Scientific Research Publishing

Open Journal of Nursing, 2018, 8, 811-822
http://www.scirp.org/journal/ojn
ISSN Online: 2162-5344
ISSN Print: 2162-5336

Development of a Tool for Assessment of Post-Myocardial Infarction Fatigue

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How to cite this paper: Brink, E., Fredriksson-Larsson, U., Alsén, P., Lång, M. and Cliffordson, C. (2018) Development of a Tool for Assessment of Post-Myocardial Infarction Fatigue. *Open Journal of Nursing*, **8**, 811-822.
https://doi.org/10.4236/ojn.2018.811061

Received: October 19, 2018
Accepted: November 19, 2018
Published: November 22, 2018

Abstract

Introduction: After treatment for myocardial infarction (MI) quite a few persons will experience different symptoms, including fatigue, during the recovery phase. The aim of the present study was to construct the multidimensional Post-Myocardial Infarction Fatigue (PMIF) scale, based on empirical data gathered in coronary heart disease contexts. **Methods**: The construction of the post-MI fatigue scale was conducted in seven steps, ending in a psychometric evaluation of the internal structure of the scale, using confirmatory factor analysis, as well as testing of convergent and discriminant validity, using correlational analysis, in a sample of 141 persons treated for MI. **Results**: The results showed that the PMIF scale represents three dimensions: physical, cognitive and emotional fatigue. It was also found that the scale is suitable for summing the items to obtain a total score representing a post-MI global fatigue dimension. **Conclusion**: The PMIF is a brief and easily completed scale for identifying persons experiencing post-MI fatigue. Early identification of fatigue, together with health behavior support, might prevent progression toward a more severe state of fatigue.

Keywords

Fatigue, Myocardial Infarction, Psychometric Evaluation, Scale Development

1. Introduction

Even in cases of successful medical treatment for myocardial infarction (MI), quite a few persons will experience different symptoms, including fatigue, during the recovery phase. Such symptoms can negatively affect well-being and daily life functioning [1], with the risk of deleterious effects on cardiovascular prognosis [2]. Research has shown that post-MI fatigue can be experienced as incomprehensible [3] and is associated with stress and coping strategies such as change of values, intrusion and social isolation [4]. Moreover, health behavior, e.g. physical activity, has been found to be negatively associated with post-MI fatigue [5]. Coronary healthcare professionals engaged in rehabilitation issues support persons experiencing distress of different varieties and degrees, but in rehabilitation programs, the symptom of fatigue has not yet been fully emphasized, and post-MI fatigue assessment is deficient [6] [7].

Fatigue refers to a symptom that emphasizes personal experiences, including bodily feelings ranging from tiredness to exhaustion that interfere with a person's ability to function [8]. During shorter periods, people may experience such symptoms (acute fatigue), due to stressors such as significant life events, hard work or sleep disturbance, which tend to decrease when the stressor wears off. Persistent symptoms, lasting more than six months (chronic fatigue), often arise in connection with disease and/or medical treatment [9] [10].

Several inventories have been developed to measure fatigue in different groups of persons with chronic conditions, mostly related to cancer diagnoses, but there are almost none targeting coronary heart diseases. In a systematic literature review of existing fatigue scales, a small number of instruments demonstrated good psychometric properties, but none met all of the criteria for an ideal fatigue instrument, which indicates that fatigue scales need to be further developed and validated [11]. Inventories are either unidimensional, measuring one dimension, or multidimensional, measuring more than one dimension. The benefits of using a unidimensional measure—capturing, e.g., fatigue severity with a summarized global score, e.g., the *Fatigue Severity Scale* [12]—include simplifying identification of fatigued versus non-fatigued persons, which is useful both in the clinic and research. However, a multidimensional fatigue inventory, e.g. *The Multidimensional Fatigue Inventory* [13], recognizes differences in fatigue experiences, allowing calculation of different fatigue dimensions; it also enables identification of qualitative aspects of fatigue, providing valuable data for both clinical and research use.

