REVIEW ARTICLE

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Fatigue Assessment Scales: A Comprehensive Literature Review

Sahar Rahimian Aghdam[a], Seyed Shamseddin Alizadeh[b*], Yahya Rasoulzadeh[b], Abdolrasoul Safaiyan[c]

[a] Department of Occupational Health Engineering, Health Faculty, Tabriz University of Medical Sciences, Tabriz, Iran
[b] Department of Occupational Health Engineering, Health Faculty, Tabriz University of Medical Sciences, Tabriz, Iran
[c] Road Traffic Center and Department of Bio-statistical and Epidemiology, Health Faculty, Tabriz University of Medical Sciences, Tabriz, Iran

***Correspondence** should be addressed to Mr Seyed Shamseddin Alizadeh, **Email:** ss.alizadeh2013@gmail.com

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Background & Aims of the Study: Fatigue is one of the most important issues regarding safety and other aspects of human life. There is a need to utilize useful instruments, such as self-reported scales to understand fatigue and its relative factors and causes. The purpose of this study was to identify and present useful self-reported scales to measure fatigue.
Materials and Methods: Data were extracted from databases, such as ISI Web of Science, Scopus, and Science Direct, and the search was undertaken considering a 22-year period (1996-2018). The search scope of this study was in ergonomics and the health outcomes and the language of the elected scales were in English. The articles that used objective fatigue scales or subjective scales for sleep-related studies were excluded from the review. Screening and appraisal of 12540 articles resulted in 115 articles being included in this review.
Results: According to the obtained results, the details of 12 self-reported fatigue scales were reported in this survey. These scales are divided into two groups, namely unidimensional (n=5) and multidimensional scales. The Brief Fatigue Inventory scale is the shortest form of the scales in this study. However, Multidimensional Fatigue Symptom Inventory and Swedish Occupational Fatigue Inventory scales evaluate five aspects of fatigue using more items. In total, 6 items in these scales measure fatigue among working population.
Conclusion: There are several scales with acceptable validation to distinguish and measure fatigue during studying or working.

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Background

Nowadays, due to the influence of economic globalization, workers have to work faster and harder than ever under high pressure induced by their managers. Moreover, the necessity to increase productivity and flexibility resulted in longer hours of work and shorter rest periods followed by the irregular working time. One of the consequences of this workload is fatigue (1). Fatigue is one of the most important problems affecting several aspects of human life (2, 3). It is a serious issue in transportation and industrial safety studies (4). Reduced levels of performance (5, 6) and motivation, disability

in decision making, and lack of creativity are among the adverse effects of this symptom (2). Fatigue includes short- and long-term outcomes, out of which discomfort, decreased ability and power, and reduced force control are among its short-term effects (7, 8).This feeling of tiredness in the workplace leads to decreasing level of performance, productivity, and quality of work, as well as increasing human errors and accidents. The long-term effects of fatigue can result in musculoskeletal and cardiovascular disorders (6) as well as chronic fatigue syndrome (9).

Fatigue is a complex, multidimensional, multifactor, and uncertain phenomenon (10) without a unique definition (1, 11, 12). There are various definitions of fatigue in the literature (1). Table 1 summarizes some of these definitions. In many studies, fatigue has been investigated regarding different aspects (1, 8, 13), namely physical or physiological fatigue (i.e., reduced performance in muscular system) (14, 15), mental fatigue (i.e., reduced alertness and mental performance with feeling of weariness) (16), objective fatigue (i.e., reduced workload) (14), acute fatigue (i.e., short duration fatigue occurring in healthy people that can be reduced after an adequate rest) (17), and chronic fatigue (i.e., generally occur due to inadequate rest after acute fatigue and is associated with some diseases, such as cancer, multiple sclerosis, depression, and Parkinson (11, 17).

The lack of a gold standard for measuring fatigue has made it difficult to control and manage fatigue by work experts and ergonomists (11). Although there are several tools to measure fatigue, it is difficult to indicate which instrument can evaluate a unique aspect of this syndrome (18).

