A comparison of an emergent factor structure of the Insomnia Severity Index set against a global context

A comparison of an emergent factor structure of the Insomnia Severity Scale within a global context

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Insomnia Severity Scale factor structure

Manuscript (not exceed 10,000 words)

ABSTRACT

Study Objectives: To identify the factor structure of the Insomnia Severity Index and test it against competing international measurement models.

Methods: A cross sectional study survey with a randomly selected sample of 1500 individual's living in Jordan. The ISI was administered and a response rate of 84% (n=1260) 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 synchronise 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 and valid instrument to detect cases of insomnia in the population. Our model helps synthesise previous approaches to measurement reported in the international literature.

Keywords: Insomnia Severity Index, Psychometric properties, factor structure, Jordan

LIST OF ABBREVIATIONS

ISI - Insomnia Severity Index

INTRODUCTION

Insomnia is recognised as a global public health issue (Choueiry, Salamoun, Jabbour, El Osta, Hajj and Rabbaa Khabbaz, 2016; Liqing, Wu, Gan, Qu, and Lu, 2016), categorized as a sleep-wake disorder and is characterised by difficulty in initiating sleep, staying asleep and/or by waking early in the morning and being unable to get back to sleep (De Crescenzo, Foti and Ciabattini 2016). The condition has been associated with many physical and psychological conditions (Ancoli-Isreal, Ayalon, and Salzman, 2008; Jespersen, Koenig, Jennum and Vuust, 2015). For example, it can lead to depression, anxiety (LeBlanc, Mérette, Savard, Ivers, Baillargeol and Morin, 2009; Wong and Fielding, 2011), addiction disorder (Shibley, Malcolm and Veatch, 2008), inattention problems, poor quality of life and overall functioning (Leger, Scheuermaier, Philip, Paillard and Guilleminault, 2001; Leger, Bayon, and Ohayon, Philip, Ement, Metlaine, and Faraut, 2014). Physically it has been associated with increased risk of stroke, obesity, diabetes and hypertension (National Institute of Health, [NIH] 2005; Fernandez-Mendoza and Vgontzas, 2013) and decreased immune functioning (Besedovsky, Lange and 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 and Baran, 2009) and increased risk of accidents (Kessler, Berglund, Coulouvrat, Fitzgerald, Hajak, Roth, and Walsh, 2012), and therefore represents a condition with great costs for both the individual and society (Leger and Bayon, 2010; Wickwire, Shaya and Scharf, 2016).

Epidemiological studies have reported a wide range of prevalence rates (Chung, Yeung, Ho, Yung, Yu, and Kwok, 2015). For example, de Souza Lopes, Rodrigues Robaina and Rotenberg (2012), estimates that between 10 – 15% of the population suffer from insomnia regularly, and a further 25-

30% reporting 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 (Leger, Poursain, Neubauer and Uchiyama, 2008). Roth, Coulouvrat and Hajak, Lakoma, Sampson, Shahly, and Kessler (2011) in America surveyed 10,094 participants, using the Brief Insomnia Questionnaire (BIQ). This study found that insomnia prevalence estimates of 22.1%, whilst in South America prevalence rates are estimated at 14.3% of the population (Rocha, Guerra and Lima-Costa, 2002) increasing to 35.4% among females (De Marchi, Reimão, Tognola and Cordeiro, 2004). However, the World Health Organisation survey of 24,434 women and 19,051 men, drawn from across 8 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 and 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% to maintaining sleep, with a frequency of three or more times a week.

Prevalence studies show insomnia is more common among older adults (Kamel and Gammack, 2006; Kim Uchiama, Okawa, Liu and Ogihara, 2000), females (Zhang and Wing 2006), those who take medication and the among those with a presence of concurrent mental health issues (Lee, Baker, Newton and 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 individuals or widowed (Li, Wing, Ho and Fong 2002; Rocha et al 2002: Xiang, Ma and Cai, Li, Xiang, Guo and Dang, 2008) when compared to single or married. 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 and Hirata, 2017) argue that it may be due to other factors such as concurrent medical and psychological condition 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 standardisation 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 and Morin, 2013).

