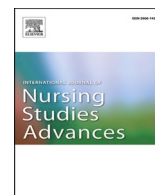


Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

International Journal of Nursing Studies Advances

journal homepage: www.sciencedirect.com/journal/international-journal-of-nursing-studies-advances

Patient-reported outcome measures for the assessment of stress in neurological patients: An integrative review

Ilkka Sairanen^{a,b,*}, Heli Virtanen^a, Päivi Hämäläinen^c, Riitta Suhonen^{a,b,d}

^a University of Turku, Department of Nursing Science, Turku, Finland

^b Turku University Hospital, Finland

^c Masku Neurological Rehabilitation Centre, Masku, Finland

^d Welfare Services County of Southwest Finland, Finland

ARTICLE INFO

Keywords:

Stress management
Nursing assessment
Patient-reported outcome measures
Review

ABSTRACT

Background: Patient stress is often overlooked in the care of patients with neurological problems. Nursing theorists have previously heralded stress assessment through conceptual clarification, while clinical nurses in the health care system hold an ideal position for implementation of assessment and coordination of support. Integrated with a hospital assessment and support scheme, recognition of stress as a target of systematic assessment can lead to improved clinical outcomes.

Objective: The aim of the study was to describe and compare patient-reported outcome measures suitable for assessment of the stress response as symptoms in neurological patients.

Design: This study is an integrative review and concept development of patient stress based on qualitative and quantitative analysis of available self-reporting instruments.

Methods: Instruments were retrieved with a systematic search from PubMed, CINAHL, PsychINFO and Web of Science reference databases on August 2, 2021. Search terms associated with the concept of stress symptoms were used. Instrument inclusion was done with the guidance of authoritative symptom inventories, with partial confirmation by a second author to mitigate bias. In the analysis, the instruments included in the review were quantitatively described and compared. Insights from the instrument composition led to clarification of our concept of stress response to further refine the list of instruments suitable for self-assessment of the stress status. This study was not registered.

Results: Based on the inclusion criteria, 23 patient-reported outcome measures extending over a variety of stress concepts were included. The similarity of items among the instruments implied a symptom cluster delineated by 59 common symptom subclasses that were grouped together in a re-classification of instrument items. A comparative quantitative analysis prompted us to distinguish the concept of stress response from antecedent, consequent, and related concepts as a manifestation of mental, somatic, and behavioral domains. Ten instruments with items covering the three domains, each with unique qualities regarding number of items, measured spread, and letter count were described.

Conclusions: Within an organizational framework, effective allotment among types of support can be founded on the patient's stress status and the stressors. The stress status manifests itself as a set of measurable symptoms. Optimal instruments for use in systematic clinical assessment of neurological patients' stress status should satisfy the suggested specification of the stress response

* Corresponding author at: Turku University Hospital, Neurocenter. Tyks, T-hospital, PO Box 52, 20521 Turku, Finland.
E-mail address: iasair@utu.fi (I. Sairanen).

<https://doi.org/10.1016/j.ijnsa.2023.100172>

Received 4 May 2023; Received in revised form 11 December 2023; Accepted 14 December 2023

Available online 15 December 2023

2666-142X/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

with a minimal number of items and concise wording. Finding and including the relevant instruments for analysis were the main limitation of the study.

Tweetable abstract: Stress of neurological patients needs to be assessed and addressed. We ranked 10 suitable instruments that can be useful in the assessment.

What is already known about this topic

- Successful stress management can alleviate patients' neurological symptoms and prevent sequelae of neurological diseases.
- Patients' stress status is experienced by the individual as a set of symptoms, which are manifestations of the bio-physiological stress response.
- Neurological maladies commonly give rise to confusion, disorientation, and fatigue, requiring concise and uncomplicated instruments to be used in stress assessment.

What this paper adds

- Minimum information needed by the nurse to organize purposeful management support for patient stress include the individual's stress status and causes of stress.
- Symptoms of the stress response fall into three essential domains of experience: mental, somatic, and behavioral.
- Ten patient-reported outcome measures incorporating the essential domains of experience were found with varying measured spread over the domains, as well as different item and letter counts.

1. Background

1.1. Psychological stress as a factor of neurological problems

Studies demonstrating associations between neurological symptoms and experienced stress, ranging from disease onset to later stages of disease progression, emphasize the need for recognition of stress in the care of patients with neurological problems. At the onset stage, psychological trauma and stressful life experiences are recognized as a key aetiological factor of functional neurological disorders (Keynejad et al., 2019). Through the immune system, stressful experiences can add to the risk of autoimmune diseases, like multiple sclerosis and myasthenia gravis (Artemiadis et al., 2011; Bogdan et al., 2020). Stress experiences can exacerbate symptoms and increase activity of diagnosed neurological diseases, like epilepsy and progressive neurodegenerative diseases (Galtrey et al., 2016; Peña-Bautista et al., 2020). Stress also contributes to chronic fatigue, a symptom of various neurological disorders that patients often consider most disabling (Chaudhuri and Behan, 2004). Finally, neurological symptoms can act as a source of stress *per se*, leaving patients with Parkinson's disease, for example, vulnerable to elevated symptom distress (Backer, 2006). The risk of disease sequelae, such as depression, can be enhanced in stress as well (Cohen et al., 2007).

1.2. Need for systematic stress assessment in neurological patients

To organize stress management support in a structured manner necessitates a systematic approach towards the concept of stress and instruments of assessment. Selye (1950) introduced *stress* as a defense mechanism against "anything that endangers life", manifested as a measurable bodily syndrome. Stress factors (stressors) activating the defense reaction can be experienced either as positive (eustress) or negative (distress) (Selye, 1975). Contemporary concept analyses have shown, however, that stress and distress have over time been used interchangeably and in a nuanced manner (Ridner, 2004; Goodnite, 2014). The bio-physiological basis of stress response defines two temporally divergent hypothalamic pathways; rapid "fight-or-flight" responses are mediated through the sympathomedullary pathway, while long-term responses result from the operation of the hypothalamic pituitary-adrenal system (Cohen et al., 2007). While concise from evolutionary and bio-physiological perspectives, the concept of stress response has yet escaped precise delineation, with no consensus on its signs and symptoms (Amirkhan et al., 2018).

