Journal of Industrial Engineering and Halal Industries (JIEHIS)
P-ISSN 2722-8150, E-ISSN 2722-8142
Vol. 5 No. 2 December 2024, Pp 01-10
https://doi.org/10.14421/jiehis.4693

Submitted: 2024-08-28
Revised: 2024-11-23
Accepted: 2024-12-10
Online: 2024-12-31

Initial Development and Validation of Physical, Psychosocial and Fatigue Level Questionnaire

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Abstract

The lack of comprehensive tool to assess both risk factors of physical and psychosocial risk factors as well as fatigue level effectively is significant in similar field research. Therefore, the aim of this study is to do the initial development and content validation of a questionnaire that identified and measure the risk factors influencing the fatigue levels. The questionnaire was developed by implementing adopt and adapt method followed by item generation in the initial development. This questionnaire was then validated in terms of content validation by expert panel reviews. The content validity result are as follows: 64-items out of 146-items scale had I-CVI below 1, 24-items with I-CVI of 0.8, and 3-items with 0.7, and the remaining items had I-CVI of below than 0.7. The average value of CVR was 1, and the S-CVI/Ave of the questionnaire was 0.93. Items with content validity of 0.7 and above was maintained, therefore, the questionnaire ended with 87-items. Findings indicates that the questionnaire is valid for assessing the physical and psychosocial risk factors associating with the fatigue levels. This questionnaire can be made a tool in assessing workplace while promote efficiency through this comprehensive tool, contributing to a better understanding of occupational risks and potential interventions.

Keywords: Questionnaire, Initial Development, Content Validation, Ergonomic risk factors, Fatigue

INTRODUCTION

The National Safety Council report highlights that 97% of workers face at least one workplace fatigue risk factor, with over 80% experiencing two or more factors, including physical demands and job stress (Bláfoss et al., 2019; Egozi et al., 2022b). Fatigue, characterized by exhaustion, decreased energy, and increased effort for task completion, poses threats to both safety and health at work and in personal life. Impairing the cognitive functioning and consequently reducing productivity and elevating the risk workplace injuries (Rahimian Aghdam et al., 2020). According to Åhsberg (2001), fatigue is recognized as a pervasive workplace issue, with its subtle indications having profound implications for safety (Åhsberg, 2000).

One of the factors considered is physical risk factors. Physical risk factors are considered as significant because they directly impact on the body's musculoskeletal system, leading to fatigue and potentially musculoskeletal disorders (MSDs). Studies, including those by Bongers et al.(1993), Chanchai et al.(2016), Cheng & Chen(2020), Egozi et al.(2022a), Hernandez Arellano et al. (2015), and Silva et al.(2022), have delved into the existence of psychosocial risk factors associated with tasks, manual handling, and other work-related concerns, and these studies identify postures, force and repetition, vibration as contributors to MSD (Ziaei et al., 2018), as these factors can lead to prolonged strain on lead to overexertion and discomfort, ultimately resulting in fatigue (Chanchai et al., 2016; Cheng & Chen, 2020; Egozi et al., 2022b; Hernandez Arellano et al., 2015; Houtman et al., 1994; Silva et al., 2022).

Research across various industries involving manual handling workers reveals in job demand, workload, work environment and relationships have an influence on workers conditions (Ahmadi et al., 2022; Bao et al., 2016a; Betancourt & Castro Muñoz, 2019; Bongers et al., 1993; Houtman et al., 1994; Larsman et al., 2011). Psychosocial risk factors in the workplace can contribute to MSD (Houtman et al., 1994; Menzel, 2007) and fatigue (Abdul Rahman et al., 2017a) due to their impact on mental well-being and overall stress levels. Addressing psychosocial risk factors in the workplace is crucial for promoting well-being, reducing physical discomfort, and preventing occupational health issues. Instances during the pandemic highlighted the impact of psychosocial risk variables on worker dissatisfaction, fatigue, and the need for proper managerial treatment (Egozi et al., 2022b).

To address the challenge of assessing fatigue in occupational settings, this study aims to develop and validate a comprehensive and robust questionnaire on physical, psychosocial and fatigue levels. The proposed questionnaire seeks to provide a time-efficient, concise, and effective method for evaluating fatigue-related risks, ultimately supporting a safer and healthier working environment.

Physical Risk Factors

In ergonomics, risk factors are actions or circumstances that increase the probability of musculoskeletal system injury (Niu, 2010). According to Jaffar and Lop (2011), risk factors were classified into three categories of physical, psychosocial, and individual risk factors.

