**Fatigue Assessment Scales: A comprehensive literature review**

**Abstract**

**Background & Aims of the Study**: Fatigue is one of the most important issues relating with safety and other aspects of human life. To understand fatigue and its relative factors and causes, there is a need to useful instruments, such as self-reported scales. The purpose of this study is to identify and present useful self-reported scales to measure fatigue.

**Materials & Methods:** Data were extracted from following three databases, ISI Web of Science, Scopus and Science direct and the search was undertaken for the period of 1996-2018. The search scope of this study was in ergonomics and health outcomes and the language of elected scales was in English. The articles that used objective fatigue scales or used the 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, details of 12 self-reported fatigue scales are reported. These scales are divided in two types; five scales of them are in unidimensional scale group and the others are multidimensional scales. The Brief Fatigue Inventory (BFI) scale is the shortest form of scales in this study. Although, the Multidimensional Fatigue Symptom Inventory (MFSI) and Swedish Occupational Fatigue Inventory (SOFI) scales by more items can evaluate five aspects of fatigue. Six questionnaires of these scales were measured fatigue among working people.

**Conclusion**: There are several scales with acceptable validation to distinguish and measuring fatigue in studies or at work.

**Key words:** Subjective Scale, Ergonomics, Instrument, Reliability, Work-related Fatigue

**Background**

Nowadays by global economics’ influence, workers have to work faster with high pressure from their managers. Need to increase productivity and flexibility of labor causes to longer work-time and shorter rest-time, and irregularity is establishing. One consequences of this work density is fatigue (1). Fatigue is one of the most important problems in several aspects of human life(2, 3). It is a serious issue in transportation and industrial safety studies (4). Reduced performance (5, 6) and motivation, disability in deciding and lack of creativity are the fatigue effects (2). Fatigue has short-term and long-term outcomes. The short-term aspects of fatigue consist of discomfort, reduction of ability and power and reduced force control (7, 8). Fatigue in work place leads to decrease of performance, productivity, quality of work and increase of human errors and accidents. The long-term effects of fatigue can lead to musculoskeletal disorders, chronic fatigue syndrome (9), and cardiovascular disorders (6).

Fatigue is a complex, multidimensional, multifactor and uncertain phenomenon (10), that present a unique definition for it, is impossible (1, 11, 12). There are various definitions of fatigue in different literatures (1). Summary of these definitions are represented in table 1. In many studies, fatigue has been divided into several aspects (1, 8, 13). Physical or physiological fatigue (defined by reduced performance in muscular system) (14, 15), mental fatigue (defined by reduced alertness and mental performance with feeling of weariness) (16), objective fatigue (defined by reduced work) (14), acute fatigue (universally it happens in healthy people. It has short duration and usually it decreases after an adequate rest) (17) and Chronic fatigue (it is generally happen after inadequate rest of acute fatigue and is associated with some diseases like cancer, multiple sclerosis, depression and Parkinson) (11, 17).

The lack of a gold standard fatigue instrument caused to controlling and managing fatigue by work experts and ergonomists being difficult(11). Although there are several tools to measure fatigue, it is difficult to say all of them can evaluate a unique aspect of it (18).

Fatigue can be measured in subjective or objective ways (19). In the medicine industries and studies, fatigue is often formed as a physical condition phenomenon and it has been derived from changes in blood pressure, hand strength, heart rate and electroencephalographic (19). Although, this method is accurate and valid, it has some limitations. First, it is an intrusive measure and it has no application in real world (20). Second, it ignores other factors that contribute in 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 method scales that available for measuring fatigue (21). Some of the famous ones include the Visual Analog Scale (VAS) (22), Multidimensional Fatigue Inventory (MFI-20) (23) and Multidimensional Fatigue Symptom Inventory (MFSI) (24). This method is practical and it is not an expensive tool. But, it is less accurate than objective methods (20).

The goal of this study is to review some of fatigue self-reported scales and describe their features and structures to know the usage of them. It is also seek to find advantages of scales to help choosing a scale for particular purpose.

**Materials and Methods**

In this study, a comprehensive literature review done on fatigue measurement scales. The databases that used to search in this study were the ISI Web of Science (WOS), Scopus and Science Direct. The search was in the period from 1996 to January 2018 and it was performed by using the “Title/ Abstract/ Keyword” recorded of the database. The full search was “Title/ Abstract/ Keyword Fatigue”. In addition, the terms of “Scale,” “Instrument,” Assessment,” “Questionnaire” and “Inventory” were combined with the main term “Fatigue”. For example, the full search was “Title/ Abstract/ Keyword Fatigue AND Questionnaire” or “Title/ Abstract/ Keyword Fatigue AND Scale.”