In the contemporary stress process model, the concepts stressor and stress response constitute the start and end points of the process, respectively, enclosing the psychological concepts of perception and appraisal and eventually leading to coping behavior (Cohen et al., 1997; Kocalevent et al., 2009). Any of the concepts of the stress process model can serve as the basis for stress status assessment (Cohen et al., 1997). For the purpose of screening and resource management, however, inventories addressing stressors and stress responses can be considered most appropriate. For stressors in particular, Holmes and Rahe's (1967) Social Readjustment Rating Scale first introduced empirically-determined weights for stress quantification. Since then, numerous parallel checklists emphasizing, for example, major life events, daily microstressors, or chronic stress factors have been developed (Cohen et al., 1997). As the quality and severity of psychological stressors are founded on the surrounding cultural context, culture-specific item tailoring for stressor assessment has been recommended (Cohen et al., 1997). The stress response, on the other hand, is a downstream component of the stress process, consolidating environmental stressors with the psychological aspects of stress into measurable signs and symptoms. Due

to the bio-physiological basis of the stress response, assessment methods ranging from blood tests to symptom questionnaires are relatively objective and universal.

2. A two-step global stress assessment scheme for neurology nurses

Any systematic assessment method needs to recognize the specific needs of groups of patients, such as disease-related confusion, disorientation, and fatigue typical for neurological conditions. Such needs motivate the use of brief instruments with uncomplicated items. In observational studies of patients completing common patient-reported outcome measures (for example, moderate or late stages of Parkinson’s disease) have been connected to increased time required to complete the questionnaire, while older patients with multiple sclerosis have reported severe difficulties with certain instrument items (Ploughman et al., 2010; Kim et al., 2006). Cognizant of respondent burden, Kocalevent et al. (2009) introduced a computerized adaptive algorithm comprising stress exposure and psychological reactions to assess stress perception. A corresponding concept pair was also integrated in Brattberg’s (2006) Stress Barometer instrument.

For the present study, we first established a stress assessment framework based on stress response and stressors. The framework consisted of two assessment steps, with a stress symptom inventory in the first step scheduled before a life events checklist in the second (Fig. 1). Stress symptoms were assessed for determination of the stress status of the individual, with numerical limits that triggered the second-step assessment of life events. These were partitioned by their manageability into ones alleviable via, for example, social work and ones that required psychological coping assistance, guiding resource allocation in the later stage. For the first step of the assessment framework, we set out to review patient-reported outcome measures applicable to the assessment of stress symptoms,

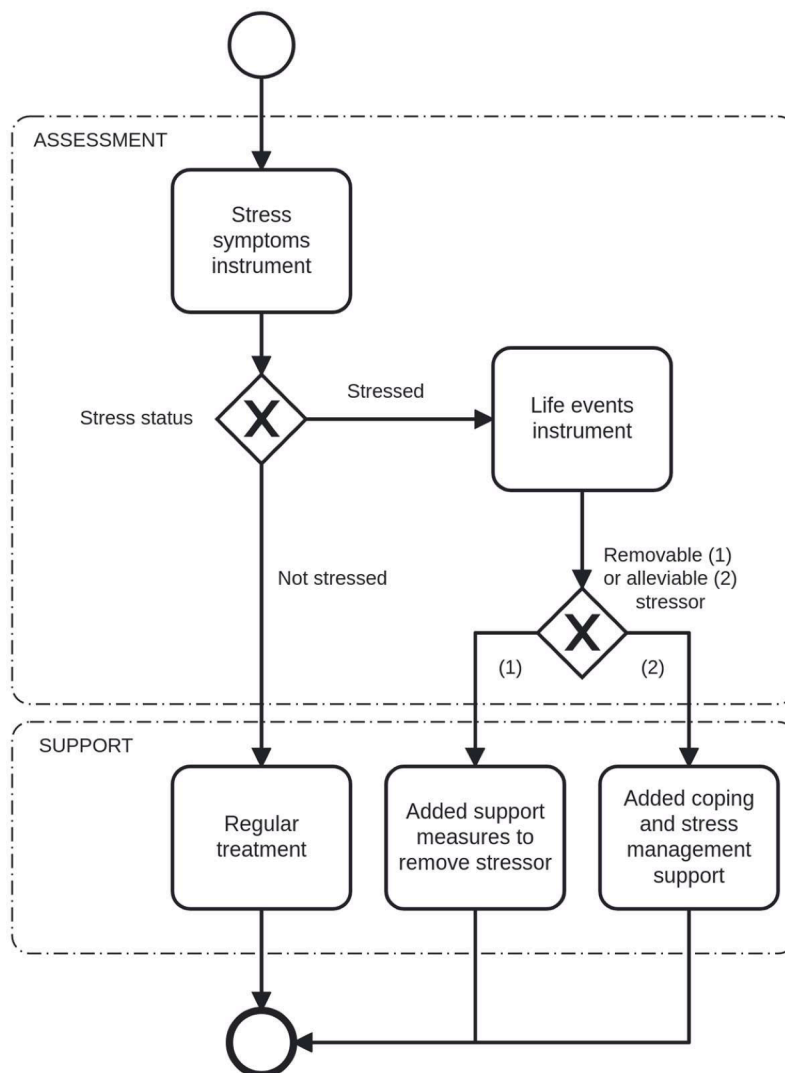


Fig. 1. Proposed organizational two-step stress assessment process for patients with neurological problems.

with a special reference to the demands of neurological patients.

