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Title

Content Analysis of Insomnia Questionnaires: A Step to Better Evaluate the Complex and Multifaceted Construct of Insomnia Disorder

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1. Introduction

Insomnia disorder is the most common mental disorder, affecting millions of people worldwide (Morin & Jarrin, 2022). Contemporary etiological models of insomnia disorder mechanisms involve a deregulation of the arousal and affective system (Altena et al., 2023). According to the most recent versions of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) and the *International Classification of Sleep Disorder* (ICSD-3), the main symptoms include difficulty initiating sleep, maintaining sleep and early morning awakenings (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017; Gauld et al., 2023). Along with these essential insomnia symptoms, which must be present despite adequate opportunity and circumstances for sleeping, the definition of insomnia disorder includes symptoms related to hyperarousal and the daytime consequences of the nighttime disturbances, which often manifest as psychiatric symptoms, in particular affective symptoms (e.g., worry, mood disturbance, reduced motivation) (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017).

Chronic insomnia disorder is frequently associated with comorbid with mental disorders, and can have a major impact on patients' prognosis and overall well-being (Freeman et al., 2020). Many studies have been conducted on it (Buysse et al., 2006; Riemann et al., 2017), and most of them use self-report questionnaires to measure insomnia disorder severity (Ali et al., 2020; Moul et al., 2004; Ruivo Marques et al., 2018). They typically consist of a series of items designed to gather reliable valid clinical information about symptoms and severity.

The Insomnia Severity Index (ISI) is the most widely used self-report questionnaire and is based on the DSM-IV criteria for insomnia disorder (Association, 2000; Bastien et al., 2001). It is very sound psychometrically (Cerri et al., 2023; Manzar et al., 2021) and has been translated into several languages (Castronovo et al., 2016; Clemente et al., 2021; Fernandez-

Mendoza et al., 2012; Gerber et al., 2016; Morin et al., 2011; Suleiman & Yates, 2011; Yu, 2010). Furthermore, it is included in the recommendations for the standard research assessment of insomnia disorder (Buysse et al., 2006) and in the European guidelines for the diagnosis and treatment of insomnia disorder (Riemann et al., 2017). The Sleep Condition Indicator (SCI) (Espie et al., 2014) is more recent. It is based on the DSM-5 insomnia disorder criteria and is also a recommended self-report questionnaire (Riemann et al., 2017). Apart from these two measures, several other self-report questionnaire have been developed and evaluated (Ali et al., 2020; Moul et al., 2004; Ruivo Marques et al., 2018).

An important issue is whether these instruments capture all of the relevant information and are interchangeable (Cerri et al., 2023). *Moul et al.* analyzed several validated self-report questionnaires and found that "*the available stock of insomnia-related questionnaires has a substantial heterogeneity*" (Moul et al., 2004). More recently, *Ali et al.* reported that there was an "*ample availability of instruments*" and suggested the need for "*more psychometric measures to ensure the trustworthiness of these instruments*" (Ali et al., 2020). A cursory glance at the items included in some of the available insomnia severity scales confirms these assumptions. For instance, whereas the ISI specifically asks individuals how worried/distressed they are about their current sleep problem (examining worrying about sleep) (Bastien et al., 2001), no such symptom is evaluated in the SCI (Espie et al., 2014). However, both the ISI and SCI investigate daytime affective symptoms (i.e. mood disturbance) (Bastien et al., 2001; Espie et al., 2014), but this is not the case of all insomnia severity questionnaires (Ali et al., 2020). This heterogeneity in terms of content means that the results obtained from one questionnaire may not be transposable to those of another, so the comparison of findings may require caution, in particular in patients with mental disorders in whom insomnia and affective symptoms might be intricately intertwined (Morin & Jarrin, 2022). Nevertheless, despite this possible content heterogeneity and the very thoughtful classification provided by *Moul et al.* (Moul et al., 2004),

no systematic quantified analysis of the item content overlap of these questionnaires has been carried out.

An original method for comparing item content in questionnaires and quantifying their degree of overlap was first developed by Fried's team in 2017 in the field of affective disorders (Fried, 2017). They used the Jaccard similarity coefficient to quantify the degree of overlap (aka. homogeneity) of content evaluated in self-reported depression questionnaires (Fried, 2017). Since then, this sort of analysis has been performed for mental pain (Charvet et al., 2022), mood and bipolar disorder (Chrobak et al., 2018; Fried et al., 2022), obsessive-compulsive disorder (Visontay et al., 2019), anxiety disorder (Karstoft & Armour, 2022; Wall & Lee, 2021), and neurological soft signs (Chrobak et al., 2021). Recently, we used it to analyze the content overlap of several self-reported sleep disorder screening questionnaires for adults (Gauld et al., 2023). To our knowledge, this method has not yet been applied to insomnia disorder severity questionnaires.

Thus, the main objective of this study was to conduct a content analysis and visualization method to better identify the different types of content (i.e. essential insomnia symptoms like "insomnia initiating", daytime symptoms like "affective symptoms", etc..) that are investigated by commonly employed self-report insomnia disorder severity questionnaires, and to compute the Jaccard index to analyze and quantify the degree to which these questionnaires overlap in content, i.e. are homogeneous. Finally, we suggest in which circumstances some of the questionnaires could prove more useful than the others.

2. Methods

The method and vocabulary used are based on those described in previous content overlap analysis studies (Charvet et al., 2022; Chrobak et al., 2018, 2021; Fried et al., 2022; Gauld et al., 2023; Karstoft & Armour, 2022; Visontay et al., 2019; Wall & Lee, 2021). Hence, a "clinical manifestation" is any unit of analysis from an item of a questionnaire. For example, the first item of the ISI ("Difficulty falling asleep") measures the clinical manifestation ("Insomnia initiating").

2.1. Selection of self-report questionnaires

To identify self-report insomnia disorder severity questionnaires for adults, we conducted a PubMed search with the following search terms: ((Insomnia [Title/Abstract]) AND (Scale [Title/Abstract] OR Questionnaire [Title/Abstract])) AND (Validation [Title/Abstract] OR Psychometric [Title/Abstract]). Additionally, we analyzed the references provided in three published reviews on self-report measures of insomnia in adults (Ali et al., 2020; Moul et al., 2004; Ruivo Marques et al., 2018). A total of 30 questionnaires were identified.

To evaluate the content analysis in terms of heterogeneity and overlap, we only included insomnia disorder severity questionnaires meeting the following criteria:

- Exploring at least essential insomnia symptoms as described in the DSM-5 and the ICSD-3 (i.e., insomnia initiating, maintaining, or early).
- Being self-reported (e.g., criteria unmet for the Brief Insomnia Questionnaire, BIQ) (Kessler et al., 2010)
- Having at least 50 citations in Google Scholar as of March 10, 2023
- Having been published in a peer-review journal with sufficient psychometric validation (e.g., criterion unmet for the Spielman Insomnia Sleep Questionnaire, SISQ) (Spielman et al., 1987)

- Being a practical tool designed for clinical settings and in line with the Wilson & Jungner criteria (Andermann et al., 2008) (e.g., criterion unmet for the Pittsburgh Insomnia Rating Scale, PIRS) (Veqar et al., 2014)
- Collecting responses on a Likert-type scale (e.g., criterion unmet for the Sleep Disorders Questionnaire, SDQ) (Douglass et al., 1994).

