at all interfering* 4 = *Very much interfering*	1.057 (1.06)	0.761	–0.140

EFA (with the total sample) of the seven items failed to provide a clear factor structure with a one-factor model, without dropping items from further analysis. The three-factor model provided acceptable fit statistics, however it isolated a single item as a potential construct and therefore was excluded as an acceptable explanation of the data. The results indicated a two-factor model as a better explanation of the data than a one- or three-factor model, using all available items and producing two clear and an acceptable factor structure (see Table 4 and Table 5).

TABLE 4
Comparison of EFA: one-, two-, and three-factor models

Model	Number of parameters	χ^2	*df*	*p*
One-factor	21	50.029	14	.000
Two-factor	27	23.873	8	.002
Three-factor	32	3.939	3	.268

It was deemed appropriate to use a two-factor model as the measurement model for testing using CFA. The two factors were examined: (1) “Active sleeping patterns” measures the immediacy of sleeping behavior, and (2) “Impact of insomnia” measures the psychosocial impact of insomnia on the individual.

Confirmatory Factor Analysis

The two-factor measurement model specified in the EFA was tested using CFA, with estimator maximum likelihood robust to deal with the floor effect observed in the data. Fit statistics show an unacceptable model: $\chi^2 = 113.57$, $df = 13$, $p = .001$; RMSEA = .079, 90% CI [.066, .092]; CFI = .961; SRMR = .036. A cross factor loading modification on Item 4 “Satisfied with current sleep pattern” was introduced to

the model based on modification indices (MI) scores (MI = 75.43). Fit statistics show an acceptable model: $\chi^2 = 43.89$, $df = 12$, $p = .001$; RMSEA = .046, 90% CI = [.032, .061]; CFI = .99; SRMR = .02. All relationships were statistically significant. The factor loadings for all items were acceptable (see Table 6).

In the two-factor model, the cross-factor loading of Item 4 remains an issue. However, model fit statistics were improved with its introduction as influencing both factors. Factor loadings would indicate it loads on "severity of insomnia" but in the original EFA it is identified on "impact of insomnia." In the three-factor model it stands alone as a single item measure not a factor. Theoretically, the item "Satisfied with current sleep pattern" could be influenced by both factors and therefore it was decided to introduce it as a single item measure of overall satisfaction with sleep and examine its relationship with both severity and impact of insomnia. The multiple indicators multiple causes model (MIMIC) was tested and fit statistics show an acceptable model: $\chi^2 = 43.89$, $df = 12$, $p = .001$; RMSEA = .046, 90% CI [.032, .061]; CFI = .99; SRMR = .02. All relationships were statistically significant (Figure 1).

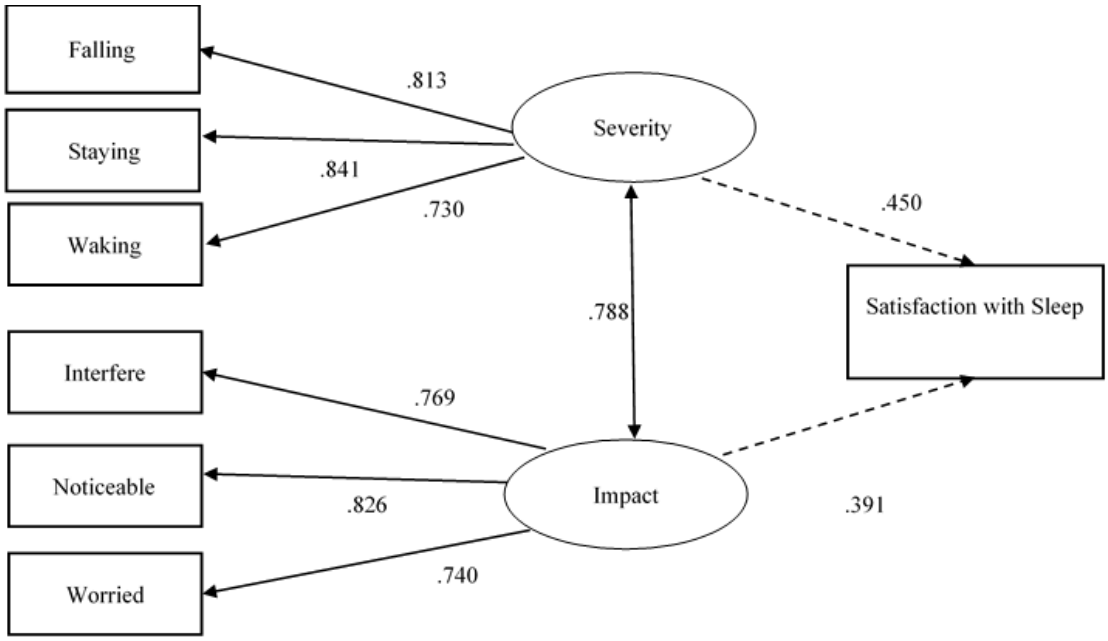

FIGURE 1
Multiple indicator multiple causes model for Insomnia Severity Index.