3. Aim of the study

The aim of the study was to describe and compare patient-reported outcome measures suitable for assessment of the stress response as symptoms in neurological patients.

4. Methods

This study is an integrative review with an overview of available patient-reporting outcome measures for stress assessment in neurological patients. As an integrative review advances understanding through integration of empirical and theoretical literature, conclusions of this study were derived from analysis of the contents of the instruments, as well as theoretical analysis of the concept (Whittemore and Knaf, 2005). This study was not registered.

4.1. Literature search

4.1.1. Systematic search for instruments

Databases PubMed, CINAHL, PsychINFO, and Web of Science were searched for stress assessment instruments. Free search terms related to stress symptoms and stress response were used (Supplementary Material 1A). The searches were performed on August 2, 2021. Preliminary probing of databases showed ambiguity in the search terms, with the recovered instruments frequently containing items nearly identical to contents of psychiatric somatization instruments and general symptom listings. The conventional search was, therefore, supplemented with searches from the PsychINFO database by recovering most-used tests and measures applying the available database filter (Supplementary Material 1B). References were analyzed for instruments at the title and abstract level, and any indicated instruments were further identified from the text. Using the ancestry method, two additional instruments were recovered (Fineout-Overholt et al., 2010).

4.1.2. Instrument inclusion and exclusion criteria

The inclusion and exclusion criteria were applied for articles and instruments alike (Table 1). Reasons for excluding articles are detailed in the record screening phase, while instrument exclusions are reported in the eligibility assessment phase (Supplementary Material 2). Due to the lack of explicit symptomatology of the human stress response, symptom listings from websites of public health authorities were used to instruct inclusion of instruments in the review (Centers for Disease Control and Prevention, 2020; National Health Service, 2019). Each instrument's content was compared to a reference inventory of 33 symptoms extracted from the websites, with major consistency as a criteria for inclusion. Furthermore, the included instruments were required to be undesignated to any particular event or stressor and have been used in the context of health care. As a borderline example, four instruments of the Derogatis checklist series were considered for inclusion (Derogatis, 2017). From this series, the Symptom Checklist-90-r and Brief Symptom Inventory were excluded based on incorporated unrelated concepts, such as phobic anxiety, paranoid ideation, and psychoticism. Notable groups of instruments excluded from the analysis comprised instruments addressing occupational stress, post-traumatic stress disorder, and single symptoms such as anxiety. The exclusion process was carefully documented, and a randomly selected 5 % of the references were reviewed by the second author.

4.2. Data analysis

4.2.1. Instrument content visualization and analysis

A common framework for visualization of the contents of the instruments was established by inductively re-classifying the items of the instruments into novel classes and subclasses. Following previous examples, three domains were inductively established: somatic,

Table 1

Instrument inclusion and exclusion criteria.

Criterion domain	Inclusion criteria	Exclusion criteria
1 Instrument items	Symptoms of stress, corresponding to a reference inventory (Centers for Disease Control and Prevention 2020; National Health Service 2019)	Little correspondence to a reference inventory of stress symptoms Major correspondence to other concepts than stress response Targeting single stress symptom or stress subconcept
2 Global stress assessment instrument	Non-specific to a stressor or an event	Specific to a stressor Specific to an event (for example trauma)
3 Instrument designed for or used in	Patients	Other uses (for example occupational)
4 Reporting agent	Self-report	Instruments designed to be filled by caregivers or health care workers
5 Article language	English language	Other language

mental, and behavioral (Cohen et al., 1997; National Health Service, 2019). The re-classification was initially done by one author and later fully examined by another. Disagreements were resolved through discussion.

For an overall view of the contents of the instruments, the re-classified items were pooled, and frequencies were displayed at the domain and class level. Variation in instrument emphasis over domains was investigated as bar charts showing frequencies of items in each domain or class and by comparing the observed percentages to an expected percentage value that assumed an equal spread of items in each domain. Common features of instrument contents were then sought by statistically partitioning the instruments into clusters using the k-means method (Hartigan and Wong, 1979). A heat map was generated to illustrate the number of items in each class and to reveal the unfilled subclasses for each instrument. Finally, the instruments were compared based on usability in neurological patients by displaying the relationship between item count and measured spread over domains. A total count of letters in the instrument items was added to measure brevity. A measured spread value was computed as a geometric mean of ratios of representation for each of the three domains. The computation and illustrations were made in R version 4.2.2. using the stats::kmeans algorithm for clustering.