We excluded questionnaires meeting the following criteria:

- Not exploring essential symptoms (e.g., Insomnia Daytime Symptoms and Impacts Questionnaire, IDSIQ) (Hudgens et al., 2021)
- Not having been specifically created to assess insomnia but to measure general sleep disturbances in adults (e.g., Pittsburgh Sleep Quality Index, PSQI, and Patient-Reported Outcomes Information System, PROMIS) (Buysse et al., 1989, 2010).

With these criteria, a total of 9 self-report insomnia severity questionnaires for adults were selected: the 7-item Insomnia Severity Index (ISI) (Bastien et al., 2001), the 11-item Regensburg Insomnia Scale (RIS) (Crönlein et al., 2013), the 8-item Sleep Condition Indicator (SCI) (Espie et al., 2014), the 13-item Insomnia Symptom Questionnaire (ISQ) (Okun et al., 2009), the 6-item Bergen Insomnia Scale (BIS) (Pallesen et al., 2008), the 8-item Athens Insomnia Scale (AIS) (Soldatos et al., 2000), the 4-item Jenkins Sleep Scale (JSS) (Jenkins et al., 1988), the 5-item Women's Health Initiative Insomnia Rating Scale (WHIIRS) (Levine et al., 2003), and the 3-item Minimal Insomnia Symptom Scale (MISS) (Broman et al., 2008). The short versions derived from the previous scales (i.e., 2-item and 3-item ISI (Kraepelien et al., 2021; Thakral et al., 2021) and 2-item SCI (Espie et al., 2014)) were not included.

2.2. Extraction and selection of items

We extracted the total number of items from these nine self-report questionnaires (Bastien et al., 2001; Broman et al., 2008; Crönlein et al., 2013; Espie et al., 2014; Jenkins et al., 1988; Levine et al., 2003; Okun et al., 2009; Pallesen et al., 2008; Soldatos et al., 2000). For the sake of clarity, an item is defined as any question that has to be answered by the individual. Thus, the number of extracted items corresponded to the number of questions included in each questionnaire. However, items included in questionnaires not evaluating any "clinical manifestations" were excluded, e.g., questions about the duration (or chronicity) of insomnia in the ISQ and in the SCI. Finally, we selected a total of 64 items in the nine insomnia questionnaires. Items extracted and selected from each questionnaire are shown in **Table 1** and **Supplementary Material 1**.

2.3. Extraction of clinical manifestations from items

The extraction of clinical manifestations from items involved three steps (see **Supplementary Materials 1)**.

2.3.1. Clinical manifestation extraction from items within each questionnaire

We used a double-blind method based on a panel of medical examiners outside the sleep community to increase reliability. Therefore, sleep experts (AR, CG, JC, and JAMF) relied on the initial work of medical students (MP and PAS) to minimize the impact of personal biases and theoretical influences on the alignment of self-reported questionnaire items with diagnostic criteria. Indeed, opinions of examiners outside the field of sleep medicine are deemed crucial in large epidemiological studies in psychiatry, such as the US Mental Hygiene Movement, the Midtown Manhattan Study, and the Stirling County studies (Coleman, 1988; March & Oppenheimer, 2014; Srole & Fischer, 1978). When a disagreement existed between experts, consensus was sought by referring to other sleep experts (LP and MMSO). The identified

clinical manifestations extracted for items in each questionnaire were grouped or separated according to two rules.

The first rule was to extract all clinical manifestations depicted by the items within each questionnaire by splitting or lumping the unit of analysis found in an item (Gauld et al., 2023). For instance, in the BIS, item 5, “"During the past month, how many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life?”, were extracted “Sleepy”, “Tired”, “Affected you at school/work”, and “Affected you in your private life”. “Affected you at school/work” and “Affected you in your private life” was lumped into “Self-complaints of disabilities”. “Sleepy” and “Tired” were split and renamed “Daytime sleepiness”, and “Fatigue”, respectively.

The second rule was the differentiation between three kinds of items:

- A “compound clinical manifestation” refers to an item that evaluates at least two distinct clinical manifestations. For example, the BIS item 5, “During the past month, how many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life?” includes “Daytime sleepiness”, “Fatigue”, and “Self-complaints of disabilities” clinical manifestations.
- A “specific clinical manifestation” derives from an item that measures a single clinical manifestation. For example, in the ISI questionnaire, item 1 “Difficulty falling asleep” refers only to the clinical manifestation of “Insomnia initiating”. When the same clinical manifestation was extracted from both a specific clinical manifestation and a compound clinical manifestation in a questionnaire, it was considered specific.
- Finally, an “idiosyncratic clinical manifestation” refers to a clinical manifestation measured in an item that appeared only in one questionnaire. For example, the clinical manifestation “Sleeping pills intake” appears only once in the RIS questionnaire (item 11).

2.3.2. Wording harmonization of clinical manifestation extraction

To avoid redundancy and bias in the analyses, we harmonized the clinical manifestation extraction of each questionnaire. We harmonized the wording of clinical manifestations that was considered to refer to a similar construct between questionnaires. For instance, item 1 "Difficulty falling asleep" in the ISI and item 1 of the SCI, "... how long does it take you to fall asleep?" were harmonized into one clinical manifestation: "Insomnia initiating".

To better harmonize the wording of the extraction with the existing literature, we used an original conservative approach based on our previous work of extracting and harmonizing clinical manifestations in two international classifications of sleep disorders (ICSD-3 and Sleep-Wake disorders section of the DSM-5) (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017; Gauld et al., 2023; Gauld, Lopez, Morin, Geoffroy, et al., 2021; Gauld, Lopez, Morin, Maquet, et al., 2021) and on the previous clinical dimensions identified in the literature (Abrishami et al., 2010; Chiu et al., 2017; Chung et al., 2008).

2.3.3. Hierarchical classification of clinical manifestations into dimensions

We thus organized the extracted clinical manifestations into the following five dimensions in line with the categorization of the diagnostic criteria in the ICSD-3 and the DSM-5 (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017) and the organization of the sleep disorders criteria diagnosis that we have previously proposed (Gauld, Lopez, Geoffroy, Morin, et al., 2021).

- The "Insomnia symptoms" dimension was defined as nighttime essential insomnia clinical manifestations. This dimension contains "Insomnia initiating", "Insomnia maintaining" and "Insomnia early".

- The “Insomnia-related symptoms” dimension is defined as the set of other clinical manifestations related to hyperarousal and sleep disturbances. This dimension contains “Worrying about sleep”, “Sleep satisfaction”, “Nonrestorative sleep”, and “Sleeping pills intake”.
- The “Daytime symptoms” dimension refers to clinical manifestations considered as daytime symptoms consequences of the nighttime disturbances. It contains “Fatigue”, “Daytime sleepiness”, “Cognitive symptoms” and “Affective symptoms”.
- The “Insomnia-related impairments” dimension includes the perceptions of distress or disabilities endured by the individual in their daily life, and which could result from insomnia symptoms, insomnia-related symptoms, or daytime symptoms, or a combination thereof. It contains “Self-complaints of distress”, “Self-complaints of disabilities”, and “Distress reported by others”, also called functional status. Insomnia-related impairments are important to consider, equally and independently from symptoms, as proposed in the ICSD-3 and the DSM-5 (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017).
- The “Sleep behaviors” dimension is defined as the set of sleep-related behaviors which determines sleep schedules. It contains “Sleep duration” and “Time-in-bed”, which together can determine sleep efficiency.