Cronbach's α and Item to Total Correlation

Cronbach's α for the instrument was acceptable — total instrument = .89 (corrected item to total correlation .62-.77); insomnia severity = .84 (corrected item to total correlation .58-.74); impact of insomnia = .84 (corrected item to total correlation .71-.84). Examination of the α scores if item deleted indicate that this score would not be improved regardless of items deleted.

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TABLE 5
One-, two-, and three-factor model: Factor loading from EFA

	One-factor model RMSEA = .045, 90% CI [.032, .059]; CFI = .996	Two-factor model RMSEA = .040, 90% CI [.022, .059]; CFI = .998		Three-factor model RMSEA = .016, 90% CI [.000, .053]; CFI = 1.0		
Difficulty falling asleep	.315	.645*	.314	.559*		
Difficulty staying asleep	.234	.684*	.232	.654*		
Problems waking up too early	.358	.693*	.357	.677*		
Satisfied with current sleep pattern	.986*	.478	.986*		.984*	
Noticeable to others/quality of life	.497*	.359	.497*			.934
Worried/distressed	.994*	.475	.994*		.994*	
Interfere with daily functioning	.983*	.471	.983*		.977*	

Note. RMSEA = root mean square error of approximation; CI = confidence interval; CFI = comparative fit index.
* $p < 05$.

TABLE 6
Two-, and three-factor model: Factor loading (standard error) from CFA

	Two-factor model		Three-factor model		
Item	Active sleeping pattern	Impact of insomnia	Active sleeping pattern	Satisfaction with sleep	Impact of insomnia
Difficulty falling asleep	.813 (.028)*		.813 (.028)*		
Difficulty staying asleep	.841 (.028)*		.841 (.028)*		
Problems waking up too early	.730 (.034)*		.730 (.034)*		
Satisfied with current sleep pattern	.450 (.055)*	.391 (.055)*		.528 (.055)	
Noticeable to others/quality of life		.769 (.024)*			.769 (.024)*
Worried/distressed		.826 (.025)*			.826 (.025)*
Interfere with daily functioning		.740 (.029)*			.740 (.029)*

Note. * $p < 05$.

Multiple Indicator Multiple Causes Model

There was a strong correlated error between insomnia severity and impact of insomnia (.77, p = .001). Likewise, insomnia severity (.449, p = .001) and impact of insomnia (.462 p = .001) impacted on satisfaction with sleep.

Only marital status was found to have a statistically significant impact on scores across the first-order latent variables "insomnia severity" and "impact of insomnia" where higher scores were reported among those participants who were not married (see Figure 2). Being divorced (.325, p = .02) or widowed (.307, p = .03) compared to being married increased scores on the ISI–sleeping pattern. Being divorced (.317, p = .02) or widowed (.271, p = .04) compared to being married increased scores on the impact of insomnia.

Age of respondent had a negative relationship on satisfaction with sleep scores, and as age increased it was accompanied by a decrease in satisfaction with sleep (50-59 years olds = –.098, p = .043; 60-69 years old = –.197, p = .001; 70+ years = –.221, p = .002). Fit statistics show an acceptable model: χ^2 = 107.548, df = 52, p = .001; RMSEA = .029, 90% CI [.021, .037]; CFI = .986; SRMR = .015.