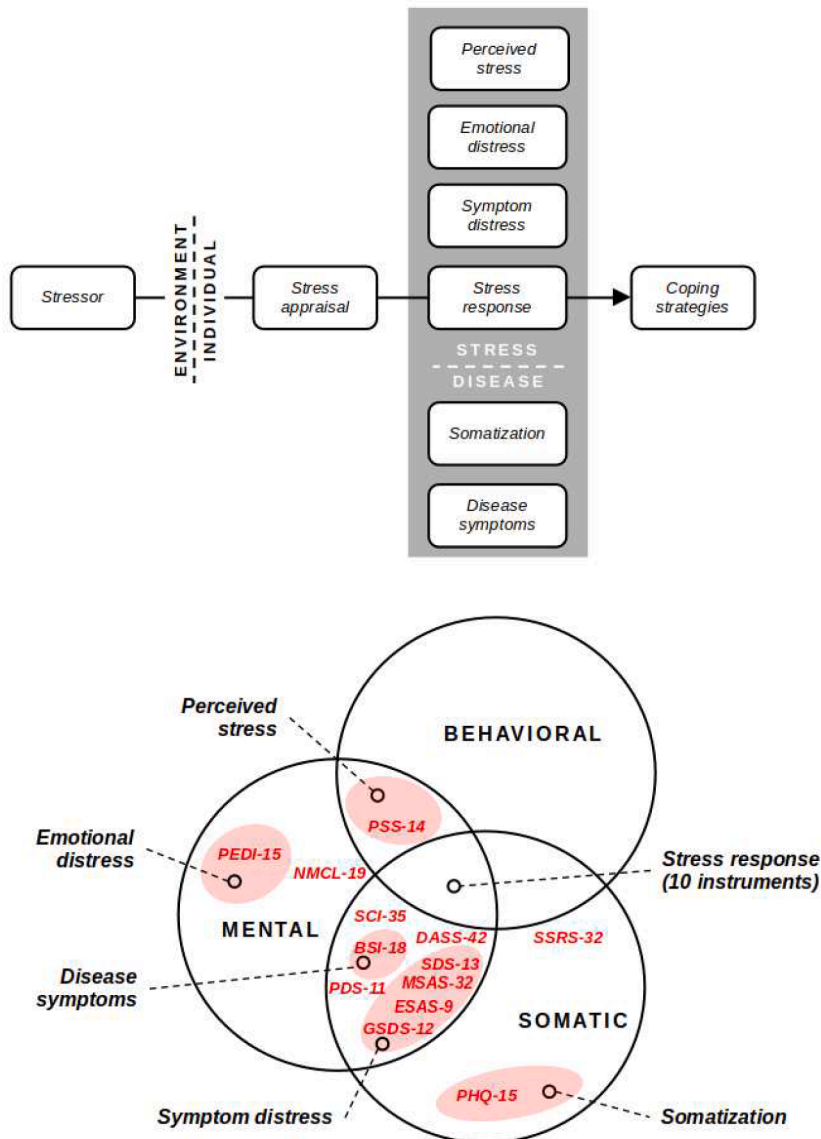


Fig. 2. Upper antecedent and consequent concepts to the stress response as a part of the stress process (horizontal arrow) and related concepts (dark background). Lower theoretical mapping of the concepts by instrument classes in a Venn diagram. Red areas indicate groups of coinciding instruments and target concepts. Abbreviations: PSS = Perceived Stress Scale, PEDI = Perceived Emotional Distress, NMCL = Negative Mood Checklist, SCI = Stress And Crisis Inventory, DASS = Depression Anxiety Stress Scale, BSI = Brief Symptom Inventory, SDS = Symptom Distress Scale, MSAS = Memorial Symptom Assessment Scale, PDS = Patient Distress Scale, ESAS = Edmonton Symptom Assessment System, GSDS = General Symptom Distress Scale, SSRS = Somatic Stress Response Scale, PHQ = Patient Health Questionnaire.

4.2.2. Concept analysis of the stress response

To clarify the concept of the stress response, the stress process was annotated using concept analysis notation (Walker and Avant, 2005). Related concepts identified after inclusion of the instruments were then differentiated from each other in a Venn diagram, which formed seven conceptual spaces from three overlapping circles that in this study represented the domains of experience (Venn, 1880). The concept clarification resulted in differentiation of the stress response from related concepts. Instruments not consistent with the proposed definition of stress response were then depicted in the Venn diagram. The conceptual analysis was done by one author and then openly discussed in the group.

5. Results

5.1. Search results and instrument inclusion

The database searches yielded 3219 discrete citations, with 63 articles embracing instruments that satisfied the inclusion criteria. In total, 23 instruments were collected for the review. For purposes of consistency and differentiation, the instruments were re-labeled with initials of the descriptive name, followed by the number of items (Supplementary Material 3).

5.2. Item-level comparison of the instruments

Item-level similarity of the instruments suggested the possibility of a symptom cluster, defined as multiple symptoms that occur together and are related to each other, with or without common etiology (Kim et al., 2005). This potential symptom cluster was explored through item pooling and re-classification. Re-classification of items induced the formation of nine classes and 59 subclasses in domains *behavioral* (three classes, nine subclasses), *mental* (three classes, 28 subclasses) and *somatic* (three classes, 23 subclasses). While classification in the somatic domain was mainly based on keywords and synonyms, items placed on the mental and behavioral domains required more interpretation with sensations placed in the former and acts and expressions in the latter. In the few cases where the item contained multiple symptoms that could be differentiated to multiple domains, the symptom mentioned first was used as the effective one. As an example, the item "My eating habits or my weight have/has changed" was classified into the behavioral domain. In the pooled view, the mental domain included 47 % of all instrument items (expected 47 %), while the somatic and behavior domains mustered 46 % (expected 37 %) and 7 % (expected 15 %) of the items, respectively (Fig. 3). The three most populated subclasses (namely *personal emotions*, *bodily symptoms*, and *strong negative emotions*) included approximately 65 % of all items (Fig. 3, upper). In summary, the items assessing somatic responses were notably overrepresented, whereas behavioral symptoms were underrepresented, in respect to the number of subclasses.