2.3.4. Data aggregation

This last step corresponded to the coding of the insomnia clinical manifestations extracted, with a three-point rating: the value “1” is given for specific or an idiosyncratic item, the value “2” is given for compound clinical manifestations, and the value “0” is given if a clinical manifestation was not included in a specific questionnaire. Each line corresponded to a clinical manifestation; each column corresponded to one of the nine questionnaires.

2.4. Statistical analysis

2.4.1. Number and frequency of clinical manifestations

Three analyses were performed based on the nine insomnia questionnaires: i) the frequency of clinical manifestations extracted from the questionnaires (from the most frequent to the least frequent for all dimensions and regarding the five dimensions: “Insomnia symptoms”, “Insomnia-related symptoms”, “Daytime symptoms”, “Insomnia-related impairments”, and “Sleep behaviors”), ii) the distribution of the clinical manifestations found in each questionnaire across the five dimensions, iii) the identification of the questionnaires with the highest number of extracted clinical manifestations (i.e., 2 items assessing the same clinical manifestation count 2) and different clinical manifestations (i.e., 2 items assessing the same clinical manifestation count 1) and with the highest number of “specific” and “compound” clinical manifestations in each questionnaire (to assess the possible lack of precision due to items constructed on the basis of at least two distinct clinical manifestations).

2.4.2. Content overlap analysis

The Jaccard Index (or “Jaccard similarity coefficient”) is a widely adopted measure of content overlap between questionnaires. It measures the similarity between binary data, ranging from 0 (no overlap) to 1 (complete overlap). It is calculated by the following equation: s/(u1 + u2 + s), with *s* representing the number of clinical manifestations shared by two questionnaires, and *u1* and *u2* the number of clinical manifestations that are unique to each one (Fried, 2017). In line with previous studies that used this type of content analysis (Charvet et al., 2022; Chrobak et al., 2018, 2021; Fried et al., 2022; Gauld et al., 2023; Karstoft & Armour, 2022; Visontay et al., 2019; Wall & Lee, 2021) and considering the absence of well-cited guidelines on the

strength or weakness of the Jaccard similarity coefficient, we used the *Evans' Straightforward Statistics for the Behavioral Sciences* rule of interpretation for the Jaccard Index (Evans, 1996): very weak: (0.00-0.19), weak: (0.20-0.39), moderate: (0.40-0.59), strong: (0.60-0.79), and very strong: (0.80-1).

Thus, we used the Jaccard Index to analyze the content overlap of the nine questionnaires. We conducted three Spearman correlations of the Jaccard Index, with the total number of clinical manifestations captured by a questionnaire to investigate whether its length played a role in the overlap, and with the number of specific and compound clinical manifestations to investigate whether the presence of specific or compound clinical manifestations also played a role in the overlap.

Finally, we calculated the Jaccard Index for each dimension to evaluate the content overlap on each of the five dimensions. We also did a pairwise analysis to analyze overlap between the questionnaires.

2.4.3. Data visualization of content overlap

We provide two original graphical representations of the distribution across the categories of the clinical manifestations measured in each questionnaire using the Python package *plotly*[1].

The interactive radar plot in **Figure 4** shows the different clinical manifestations identified in each questionnaire. The clinical manifestations were allocated to angles while the questionnaires were assigned to different radii. The sunburst plot in **Figure 5** demonstrates the hierarchical arrangement of the clinical manifestations within the proposed dimensions. These interactive figures are available online in our GitHub repository and allow clinicians and researchers to easily visualize the different clinical manifestations evaluated in these questionnaires (see next paragraph).

[1]https://github.com/plotly/plotly.py

2.4.4. Availability and reproducibility of results

Based on a previous sleep overlap study and with a view to openness and sharing, all our data, results, figures, tables, and code are available in the GitHub repository[2]. The repository contains the analysis notebook already executed and saved in html format[3]. To foster reproducibility, we set up a Binder repository[4] for reproducing our results fully online. Finally, we adapted our analysis notebook so that it can calculate the same metrics and produce the same figures and tables as the present analysis for any dataset, if it is formatted as specified in the dedicated GitHub repository[5].

[2] https://github.com/vincentpmartin/insomnia.content.analysis
[3] https://raw.githack.com/vincentpmartin/insomnia.content.analysis/main/jupyter_notebook_insomnia_content_analysis.html
[4] https://mybinder.org/v2/gh/vincentpmartin/insomnia.content.analysis/HEAD?labpath=jupyter_notebook_insomnia_content_analysis.ipynb
[5] https://github.com/vincentpmartin/generic.content.analysis

3. Results

3.1. Number and frequency of clinical manifestations

The nine questionnaires comprised 64 items that provided 16 different clinical manifestations, with 66 extracted clinical manifestations. **Figure 1** shows the frequency of each different clinical manifestation from the most frequent to the least frequent for all dimensions and regarding the five dimensions "Insomnia initiating" and "Insomnia maintaining" were the most common clinical manifestations and appeared in all the questionnaires. "Sleep satisfaction" was the most common clinical manifestation from the "Insomnia-related symptoms" dimension (appearing in 6 out of 9 questionnaires– 66.0%), "Fatigue" was the most common clinical manifestation from the "Daytime symptoms" dimension (appearing in 5 out of 9 questionnaires – 55.6%), and "Self-complaints of distress" and "Self-complaints of disabilities" were the most common clinical manifestations from the "Insomnia-related impairments" dimension (appearing in 5 questionnaires on 9 – 55.6%).

Figure 2 shows the distribution of the clinical manifestations in each questionnaire across the five dimensions. By design, all questionnaires have clinical manifestations of the "Insomnia symptoms" dimension. Only one questionnaire does not contain any clinical manifestations from the "Insomnia-related symptoms" dimension (JSS) (Jenkins et al., 1988), and three questionnaires do not contain any clinical manifestations from the "Daytime symptoms" dimension (RIS, WHIIRS and MISS) (Broman et al., 2008; Crönlein et al., 2013; Levine et al., 2003). Two of them do not contain any clinical manifestations from the "Insomnia-related impairments" dimension (WHIIRS and MISS) (Broman et al., 2008; Levine et al., 2003). The "Sleep behaviors" dimension appears in only two questionnaires (RIS and AIS) (Crönlein et

al., 2013; Soldatos et al., 2000). The number and the distribution of clinical manifestations across the dimensions are available in our online analysis notebook[6].

The questionnaires containing the largest number of different clinical manifestations were the ISI (N = 11/16), the RIS (N = 10/16), and the SCI and the ISQ (N = 9/16) (**Table 2**). Among the 66 extracted clinical manifestations, 15 were compound (22.7%) and 51 were specific (77.3%). Among the 16 different clinical manifestations, three were idiosyncratic (18.8%), appearing only in one questionnaire. The questionnaires with the largest number of compound clinical manifestations were the ISI and the SCI (resp. 6 and 5), followed by the BIS (3), and the JSS (1). The RIS, ISQ, AIS, WHIIRS and MISS contained only specific clinical manifestations (**Table 2**).