It has been hypothesized that fatigue is related to depression; depressed people generally experience fatigue [14], but research has indicated that only a proportion of those experiencing post-MI fatigue are depressed [15]. Depressed people need medical treatment to prevent negative illness experiences and a poor prognosis. When a person experiences fatigue after myocardial infarction, without a coexisting diagnosis of depression, self-care strategies to improve health and fatigue relief should be identified. Therefore, the aim of the present study was to construct a multidimensional post-MI fatigue inventory, the PMIF, based on empirical data gathered in coronary heart disease contexts, and to psychometrically evaluate the internal structure of the PMIF as well as test its convergent and discriminant validity. This involves: 1) confirming the hypothesized factor structure, e.g., whether the scale represents the three dimensions of fatigue: physical, emotional and cognitive (internal structure); 2) testing whether the scale is positively correlated with The Multidimensional Fatigue Inventory (MFI-20) [13] (convergent validity) and negatively correlated with the Cardiac-Self-Efficacy scale (CSE scale) [16] (discriminant validity).

2. Methods

2.1. Procedure for Post-MI Fatigue Scale Development

The present project of developing a multidimensional post-MI fatigue scale was conducted in seven steps. The first step: After reviewing current literature to explore existing definitions of fatigue, we found that our definition of post-MI fatigue was in accordance with earlier descriptions of the symptom, covering physical, emotional and cognitive aspects [17] [18] [19] [20]. Further, we found a wide range of existing fatigue inventories that have mostly been constructed for use in chronic illness settings, most inventories being designed to measure fatigue related to cancer diseases and treatment. Literature reviews have provided an overview and evaluation of many of these inventories [11] [21]. Based on our own literature search, we concluded that there is a lack of fatigue inventories targeting coronary heart disease contexts. However, the research has shown negative effects of vital exhaustion in persons treated for coronary heart disease [2] [22]. Additionally, a multidimensional inventory *the Piper Fatigue scale* [23]—designed to measure fatigue in persons treated for cancer in relation to four fatigue dimensions (behavioral, affective, sensory, and cognitive)—has been used in coronary care settings [5] [24] [25]. The second step: In our own research on post-MI fatigue, we have acquired some experience of fatigue assessment [4] [15] [26] using the MFI-20, primarily designed to measure fatigue in persons treated for cancer and to capture five dimensions: general fatigue, physical fatigue, reduced activity, reduced motivation and emotional fatigue [13].

The third step: Our main reason for developing the PMIF scale is based on our earlier research using qualitative methodology to explore post-MI fatigue from the fatigued persons' point of view; this research enabled us to develop the present fatigue-item pool. In interview studies aimed at discovering what fatigue means to persons treated for MI, participants reported a range of post-MI fatigue experiences [3] [27]. Over a number of years, we have discussed these expressions of fatigue experiences continuously within our research group and with healthcare professionals. The fourth step: These discussions resulted in the idea of constructing a scale covering the main features of fatigue in persons treated for MI, including three dimensions: *physical fatigue*, (e.g., lack of strength, body feels heavy), *cognitive fatigue* (e.g., concentration difficulties, forgetfulness) and *emotional fatigue* (e.g., cheerless, disagreeable). The fifth step: 32 items were developed as a basis for measurement and testing [28]. The sixth and seventh steps: the item-pool was analyzed, and based on low face validity, 10 items were removed. The present confirmatory factor analysis was conducted using 22 items.

2.2. Respondents in Evaluation of the Post-MI Fatigue Scale

The study comprised 141 persons, ≤75 of age, diagnosed with MI two months earlier. The MI diagnosis was based on electrocardiographic data, symptoms and enzymatic criteria. Respondents were consecutively recruited to participate in a longitudinal follow-up of recovery after MI. The project was approved by the Regional Ethical Review Board (720 - 10), and respondents gave their written informed consent. Three research nurses did the recruiting during the participants' first week of treatment at a coronary care unit in a Swedish regional hospital. Exclusion criteria were cognitive disorientation, communicative disabilities, and other severe diseases (e.g., cancer). Demographic and clinical data were obtained from interviewing and from hospital charts during the first week in hospital; see Table 1.

2.3. Measurements

The present results are based on data acquired through a package of questionnaires sent by post to respondents two months after the acute heart event. In the present study, the PMIF scale was complemented with the MFI-20 [13], another comparable fatigue measure appropriate for testing convergent validity. The CSE Scale [16] was used to test discriminant validity, because, theoretically, a person with high cardiac self-efficacy should in some way be able to compensate for the influence of fatigue better than a person scoring low on cardiac self-efficacy. Moreover, the Montgomery Åsberg Depression Rating Scale (MADRS) [29] was included to discriminate fatigue from depression.