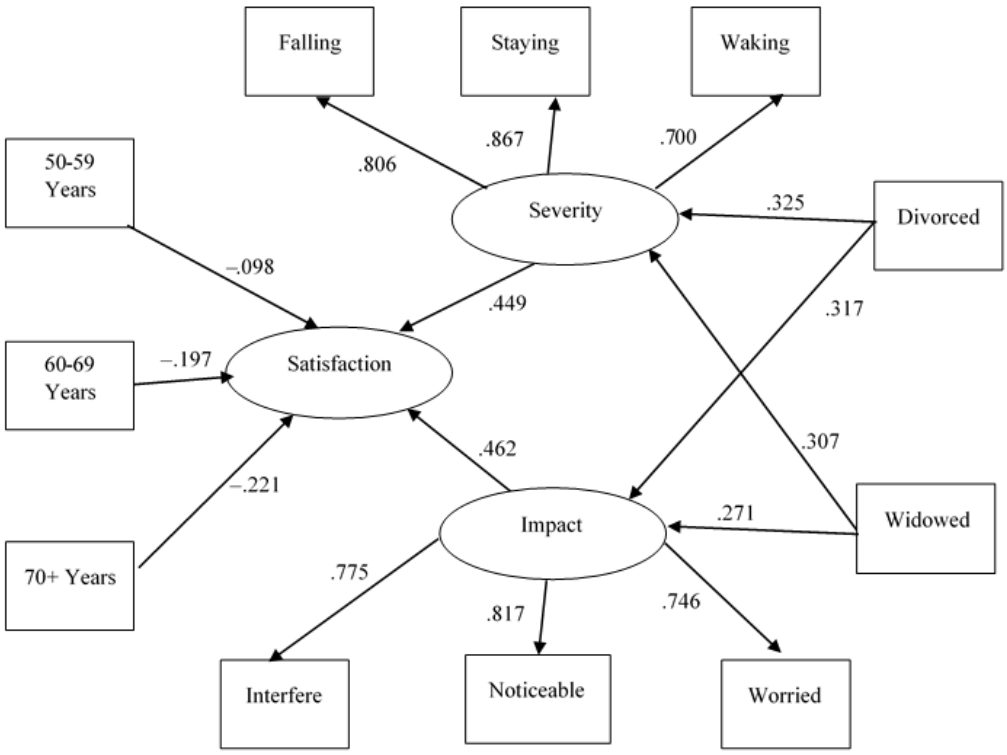

FIGURE 2
The measurement model of the ISI and statistically significant demographic characteristics.

DISCUSSION

Insomnia is a global issue which impacts on people worldwide (Choueiry et al., 2016) and has a significant effect on quality of life and burden on society (Wickwire, et al., 2016). The ISI has been proven as an internationally renowned screening tool to identify the severity of insomnia and has been used across

clinical populations (Gagnon et al., 2013; Morin et al., 2011; Moscou-Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014; Veqar and Hussain, 2017; Wong et al., 2017; Yazdi et al., 2012). This study provides a fuller understanding of the factor structure and construct validity of the tool.

The overall severity rates of insomnia among the Jordian population are much lower than those reported in international studies worldwide. Less than 10% of this population were reported as having symptoms of insomnia (9.8%), well below prevalence rates reported by the WHO in Asia and Africa (Stranges et al., 2012), by de Souza Lopes et al. (2012) in South America, and Rocha et al. (2002) in Europe. However, the WHO (Stranges et al 2012) reported that prevalence rates of insomnia varied greatly across and within countries and depended on the criteria and methods of assessment. The ISI is the most widely used measure of insomnia severity and chronicity in the literature, closely aligned to the *DSM-5* (American Psychiatric Association, 2013) criteria for insomnia and should therefore be used as the standard measure of insomnia severity. This would permit comparability of prevalence rates internationally.

The findings presented here challenge the perception of measuring severity of insomnia as a single construct (Dragioti et al., 2015; Morin et al., 2011; Sierra et al., 2008). Findings from the EFA and CFA clearly show that a multifactorial model underlies the ISI. This position is not new within the research literature (e.g., Bastien et al., 2001; Moscou -Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014). The *DSM-5* criteria for a definition of insomnia include two elements: (1) quantity of sleep and sleep quality/type as measured by sleep initiation, maintenance, and duration, and (2) sleep disturbance causing clinically significant distress or impairment. It identifies an overall dissatisfaction with sleep as the combination of both factors, alongside frequency per week, duration of a three-month period, and exclusion of extenuating circumstances (American Psychiatric Association, 2013).

The findings from this study show that the EFA identified the three-factor model as being the best fit for the sample under investigation. However, whilst the three-factor model provides a better fit statistically, ambiguity on the placement of the item “Satisfaction with sleeping” and its reliance on cross-factor loading similar to findings reported by Castronovo et al. (2016), raises considerable doubts about its statistical inclusion as a separate construct.

The body of research evidence clearly shows Items 1-3 loading on a measure of “severity of insomnia” and measure the nocturnal element of insomnia such as quantity and quality of sleep — those elements of insomnia that are equated with polysomnography measures. Items 5-7 loading on a measure of “impact of insomnia” (Bastien et al., 2001; Castronovo et al., 2016; Moscou -Jackson et al., 2016; Sadeghniiat-Haghighi et al., 2014) address the psychological impact of insomnia — the clinical distress or impairment — on the individual in their day-to-day activities. To a greater extent the findings from this study support this position.

It is the placement of the item “Satisfaction with sleeping patterns” that causes most ambiguity among factor structures in the literature and in this study too. Moscou- Jackson et al. (2016) identified this item as loading onto “impact of insomnia” as the finding from the EFA does in this study. Yet the findings from the CFA introduce it as a cross-factor loading and examination of the factor loadings indicates it would be better placed loading on “severity of insomnia,” similar to findings reported by others (Chung et al., 2011; Sadeghniiat-Haghighi et al., 2014; Savard et al., 2004; Yu, 2010;). In 2014, Sadeghniiat-Haghighi and colleagues reported that “satisfaction with sleep patterns” could exist across either or both constructs. Whilst Bastien et al. (2001) and Castronovo et al. (2016) reported that “satisfaction with sleeping pattern” loaded onto a separate three-item factor, where the presence of cross- factor loading within the model was permitted, Bastien et al. (2001) and Castronovo et al. (2016) placed “satisfaction with sleep” with “initiation of sleep” and “distress case by lack of sleep” to form a separate construct with cross-factor loading.