The survey focused on fatigue and its subjective measurement tools and the articles with objective fatigue measuring tools or sleepiness measuring tools are excluded from survey. The articles which cited just in abstract or as reports of conference were not included. There were 12540 documents found via databases search. The conferences and irrelevant subjects were removed from the study, so, the 120 articles from WOS, the 70 articles from Scopus and the 61 articles from Science Direct databases were remained to study. The total number of 251 articles was decreased to 115 documents after removing duplicates. Remain articles have been analyzed by following protocol: 1) title of work, 2) publications year, 3) country, 4) method of article: which scale was used for assessing fatigue and 5) application of scales.

**Results**

At the end, 12 scales were found. Information of all gathered scales are presented in table 2 and 3. Each table summarizes scales features, structures and purposes. Also, more details are provided in the accompaniment texts for all scales. In this paper, fatigue measurement scales were divided into two groups:

**A) Unidimensional Scales**

1. FACT-F subscale

The FACT scale is a general incorporation of questions which assesses health related QOL (quality of life) in cancer patients. The FACT-Fatigue (FACT-F) is a subscale from this comprehensive questionnaire. The 13-item FACT-F subscale is used 5-point Likert scale to assess fatigue among cancer patients. The reliability of the subscale was shown be satisfactory. Good internal consistency and test-retest reliability was demonstrated for this subscale. Also, convergent-divergent validity and discriminant validity were evaluated in cancer population. The greatest utility of FACT-F is in defining both the physical and functional outcomes of fatigue (25).

2. Brief Fatigue Inventory (BFI)

The BFI was designed on the basis of Brief Pain Inventory. It has 9 item with using 11-point Likert sale (0 = no fatigue, 10 = fatigue as bad as you can imagine). Three items of scale ask from cancer patients to rate the intensity of their fatigue. Six items measure that; fatigue has interfered with various perspective of people life in last 24 hours. It is simple and easy to understand and this is advantage of this scale (26).

3. Schedule of Fatigue and Anergia (SOFA)

The SOFA scale was developed in two forms, the SOFA/CFS to identify CFS (chronic fatigue syndrome) patients in clinics and the SOFA/GP to identify of prolonged fatigue syndromes. The SOFA includes 10 items with 5-point Likert scale to assesses fatigue in the both forms. The scales have good validity in patients with CFS and prolonged fatigue syndrome (27).

4. Need for Recovery Scale (NFR)

The NFR is an 11-item scale that measure severity and duration of fatigue symptoms. This scale indicates that, are the respondents completely recovered from the continuous effort during the work or not? The content validation was evaluated for this scale and also it was shown to have good reliability. The simplicity of this scale, because of dipole answering categories (yes or no) and easy to fill, caused to it become an accepted scale for investigators (28).

5. Fatigue Assessment Scale (FAS)

The FAS is a unidimensional fatigue scale that using 5-point Likert scale to rate persons’ usually feels from 1= never, to 5 = always. It has 10 items that nine items of this questionnaire was taken from four useful fatigue scale, consists of: the Checklist Individual Strength (CIS-20) (25), the Emotional Exhaustion subscale (EE scale) from the Dutch version of the Maslach Burnout Inventory (MBI) (29), the Energy and Fatigue subscale from the World Health Organization Quality of Life assessment instrument (EF-WHOQOL-100) (30) and the Fatigue Scale (FS) (31). The FAS reliability and content validity was satisfactory. The construct of this scale has a benefit for administer, it is short and easy to use (29).

**B) Multidimensional Scales**

1. Fatigue Symptom Inventory (FSI)

The FSI at first, was developed for assessing chronic fatigue in general and in cancer patients. It includes 13 items, using 11-point rating scale (0 = not at all fatigued and 10 = extreme fatigue). The scale consists of three measurement of fatigue intensity, interference of fatigue and fatigue duration. In the measure of intensity, the items ask to rate the intensity of fatigue at its worst, on average, and at least. Following the intensity items, to assess the interference of fatigue, the responders should answer the questions to indicate the measure of which fatigue interfered with common activity and work activity. The next items measure fatigue duration, for example, in previous week how many days fatigue was experienced. The validity of scale was developed by assessing the construct, convergent and divergent validities. Generally, it was shown that, the FSI was established as a valid and reliable scale (32).