Fatigue can be measured using subjective or objective methods (19). In the medicine industry and medical studies, fatigue is often regarded as a physical condition that is accompanied by changes in blood pressure, hand strength, and heart rate which can be measured using electroencephalography (19). Although this method is accurate and valid, it has some limitations. Firstly, it is an intrusive measure and it has no application in the real world (20). In addition, it ignores other factors that contribute to fatigue process (19). A number of subjective measurements or self-reported measures have been developed to assess fatigue among patients and working population. There are more than 30 subjective scales that are available for measuring fatigue (21). Some of the famous ones include the Visual Analog Scale (22), Multidimensional Fatigue Inventory (23), and Multidimensional Fatigue Symptom Inventory (MFSI) (24). The subjective methods are practical and cheap; however, they are less accurate than objective methods (20).

The purpose of this study was to review some of the fatigue self-reported scales and describe their features and structures to gain a better understanding of their utilization. To this end, it also aimed to evaluate the advantages of the scales to help choose the best tool based on

Table 1) Summary of fatigue definitions

Author	Definition
Grandjean (1988)	Fatigue is a gradual process, and it seems to be associated with reduced performance and alertness, as well as reluctance to work and do any effort (39, 40).
Gander P (2011)	Fatigue is a disability to perform work at a desirable level because of inadequate recovery from daily activities (13).
Barker LM (2011)	Fatigue is a multidimensional phenomenon that results from physiological and socioeconomic factors, and prolonged activities affecting the body and mind of person (41).
Jamroz K (2013)	Fatigue is an internal mood resulting in a decreased level of ability to work (8).
Parhizi S (2013)	In general, fatigue is in relation to behavioral, mental, and physiological responses to excessive work and inadequate recovery (12).

specific purposes.

Materials & Methods

In this study, a comprehensive literature review was conducted on fatigue measurement scales. The databases employed in this study included ISI Web of Science (WOS), Scopus, and Science Direct. The search was performed considering a 22-year period (1996-2018) using the titles, abstracts, and keywords recorded in the databases. Subsequently, a full search was conducted using titles, abstracts, keywords, and the term "Fatigue". In addition, the terms, such as "Scale", "Instrument", "Assessment", "Questionnaire", and "Inventory" were combined with the main term "Fatigue". Furthermore, another full search was performed using titles, abstracts, keywords, and the terms "Fatigue AND Questionnaire", or titles, abstracts, keywords and the terms "Fatigue AND Scale".

This survey is focused on fatigue and its subjective measurement tools. As a result, the articles with objective fatigue measurement tools or instruments for measuring sleepiness were excluded from the survey. Moreover, this survey included no articles which cited just in abstract or as reports of the conference. There were 12540 documents found via databases search. The conferences and irrelevant subjects were removed from the study; accordingly, 120, 70, and 61 articles were remained in WOS, Scopus, and Science Direct, respectively. The total number of 251 articles was decreased to 115 documents after removing duplicates. The remaining articles were analyzed using the following protocol: 1) title of the article, 2) publication year, 3) country, 4) research methodology (i.e., the scale that was used for assessing fatigue), and 5) application of the scales.

Results

According to the search result, 12 scales were eventually included in this survey. Tables 2 and 3 summarize the information of all gathered scales. Each table tabulates the scale features, structures, and purposes. Moreover, more details are provided in the accompaniment texts for all scales. In this study, fatigue measurement scales were divided into two groups of unidimensional and multidimensional.

A) Unidimensional Scales

1. The Functional Assessment of Cancer Therapy-Fatigue subscale

The Functional Assessment of Cancer Therapy scale is general incorporation of questions that assesses health-related quality of life (QOL) in cancer patients. The FACT-