The current Diagnostic and Statistical Manual for Mental Disorders (5th Ed. American Psychiatric Association [APA] 2013) 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, behaviourally 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 and;
- The problem cannot be attributed to substance use or medication.

Self-report instruments such as 'The Insomnia Severity Scale' (ISI) provides a measure of the key symptoms of clinical insomnia (Moscou-Jackson, Allen, Smith and Haywood Jr, 2016) and it has been aligned with the DSM V classification (Gagnon et al 2013). The scale comprises seven items that measure perceived insomnia over a two-week period. It 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 3-months) of insomina.

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 alpha scores of the total items show strong internal consistency across a number of studies involving varied clinical and non-clinical populations (Sierra, Guillén-Serrano and Santos-Iglesias 2008; Boysan, Güleç, Beşiroğlu and Kalafat, 2010; Fernandez-Mendoza, Rodriguez-Muñoz, Vela-Bueno, Olavarrieta-Bernardino, Calhoun, Bixler and Vgontzas, 2013; Sadeghniiat-Haghighi, et al 2014; Kaufmann, Orff, Moore, Delano-Wood, Depp and Schiehser, 2017; Vegar and Hussain, 2017). It has been shown to have strong discriminant validity in identifying a clinical population of insomnia patients across countries, conditions and settings (Morin, Belleville, Bélanger and Ivers, 2011; Yazdi, Sadeghniiat-Haghighi, Zohal and Elmizadeh, 2012; Gagnon et al 2013; Sadeghniiat-Haghighi et al 2014; Moscou-Jackson et al 2016; Wong, Lau, Espie, Luik, Kyle and Lau, 2017; Vegar and Hussain, 2017); convergent validity (Fernandez-Mendoza et al 2013; Yu 2010; Chung, Kan and Yeung, 2011; Morin et al 2011, Boysan et al 2010; Moscou-Jackson et al 2016; Kaufam, Orff, Moore, Delano-Wood, Depp and Schiehser, 2017) and

test-retest (Chahoud,Chahine, Salameh and Sauleau 2017); criterion related validity (Sadeghniiat-Haghighi et al 2014) and concurrent validity (Bastien, Vallières, Morin, 2001, Sadeghniiat-Haghighi et al 2014; Chung et al 2015; Gerber, Lang, Lemola, Colledge, Kalak, Holsboer-Trachsler, Brand, 2016; Moscou -Jackson et al 2016; Castronovo, Galbiati, Marelli, Brombin, Cugnata, Giarolli, and Ferini-Strambi, 2016).

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

<< Insert Table 1 here>>

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 – 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 items 5-7 on Impact of Insomnia (Bastien et al 2001; Sadeghniiat-Haghighi et al

2014; Chung et al 2015; Moscou -Jackson et al 2016; Castronovo et al 2016).

Examination of the variability across the factor structure models reported in the literature highlight the issue of a measure relating to the placement of an item relating to satisfaction with sleeping behaviour. 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. Either 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, and Anderson, 2010, pg.676). This provides significant challenges in instrument development (Edwards and Bagozzi, 2000).

Alternatively, satisfaction is placed either on Severity of Insomnia (Yu 2010; Chung et al 2011; or impact of insomnia (Moscou-Jackson 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 the 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 scale 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 (2011) 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 to three-fold: first to examine the factor structure

of the Insomnia Severity Index; 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 details on the emergent model.

METHODS

A large scale cross sectional survey was conducted with a randomly selected sample of 1500 individual living in Amman; the capital city of Jordan. Participants were recruited and assessed using a standardised tool and key demographic details recorded.

Sample

This study formed part of a larger study looking at COPD and psychological comorbidities among a non-clinical population in Jordan (Al-Smadi, Omar, Loai, Ashour, Slater, and Fitzsimon, 2017). A list of registered residents was obtained from Amman Municipality. Inclusion criteria were: resident in Jordan, aged at least aged 40 years old and more. The list included 200,000 houses and from this sampling frame a random sample of 1,500 houses were 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 sheet were distributed and written consent obtained. Demographical data sheet and study questionnaires were self-completed by willing participants. In total, 1260 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 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).