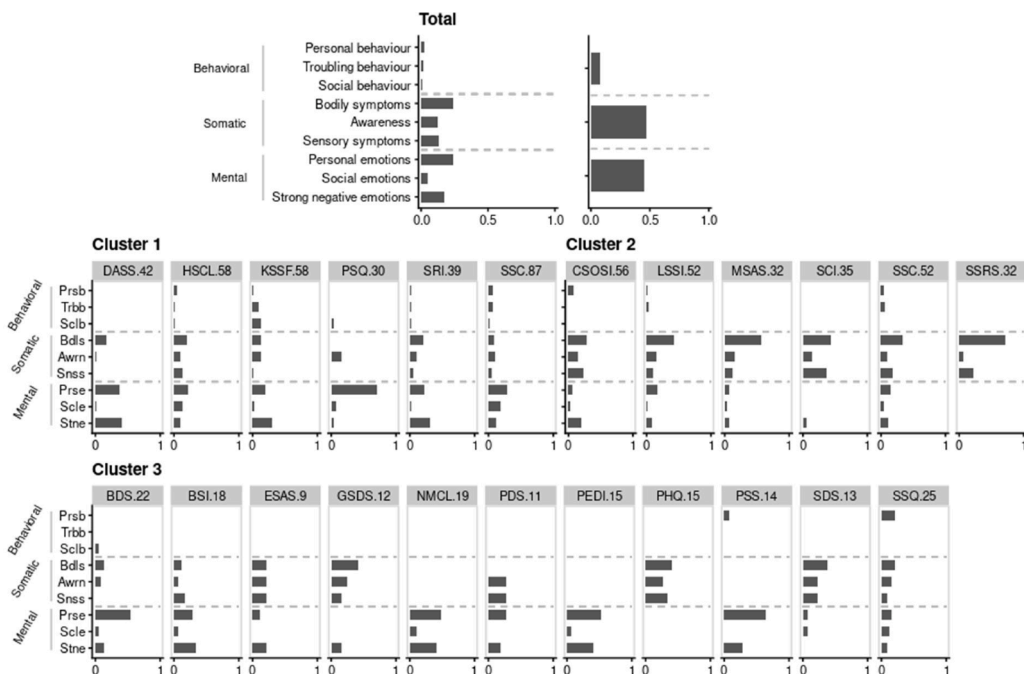


Fig. 3. Frequencies of pooled items in each class (upper left) and domain (upper right) in instruments for assessment of patient stress content profiles of stress burden instruments partitioned into three clusters (lower). Abbreviations: Prsb = Personal behavior, Trbb = Troubling behavior, Sclb = Social behavior, Bdls = Bodily symptoms, Awrn = Awareness, Snss = Sensory symptoms, Prsee = Personal emotions, Scle = Social emotions, Stne = Strong negative emotions.

Statistical clustering into three clusters yielded clusters with distinct qualities. Two clusters separated based on item profiles. The first cluster contained six medium-sized and one large instrument that emphasized the mental domain, while an equal number of medium-sized instruments with a focus on the somatic domain were represented in the second cluster (Fig. 3, lower). In the third cluster, small size with 25 or fewer items was the sole distinctive feature of the instruments (Fig. 3, lower).

5.3. Conceptual clarification of the stress response

Curiously, the instruments selected on the basis of item similarity in this review were found to target a range of stress-related concepts, such as somatization, symptom distress, disease symptoms, and emotional distress (Supplementary Material 3). In the concept analysis notation, life events and their individual interpretation are regarded as conceptually antecedent, while coping strategies are a consequent concept in relation to the stress response. The target concepts other than stress response or stress symptoms