2. Multidimensional Fatigue Symptom Inventory (MFSI)

The MFSI was developed for assessing fatigue in cancer patients. Five dimensions were attended to assess general fatigue, physical fatigue, mental fatigue, vigor and emotional fatigue. Also, for these factors, different labelling is used: global experience, somatic symptoms, cognitive symptoms, affective symptoms and behavioral symptoms of fatigue. These five factors with 6 items each were hold, produce a 30-item scale. The MFSI used 5-point Likert scale to assess fatigue. The assessment has well internal consistency and good test-retest reliability, convergent and divergent validity. Also, it was shown that, the MFSI can differentiate between scores of cancer and non-cancer patients (24).

3. Piper Fatigue Scale (PFS, revised)

The revised version of PFS includes 22 items with 10-point Likert scale (0-3 = mild, 4-6 = moderate, 7-10 = severe fatigue) and it measures fatigue among cancer patients. It consists of four factors: affective, behavior, sensory and mood/cognition. Internal consistency of the scale was good and it was shown to be reliable and valid scale (33).

4. Checklist Individual Strength (CIS)

The CIS is a multidimensional scale that used 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 and measure various aspects of fatigue by 7-point Likert scale. Dimensions which measure by the CIS are: activity reduction, reduction in concentration and the subjective experience of fatigue and reduction in motivation. Discriminant and convergent validity of this questionnaire was satisfactory and it was a reliable scale (25).

5. Swedish Occupational Fatigue Inventory (SOFI)

The SOFI was developed to measure fatigue after work. This scale includes 20 items which using 7-point Likert scale to assess fatigue among workers (0 = not at all, 6 = to a very high degree). These items grouped to five dimensions: 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 of scale was shown to be satisfactory. Also, the concurrent validation of SOFI was evaluated and it was a valid scale (34-36).

6. Occupational Fatigue Exhaustion Recovery Scale (OFER)

The OFER is a 15-item scale to measure fatigue. It consists of three factors, chronic fatigue, acute fatigue and inter-shift recovery. It used 7-point Likert scale to assess amount of fatigue (0 = completely rested, 6 = completely exhausted). The OFER instrument includes a subscale assessing the form of recovery achieved between work shifts. This form is certainly important mediator of the improvement of acute fatigue conditions to chronic fatigue features (37).

7. The Chalder Fatigue Scale (CFQ)

The CFQ (it differentiates from Chalder chronic fatigue syndrome or CFS) is a self-reported scale to measure severity and extent of fatigue in working population and patients group. It includes 11 items that answered on a 4-point Likert scale (including 0 = better than usual, 1 = no worse than usual, 2 = worse than usual and 3 = much worse than usual). Reliability factors for the CFQ were shown to be high in studies of occupational and general population. The Chalder Fatigue Scale measures two dimensions, physical fatigue and psychological fatigue (38).

**Discussion**

The aim of this study was to identify new developed fatigue self-reported scales. There are several scales with different properties and structures. Each scale structure is monolith or separate to several parts due to their goals. The purpose of one scale may be just a single factor or measuring fatigue for identifying 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 nine-item scale with a single dimension reports fatigue severity. The efficiency of BFI is replaceable with a 13-item FACT-F scale and with the Fatigue scale of POMS. Both of them represent a single factor that assess the severity of fatigue (26). But, the FACT-F is a little differ from other scales in important way, patients able to answer all the questions of FACT-F without any experience of fatigue (25). The FAS is another unidimensional scale that measure one construct, and it is name fatigue. This new 10-item fatigue scale was formed based on semantic and empirical considerations. It has representative for the Dutch population and it has shown good psychometric qualities (29).