Instrumentation

The Insomnia Severity Index (Morin 1993) was developed based on criteria outlined in the DSM-IV – TR (APA 1994) and the International Classification of Sleep Disorders [ICSD] (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** 0-none to 4-very severe; **item 4** 0-very satisfied to 4-very dissatisfied; **item 5** 0-not at all interfering to 4-very much interfering; **item 6** 0-not at all noticeable to 4- very noticeable; **item 7** 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 summated to total scores with 0-7 = indicating no clinically significant insomnia; 8-14 = Sub threshold Insomnia; 15 – 21 = Clinical Insomnia (Moderate-Severity); 22-28 = Clinical Insomnia (Severe).

Statistical Analysis

Descriptive 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 was conducted using the Kaiser-Meyer-Olkin Measures of Sampling Adequacy and Bartletts test of sphericity. An initial exploratory factor analysis was conducted specifying a 1 – 3 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 exploratory factor analysis was then analysed within a confirmatory framework, using the same data. The model was re-specified using the modification indices provided in the statistical output until acceptable and a statistically significant relationship identified. Cronbach alpha scores were generated for factors in the accepted factor model. The impact of demographic details on the factor model was examined using regression.

Acceptance modification criteria were applied as follows:

1. The items to first order factors were fitted initially;
2. Correlated error variance permitted as all items were measuring the same unidimensional construct;
3. Factor loadings above 0.45 to provide a strong emergent factor structure (based on sample size; Hair et al 2010).
4. Only statistically significant relationship retained to help produce as parsimonious a model as possible.

Acceptable fit statistics were set at Root Mean Square Estimations of Approximation (RMSEA) of 0.05 or below; 90% RMSEA higher bracket below 0.08; and Confirmation Fit Indices (CFI) of 0.95 or higher and SRMR below 0.05 (Wang and Wang, 2012; Byrne, 2013).

Ethics

Full ethical approval was sought and gained from 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 was securely stored.

RESULTS

From 1,500 individuals living in Amman; the capital city of Jordan approached, 1,260 (84%) consented to participate in the study. Table 2 summarizes descriptive statistic of the sample. The majority (92.9%) of participants were Jordanian, married (78.0%;) and most were aged 40 – 49

years of age and a majority had a college or university degree. There was an even distribution of male and female respondents in the sample.

<< Insert table 2 here>>

Measures of Distribution

Mean scores indicate a low level of anxiety among the 7 items. As shown in Table 3, the highest scored items were 'satisfied with current sleep patterns (x=1.348) and the lowest was Worried/distressed about your sleep (x=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) reported sub-threshold insomnia. A further 9.6% were clinically insomniac as 8.6% (n=108) reported moderate insomnia and 1.2% (n=15) severe insomnia.

<< Insert table 3 here>>

Exploratory Factor Analysis

The Kaiser-Meyer-Olkin Measures of sampling adequacy 0.894; Bartletts test of sphericity (chi square 4527, df=21, p=0.001). KMO scores of ≥0.8 and Bartletts test of significant p≥0.05 are acceptable values.

Exploratory factor analysis of the 7 items failed to provide a clear factor structure with a 1 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).

<< **Insert table 4 & 5 here**>>

It was deemed appropriate to use a two-factor model as the measurement model for testing using confirmatory factor analysis. The two factors were examined and titled: - (1) – 'Active sleeping patterns' measures the immediacy of sleeping behaviour and (.2) – Impact of Insomnia measures the psychosocial impact of insomnia on the individual.

Confirmatory Factor Analysis

The 2-factor measurement model specified in the exploratory factor analysis was tested using confirmatory factor analysis, with estimator Maximum likelihood robust to deal with the floor effect observed in the data. Fit statistics show an unacceptable model: Chi-square test of model fit = 113.57, df = 13, p=0.001; RMSEA = 0.079, 90% RMSEA = 0.066 – 0.092, CFI = 0.961, SRMR = 0.036. A cross factor loading modification on Item 4 'Satisfied with current sleep pattern' was introduced to the model based on modification indices scores (75.43). Fit statistics show an acceptable model: Chi-square test of model fit = 43.89, df = 12, p=0.001; RMSEA = 0.046, 90% RMSEA = 0.032 – 0.061, CFI = 0.99, SRMR = 0.02. All relationships were statistically significant. The factor loadings for all items were acceptable (See table 6).