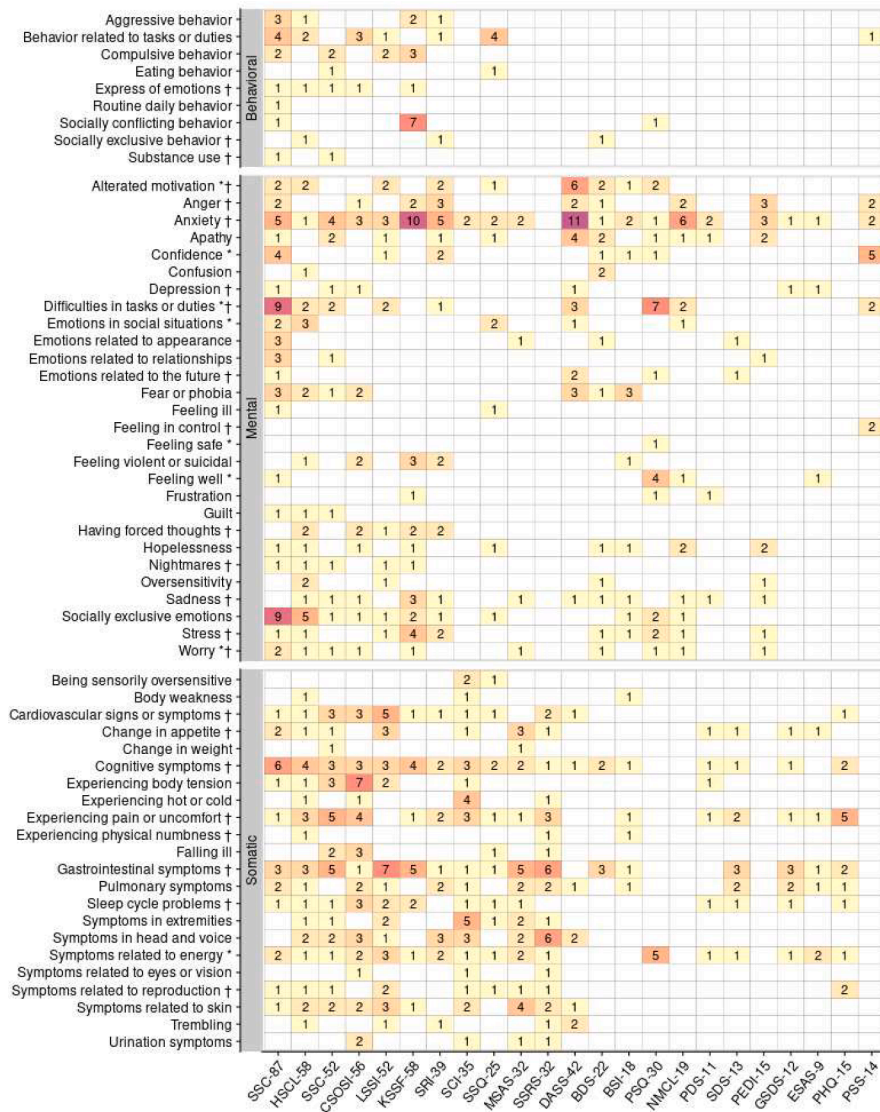


Fig. 4. Count of items in common subclasses in instruments for assessment of patient stress. Unfilled slots indicate zero items. Reference marks: * = subclasses with eustress and distress items; † = subclasses containing the reference symptoms used as instrument inclusion criteria. Abbreviations: BDS = Beirut Distress core, BSI = Brief Symptom Inventory, CSOSI = Calgary Symptoms of Stress Inventory, DASS = Depression Anxiety Stress Scale, ESAS = Edmonton Symptom Assessment System, GSDS = General Symptom Distress Scale, HSCL = Hopkins Symptom Checklist, KSSF = Ketterer Stress Symptom Frequency, LSSI = Lipp’s Stress Symptom Inventory for Adults, MSAS = Memorial Symptom Assessment Scale, NMCL = Negative Mood Checklist, PDS = Patient Distress Scale, PEDI = Perceived Emotional Distress, PHQ = Patient Health Questionnaire, PSQ = Perceived Stress Questionnaire, PSS = Perceived Stress Scale, SCI = Stress And Crisis Inventory, SDS = Symptom Distress Scale, SRI = Stress Response Inventory, SSC = Stress Symptom Checklist, SSQ = Subclinical Stress Questionnaire, SSRS = Somatic Stress Response Scale.

were aligned as related to the concept of stress response (Fig. 2 upper). The related concepts could be grouped into concepts of everyday stress and pathological ones.

In the diagrammatic analysis, the concepts of symptom distress and perceived stress aligned with the mental and behavioral domains. Perceived stress was placed with the corresponding instrument Perceived Stress Scale. Emotional distress was viewed as a concept of the mental domain, aligning with the instrument Perceived Emotional Distress. Similarly, the concept of somatization paralleled with the instrument Patient Health Questionnaire-15 in the somatic domain after reclassification of instrument items. In this analysis, the stress response was found to exclusively occupy the intersection of the three domains, providing novel clarification to the concept definition. Of the 10 instruments fulfilling this definition, however, only one instrument was originally purposed for the measurement of the stress response, with the other six instruments targeting the concept of stress symptoms, two instruments targeting distress in some form, and one instrument targeting the concept of perceived stress. Furthermore, three instruments that identified stress response as a target of assessment, the Depression Anxiety Stress Scale, Negative Mood Checklist, and Somatic Stress Response Scale, were placed into other conceptual spaces in this analysis.

5.4. Quantitative instrument-level analysis

Initially, the quantitative heat map illustration of re-classified items suggested a conclusion that the larger the instrument, the more assessment there were over domains (Fig. 4). However, as clarification of the concept indicated that all three domains were essential in assessment of the stress response, we used the geometric mean of ratios to determine the measure of spread over them. The geometric mean is known as the appropriate measure for averaging ratios expressed in percentages, as in the present case (Clark-Carter, 2005). Furthermore, the purpose was to take advantage of the property of geometric mean to result to zero if one or more domains were uncovered. As a result, 10 instruments that contained items in all three domains were compared in the final analysis. In a graph showing measured spread in relation to the number of items, a regression line was drawn to split the instruments into two groups: instruments above the regression line had greater measured spread over domains in relation to the number of items, indicating wider assessment over the total stress symptom cluster (Fig. 5). Instruments that efficiently employed minimal amount of items to produce greatest measured spread over domains, found above the regression line at the left side of the graph, were considered preferable for neurological patients to minimize respondent burden.

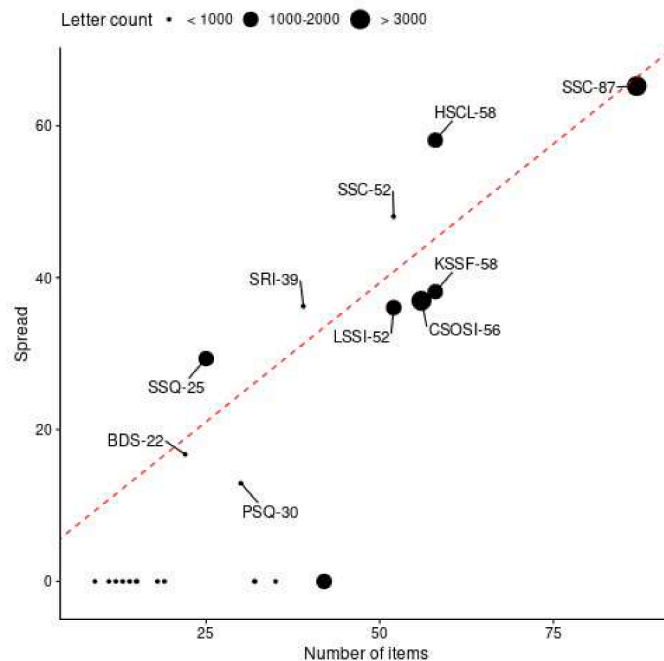


Fig. 5. The relationship between the number of items and their measured spread over symptom domains in instruments of patient stress symptom assessment. Labels of instruments with a spread value of zero are omitted for clarity. The size of the dot indicates the count of letters in three categories. Red line denotes regression line for the labelled data points. Abbreviations: BDS = Beirut Distress core, CSOSI = Calgary Symptoms of Stress Inventory, HSCL = Hopkins Symptom Checklist, KSSF = Ketterer Stress Symptom Frequency, LSSI = Lipp's Stress Symptom Inventory for Adults, PSQ = Perceived Stress Questionnaire, SRI = Stress Response Inventory, SSC = Stress Symptom Checklist, SSQ = Subclinical Stress Questionnaire.

6. Discussion

In the present study, the concept of stress response was explored via analysis of items in self-reporting assessment instruments. Symptoms of the stress response fell into three essential domains of experience: the mental, the somatic, and the behavioral. Global measurement of stress is often characterized as assessment lacking reference to a specific stressor (Golden-Kreutz et al., 2005). Overall stress assessment has been approached through formulation of guidance or items of the instruments or by compiling assessment targets. For example, Linn (1986) generalized stress as a sense of "pressure" related to different events of life. Others have merged subscales targeting various stress concepts to achieve a global view (Brattberg, 2006; Kocalevent et al., 2009). In our study, the list of instruments from the initial search was resolved for global instruments by defining the concept of stress response via the intersection of somatic, mental, and behavioral domains of experience. In practical terms, a global stress response assessment scale should assess symptoms from all of the three assessment domains.