Physical activities that required the body to perform awkward or repetitive tasks in performing heavy or demanding physical tasks have been well known as the main factor for the occurrence of musculoskeletal injuries such as musculoskeletal disorders (MSDs). Risks such as awkward posture, forceful exertions were few of the significant contributors to the deterioration of workers' health, where these risks can lead to impending MSDs, and other chronic conditions due to the strain it had placed on the human body(Bernard et al., 1997; Burgess-Limerick, 2012; Franco & Fusetti, 2004). Various physical risk factors exist at workplace specifically involved in manual material handling like frequent lifting, bending, and carrying and pushing. And according to researchers, even a low level of force can cause small amounts of damage to the body tissues(Burgess-Limerick, 2012). Therefore, tasks that requires excessive physical effort could lead to an acute and cumulative damage to muscles, joints, and even bones, with supported findings stated that repeated lifting of objects can lead to back injuries and other musculoskeletal issues(Kamat et al., 2017).

Published literatures have suggested that these are considered the primary risk factors; awkward posture, repetition, forceful exertion, and static loading (Jaffar et al., 2011; Ruzairi et al., 2022; Sukadarin et al., 2013). A body outside of its normal stature of position that deviates from body's neutral position while performing work activities defines the concept of awkward posture. Postures that occurs when body in unnatural position, such as twisting, stretching, bending, or reaching causes muscles to be used and become stressed when the body is subjected to high repetition, surpassing their endurance time without taking proper breaks in-between can ultimately exposed to risk of injuries(Al Amin et al., 2013).

Repetition can also be defined as performing identical motion or a set of motions excessively, as it involves performing the task that repeatedly uses the similar muscles with little chance to rest. It is a significant ergonomic risk factors in workplaces and it can lead to a range of MSDs and bodily discomfort to the working individuals. When manual handling workers are subjected to higher workload, repetitive tasks are inevitable and can lead to muscles feeling fatigued and experience muscle pains (Al Amin et al., 2013; Estember & Que, 2020). And these circumstances is concerning because when they work in a fatigued state, it can increase the likelihood of making errors and conducts of unsafe acts that can result in further body strain or accidents (Thompson et al., 2017; Yung et al., 2017).

Moreover, forceful exertion entails the use of high levels of force while transferring or sustaining a burden, such as lifting, lowering, pushing, tugging, carrying and moving a load with one's hand or by employing body force. These conditions could and may overload the muscles and tendons, therefore risking the worker's body. Especially when it is performed repetitively, they will be a greater risk to be exposed to MSDs. Muscles contract much harder than it normally would during excessive force, due to the stressed muscles, tendons and joints too(Mahmod et al., 2020).

Psychosocial Risk Factors

Psychosocial stressors such as stress, conflicts with colleagues or superiors, time pressure, cognitive overload interacts with physical risk factors (Devereux et al., 2002). These risks may affect the worker's psychological response to their work and it was found that it has an influence on risk of back pain(Johansson & Rubenowitz, 1994). According to Sullivan (Sullivan et al., 2005), increase in workload holds double the risk of having low back problems. This suggests that the demanding work can also affect individuals psychologically because depending on each individual's personality type, psychosocial stressful environments can lead to increased muscle coactivity which means increased spine load, risking fatigue and musculoskeletal discomfort symptoms (Bao et al., 2016b). To date, there is little to known about the role of psychosocial work characteristics in the ethology of fatigue. So among the effort to examine the wide range of psychosocial, U.Bultmann proves that psychosocial work characteristics were significant predictors for the onset of fatigue in the working population (Abdul Rahman et al., 2017b).

Fatigue

Fatigue is a common phenomenon in the working population, that resulted from intensive manual labor or mental exertion, and broadly described as a complex and multidimensional outcome of the physical and psychological strength (Åhsberg, 2000). Outcomes of fatigue can be classified into two categories: 1) short-term effects (decreased in strength, muscle fatigue, motor control), 2) Long-term effects (MSDs, chronic fatigue syndrome (CFS)(Fukuda et al., 1994), and impaired body health performance(Ricci et al., 2007)

Study be Reza *et al.* (Reza et al., 2021) stated that there is a strong significance relationship between MSD symptoms and muscle fatigue due to the poor work postures, especially in their lower extremities. The decline in muscle performance and strength can lead to feeling discomfort, reduced efficiency, thus have an increased risk of injury. Muscle fatigue also can be influenced by the work duration, work environment, circadian rhythm, and the overall health conditions. This was proven by Hyun *et al.,*(Ryu et al., 2023) proves that higher exposure to psychological distress and disrupted sleep can predict for the onset of acute fatigue(Ryu et al., 2023).