Table 2) Unidimensional fatigue scales and features

Scale (year)	Country	What is assessed	Type of fatigue	Target population	Advantages	Number of samples	Number of items	Type of scale	Cronbach 's Alpha
FACT-F(1997)	USA	Severity, Impact	General	Cancer patients	Brief instrument	-	13	5-point Likert	0.93
BFI (1999)	USA	Intensity	General	Cancer patients	Simple and easy	305	9	11-point Likert	0.96
SOFA (2000)	Australia	Phenomenology, Severity	Physical, Mental	Primary care, CFS	Short and easy	1593 + 770	10	5-point Likert	-
NFR (2003)	Netherlands	Severity, Duration	General	Working population	Easy	68775	11	dichotomous (Yes/No)	0.80
FAS (2004)	Netherlands	Phenomenology, Severity	Physical, Mental	Working population	Short and easy	876	10	5-point Likert	0.87

Table 3) Multidimensional fatigue scales and features

Scale (year)	Country	What is assessed	Type of fatigue	Target population	Advantages	Number of factors	Number of samples	Number of items	Type of scale	Cronbach's Alpha
FSI (1998)	USA	Severity, interference, duration	General	Cancer	Short	3	107	13	11-point Likert	0.93-0.95
MFSI (1998)	USA	Phenomenology, severity	General, physical, mental, vigor, emotional	Cancer	Differentiate between cancer and non-cancer patients	5	345	30	5-point Likert	0.85-0.96
PFS (1998)	Thailand	Phenomenology, severity	Mood, psychological	Cancer	-	4	382	22	10-point Likert	0.97
CIS (2000)	Netherlands	Phenomenology, severity	Chronic,	CFS, Working population	Discriminate among groups with differences in fatigue	4	219	20	7-point Likert	0.83-0.92
SOFI (2000)	Sweden	Phenomenology, severity	Psychological, physical	Working population	Treat distinct fatigue conditions separately	5	597	20	7-point Likert	0.81-0.92
OFER (2005)	Australia	Phenomenology, severity	Physical, mental, acute, chronic	Working population	Simple	3	479	15	7-point Likert	0.75-0.93
CFQ (2014)	UK	Extent, severity	Psychological, physical	Working population	Short and straightforward	2	-	11	4-point Likert	0.90

Fatigue (FACT-F) is a subscale of this comprehensive questionnaire. This 13-item FACT-F subscale is scored based on a 5-point Likert scale to assess fatigue among cancer patients. The satisfactory reliability of this subscale was confirmed along with its good internal consistency. Moreover, this scale showed acceptable test-retest reliability. Furthermore, convergent-divergent validity and discriminant validity were evaluated in cancer population. The greatest benefit of FACT-F is in defining both the physical and functional outcomes of fatigue (25).

2. Brief Fatigue Inventory

The Brief Fatigue Inventory (BFI) was developed on the basis of the Brief Pain Inventory. It consists of 9 items that are scored on an 11-point Likert scale from 0 (no fatigue) to 10 (fatigue as bad as you can imagine). Three items ask cancer patients to rate the intensity of their fatigue. In addition, 6 items measure whether fatigue interfered with different aspects of people's lives in the last 24 hours. Regarding the advantages, one can signify the simplicity and understandable nature of this scale (26).

3. Schedule of Fatigue and Anergy

The Schedule of Fatigue and Anergy (SOFA) scale was developed in two forms, the SOFA chronic fatigue syndrome (CFS) to identify CFS patients in clinics and the SOFA/General Physician (GP) to identify prolonged fatigue syndromes. The SOFA includes 10 items that are scored based on a 5-point Likert scale to assess fatigue in both forms. The scales showed good validity in patients with CFS and prolonged fatigue syndrome (27).

4. Need for Recovery Scale

The Need for Recovery Scale (NFR) is an 11-item scale that measures the severity and duration of fatigue symptoms. This scale indicates that whether the respondents completely recovered from work-related exertions. The content validity of this scale was evaluated, and it showed good reliability. Since this scale is easy to fill due to the dichotomous nature of questions (i.e., Yes or No), it is regarded as an accepted scale for investigators (28).

5. Fatigue Assessment Scale

The Fatigue Assessment Scale (FAS) is a unidimensional fatigue scale to rate how a person usually feels that is scored using a 5-point Likert scale from 1 (never) to 5 (always).