In contrast, in multidimensional scales, each subscale scores are computed for each factor. For example, the MFSI is one of them. It includes five dimensions and each dimension be free of other. May be a person found to suffer from physical symptoms but he/she is free of somatic or cognitive symptoms. Also, other person may experience symptoms from all dimensions of fatigue measured by the MFSI (24). The OFER is an instrument that measures the fatigue elements of chronic fatigue, acute fatigue and inter-shift recovery. Chronic fatigue is a measure of exhaustion includes physical, cognitive and emotional elements. For measure acute work fatigue, there is the subscale of acute fatigue; this is an experience that varying from shift to shift or week to week on the basis of workplace requirements. The third subscale is a measure of the range to which a worker retrieve energy spend during the previous work shift (37). The Swedish Occupational Fatigue Inventory (SOFI) have five factor structure. Among these factors, lack of energy was the main fatigue dimension for all occupations. Among the firemen, perceived fatigue was described as physical exertion and sleepiness was described for locomotive engineers. Also, the perceived fatigue among the cashiers was described by lack of energy (34-36). In these multidimensional scales, each factor of one scale was described different goals. Although, they have linked to each other, too. Like SOFI subscales. Lack of energy correlated with the other four subscales, physical exertion and physical discomfort linked to each other and two factors of lack of motivation and sleepiness can be considered as a mental factor (34-36).

**Limitations of Review**

A limitation of this study may be that the selected articles were only from studies in English and published from 1996 to 2018. Also, the inclusion of specific publication data screening and appraisal steps have been doing can lead to existing the potential to have missed other related articles for this study.

**Conclusion**

Need to understanding of fatigue and its relative factors lead to development of fatigue assessment tools. It is clear that having a gold standard for assessing fatigue is impossible. Different aspects of fatigue with a number of affective factors need to different scales. Unidimensional scales are developed to assess just a single aspect of fatigue feeling. These scales are brief and useful and it is the advantages of these types of scales. They are easy to fill and 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, because they are short and simple to fill and also can detect different factors of fatigue.

**References:**

1. Dawson D, Ian Noy Y, Härmä M, Åkerstedt T, Belenky G. Modelling fatigue and the use of fatigue models in work settings. Accident Analysis & Prevention. 2011;43(2):549-64. <https://doi.org/10.1016/j.aap.2009.12.030>

2. Jazani RK, Saremi M, Rezapour T, Kavousi A, Shirzad H. Influence of traffic-related noise and air pollution on self-reported fatigue. International Journal of Occupational Safety and Ergonomics. 2015;21(2):193-200. <https://doi.org/10.1080/10803548.2015.1029288>

3. Theorell-Haglöw J, Lindberg E, Janson C. What are the important risk factors for daytime sleepiness and fatigue in women? Sleep. 2006;29(6):751-7. <https://doi.org/10.1093/sleep/29.6.751>

4. Wang T-C, Chuang L-H. Psychological and physiological fatigue variation and fatigue factors in aircraft line maintenance crews. International Journal of Industrial Ergonomics. 2014;44(1):107-13. <https://doi.org/10.1016/j.ergon.2013.11.003>

5. de Croon EM, Sluiter JK, Frings-Dresen MH. Need for recovery after work predicts sickness absence: a 2-year prospective cohort study in truck drivers. Journal of psychosomatic research. 2003;55(4):331-9. <https://doi.org/10.1016/S0022-3999(02)00630-X>

6. Useche SA, Ortiz VG, Cendales BE. Stress-related psychosocial factors at work, fatigue, and risky driving behavior in bus rapid transport (BRT) drivers. Accident Analysis & Prevention. 2017;104:106-14. <https://doi.org/10.1016/j.aap.2017.04.023>

7. Yung M. Fatigue at the workplace: Measurement and temporal development. 2016. <http://hdl.handle.net/10012/10119>

8. Jamroz K, Smolarek L. Driver Fatigue and Road Safety on Poland’s National Roads. International Journal of Occupational Safety and Ergonomics. 2013;19(2):297-309. <https://doi.org/10.1080/10803548.2013.11076987>

9. Fukuda K, Straus SE, Hickie I, Sharpe MC, Dobbins JG, Komaroff A. The chronic fatigue syndrome: a comprehensive approach to its definition and study. Annals of internal medicine. 1994;121(12):953-9. https://doi.org/10.7326/0003-4819-121-12-199412150-00009

10. Stynen D, Jansen NWH, Kant I. The impact of work-related and personal resources on older workers’ fatigue, work enjoyment and retirement intentions over time. Ergonomics. 2017;60(12):1692-707. <https://doi.org/10.1080/00140139.2017.1334094>

11. Lu L, Megahed FM, Sesek RF, Cavuoto LA. A survey of the prevalence of fatigue, its precursors and individual coping mechanisms among U.S. manufacturing workers. Applied Ergonomics. 2017;65:139-51. <https://doi.org/10.1016/j.apergo.2017.06.004>

12. Parhizi S, Steege LM, Pasupathy KS. Mining the relationships between psychosocial factors and fatigue dimensions among registered nurses. International Journal of Industrial Ergonomics. 2013;43(1):82-90. <https://doi.org/10.1016/j.ergon.2012.11.010>