The impacts of muscle fatigue affects both physically and psychologically. It can cause multiple conditions that would lead to unsafe work practices. Such feelings of soreness, feeling weak, and decreased coordination could lead to MSDs and workplace injuries. While psychologically, reduced motivation and increased stress are possible to happen. This can be proven by a study on a working population that has demanding work demands and work pace, they had a high prevalence chronic and persistent fatigue, thus causing MSD pains (Abdul Rahman et al., 2017b).

METHODS

Study design

To comprehensively assess the physical and psychosocial risk factors affecting fatigue levels, a two-step method design was employed. The instrument development occurred in two sequential steps: One for instrument design, and second step is content validity through judgemental evidence conducted by a panel of experts with related academic backgrounds and industrial manager experts to enhance the questionnaire’s content validity. The ethical approval from The International Islamic University Malaysia (IIUM) Research Ethics Committee (IREC) with reference number IREC-2022-212 had been obtained before the study. Participants were provided written information regarding the purpose of the study, as well the consent form. Participants gave their consent before the data collection, and their participation was entirely voluntary.

Questionnaire design

The questionnaire was developed using an adaptive approach, drawing from multiple validated questionnaires. Adjustments were made to align with the study’s objectives while maintaining the integrity of the items. The construction process focused on including items that assess physical and psychosocial risk factors associated with fatigue among working individuals. These items were derived from comprehensive reviews of existing literature and validated assessment tools. The content underwent expert validation and screening to ensure relevance and accuracy. Additionally, forward translation was conducted to maintain consistency and accuracy during the development process. Qualitative analyses were performed to assess the validity and reliability of the questionnaires.

The researchers considered items that highlights the presence of risk factors of physical and psychosocial and fatigue. Data from industrial visits and reviews of existing literature and related assessment tools available using multiple online search engines such as Science Direct, Elsevier, Scopus and Web of Science (WOS), and other online databases. Using the combination of multiple questionnaires, (i) Risk Factor Questionnaire (RFQ)(Halpern et al., 2001), (ii) Copenhagen Psychosocial Questionnaire (COPSOQ)(Burr et al., 2019), (iii) Swedish Occupational Fatigue Inventory (SOFI)(Åhsberg, 2000), which would determine the risk factors individuals exposed to throughout their working period in the industry.

The combination of these models produced an initial draft with 146 items: Physical risk factor with (4) constructs: frequency of work posture, time spent on specific work tasks, weighs of the lifted objects (Halpern et al., 2001); Psychosocial risk with (5) main constructs: demands, work organization and job content, work relationships, work individual interface, job employment factors (Burr et al., 2019); Fatigue inventory with (5) constructs; physical discomfort, physical exertion, lack of motivation, lack of energy, sleepiness (Holmström & Engholm, 2003). The researchers began developing the questionnaires by highlighting the factors that will the determine the level of fatigue associated with exposure of the risk factors. Two types of Likert scale were utilised; a 7-point Likert scale ranging from *Zero degree* to *Very high degree*, and five-point Likert scale was used for systematic evaluation of reliability and validity.

Expert panel review

The initially constructed questionnaire would then be evaluated by panels of five-member expertise in the areas of ergonomics, and occupational safety and health. According to Zamanzadeh *et al*.(2015a), minimum of 5 people was proposed for an instrument to have sufficient control over chance agreement (Zamanzadeh et al., 2015b). The ideal size of expert panels for reviewing an instrument range from 2 to 20 individuals, with a minimum of 5 experts suggested to ensure effective control over chance agreement (Zamanzadeh et al., 2015b). Content validity was determined using several expert panels (n = 5) that included three academics with a doctorate qualification and an ergonomist, and two-senior industrial safety and health managers.