Gerber et al. (2016) reported findings where the relationship between the item "Satisfaction with sleeping pattern" loaded strongly on the total instrument first-order latent variable "insomnia" (.89-.95), and statistical protocol would suggest both measures are measuring the same thing. This paper builds on Gerber et al.'s (2016) findings and used a novel approach of dealing with the placement of the measure of "satisfaction with sleeping," by removing it as a contributory item in either construct. Instead it was used as a single item measure that is influenced by the constructs "severity of insomnia" and "impact of insomnia," thus, providing a clearly defined factor structure for severity of insomnia and impact of insomnia. Theoretically, this is justified as it is in keeping with the *DSM-5* definition of insomnia, whereby (dis)satisfaction is a product of quantity/quality and clinical distress (American Psychiatric Association, 2013). The fit statistics for this model support this new model. It helps reconcile previous research literature findings by providing an alternative model of the ISI, synchronizing findings relating to the purported two- and three-factor models within an overarching measure of satisfaction. With this model the extensive evidence relating to the psychometric properties of the tool are maintained, and in some cases better explained — such as the moderate reliability between polysomnography measures and the overall instrument. With the new model this relationship can be directly linked to quantity/quality of sleep. Whilst Sadeghniiat-Haghighi et al. (2014) provided some evidence relating to this, further examination is recommended.

The model is further supported by the impact of demographic characteristics on the component parts of the accepted model. Both severity and impact of insomnia had a statistically significant relationship with "satisfaction with sleeping," where increased severity and impact scores were associated with increased dissatisfaction with sleeping patterns. This provides a measure of convergent validity of the measures.

Examination of the impact of demographic characteristics on the emergent model shows marital status as having a significant impact on both severity and impact. People who were divorced or widowed were more likely to have higher scores than married respondents. This was similar to findings reported by Li et al. (2002), and Rocha et al. (2002). However, no significant relationship was found for gender and age as previously reported by Zhang and Wing (2006) and Stranges et al. (2012). The age of the respondent was found to have an impact on satisfaction with sleeping patterns, where, as age increases, satisfaction levels also increased. This is contradictory to previous research (Kamel & Gammack, 2006; Kim et al., 2000; Stranges et al., 2012) that reported a significant impact of age with greater levels of insomnia associated with older people. Similar to Stranges et al. (2012), education level has no significant impact on insomnia scores in this sample.

These findings provide a significant contribution to our understanding of severity of insomnia and how it translates into (dis)satisfaction with sleep patterns, its effective measurement, and consequently its management. A better understanding of the constituent parts that comprise a clinical definition of insomnia and their accurate measurement may provide a better understanding of the aetiology of insomnia, its relationship with other physical and psychological conditions and the impact of treatment for insomnia itself or comorbid conditions. It may also assist in the tailoring of interventions to address specific aspects of the model and the measurement of intervention effectiveness.

Strengths of the Study

The use of a standardized instrument, powered sample size, and acceptable ratio of respondents to items provides external validity and increases generalizability of the findings. An extensive examination of the instrument, merging theoretical and data-driven investigation, ensures the strongest possible evidence

of a stable factor structure is produced. The ISI is closely aligned to the diagnostic criteria of the *DSM-5* (American Psychiatric Association, 2013) and therefore has strong clinical relevance.

Limitations

Whilst the ISI is an internationally renowned tool it has limitations, as it does not include measures of frequency per week and duration of symptoms so to reflect the diagnostic criteria of clinical insomnia of the *DSM-5* (American Psychiatric Association, 2013). The model proposed in this paper is only informed from one study and therefore requires further examination across different populations and clinical settings and the examination of the impact of independent variables. Further testing of the psychometric model and its properties against other standardized assessment tools and in clinical diagnosis is required.

Conclusion

Insomnia has a profound impact on the psychological and physical well-being of an individual, as well as costing society significantly. The ISI is, globally, the most popular measure of severity of insomnia. There is still uncertainty about the accuracy of factor models to best represent the items of the ISI. This paper provides an alternative model that confirms the stability of two factors (severity and impact of insomnia) and links it to measures of satisfaction with sleeping patterns. It maintains the concept of insomnia but postulates it with an alternative multiple input multiple causes model of explanation. The examination of the impact of demographic characteristics shows that age and marital status effect different elements of the new model, with age effecting satisfaction and being divorced/widowed effecting severity and impact of insomnia. The model provides an alternative for future research in clinical and research practice.

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