This simple definition of a global stress assessment instrument can serve particular use in differentiating instruments with similarity in items but varying target concepts. With geometric mean as the measure of spread, 10 out of 23 instruments suitable for stress response assessment fulfilled the definition in this study. For use in different groups of patients, an assortment of available assessment instruments, each with slightly varying coverage over stress-related symptoms, can be advantageous to manage practical issues, like the overlap of symptoms of stress and neurological disease (Djamshidian and Lees, 2014).

6.1. Optimal clinical instruments for neurological patients' stress assessment

We have approached optimality of the instruments for stress assessment in neurological patients through two clinically important factors: the usability in minimizing respondent burden and the construct validity corresponding with the suggested definition of the concept. In our study, four instruments complying with the suggested definition for a global instrument were separated from the rest by a regression line in a scatter plot that displayed the spread value over the number of items. Two of these, the 39-item Stress Response Inventory and 52-item Stress Symptom Checklist, appeared the most uncomplicated with the count of letters as a measure of brevity (Koh et al., 2001, Bourne, 2011, respectively).

We have contemplated stress assessment in a demanding group of patients, contextualizing the study in the health care system with a two-step stress assessment scheme that aligns allotment of support based on the burden of the individual. In practice, differentiating stress symptoms from overlapping neurological symptoms, as well as addressing respondent burden, are of high importance in patients with neurological problems. The instruments were, therefore, evaluated in this study by their construct validity and usability. Consequently, the analysis regarded the instruments as objective tests, ignoring the variation in response scales or formulation of items that typically give instruments their unique psychometric fingerprint. Neurological nurses should consider supplementary metrics of the psychometric qualities of validity and reliability when choosing the instrument. Alternatively, the list of symptom classes aggregated from current instruments can serve as a basis for development of a novel instrument for assessment of the global stress response.

6.2. Limitations of the study

Certain drawbacks should be taken into consideration. The process of instrument selection was identified as the main risk of bias, and some aspects of instrument discovery and identification suggested that a more robust search strategy could have been developed. Firstly, a relatively large number of references needed to be screened for article discovery, as well as the fact that non-systematic methods supplemented the search, indicated that the search terms might have been formulated better. To alleviate selection bias, confirmation by two authors was planned but later reduced to partially double-check 5 % of the total number of references due to resource constraints. Furthermore, during the screening, it became clear that the article abstracts did not always indicate the use of an instrument, possibly resulting in rejection of relevant studies. Secondly, the latter part of the search for instruments using a database filter addressed only a single database and yielded only the 50 most-used instruments for each search term. However, as we noted that the two parts of the search produced the same instruments multiple times, we likely achieved satisfactory saturation across the databases.

The conceptual level findings of this study were inductive and require additional verification in future studies. Item-level descriptive illustration of the re-classification in the form of a heat map mitigates the risk of bias in the analysis. Our framework of stress concepts was founded on a process model, which itself might not be fully conceptually delineated; for example, various behavioral symptoms could possibly be classified as concepts of stress responses and coping strategies. With no generally accepted inventory of stress symptomatology, in the instrument identification phase, we made use of a non-systematic method. The list of symptoms used, as well as the symptom categories aggregated in this study, could represent both direct and indirect responses to the physiological stress pathways. Indeed, certain symptoms, like long-term disturbance in sleep, could lead to other symptoms, like gastrointestinal, skeletal or psychological problems (Janson et al., 2001). In addition, differentiation of the related concepts with stress responses was inductive with anecdotal examples from our instrument contents. Nevertheless, we believe that for the analysis, we accomplished gathering instruments within a common conceptual sphere and, through analysis, provided a well-founded suggestion for definition for a self-reporting stress response instruments.

7. Conclusions

We found that the stress response is a distinct phenomenon that can manifest in three different domains; mental, somatic, and behavioral. Clarification of the concept is important for clinical nurses to be able to distinguish the stress response from phenomena with similar expression in neurological patients. There are 10 self-reporting instruments available for assessing the stress response of neurological patients, each with different measured spread over the domains and varying in terms of number of items and brevity.

Funding sources

No external funding.

CRedit authorship contribution statement

Ilkka Sairanen: Writing – original draft, Visualization, Methodology, Investigation, Data curation, Conceptualization. **Heli Virtanen:** Validation, Investigation, Data curation. **Päivi Hämäläinen:** Writing – review & editing, Conceptualization. **Riitta Suhonen:** Writing – review & editing, Supervision, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

None.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.ijnnsa.2023.100172](https://doi.org/10.1016/j.ijnnsa.2023.100172).