These experts included three academic researchers with a doctorate qualification and specializing in occupational safety and health and ergonomics, and two senior industrial managers of safety, health and environment with rich experiences in the industrial filed. The experts offered comments and suggestion on items whether it should be removed or modified. They had also evaluated the level of importance of each item for its corresponding construct on a 5-point Likert scales of Frequency (1 = never, 2 = rarely, 3 = sometimes, 4 = often, 5 = always); Agreement (1 = definitely not, 2 = probably not, 3 = possibly, 4 = probably, 5 = definitely); Satisfaction (1 = very dissatisfied, 2 = dissatisfied, 3 = neither, 4 = satisfied, 5 = very satisfied), and a 7-point Likert scale (0 = zero degree, 3 = middle degree, 6 = to a very high degree)(Azmawati Husain, 2020; Halpern et al., 2001; Lee et al., 2021; Nuebling et al., 2013). Ample time was allocated to the appointed expert panels for reviewing and reaching an agreement on the overall relevance of the construct to ensure the instrument's comprehensiveness.

Content validity

In the assessment of content validity, various indices were computed; Item-level Content validity index (I-CVI); Scale-level validity index (S-CVI/Ave), and the content validity ratio (CVR)(Bai et al., 2018; Rodrigues et al., 2017). The I-CVI was computed as the number of experts giving a rating of "essential" for each item divided by the total number of experts. Values of range from 0 to 1 where I-CVI > 0.79, therefore the item is relevant, if the value is below 0.70, item is eliminated (Zamanzadeh et al., 2015b).

The S-CVI is calculated using the number of items in a tool that have achieved a rating of "relevant". The methods to calculate the S-CVI is the average CVI(S-CVI/Ave), calculated by taking the sum of I-CVIs divided by the total number of items (Zamanzadeh et al., 2015b). A S-CVI/Ave of higher than equal to 0.9 are considered an excellent content validity (Winwood et al., 2005).

The content validity ratio (CVR) measures the essentiality of an item (Bai et al., 2018). CVR varies between -1 and 1, and the higher the score indicates greater agreement among expert panels. The formula for the CVR is CVR = (Ne – N/2) / (N/2), where the Ne is the number of panels indicating an item as "essential" and the N is the total number of panels.

Together with the content validity survey was a cover letter and the instrument, outlining the purposes for inviting experts to participate. The instructions provided were clear and concise, guiding the experts on how to rate each item. In order to assess the essentiality, clarity, and relevance of the items, experts were provided with a questionnaire scale sheet. This sheet would be used by the experts to help them rate the questionnaire. Essential scale, a 3-point scale was used, and responses include: 1 = *not necessary*, 2 = *acceptable but need more minor revision*, and 3 = *essential*. The clarity scale was: 1 = *not clear*, 2 = *clear but need minor revision*, and 3 = *very clear* (Bai et al., 2018; Zamanzadeh et al., 2015b). Under every construct in the content validity survey, a blank segment were provided for additional comments and recommendations by the experts. The recommended numbers of expert panels to review an instrument varies from 2 to 20 individuals, and at least 5 persons were recommended to have sufficient control over chance agreement (Zamanzadeh et al., 2015b). Content validity was determined using several expert panels (n = 5) that included three academics with a doctorate qualification and an ergonomist, and two-senior industrial safety and health managers.

Statistical analysis

The responses from the expert panels were collected while the time allocated to review the process of the questionnaire development. The measurement of questionnaire validity was performed using Statistical Package for Social Sciences (IBM SPSS).

RESULTS AND DISCUSSION

The I-CVI calculations for the relevancy of each item are in Table 1. 60-items out of 146-items had an I-CVI of 1.00, 24-items with the score 0.8 and 3-items with 0.7, and the remaining items had I-CVI below than 0.6. It was considered that majority of the items were "essential" for this questionnaire, with the exception of seven constructs: five on psychosocial risk factors, and two on physical risk factors. Clarity for items was calculated using a 3-point scale (1 = *not clear*, 2 = *item clear but need minor revision*, 3 = *very clear*). Fortyfour items had clarity score I-CVI = 1.00, twenty items a score of 0.8, and three items a score of 0.6. The S-CVI/Ave was 0.9264, which meant the items were good and demonstrates high content validity of the instrument. Hence, the average value of CVR was 1.00 where eighty-seven items were marked “essential” and had a CVR of 1.00.

Following the item reduction through screening and refinement of the questionnaire items ended with 87 items based on the recommendations of the five expert panels. In the validation of face and content validity process, according to those five expert panels’ comments and responses, there were no additional items, and further modifications to the instrument. The overall content validity of all items was within the acceptable range (more than 0.7). The S-CVI value was considered to have good high content validity level with score above 0.8.

Table 1. Expert ratings on clarity and relevance of Physical, Psychosocial and Fatigue construct items during initial development.