3.2. Content overlap analysis

Table 2 presents the average Jaccard Index, the number of items, and the number of specific and compound clinical manifestations per questionnaire. The mean overlap between the questionnaires evaluated with the Jaccard Index was 0.409 (SD = 0.027), indicating a moderate similarity. The questionnaire with the highest average Jaccard index was the BIS (0.489). The BIS was followed by the SCI (0.453), the AIS (0.447), the ISI (0.428), and the ISQ (0.423). These five questionnaires are also those that have clinical manifestations belonging to four dimensions (Insomnia symptoms, Insomnia-related symptoms, Daytime symptoms, and Insomnia-related impairments). Nevertheless, the correlations between the Jaccard Index and the total number of clinical manifestations or the number of specific clinical manifestations or

[6] https://raw.githack.com/vincentpmartin/insomnia.content.analysis/main/jupyter_notebook_insomnia_content_analysis.html

compound clinical manifestations were not significant (respectively: ϱ = 0.338, p = 0.374, ϱ = 0.211, p = 0.586, and ϱ = 0.566, p = 0.112).

Regarding the dimensions, the mean overlap was the highest for "Insomnia symptoms" (0.833), followed by "Insomnia-related impairments" (0.578), "Sleep behaviors" (0.500), and "Daytime symptoms" (0.406). The overlap was the lowest for "Insomnia-related symptoms" (0.378).

Lastly, the SCI and the ISQ questionnaires had the highest pairwise overlap (0.800), followed by the SCI and the ISI (0.667) and the AIS and the BIS (0.600). The questionnaires that had the lowest pairwise overlap were the ISI and the MISS (0.167), and the ISQ and the WHIIRS (0.182) (**Figure 3**).

3.3. Visualization of content overlap

Figure 4 shows the content overlap of clinical manifestations in the nine questionnaires (see https://chart-studio.plotly.com/~vincent.martin/49/#/ for an interactive version online). This figure clearly demonstrates which clinical manifestation is evaluated by which questionnaire.

A hierarchical arrangement of the clinical manifestations according to the dimensions is shown in the sunburst plot in **Figure 5** (see https://chart-studio.plotly.com/~vincent.martin/53/#/ for an interactive version online). This figure provides a smart solution to visualize the different type dimensions and clinical manifestations explored by these questionnaires.

4. Discussion

4.1 Key findings

This is the first systematic quantified analysis of content and overlap in nine commonly used self-report questionnaires of insomnia disorder severity for adults. Our results highlight the heterogeneity among the questionnaires analyzed (i.e., a moderate overlap – with a mean Jaccard Index of 0.409) and demonstrate visually the different types of clinical manifestations

that are investigated by each questionnaire. Although they are all psychometrically sound instruments (Cerri et al., 2023; Manzar et al., 2021), differences in their content suggest that the results derived from them should not be compared and used interchangeably. Instead, we consider that the most appropriate questionnaire should be selected based on the issue to be addressed and the content of the questionnaire. According to the dimensions in which we grouped the contents of clinical manifestations from these questionnaires, we propose classifying them into three groups: questionnaires mainly assessing core dimensions of insomnia, which would be more suitable for evaluating insomnia disorder for clinical issues (i.e., ISI (Bastien et al., 2001), SCI (Espie et al., 2014), BIS (Pallesen et al., 2008), and ISQ (Okun et al., 2009)); brief scales, which could be very useful for epidemiological issues (i.e., WHIIRS (Levine et al., 2003), JSS (Jenkins et al., 1988), and MISS (Broman et al., 2008)), and questionnaires assessing co-occurring sleep clinical manifestations, apart from the core dimensions of insomnia, which would be most useful for phenotyping issues (i.e., AIS (Soldatos et al., 2000), and RIS (Crönlein et al., 2013)).

4.2 Clinical issues: towards a better assessment of the core dimensions of insomnia

Four dimensions were mostly explored by the questionnaires: “Insomnia symptoms” (9/9), “Insomnia-related symptoms” (8/9), “Daytime symptoms” (6/9, in particular, cognitive and affective symptoms, 3/9 each), and “Insomnia-related impairments” (6/9). This is not surprising, since these four dimensions are in line with the core clinical diagnostic criteria of insomnia disorder in the ICSD-3 and the DSM-5 (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017; Gauld, Lopez, Geoffroy, Morin, et al., 2021). The ISI (Bastien et al., 2001) and the SCI (Espie et al., 2014), which are the most recommended tools (Buysse et al., 2006; Riemann et al., 2017), explore these four main dimensions, as well as the BIS (Pallesen et al., 2008) and the ISQ (Okun et al., 2009). Therefore, they seem to be

the most suitable tools for addressing clinical issues. As expected, these four scales show the greatest overlap (the highest for the BIS with a Jaccard Index at 0.49 on six items and the lowest for the ISQ at 0.42 on 13 items) and a moderate to very strong overlap from one to another (from 0.46 between the ISI and the BIS and 0.80 between the ISI and the SCI).

Nevertheless, except for the essential "Insomnia symptoms" dimension, which shows strong overlap (mean Jaccard Index at 0.83), the other dimensions show weak-to-moderate overlap. For instance, regarding the "Insomnia-related symptoms", the SCI only explores "Sleep satisfaction" while the ISQ only explores "Nonrestorative sleep", and "Worrying about sleep" is assessed only in the ISI. Above all, there is a lack of distinction between the "Daytime symptoms" and the "Insomnia-related impairments" dimensions. This confusion is further illustrated by the numerous compound clinical manifestations included within the "Daytime symptoms" (9/15, 60%) and the "Insomnia-related impairments" (4/11, 36%) dimensions. These clinical manifestations are mostly represented in the ISI (6/11, 55%), the SCI (n=5/9, 56%), and the BIS (n=3/8, 38%).

Arguably, the inclusion of more than one clinical manifestation in the same item may affect the reliability and validity of its assessment. For instance, in the BIS, the evaluation of "Daytime sleepiness" might be distorted by the presence or not of "Fatigue" and "Self-complaints of disabilities" (Item 5: "During the past month, how many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life?"). The ISQ has the advantage of including only specific clinical manifestations. Hence, the three clinical manifestations described above are evaluated in three different items ("Daytime sleepiness" in the item 13: "How sleepy do you feel during the day?"; "Fatigue" in the item 12: "Have your sleep difficulties made you feel fatigued?"; "Self-complaints of disabilities" in the item 7: "Have your sleep difficulties affected your work?"). Lastly, clinical manifestations may be either unique (i.e., explored by only one item) or redundant (i.e., explored by more than one

item within the same questionnaire). For instance, in the ISQ, there are two items for "Insomnia maintaining", two items for "Nonrestorative sleep", and three items for "Self-complaints of disabilities", while each clinical manifestation is unique and assessed only in one item in the ISI.

These results suggest that to better assess the core dimensions of insomnia disorder for clinical issues, self-report questionnaires should avoid items with compound clinical manifestations and should clearly differentiate between insomnia symptoms (in terms of essential insomnia symptoms, insomnia-related symptoms and daytime symptoms) and insomnia-related impairments (also called sleep-related impairment, affecting functional status) (Buysse et al., 2010). It is important to evaluate symptoms and impairments equally and independently as different concepts (Eriksen & Risør, 2014; Tj, 2004), as proposed in the classification of mental and sleep disorders (American Academy of Sleep Medicine, 2014; American Psychiatric Association, 2017; Gauld, Lopez, Geoffroy, Morin, et al., 2021), in previous sleep studies (Martin et al., 2023; Weaver, 2001), and in the field of psychiatry (Best et al., 2020; Norman et al., 2000; Tanner et al., 2019; Thomas et al., 2017). This idea is well represented in sleep medicine with the development of the PROMIS, which distinguishes between sleep disturbance (i.e., symptoms) and sleep-related impairments (Buysse et al., 2010). Moreover, previous studies on the definition of an ideal treatment in terms of benefits/risks by patients involved in clinical trials have shown that expectations in terms of treatment benefit for insomnia disorder relate more to insomnia-related impairments than to insomnia symptoms *per se* (Heidenreich et al., 2022; Rosenberg et al., 2021; Schutte-Rodin et al., 2008). To evaluate all these dimensions, redundant items could be helpful to better characterize them for clinical purposes, but this increased number of items may not be appropriate for epidemiological issues.