It consists of 10 items, 9 of which were derived from four useful fatigue scales, namely the Checklist Individual Strength (CIS) (25), the Emotional Exhaustion subscale from the Dutch version of the Maslach Burnout Inventory (29), the Energy and Fatigue subscale from the World Health Organization Quality of Life assessment instrument (30), and the Fatigue Scale (31). The satisfactory reliability and content validity of FAS were confirmed. Moreover, this scale is short and easy to (29).

B) Multidimensional Scales

1. Fatigue Symptom Inventory

The Fatigue Symptom Inventory (FSI) was developed to assess chronic fatigue in general and cancer patients. It includes 13 items which are scored based on an 11-point rating scale from 0 (not at all fatigued) to 10 (extreme fatigue). The scale consists of three measurements of fatigue intensity, interference of fatigue, and fatigue duration. Regarding the intensity measurement, the items ask the patients to rate the intensity of fatigue at its worst, on average, and at least. Following that, the responders should answer the questions to indicate which fatigue interfered most with common and work activities. The next items measure fatigue duration using the number of days fatigue was experienced by the patient in the previous week. The validity of the scale was developed using the construct, convergent, and divergent assessments. Generally, it was shown that the FSI was established as a valid and reliable scale (32).

2. Multidimensional Fatigue Symptom Inventory

The Multidimensional Fatigue Symptom Inventory (MFSI) was developed for assessing fatigue in cancer patients. Five dimensions were attended to assess general, physical, mental, vigor, and emotional fatigues. Moreover, for these factors, different labels are used, such as global experience, somatic symptoms, cognitive symptoms, affective symptoms, and behavioral symptoms of fatigue. These five factors along with their 6 items produce a 30-item scale. The MFSI is scored based on a 5-point Likert scale to assess fatigue. The assessment has good internal consistency and test-retest reliability, as well as convergent and divergent validity. Additionally, it was shown that the MFSI can differentiate between scores of cancer and non-cancer patients (24).

3. Piper Fatigue Scale

The revised version of the Piper Fatigue Scale (PFS) includes 22 items which are scored based on a 10-point Likert scale from 0 (mild) to 4-6 (moderate), and 7-10 (severe fatigue). It also measures fatigue among cancer patients. It consists four factors, namely affective, behavior, sensory, and mood/cognition. The internal consistency of the scale was good, and it was shown to be a reliable and valid scale (33).

4. Checklist Individual Strength

The Checklist Individual Strength (CIS) is a multidimensional scale that is utilized to assess chronic fatigue. At first, it was developed to measure fatigue among chronic fatigue patients and other chronic illnesses. The CIS is a 20-item self-reported scale measuring different aspects of fatigue using a 7-point Likert scale. Dimensions that are measured by the CIS include decreased level of activities, reduction in concentration and motivation, as well as subjective experience of fatigue. Discriminant and convergent validity of this questionnaire were satisfactory and it was confirmed a reliable scale (25).

5. Swedish Occupational Fatigue Inventory

The Swedish Occupational Fatigue Inventory (SOFI) was developed to measure fatigue after work. This scale includes 20 items which are scored based on a 7-point Likert scale to assess fatigue among workers from 0

(not at all) to 6 (to a very high degree). These items are classified into five groups, namely physical discomfort, lack of energy, physical exertion, lack of motivation, and sleepiness. These factors correlated with each other. The factors of physical exertion and physical discomfort can be considered as a physical factor and sleepiness and lack of motivation can be considered as a mental factor. The internal consistency for each factor was shown satisfactory. Moreover, the concurrent validation of SOFI was evaluated and it was confirmed as a valid scale (34-36).

6. Occupational Fatigue Exhaustion Recovery Scale

The Occupational Fatigue Exhaustion Recovery Scale (OFER) is a 15-item scale to measure fatigue. It consists of three categories of chronic fatigue, acute fatigue, and inter-shift recovery. It is scored based on a 7-point Likert scale to assess the amount of fatigue from 0(completely rested) to 6 (completely exhausted). The OFER instrument includes a subscale assessing the form of recovery achieved between work shifts. This form is an important mediator of the improvement of acute fatigue conditions to chronic fatigue features (37).