13. Gander P, Hartley L, Powell D, Cabon P, Hitchcock E, Mills A, et al. Fatigue risk management: Organizational factors at the regulatory and industry/company level. Accident Analysis & Prevention. 2011;43(2):573-90. <https://doi.org/10.1016/j.aap.2009.11.007>

14. González Gutiérrez JL, Jiménez BM, Hernández EG, López López A. Spanish version of the Swedish Occupational Fatigue Inventory (SOFI): Factorial replication, reliability and validity. International Journal of Industrial Ergonomics. 2005;35(8):737-46. <https://doi.org/10.1016/j.ergon.2005.02.007>

15. Belz SM, Robinson GS, Casali JG. Temporal separation and self-rating of alertness as indicators of driver fatigue in commercial motor vehicle operators. Human Factors. 2004;46(1):154-69. [https://doi.org/10.1518/hfes.46.1.154.30393](https://doi.org/10.1518%2Fhfes.46.1.154.30393)

16. Leung AWS, Chan CCH, He J. Structural stability and reliability of the Swedish occupational fatigue inventory among Chinese VDT workers. Applied Ergonomics. 2004;35(3):233-41. <https://doi.org/10.1016/j.apergo.2004.02.004>

17. Shen J, Barbera J, Shapiro CM. Distinguishing sleepiness and fatigue: focus on definition and measurement. Sleep Medicine Reviews. 2006;10(1):63-76. <https://doi.org/10.1016/j.smrv.2005.05.004>

18. Fekedulegn D, Burchfiel CM, Ma CC, Andrew ME, Hartley TA, Charles LE, et al. Fatigue and on-duty injury among police officers: The BCOPS study. Journal of Safety Research. 2017;60:43-51. <https://doi.org/10.1016/j.jsr.2016.11.006>

19. Di Milia L, Smolensky MH, Costa G, Howarth HD, Ohayon MM, Philip P. Demographic factors, fatigue, and driving accidents: An examination of the published literature. Accident Analysis & Prevention. 2011;43(2):516-32. <https://doi.org/10.1016/j.aap.2009.12.018>

20. Ji Q, Lan P, Looney C. A probabilistic framework for modeling and real-time monitoring human fatigue. IEEE Transactions on systems, man, and cybernetics-Part A: Systems and humans. 2006;36(5):862-75. [10.1109/TSMCA.2005.855922](https://doi.org/10.1109/TSMCA.2005.855922)

21. Dittner AJ, Wessely SC, Brown RG. The assessment of fatigue: a practical guide for clinicians and researchers. Journal of psychosomatic research. 2004;56(2):157-70. <https://doi.org/10.1016/S0022-3999(03)00371-4>

22. Lee KA, Hicks G, Nino-Murcia G. Validity and reliability of a scale to assess fatigue. Psychiatry Research. 1991;36(3):291-8. <https://doi.org/10.1016/0165-1781(91)90027-M>

23. Smets E, Garssen B, Bonke Bd, De Haes J. The Multidimensional Fatigue Inventory (MFI) psychometric qualities of an instrument to assess fatigue. Journal of psychosomatic research. 1995;39(3):315-25. <https://doi.org/10.1016/0022-3999(94)00125-O>

24. Stein KD, Martin SC, Hann DM, Jacobsen PB. A multidimensional measure of fatigue for use with cancer patients. Cancer practice. 1998;6(3):143-52. <https://doi.org/10.1046/j.1523-5394.1998.006003143.x>

25. Beurskens AJ, Bültmann U, Kant I, Vercoulen JH, Bleijenberg G, Swaen GM. Fatigue among working people: validity of a questionnaire measure. Occupational and environmental medicine. 2000;57(5):353-7. <http://dx.doi.org/10.1136/oem.57.5.353>

26. Mendoza TR, Wang XS, Cleeland CS, Morrissey M, Johnson BA, Wendt JK, et al. The rapid assessment of fatigue severity in cancer patients. Cancer. 1999;85(5):1186-96. [https://doi.org/10.1002/(SICI)1097-0142(19990301)85:5<1186::AID-CNCR24>3.0.CO;2-N](https://doi.org/10.1002/(SICI)1097-0142(19990301)85:5%3C1186::AID-CNCR24%3E3.0.CO;2-N)