<<**Insert table 6 here**>>

In the 2-factor model the cross factor loading of item 4 remains an issue with model fit statistics being improved with its introduction as influencing both factors. Factor loadings would indicate it loads on to Severity of Insomnia but in the original exploratory factor analysis 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-square test of model fit = 43.89, df = 12, p=0.001; RMSEA = 0.046, 90% RMSEA = 0.032 – 0.061, CFI = 0.99, SRMR = 0.02. All relationships were statistically significant.

<<Insert figure 1 here>>

Cronbach's Alpha and Item to Total correlation

Cronbach's alpha for the instrument was acceptable (Total Instrument 0.89 [corrected item to total correlation 0.62 – 0.77]; Insomnia Severity = 0.84 [corrected item to total correlation 0.58 – 0.74]; Impact of Insomnia = 0.84 [corrected item to total correlation 0.71 – 0.84]). Examination of the alpha if item deleted scores indicate that this score would not be improved regardless of items deleted.

Multiple Indicator Multiple Causes Model

There was a strong correlated error between Insomnia Severity and Impact of Insomnia (0.77, p=0.001). Likewise, Insomnia Severity and Impact of Insomnia impacted on Satisfaction with Sleep (Insomnia severity (0.46, p=0.001) and Impact of Insomnia (0.39 p=0.001).

Only married 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 (0.27

p=0.02) or widowed (0.256 p=0.03) compared to being married increased scores on the Insomnia Severity Index – Sleeping Pattern. Being divorced (0.24 p=0.02) or widowed (0.21 p=0.04) compared to being married increased scores on the Insomnia Severity Index – Impact of Insomnia.

<< Insert figure 2 here>>

Age of respondent had a negative relationship on satisfaction with sleep scores, and as age increased it was accompanied with a decrease in satisfaction with sleep (50 – 59 years olds -0.096, p=0.043; 60 – 69 years old -0.187 p=0.001; 70+ years -0.209 p=0.002). Fit statistics show an unacceptable model: Chi-square test of model fit = 107.548, df = 52, p=0.001; RMSEA = 0.029, 90% RMSEA = 0.021 – 0.037, CFI = 0.986, SRMR = 0.015.

DISCUSSION

Insomnia is a global issue and impacts on people worldwide (Choueiry et al 2016; Liqing et al 2016) and has a significant impact on quality of life and burden on society (Wickwire, et al 2016). The ISI has been proven as the internationally renowned screening tool to accurately identify the presence/absence of clinical insomnia and has been used across clinical populations (Morin et al 2011; Yazdi et al 2012; Gagnon et al 2013; Sadeghniiat-Haghighi et al 2014; Moscou-Jackson et al 2016; Wong et al 2017; Vegar and Hussain, 2017;). This study provides a fuller understanding of what the tool is measuring.

The overall prevalence rates of insomnia among the Jordian population, are much lower that reported in international studies worldwide. Less than 10% of this population were reported as insomniac (9.8%), well below prevalence rates reported by the WHO in Asia and Africa (Stranges et al 2012), 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 in the literature, closely aligned to the DSM (5^{Th} Ed) criteria for insomnia and should therefore be used as the standard measure of insomnia. This would permit comparability of prevalence rates internationally.

The findings presented here challenge the perception that insomnia is a single construct (Sierra et al 2008;, Morin et al 2011; Dragioti et al 2015). Findings from the exploratory and confirmatory factor analysis clearly show that a multi-factorial model underlies the ISI. This position is not new within the research literature (for example, Bastien et al 2001; Sadeghniiat-Haghighi et al 2013; Moscou -Jackson et al 2016). The DSM (5^{th} Ed) criteria for a definition for insomnia includes 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 (APA 2013). It does identify an overall dissatisfaction with sleep as the combination of both factors, (alongside frequency per week, duration of a 3-month period and exclusion of extenuating circumstances (APA 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 finding reported by Cartronovo et al (2016), does raises considerable doubts about its statistical inclusion as a separate construct.