4.3 Epidemiological issues: towards a compromise between brevity and exhaustiveness

Among the nine questionnaires included, three of them had fewer than six items. Therefore, their length makes them more suitable for epidemiological issues. The briefest questionnaires were the WHIIRS (5 items) (Levine et al., 2003), the JSS (4 items) (Jenkins et al., 1988), and the MISS (3 items) (Broman et al., 2008). Overall, they show a weak-to-moderate overall Jaccard index (from 0.300 for the MISS to 0.406 for the WHIIRS). This is due to the number of dimensions they assess: only one, in addition to the essential "Insomnia symptoms" dimension (i.e., "Insomnia-related symptoms" in the WHIIRS and the MISS, and "Daytime symptoms" in the JSS).

Nevertheless, "Insomnia-related impairments", defined above as one of the core dimensions of insomnia, is not evaluated in any of these short scales. Of note, previous studies proposed short-form versions of validated scales (Espie et al., 2014; Kraepelien et al., 2021; Thakral et al., 2021). However, these short versions, featuring items similar to those of the original scales, were not included in this content analysis in order not to artificially increase the overlap. In their original publication, *Espie et al.* provided a two-item short form of the SCI (Espie et al., 2014) (Item 3 and Item 7). According to our content analysis methodology, this short form contains two specific and unique symptoms referring to the "Insomnia-related symptoms" and the "Insomnia-related impairments" dimensions. More recently, two studies developed and validated a two-item (Item 4 and item 7) and a three-item (Item 4, item 6 and item 7) version of the ISI (Kraepelien et al., 2021; Thakral et al., 2021). These short versions contain items with symptoms from the same two dimensions featuring in the short version of the SCI (Espie et al., 2014). Surprisingly, these short versions of the SCI and the ISI do not provide any evaluation of essential "Insomnia symptoms" (insomnia initiating, insomnia maintaining and insomnia early), yet they are considered as very important symptoms by the ICSD-3 and the DSM-5. Thus, to our knowledge, no short questionnaire evaluates both essential "Insomnia symptoms" and "Insomnia-related impairments".

These results suggest that to strike a good balance between brevity and exhaustiveness for epidemiological issues, self-report questionnaires could use items evaluating various related symptoms (compound symptoms) in a non-redundant manner. Future work on the development of abbreviated insomnia scales should focus not only on psychometric and factor analysis but also on content analysis, since a limited selection of symptoms has the effect of leaving out certain core dimensions of insomnia disorder. A reduction in the number of items could help in better using such tools in epidemiological settings, but this could lead to limiting the information collected if the aim is to establish a phenotypic classification of insomnia.

4.4 Phenotyping insomnia: towards a tool for precision sleep medicine

Two clinical manifestations were poorly explored while being of interest in a phenotyping perspective. Among the five dimensions of clinical manifestation of insomnia disorder, "Sleep behaviors" is explored only in the AIS (Soldatos et al., 2000) and the RIS (Crönlein et al., 2013). Moreover, symptoms related to hyperarousal, which are important insomnia-related symptoms, are included only in the RIS, which explores cognitive hyperactivity (e.g., Item 7: "I think a lot about my sleep" and Item 8: "I am afraid to go to bed because of my disturbed sleep"). Despite the rarity of these clinical manifestations in the questionnaires, these symptoms suggest that different insomnia symptoms may not be regarded simply as interchangeable indicators of its severity. According to an integrated multi-domain approach (Riemann, 2018; Riemann et al., 2020), the assessment of co-occurring sleep clinical manifestations could indeed constitute an opportunity to characterize the insomnia disorder phenotype in order to better predict the disorder's natural course or the response to treatment.

Sleep duration is of importance, as previous studies have highlighted differences in individuals with insomnia disorder who are short or long sleepers (Fernandez-Mendoza et al., 2011; Fernandez-Mendoza et al., 2015; Olaithe et al., 2021; van Mill et al., 2014; Vgontzas et al.,

2012; Vgontzas, Liao, Bixler, et al., 2009; Vgontzas, Liao, Pejovic, et al., 2009). Studies have shown that the cardiometabolic prognosis and mental health of patients with chronic insomnia disorder are poorer if associated with objective short sleep duration (Dai et al., 2023; Fernandez-Mendoza et al., 2015; van Mill et al., 2014; Vgontzas, Liao, Bixler, et al., 2009; Vgontzas, Liao, Pejovic, et al., 2009). Furthermore, objective short sleep duration appears to promote the incidence or recurrence of insomnia disorder (Vgontzas et al., 2012). Although sleep duration assessed via questionnaires is not an objective measure, several studies have highlighted the usefulness of evaluating self-reported sleep duration, and have linked sleep duration, identified through self-reporting, to a variety of health conditions, cognitive impairments and mortality risk (Buxton & Marcelli, 2010; Kyle et al., 2017; Nunes et al., 2008). Thus, the inclusion of sleep duration in an insomnia disorder questionnaire could be helpful for the identification of a specific insomnia disorder phenotype. Of note, besides investigating sleep duration and showing one of the highest overall Jaccard index (0.45), the AIS displays some other particularities that should be mentioned. “Daytime symptoms” are explored using the “Daytime sleepiness” symptom. This symptom has an interesting relationship with insomnia disorder. Indeed, daytime sleepiness may reflect the presence of a comorbidity (Lichstein et al., 1994), or be indicative of more severe insomnia disorder (Riemann et al., 2017; Vgontzas et al., 2012).

Insomnia symptoms related to hyperarousal are key components in contemporary etiological models of insomnia disorder (Kalmbach et al., 2018; Riemann et al., 2010), which suggests that insomnia disorder is very similar to affective and anxiety disorders. The hyperarousal mechanism has been postulated to explain how transient insomnia can turn into a chronic disorder: subjects who tend to focus cognitively on their sleep problem and its consequences, and start to ruminate about their sleep, are prone to develop “learned sleep preventing associations”, which throw light on the chronicity of the disorder. However, many patients with

chronic insomnia disorder display cognitive hyperactivity or anxiety about sleep (Riemann et al., 2010). Therefore, cognitive hyperarousal could also be an important clinical manifestation of a specific insomnia disorder phenotype. To date, hyperarousal-related symptoms have been commonly explored in specific questionnaires (e.g., The Hyperarousal Scale, the Arousability Predisposition Scale, and the Pre-sleep Arousal Scale) (Coren & Mah, 1993; Nicassio et al., 1985; Regestein et al., 1993). The RIS appears to be the sole insomnia severity questionnaire assessing this concept. Nevertheless, the RIS has some issues that require discussion. It does not include "Daytime symptoms", which explain its weak overall Jaccard index (0.35). However, it is also the only questionnaire that includes sleeping pills intake, which is a frequent behavior (15%) among patients with insomnia disorder in primary care settings (Bjorvatn et al., 2017; Torsvik et al., 2023), and is very important to consider in the implementation of CBT for insomnia (Sweetman et al., 2021). Nevertheless, taking into account the affective and anxiety symptoms related to hyperarousal in insomnia disorder could be very important to better phenotype this disorder, and to better disentangle the intertwined relation between insomnia and psychiatric symptoms. This complex interaction is highlighted by comparing the extracted clinical manifestations in the content analysis of affective disorders. Insomnia initiating, maintaining, and early, and fatigue are assessed in the seven common depression scales, and sleepiness in four of them (Fried, 2017). Other clinical manifestations are lumped into affective/cognitive symptoms in our content analysis and assessed in three of the nine common insomnia scales. A content analysis based on the diagnostic criteria of the DSM-5 found that the most frequent symptoms among the 202 diagnoses were insomnia, difficulty concentrating, and irritability (Forbes et al., 2023). Further cross-diagnostic content analyses of severity questionnaires would allow better understanding of the complex interaction between sleep and mental disorders. Hierarchical classification by dimensions, as performed in the

present study, constitutes a useful tool to enhance reliability and better harmonize content analyses made by different experts.