Construct	No. of items	Expert judgement					I-CVI
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	
Physical factors							
Frequency of work posture	1	1	0	1	1	1	0.8
	2	1	0	1	1	1	0.8
	3	1	0	1	1	1	0.8
Time spent on specific work task	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
	5	0	0	1	1	1	0.6
	6	0	0	1	1	1	0.6
	7	0	1	1	1	1	0.8
	8	1	1	1	1	1	1
	9	1	1	1	1	1	1
	10	1	1	1	1	1	1
	11	1	1	1	1	1	1
Weighs of the lifted object	1	1	0	1	1	1	0.8
	2	1	0	1	1	1	0.8
	3	1	0	1	1	1	0.8
Average						S-CVI/Ave	**0.87**
Psychosocial factors							
Qualitative demands	1	0	1	1	1	1	0.8
	2	1	1	1	1	1	1
	3	0	1	1	1	1	0.8
	4	1	1	1	1	1	1
Cognitive demands	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Emotional demand	1	1	1	1	0	1	0.8
	3	0	1	1	0	1	0.6
Sensorial demand	1	1	0	1	1	1	0.8
	2	0	0	1	1	1	0.6
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Influence at work	1	1	0	1	1	1	0.8
	2	1	0	1	0	1	0.6
	3	1	0	1	0	1	0.6
	4	1	0	1	0	1	0.6
Degree of freedom at work	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Predictability	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
Role clarity	1	1	1	1	1	1	1
	2	1	1	1	1	1	1

Construct	No. of items	Expert judgement					I-CVI
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Role conflicts	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Social support	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	0	1	1	1	1	0.8
	4	0	1	1	1	1	0.8
Feedback at work	1	0	1	1	1	1	0.8
	2	1	1	1	1	1	1
Social relations	1	1	1	1	1	1	1
	2	1	1	1	1	1	0.8
	3	0	1	1	1	1	0.8
Concerns	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Average						S-CVI/Ave	**0.90**
Fatigue level							
Physical exertion	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Physical discomfort	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Lack of motivation	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Lack of energy	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Sleepiness	1	1	1	1	1	1	1
	2	1	1	1	1	1	1
	3	1	1	1	1	1	1
	4	1	1	1	1	1	1
Average						S-CVI/Ave	**1**

Items from the developed questionnaire showed satisfactory results on the CVI and S-CVI(Ave) during content validation from the expert panel judges, further indicates good content validity. The questionnaire was developed using a systematic process that involved a panel of experts followed by evidence of relevancy of content validity (Zamanzadeh et al., 2015b). The table demonstrates that the constructs related to physical factors, psychosocial factors, and fatigue levels are considered relevant and valid by experts, with particularly high agreement on the items assessing cognitive demands, cognitive demands and fatigue levels. This aligns with previous studies which highlight the importance of rigorous content validity evaluation to ensure the relevance of measurement instruments (Bai et al., 2018; Zamanzadeh et al., 2015b). Furthermore, the methodological approach involving expert panels is consistent with best practices in scale development, ensuring that the instrument comprehensively covers the intended content domain construct (Zamanzadeh et al., 2015b). The unanimous agreement on fatigue levels, with perfect I-CVI scores, suggests the robustness of these items in assessing this construct, which is critical in occupational health research (Åhsberg, 2000; Lee et al., 2021).

CONCLUSION

The current research undertook the development and content validation of a questionnaire assessing physical and psychosocial risk factors contributing to fatigue. The questionnaire comprehensively covered diverse risk factors, including bodily characteristics, job demand, work organization, job content, and interpersonal relations and leadership, as well as work-individual interface. The research suggests broader applicability beyond this group. The questionnaire's versatility indicates its potential usefulness in various population engaged in a physically and psychosocially demanding environment. This instrument provides a tool to assist with assessment of factors that may support or hinder the risk of temporary or permanent injuries on individuals. Recommendation for future studies using this questionnaire is suggested to conduct pre-testing on a certain working population to determine the reliability of this questionnaire for the specific work population, and further validate the instrument using the test-retest reliability and exploratory factor analysis (EFA).

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the expert panels for their invaluable contribution to this study. Additionally, heartfelt appreciation is extended to the workers in the courier service industry for their full cooperation, which made this study possible. The authors would also like to thank the Ministry of Higher Education for providing financial support for (FRGS) No. FRGS/1/2021/SKK06/UMP/02/2 (University reference RDU210156) and University Malaysia Pahang Al-Sultan Abdullah for additional financial support under under Internal Research grant PGRS230360.

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