The body of research evidence clearly shows item 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 equate with polysomnography measures. Items 5-7 on a measure of 'impact of insomnia' (Bastien et al 2001; Sadeghniiat-Haghighi et al 2014; Moscou - Jackson et al 2016; Castronovo et al 2016) and 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 exploratory factor analysis does in this study. Yet the findings from the confirmatory factor analysis introduces it as a cross factor loading and examination of the factor loadings indiacting it would be better placed loading on to 'severity of insomnia', similar to findings reported by otheres (Savard et al 2004; Yu 2010; Chung et al 2011; Sadeghniiat-Haghighi et al 2014). In 2014, Sadeghniiat-Haghighi and colleagues study, 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 3-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 to 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's et al (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^{th}) definition of insomnia, whereby (dis)satisfaction is a product of quantity/quality and clinical distress (APA 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, synchronising findings relating to the purported 2 and 3 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 details on the component parts of the accepted model. Both severity and impact of insomnia had a statistically significant relationship with 'satisfaction with sleeping', where increase 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 details on the emergent model show marital status as having a significant impact on both severity and impact. People who have were divorced or widowed were more likely to have higher scores than married respondents. This was similar to findings reported Li, Wing, Ho, and Fong, (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) respectively. 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 contridctory to previous research (Kim et al 2000; Kamel and Gammack, 2006; Stranges et al 2012) that reported a significant impact of age with greater levels of insomnia aossiocated with older people. Similar to Stranges et al 92012) education levels has no significant impact on insomnia scores in this sample.

These findings provide a significant contribution to our understanding 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; and 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 aspect of the model and the measurement of intervention effectiveness.

Strengths of the study

The use of a standardised 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 ($5^{th,}$ APA 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 reflecting the DSM (5th Ed) (APA 2013). The model proposed in this paper requires is only informed from one study and thereforerequires further examination across different populations and clinical settings and the examination of the impact independent variables.

Conclusion

Insomnia has a profound impact on the psychological and physical wellbeing of an individual, as well as costing society significantly. The Insomnia Severity Index is the most popular measure of insomnia, globally. 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 details shows that age and marital status effect different elements of the new model, 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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Table 1: Psychometric properties and factor structure of the ISI

Year	Authors	Country	Setting	Population	Factor structure
2001	Bastien et al	Canadian – French	French	N=145 insomnia patients	Three factor model
2004	Savard et al	USA	English	N=1670 Cancer patients	Two factor model

2008	Sierra et al	Spanish	Spain	N=230 Older people	One factor model
2010	Yu	China	Chinese	N=585 older people	Two factor model
2010	Boysan et al	Turkey	Turkish	Clinical (n=34) and non-clinical (n=258)	Two factor model
2011	Chung et al	China	Chinese	N=1516 adolescents	Two factor model
2011	Morin et al	Canada		n=959 survey; Clinical (n=183) and non-clinical (n=62)	One factor model
2011	Lahan and Gupta	India	Hindi	Clinical (n=45) and non-clinical (n=20)	One factor model
2013	Fernandez-Mendoza et al	Spain	Spanish	N=500 non-clinical	1-3 factor model
2014	Sadeghniiat-Haghighi et al	Persian	Iran	N=1037 Insomnia patient	Two factor model
2014	Cho et al	Korean	Korea	N=614 insomnia patients	One factor model
2014	Ahmed	Saudi Arabia	Arabic	N=83 non-clinical	One factor model
2015	Dragioti et al;	Swedish		N=836 Chronic pain patients	One factor model with

					items removed
2016	Castronovo et al	Italy	Italian	N=272 insomnia patients	Three factor model
2016	Gerber et al	German	Switzerland	N=1475 youth; 862 university students; n=533 adults	One factor model
2016	Moscou-Jackson et al	USA	English	N=263 Sickle cell disease	two factor model
2017	Chahoud et al	French English	Lebanon	N=104 students	two factor model in English and 3 factor model in French
2017	Kaufmann et al	English	USA	N=83 Traumatic Brain Injury	One factor model
2017	Vegar & Hussain	Indian	India	N=25 Non-clinical	One factor model
2017	Byrne et al	English	USA	N=462 insomnia patients (youth)	Two factor model
2018;	Dieck et al	German	Germany	N=416 clinical population, n=284 non-clinical	One factor model