Finally, these results suggest that although the assessment of associated clinical manifestations of insomnia disorder could provide relevant information for phenotyping insomnia disorder in the area of precision sleep medicine, there are only two questionnaires that evaluate such characteristics (Crönlein et al., 2013; Soldatos et al., 2000). Although the evaluation of insomnia disorder phenotypes mostly relies on the use of additional specific questionnaires that were not included in this study, further studies are needed to identify the minimal list of clinical manifestations to be included in self-report questionnaires of insomnia severity in adults, whose goal is to evaluate specific phenotypes of insomnia disorder.

4.5 Limitations

All our results and suggestions should be considered within certain limitations. First, regarding the selection of questionnaires, several questionnaires assessing sleep complaints were not included in this analysis, such as questionnaires not specifically designed for insomnia or not including essential "Insomnia symptoms". Nevertheless, a more global analysis of all the questionnaires related directly or indirectly to insomnia, to its psychological correlates (e.g., Dysfunctional Beliefs and Attitudes about Sleep, DBAS) (Morin et al., 1993), to its daytime consequences (e.g., Insomnia Daytime Symptoms and Impacts Questionnaire, IDSIQ) (Hudgens et al., 2021), and to sleep disturbance in general terms (e.g., Patient Reported Outcomes Measures for Sleep Disturbance, PROMIS-SD) (Buysse et al., 2010) would provide additional information.

Second, regarding the extraction of items, we did not consider the variation in the response scale from one questionnaire to another. For instance, the ISI features only intensity scales (from none to very severe), while the BIS contains only frequency scales (from never to every

day). Although strongly related, they may be decorrelated in some individuals (e.g., intense but rare insomnia symptoms vs frequent but mild insomnia symptoms). Frequency appears as a main criterion of chronic insomnia in the DSM-5 (i.e., ≥ 3 times per week) (American Psychiatric Association, 2017), while intensity is the most frequent response scale in the questionnaires included in this content analysis (68% of the 64 items). Furthermore, rating scales differ regarding the number of categories (four or five response options) and type of response labeling (verbal, such as "not at all" to "very much" (i.e., SCI), or verbal coupled with numbers, such as "0" to "4" (i.e., ISQ)). In addition, the time frame evaluated is almost always the past month, except in the ISI where it is the past two weeks. Moreover, only the SCI and the ISQ explore the period of evolution of insomnia severity, which is one of the diagnostic criteria of chronic insomnia disorder, and could be the most appropriate scale for insomnia disorder screening (American Psychiatric Association, 2017). The effect of several rating scale attributes on the responses of questionnaire takers has also received attention (Krabbe & Forkmann, 2012). Finally, the regularity of symptoms, which may indicate a certain type of insomnia producing more/less poor-into-rebound sleep, is thought to be associated with better treatment responsiveness and should be considered as a symptom of prognostic value (Chan et al., 2017). All these differences should be considered in future content analysis studies and in psychometric studies.

Third, regarding the extraction of clinical manifestations, items were separated or grouped together while remaining as conservative as possible (Fried, 2017). This split and lump procedure was constrained by clinical relevance (Fried, 2017). Nevertheless, the impact of the granularity of the extraction of clinical manifestations in terms of precision should be discussed in further analysis. For instance, and in particular for the evaluation of chronic insomnia disorder, it might be difficult to distinguish a self-complaint of distress or disabilities due to a lack of sleep in a rational individual (e.g., "My lack of sleep impacts my work abilities") from

excessive worrying about sleep in an individual with sleep disbeliefs (e.g., “I am concerned about getting a good night's sleep before workdays”). However, the hierarchical classification of clinical manifestations proposed in Figure 5 constitutes an innovative approach compared to the initial methodology described by *Fried* (Fried, 2017). It allows a new level of analysis by dimension that helps control the risks of excessive splitting or lumping that could hamper content visualization and bias overlap analyses.

Fourth, despite our double-blind extraction methodology, this content visualization and overlap analysis solely rely on an expert “top-down” approach. These findings need further data-based evaluation using either factorial or network analysis to confirm their suitability and coherence across various populations. This empirical data-based “bottom-up” approach could help to further improve the characterization of the complex and multifaceted construct of insomnia disorder. These back-and-forth strategies between expert opinion and empirical data analysis constitute an innovative integrative methodology which should be properly defined and widely used in sleep and mental disorders.

5. Conclusion

By systematically evaluating the items content of these nine widely used questionnaires, we were able to identify several points of interest that can help in selecting one questionnaire instead of another and, perhaps, lead to the development of a new insomnia disorder questionnaire or the refinement of existing ones. These include the use of specific vs compound clinical manifestations, the distinction between sleep symptoms and sleep-related impairments, and the assessment of sleep duration and hyperarousal symptoms, aspects usually overlooked in the questionnaires analyzed herein. Overall, the content analysis of insomnia disorder severity questionnaires has proven to be a valuable method for disentangling the frequent comorbidity between insomnia disorder and affective disorder and for better characterizing and visualizing the different types of insomnia disorder phenotype.

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Table 1. Items extracted from the nine questionnaires of insomnia disorder severity for adults.