27. Hadzi-Pavlovic D, Hickie I, Wilson A, Davenport T, Lloyd A, Wakefield D. Screening for prolonged fatigue syndromes: validation of the SOFA scale. Social psychiatry and psychiatric epidemiology. 2000;35(10):471-9. https://doi.org/10.1007/s001270050266

28. Van Veldhoven M, Broersen S. Measurement quality and validity of the “need for recovery scale”. Occupational and environmental medicine. 2003;60(suppl 1):i3-i9. <http://dx.doi.org/10.1136/oem.60.suppl_1.i3>

29. Michielsen HJ, De Vries J, Van Heck GL, Van de Vijver FJ, Sijtsma K. Examination of the Dimensionality of Fatigue: The Construction of the Fatigue Assessment Scale (FAS). European Journal of Psychological Assessment. 2004;20(1):39. <https://doi.org/10.1027/1015-5759.20.1.39>

30. Group W. Development of the World Health Organization WHOQOL-BREF quality of life assessment. Psychological medicine. 1998;28(3):551-8. <https://doi.org/10.1017/S0033291798006667>

31. Chalder T, Berelowitz G, Pawlikowska T, Watts L, Wessely S, Wright D, et al. Development of a fatigue scale. Journal of psychosomatic research. 1993;37(2):147-53. <https://doi.org/10.1016/0022-3999(93)90081-P>

32. Hann D, Jacobsen P, Azzarello L, Martin S, Curran S, Fields K, et al. Measurement of fatigue in cancer patients: development and validation of the Fatigue Symptom Inventory. Quality of Life research. 1998;7(4):301-10. https://doi.org/10.1023/A:1024929829627

33. Piper BF, Dibble SL, Dodd MJ, Weiss MC, Slaughter RE, Paul SM, editors. The revised Piper Fatigue Scale: psychometric evaluation in women with breast cancer. Oncology nursing forum; 1998: Oncology Nursing Society. https://psycnet.apa.org/record/2015-14585-001

34. Åhsberg E. Dimensions of fatigue in different working populations. Scandinavian Journal of psychology. 2000;41(3):231-41. <https://doi.org/10.1111/1467-9450.00192>

35. Ahsberg E, Gamberale F, Gustafsson K. Perceived fatigue after mental work: an experimental evaluation of a fatigue inventory. Ergonomics. 2000;43(2):252-68. <https://doi.org/10.1080/001401300184594>

36. Åhsberg E, Gamberale F. Perceived fatigue during physical work: an experimental evaluation of a fatigue inventory. International Journal of Industrial Ergonomics. 1998;21(2):117-31. <https://doi.org/10.1016/S0169-8141(96)00071-6>

37. Winwood PC, Winefield AH, Dawson D, Lushington K. Development and validation of a scale to measure work-related fatigue and recovery: the Occupational Fatigue Exhaustion/Recovery Scale (OFER). Journal of Occupational and Environmental Medicine. 2005;47(6):594-606. https://doi.org/10.1097/01.jom.0000161740.71049.c4

38. Jackson C. The Chalder fatigue scale (CFQ 11). Occupational Medicine. 2014;65(1):86-.<https://doi.org/10.1093/occmed/kqu168>

39. Grandjean E. Fitting the task to the Man. A Texbook of Occupational Ergonomics. Taylor & Francis. London; 1988. <https://doi.org/10.1201/9780367807337>

40. Li Z, Jiao K, Chen M, Wang C. Reducing the effects of driving fatigue with magnitopuncture stimulation. Accident Analysis & Prevention. 2004;36(4):501-5. <https://doi.org/10.1016/S0001-4575(03)00044-7>

41. Barker LM, Nussbaum MA. The effects of fatigue on performance in simulated nursing work. Ergonomics. 2011;54(9):815-29. <https://doi.org/10.1080/00140139.2011.597878>

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| Table 1. Summary of fatigue definitions | |
| Author | **Definition** |
| Grandjean (1988) | Fatigue is gradual and stored process and it seems to be associated with reduced performance and alertness, reluctance to work and any effort (39, 40). |
| Gander P (2011) | Fatigue is a disability to perform work at the 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 activity that effect on body and mind of person (41). |
| Jamroz K (2013) | Fatigue is an internal mood that causing to decrease the ability of working (8). |
| Parhizi S (2013) | In general, fatigue is in relation with behavioral, mental and physiological respond to excessive work and inadequate recovery (12). |

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| 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 |

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| 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 |