Table 2. Demographic Details of Participants

Demographic	**Percentage**	**Demographic**	**Percentage**
Male	49.8% (n=627)	Less than secondary	8.3% (n=105)
Female	50.2% (n=633)	Secondary School	24.6% (n=310)
Jordanian	92.9% (n=1171)	BS	54.9% (n=692)
Other	7.1% (n=89)	Post Graduate	12.1% (n=153)
Married	78.0% (n=983)	40 – 49 years	45.1% (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)

Table 3. Mean scores (SD), Skewness, Kurtosis and Factor loading of items of Insomnia Severity Index

	Scoring Range	Mean (SD	Skewness	Kurtosis
Difficulty falling asleep	0-None 4-Very Severe	0.918	0.903	-0.166
Difficulty staying asleep	0-None 4-Very Severe	0.927	0.893	-0.073
Problems waking up too	0-None 4-Very Severe	1.020	0.924	-0.079

early				
Satisfied with current sleep pattern	0-Very Satisfied 4-Very Dissatisfied	1.348	0.514	-0.225
Noticeable to others/Quality of life	0-Not at all noticeable 4-Very much noticeable	0.869	0.861	0.080
Worried/Distressed	0-Not at all worried 4-Very much worried	0.776	1.067	0.580
Interfere with daily functioning	0-Not at all interfering 4- Very much interfering	1.057	0.761	-0.140

Table 4. Comparison of Exploratory factor analysis one, two and three factor models

Model	Number of Parameters	Chi-Square	Degrees of Freedom	P-Value
1-factor	21	50.029	14	0.0000
2-factor	27	23.873	8	0.0024
3-factor	32	3.939	3	0.2681

Table 5. One, Two and Three Factor Model with Factor loading/ (* significant at 5% level) from Exploratory Factor Analysis

	1 - Factor Model RMSEA=0.045; 90% RMSEA 0.032 – 0.059 CFI=0.996	**2 – Factor Model RMSEA=0.040; 90% RMSEA 0.022 – 0.059 CFI=0.998**		**3 – Factor Model RMSEA=0.016; 90% RMSEA 0.000 – 0.053 CFI=1.0**		
Difficulty falling asleep	0.315	0.645*	0.314	0.559*		
Difficulty staying asleep	0.234	0.684*	0.232	0.654*		
Problems waking up too early	0.358	0.693*	0.357	0.677*		
Satisfied with current sleep pattern	0.986*	0.478	0.986*		0.984*	
Noticeable to others/Quality of life	0.497*	0.359	0.497*			0.934
Worried/Distressed	0.994*	0.475	0.994*		0.994*	
Interfere with daily functioning	0.983*	0.471	0.983*		0.977*	

Table 6. Two and Three Factor Model Factor loading/ Standard Error (* significant at 5% level) from Confirmatory Factor Analysis

	2 – Factor Model		3 – Factor Model		
	Active Sleeping Pattern	**Impact of Insomnia**	**Active Sleeping Pattern**	**Satisfaction with Sleep**	**Impact of Insomnia**
Difficulty falling asleep	0.8.13/0.028*		0.8.13/0.028*		
Difficulty staying asleep	0.841/0.028*		0.841/0.028*		
Problems waking up too early	0.730/0.034*		0.730/0.034*		
Satisfied with current sleep pattern	0.450/0.055*	0.391/0.055*		0.528	
Noticeable to others/Quality of life		0.769/0.024*			0.769/0.024*
Worried/Distressed		0.826/0.025*			0.826/0.025*
Interfere with daily functioning		0.740/0.029*			0.740/0.029*