7. The Chalder Fatigue Scale

The Chalder Fatigue Scale (CFQ) (it differentiates from Chalder chronic fatigue syndrome or CFS) is a self-reported scale to measure the severity and extent of fatigue in the working population and patients group. It includes 11 items that are scored on a 4-point Likert scale from 0 (better than usual) to 1 (no worse than usual), 2 (worse than usual), and 3 (much worse than usual). The satisfactory reliability of CFQ was confirmed in the studies of occupational and general population. The Chalder Fatigue Scale measures two dimensions, namely physical and psychological fatigue (38).

Discussion

This study aimed to identify the new developed fatigue self-reported scales. There are several scales with different properties and structures. The structures of some scales are monolithic and the others are separated into several parts due to their goals. The purpose of scales may just measure single or several factors, such as physical fatigue, mental fatigue, or cognitive fatigue.

Unidimensional fatigue scales measure fatigue for just a single goal. The BFI is a 9-item scale with a single dimension that assesses fatigue severity. The efficiency of BFI is replaceable with a 13-item FACT-F scale and Profile of Moods States Fatigue subscale. Both of them represent a single factor that measures the severity of fatigue (26). However, there is a little difference between FACT-F from and other scales in that the patients are able to answer all the questions of FACT-F without any experience of fatigue (25). The FAS is another unidimensional scale that measures one construct, namely fatigue. This new 10-item fatigue scale was developed based on semantic and empirical considerations. It is a representative of the Dutch population and it has shown good psychometric properties (29).

In contrast, in multidimensional scales, each subscale is scored for each factor. For instance, the MFSI includes five dimensions, and each dimension is not dependent on the other one. A respondent may be found to suffer from physical symptoms; however, s/he is free of somatic or cognitive symptoms. Furthermore, individuals may experience all dimensions of fatigue measured by the MFSI (24).

In the same line, the OFER is an instrument that measures chronic and acute fatigue, as well as the inter-shift recovery. Chronic fatigue is a measure of exhaustion which includes physical, cognitive, and emotional elements. Regarding the measurement of acute work fatigue, there is

a subscale of acute fatigue which can be experienced differently regarding work shift or week to week on the basis of workplace requirements. The third subscale measures the range of which a worker retrieves energy spent during the previous work shift (37). The SOFI has a five-factor structure. Out of these factors, lack of energy was the main fatigue dimension for all occupations; in addition, the firemen, and locomotive engineers suffered most from physical exertion and sleepiness, respectively. Moreover, the perceived fatigue among the cashiers was described by lack of energy (34-36). Although the factors are linked to each other in these multidimensional scales, each describes different goals (i.e., SOFI subscales). Furthermore, lack of energy correlated with other four subscales, and physical exertion as well as physical discomfort linked to each other. In total, two factors, namely lack of motivation and sleepiness can be considered as mental factors (34-36).

Limitations of the Review

One of the limitations of this study is the selection of English articles over a 22-year period (1996-2018). Moreover, the inclusion of specific publication data screening and appraisal steps may lead to missing other related articles for this study.

Conclusion

The necessity to understand fatigue and its relative factors leads to the development of fatigue assessment tools. It is clear that there is no gold standard for fatigue assessment. Different aspects of fatigue with a number of affective factors are required to be assessed using different scales. Unidimensional scales are developed to assess just a single aspect of this feeling. These scales are brief and useful which are among the advantages of these types of scales. They are easy to fill, and the administers can evaluate the impact of fatigue without any details about its quality. However, these scales cannot consider the aspects of fatigue. In contrast, multidimensional scales are longer with more details. These scales allow administers to obtain more qualitative and quantitative information about fatigue. Multidimensional scales can differentiate fatigue aspects and consider them separately. Among these scales, the CFQ, OFER, and FSI may be better than others since they are short, easy to fill, and can detect different factors of fatigue.

Footnotes

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Conflict of Interest

The authors declare no conflict of interest.

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