Questionnaire	Item
Insomnia Severity Index (ISI) (Bastien et al., 2001)	Item 1: Difficulty falling asleep? Item 2: Difficulty staying asleep? Item 3: Problems waking up too early? Item 4: How satisfied/dissatisfied are you with your current sleep pattern? Item 5: How noticeable to others do you think your sleep problem is in terms of impairing the quality of your life? Item 6: How worried/distressed are you about your current sleep problem? Item 7: To what extent do you consider your sleep problem to interfere with your daily functioning (e.g., daytime fatigue, mood, ability to function at work/daily chores, concentration, memory, mood, etc.) currently?
Minimal Insomnia Symptom Scale (MISS) (Broman et al., 2008)	Item 1: Difficulties falling asleep? Item 2: Night awakenings? Item 3: Not being rested by sleep?
Jenkins Sleep Scale (JSS) (Jenkins et al., 1988)	Item 1: How often in the past month did you have trouble falling asleep? Item 2: How often in the past month did you wake up several times per night? Item 3: How often in the past month did you have trouble staying asleep (including waking far too early)? Item 4: How often in the past month did you wake up after your usual amount of sleep feeling tired and worn out?
Bergen Insomnia Scale (BIS) (Pallesen et al., 2008)	Item 1: How many days a week has it taken you more than 30 minutes to fall asleep after the light was switched off? Item 2: How many days a week have you been awake for more than 30 minutes between periods of sleep? Item 3: How many days a week have you awakened more than 30 minutes earlier than you wished without managing to fall asleep again? Item 4: How many days a week have you felt that you have not had enough rest after waking up? Item 5: How many days a week have you been so sleepy/tired that it has affected you at school/work or in your private life? Item 6: How many days a week have you been dissatisfied with your sleep?
Athens Insomnia Scale (AIS) (Soldatos et al., 2000)	Item 1: Sleep induction (time it takes you to fall asleep after turning-off the lights)? Item 2: Awakenings during the night? Item 3: Final awakening earlier than desired? Item 4: Total sleep duration? Item 5: Overall quality of sleep (no matter how long you slept)? Item 6: Sense of well-being during the day? Item 7: Functioning (physical and mental) during the day? Item 8: Sleepiness during the day?
Women's Health Initiative Insomnia Rating Scale (WHIIRS) (Levine et al., 2003)	Item 1: Did you have trouble falling asleep? Item 2: Did you wake up several times at night? Item 3: Did you wake up earlier than you planned to? Item 4: Did you have trouble getting back to sleep after you woke up too early? Item 5: Overall, was your typical night's sleep during the past 4 weeks?
Sleep Condition Indicator (SCI) (Espie et al., 2014)	Item 1: How long does it take you to fall asleep? Item 2: If you then wake up during the night, how long are you awake for in total? (add all the awakenings) Item 3: How many nights a week do you have a problem with your sleep? Item 4: How would you rate your sleep quality? Item 5: To what extent has poor sleep, affected your mood, energy, or relationships? Item 6: To what extent has poor sleep, affected your concentration, productivity, or ability to stay awake? Item 7: To what extent has poor sleep, troubled you in general? Item 8: Finally, how long have you had a problem with your sleep?
Regensburg Insomnia Scale (RIS) (Crönlein et al., 2013)	Item 1: At what time do you usually go to bed and when do you usually wake up? Item 2: How many minutes do you need to fall asleep? Item 3: How many hours do you sleep during the night? Item 4: My sleep is disturbed. Item 5: I wake up too early. Item 6: I wake up from the slightest sound. Item 7: I feel that I have not slept all night.

	Item 8: I think a lot about my sleep. Item 9: I am afraid to go to bed because of my disturbed sleep. Item 10: I feel fit during the day. Item 11: I take sleeping pills in order to get to sleep.
Insomnia Symptom Questionnaire (ISQ) (Okun et al., 2009)	Item 1: Difficulty falling asleep? Item 2: Difficulty staying asleep? Item 3: Frequent awakenings from sleep? Item 4: Feeling that your sleep is not sound? Item 5: Feeling that your sleep is unrefreshing? Item 6: How much do your sleep problems bother you? Item 7: Have your sleep difficulties affected your work? Item 8: Have your sleep difficulties affected your social life? Item 9: Have your sleep difficulties affected other important parts of your life? Item 10: Have your sleep difficulties made you feel irritable? Item 11: Have your sleep problems caused you to have trouble concentrating? Item 12: Have your sleep difficulties made you feel fatigued? Item 13: How sleepy do you feel during the day?

Table 2. Average Jaccard Index, number of items and of specific and compound clinical manifestations in the 9 questionnaires of insomnia disorder severity. ISI: Insomnia Severity Index; RIS: Regensburg Insomnia Scale; SCI: Sleep Condition Indicator; ISQ: Insomnia Symptom Questionnaire; BIS: Bergen Insomnia Scale; AIS: Athens Insomnia Scale; JSS: Jenkins Sleep Scale; WHIIRS: Women's Health Initiative Insomnia Rating Scale; MISS: Minimal Insomnia Symptom Scale.

	Average Jaccard Index	**Number of items**	**Specific clinical manifestations**	**Compound clinical manifestations**	**Total number of extracted clinical manifestation**	**Total number of different clinical manifestation**
ISI	0.428	7	5	6	11	11
RIS	0.349	11	10	0	10	10
SCI	0.453	7	4	5	9	9
ISQ	0.423	13	9	0	9	9
BIS	0.489	6	5	3	8	8
AIS	0.447	8	8	0	8	8
JSS	0.384	4	3	1	4	4
WHIIRS	0.406	5	4	0	4	4
MISS	0.300	3	3	0	3	3
MEAN	**0.409** (mean)	**64** (total)	**51** (total)	**15** (total)	**66 (total)**	**16** (total)