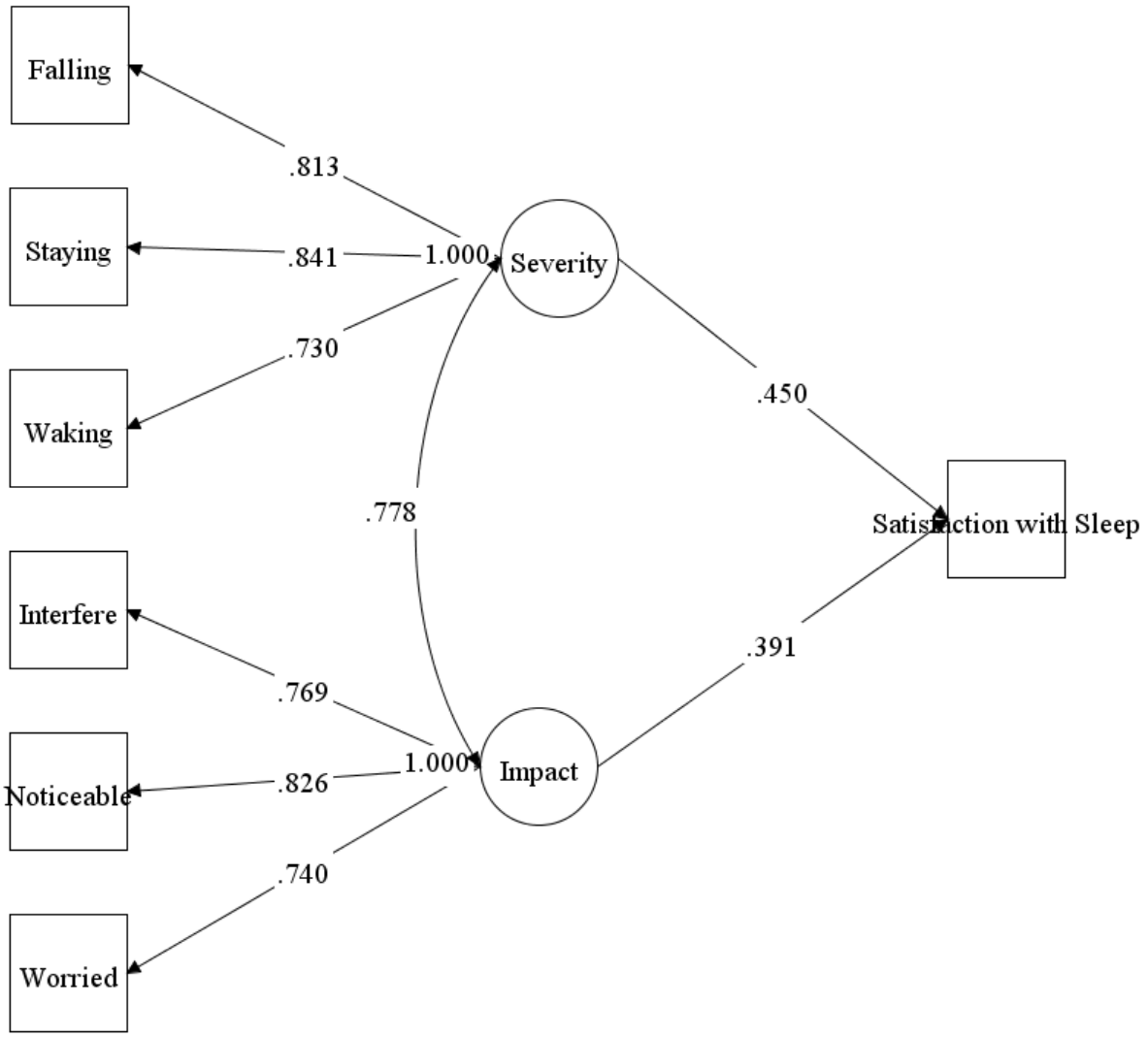

Figure 1. Multiple Indicator Multiple Causes Model for Insomnia Severity Index

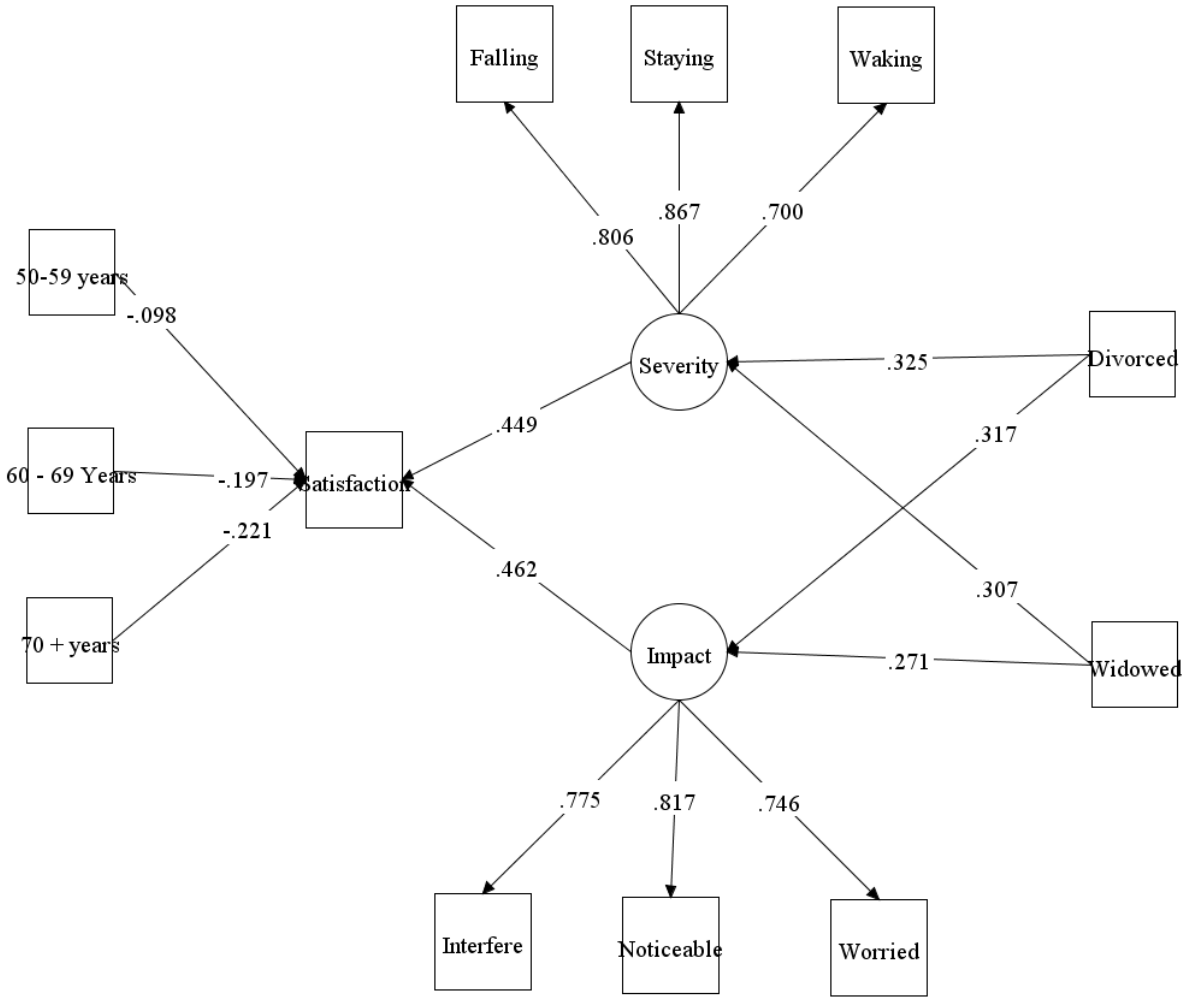

Figure 2. The measurement model of the Insomnia Severity Index (ISI) and statistically significant demographic characteristic