References

- Amirkhan, J.H., Landa, I., Huff, S., 2018. Seeking signs of stress overload: symptoms and behaviors. *Int. J. Stress Manag.* 25 (3), 301.
- Artemiadis, A.K., Anagnostouli, M.C., Alexopoulos, E.C., 2011. Stress as a risk factor for multiple sclerosis onset or relapse: a systematic review. *Neuroepidemiology* 36 (2), 109–120.
- Backer, J.H., 2006. The symptom experience of patients with Parkinson's disease. *J. Neurosci. Nurs.* 38 (1), 51.
- Bogdan, A., Barnett, C., Ali, A., AlQwaify, M., Abraham, A., Mannan, S., Ng, E., Brill, V., 2020. Chronic stress, depression and personality type in patients with myasthenia gravis. *Eur. J. Neurol.* 27 (1), 204–209.
- Bourne, E.J., 2011. *The Anxiety and Phobia Workbook*. New Harbinger Publications.
- Brattberg, G., 2006. User friendly and 'useworthy' stress barometer. *Stress Health J. Int. Soc. Invest. Stress* 22 (2), 105–114.
- Chaudhuri, A., Behan, P.O., 2004. Fatigue in neurological disorders. *Lancet* 363 (9413), 978–988.
- Centers for Disease Control and Prevention, 2020. Web Site. <https://www.cdc.gov/injury/features/dealing-with-stress/index.html>. Accessed 19.4.2021.
- Clark-Carter, D., 2005. Geometric mean. *Encyclopedia of statistics in behavioral science*. <https://doi.org/10.1002/0470013192.bsa376>.
- Cohen, S., Kessler, R.C., Gordon, L.U., 1997. *Measuring stress: A guide For Health and Social Scientists*. Oxford University Press on Demand.
- Cohen, S., Janicki-Deverts, D., Miller, G.E., 2007. Psychological stress and disease. *JAMA* 298 (14), 1685–1687.
- Derogatis, L.R., 2017. SCL-90-R and BSI tests: the Derogatis checklist series. Webinar. Available online. www.pearsonassessments.com/professional-assessments/blog-webinars/webinars/2017/11/scl-90-r-and-bsi-tests-the-derogatis-checklist-series-111517.html.
- Djamshidian, A., Lees, A.J., 2014. Can stress trigger Parkinson's disease? *J. Neurol. Neurosurg. Psychiatry* 85 (8), 878–881.
- Fineout-Overholt, E., Melnyk, B.M., Stillwell, S.B., Williamson, K.M., 2010. Evidence-based practice step by step: critical appraisal of the evidence: part I. *AJN Am. J. Nurs.* 110 (7), 47–52.
- Galtrey, C.M., Mula, M., Cock, H.R., 2016. Stress and epilepsy: fact or fiction, and what can we do about it? *Pract. Neurol.* 16 (4), 270–278.
- Golden-Kreutz, D.M., Thornton, L.M., Gregorio, W.D., Frierson, G.M., Jim, H.S., Carpenter, K.M., Shelby, R.A., Andersen, B.L., 2005. Traumatic stress, perceived global stress, and life events: prospectively predicting quality of life in breast cancer patients. *Health Psychol.* 24 (3), 288.
- Goodnite, P.M., 2014. Stress: a concept analysis. *Nurs. Forum* 49 (1), 71–74.
- Hartigan, J.A., Wong, M.A., 1979. Algorithm AS 136: a k-means clustering algorithm. *J. Royal Stat. Soc. Series c (Applied Statistics)* 28 (1), 100–108.
- Holmes, T.H., Rahe, R.H., 1967. The social readjustment rating scale. *J. Psychosom. Res.* 11 (2), 213–218.
- Janson, C., Lindberg, E., Gislason, T., Elmasry, A., Boman, G., 2001. Insomnia in men—A 10-year prospective population based study. *Sleep* 24 (4), 425–430.
- Keynejad, R.C., Frodl, T., Kanaan, R., Pariante, C., Reuber, M., Nicholson, T.R., 2019. Stress and functional neurological disorders: mechanistic insights. *J. Neurol. Neurosurg. Psychiatry* 90 (7), 813–821.
- Kim, M.Y., Dahlberg, A., Hagell, P., 2006. Respondent burden and patient-perceived validity of the PDQ-39. *Acta Neurol. Scand.* 113 (2), 132–137.
- Kim, H.J., McGuire, D.B., Tulman, L., Barsevick, A.M., 2005. Symptom clusters: concept analysis and clinical implications for cancer nursing. *Cancer Nurs.* 28 (4), 270–282.
- Kocalevent, R.D., Rose, M., Becker, J., Walter, O.B., Fliege, H., Björner, J.B., Kleiber, D., Klapp, B.F., 2009. An evaluation of patient-reported outcomes found computerized adaptive testing was efficient in assessing stress perception. *J. Clin. Epidemiol.* 62 (3), 278–287.
- Koh, K.B., Park, J.K., Kim, C.H., Cho, S., 2001. Development of the stress response inventory and its application in clinical practice. *Psychosom. Med.* 63 (4), 668–678.
- Linn, M.W., 1986. A global assessment of recent stress (GARS) scale. *Int. J. Psychiatry Med.* 15 (1), 47–59.
- National Health Service, 2019. Web Site. <https://www.nhs.uk/mental-health/feelings-symptoms-behaviours/feelings-and-symptoms/stress/>. Accessed 19.4.2021.

- Peña-Bautista, C., Casas-Fernández, E., Vento, M., Baquero, M., Cháfer-Pericás, C., 2020. Stress and neurodegeneration. *Clinica Chimica Acta* 503, 163–168.
- Ploughman, M., Austin, M., Stefanelli, M., Godwin, M., 2010. Applying cognitive debriefing to pre-test patient-reported outcomes in older people with multiple sclerosis. *Qual. Life Res.* 19 (4), 483–487.
- Ridner, S.H., 2004. Psychological distress: concept analysis. *J. Adv. Nurs.* 45 (5), 536–545.
- Selye, H., 1950. Stress and the general adaptation syndrome. *Br. Med. J.* 1 (4667), 1383.
- Selye, H., 1975. Stress and distress. *Compr. Ther.* 1 (8), 9–13.
- Venn, J., 1880. I. On the diagrammatic and mechanical representation of propositions and reasonings. *Lond. Edinb. Dublin Philos. Magaz. J. Sci.* 10 (59), 1–18.
- Walker, L.O., Avant, K.C., 2005. *Strategies For Theory Construction in Nursing*, 4. Pearson/Prentice Hall, Upper Saddle River, NJ.
- Whittemore, R., Knafl, K., 2005. The integrative review: updated methodology. *J. Adv. Nurs.* 52 (5), 546–553.