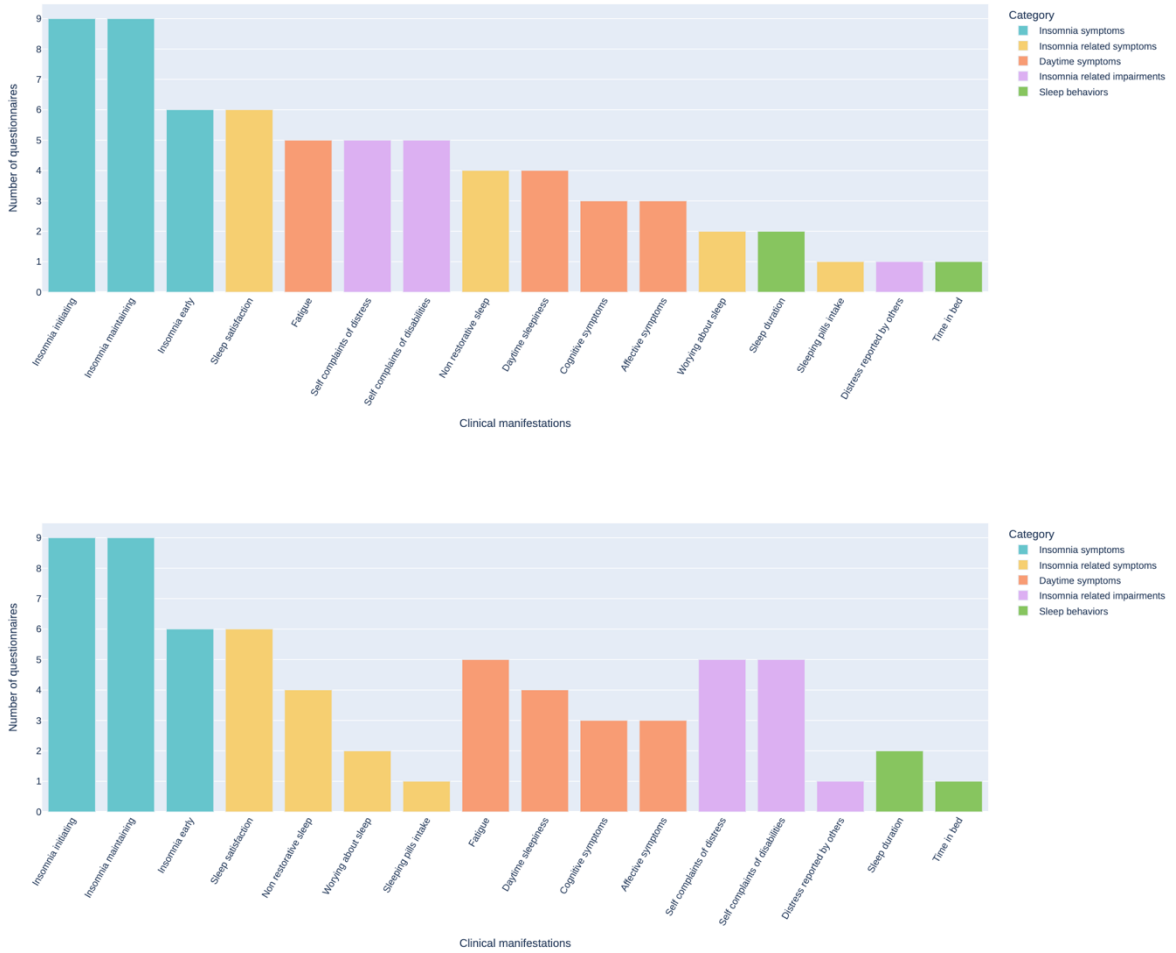

Figure 1. Frequency of clinical manifestations identified in the 9 questionnaires of insomnia disorder severity. **(Top)** Plot organized from the most frequent to the least frequent for all dimensions. **(Bottom)** Plot organized from the most frequent to the least frequent regarding the five dimensions as identified previously (Gauld, Lopez, Geoffroy, Morin, et al., 2021; Gauld, Lopez, Morin, Geoffroy, et al., 2021; Gauld, Lopez, Morin, Maquet, et al., 2021).

Figure 2. Distribution of the clinical manifestations found in each questionnaire across the five dimensions. ISI: Insomnia Severity Index; RIS: Regensburg Insomnia Scale; SCI: Sleep Condition Indicator; ISQ: Insomnia Symptom Questionnaire; BIS: Bergen Insomnia Scale; AIS: Athens Insomnia Scale; JSS: Jenkins Sleep Scale; WHIIRS: Women's Health Initiative Insomnia Rating Scale; MISS: Minimal Insomnia Symptom Scale.

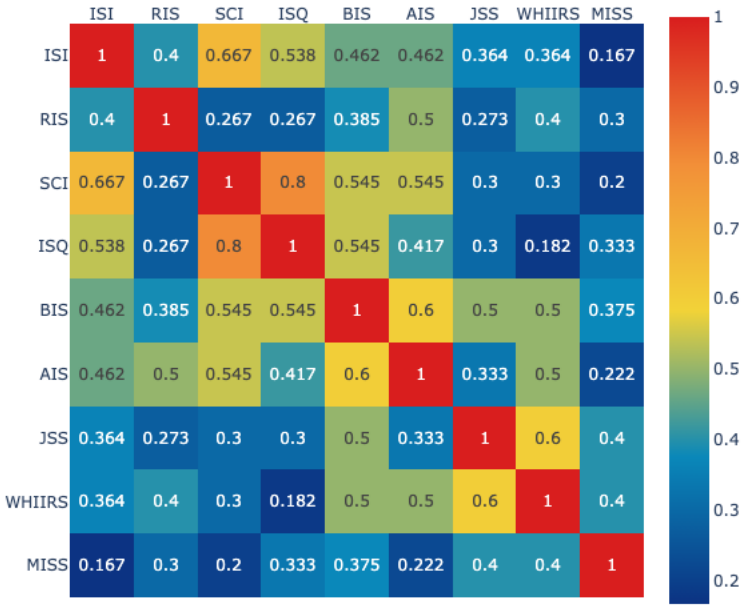

Figure 3. Jaccard Index overlap of item content of the 9 questionnaires of insomnia disorder severity for each pair of questionnaires. ISI: Insomnia Severity Index; RIS: Regensburg Insomnia Scale; SCI: Sleep Condition Indicator; ISQ: Insomnia Symptom Questionnaire; BIS: Bergen Insomnia Scale; AIS: Athens Insomnia Scale; JSS: Jenkins Sleep Scale; WHIIRS: Women's Health Initiative Insomnia Rating Scale; MISS: Minimal Insomnia Symptom Scale.

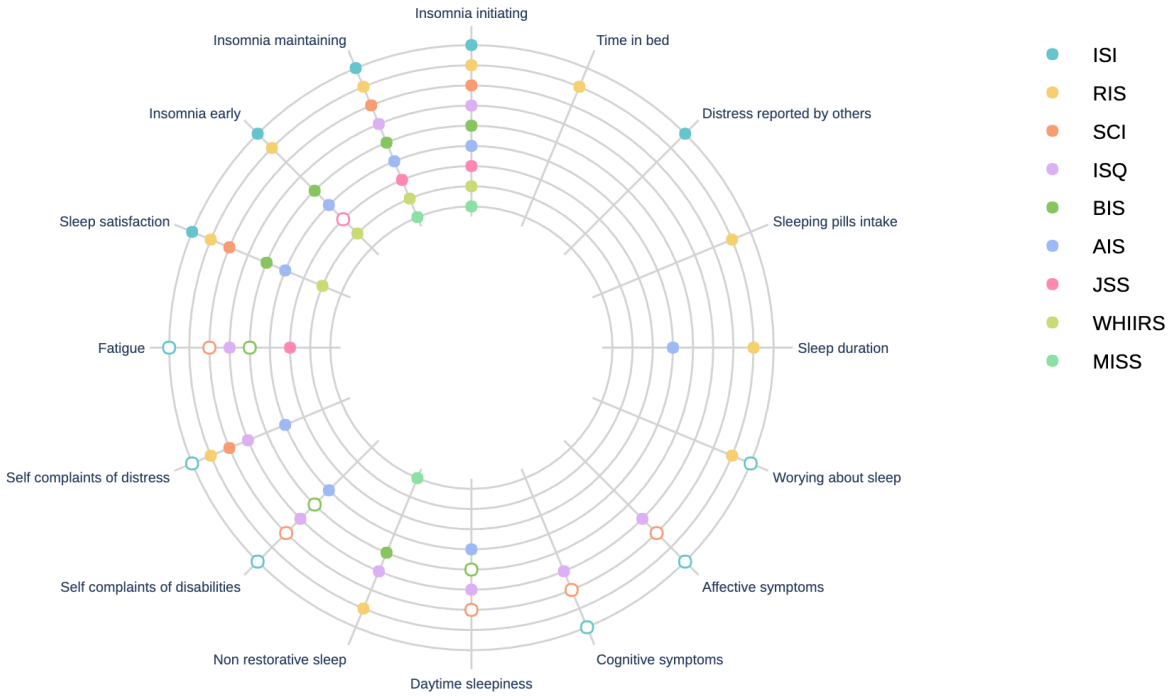

Figure 4. Content overlap of the clinical manifestations in the 9 selected questionnaires of insomnia disorder severity. Colored circles for a clinical manifestation indicate that this is a specific clinical manifestation, while empty circles indicate that this is a compound clinical manifestation. See also the interactive version of this Figure online: https://chart-studio.plotly.com/~vincent.martin/49/#/. ISI: Insomnia Severity Index; RIS: Regensburg Insomnia Scale; SCI: Sleep Condition Indicator; ISQ: Insomnia Symptom Questionnaire; BIS: Bergen Insomnia Scale; AIS: Athens Insomnia Scale; JSS: Jenkins Sleep Scale; WHIIRS: Women's Health Initiative Insomnia Rating Scale; MISS: Minimal Insomnia Symptom Scale.

Figure 5. Sunburst plot indicating the hierarchical arrangement of the clinical manifestations according to dimensions. Blue: Insomnia symptoms; Red: Insomnia-related symptoms; Yellow: Daytime symptoms; Purple: Insomnia-related impairments; Green: Sleep behaviors Please also see the interactive version of this Figure online: https://chart-studio.plotly.com/~vincent.martin/53/#