Post-myocardial Infarction Fatigue scale (*PMIF*): This scale was developed and evaluated in the present study to measure post-MI fatigue. The final scale consists of 15 items (the scale development included item reductions, from 32 to 22 and finally 15 items, please see introduction and analysis sections in this article). A 5-point rating format is used, where higher scores indicate higher levels of fatigue. The multi-dimensionality comprises three subscales: physical, cognitive and emotional fatigue. For the final version of the PMIF, the possible response range is 0 - 20 for the subscales and 0 - 60 for a summarized global fatigue score. Cronbach's alpha = 0.90.

Table 1. Demographic and clinical data ($n = 141$).

Demographics	
Female	22%
Smoking	41%
Age mean (SD)	63 (7.7)
Clinical data	
History of MI	10%
PCI[a]	80%
CABG[b]	2.8%

[a]PCI, percutaneous coronary intervention; [b]CABG, coronary artery bypass grafting.

Multi-Dimensional Fatigue Inventory (*MFI*-20): This inventory was originally designed to measure fatigue in persons treated for cancer and provides information on the degree and multi-dimensionality of fatigue experiences. The scale consists of 20 items with a 5-point rating format, where a higher score indicates a higher level of fatigue [13]. In the present study, to measure convergent validity, we used a global score transformed from raw scale scores into interval scale sores, confirmed in a psychometric evaluation of MFI-20 in a sample of persons treated for MI [26]. Cronbach's alpha = 0.88.

Cardiac Self-Efficacy (*CSE*): This scale was designed to measure self-efficacy in persons treated for coronary heart disease and provides information on confidence about maintaining function and controlling symptoms. The scale consists of 13 items with a 5-point rating format, where a higher score indicates a higher level of self-efficacy [16]. In the present study, to measure discriminant validity, we used a global score confirmed in a psychometric evaluation of CSE in a sample of persons treated for acute coronary syndrome [30]. Cronbach's alpha = 0.90.

Montgomery Åsberg Depression Rating Scale (*MADRS*): This scale was designed to measure depressive symptoms. The sale consists of nine items with a 6-point rating scale and with a possible range of 0 - 54, where a higher global score indicates depression symptoms [29]. In the present study, we used the global score to evaluate the overlap between fatigue and symptoms of depression. Cronbach's alpha = 0.84.

2.4. Analysis

Confirmatory factor analysis (CFA) was performed to examine the extent to which the factor structure replicated the hypothesized hierarchical models, for each of the three scales. In this effort, the Mplus version 5 [31], within the STREAMS environment [32], was used. The total amount of internal missing data was relatively small, 21 scores distributed across 13 items. To include as much information as possible, the missing data modeling technique implemented in the Mplus program was used [33]. This technique gives unbiased estimates under moderate assumptions, which in the current study are fully satisfied [34] [35].

Model fit was estimated by: 1) χ^2 goodness-of-fit, χ^2/df, which should be beyond 2 - 3, 2) the Root Mean Square Error of Approximation (RMSEA), where a value should be below 0.05 for a good fit and below 0.08 for a model to be acceptable, 3) the Standardized Root Mean Square Residual (SRMR), which should be below 0.08 for a good fit and, 4) the Comparative Fit Index (CFI), where a value of 0.90 or higher indicates acceptable model fit [36].

Mean summed scores for each scale were assessed, and then convergent and discriminant validity were considered based on calculations of Pearson's correlations [28].

3. Results

In an evaluation of the factor structure, CFA was performed, in line with the a priori, hypothesized three-factor model design, using the 22 items as indicators of the factor structures: *Physical fatigue* eight items, *Cognitive fatigue* seven items, and *Emotional fatigue* seven items. Initially, in a test of the three-factor model, items found to have low factor loadings were visually examined, questioned and—after careful consideration—deleted. Accordingly, the number of items was reduced from 22 to 15. Further, the fit indices were improved, and the hypothesized factor structure was successfully confirmed. The standardized factor loading showed that all items were positively and significantly associated with one of the three factors to which they belonged, resulting in five items in each of three subscales (**Figure 1**). Each of the 15 items was an indicator of one of the three factors, showing that the final confirmatory model was built up with one latent variable for each of the three subscales; physical, cognitive and emotional fatigue, and with covariance between the three latent variables, resulting in a good fit; χ^2 (87, N = 141) = 126.376, CFI (0.972), SRMR (0.049) and RMSEA (=0.057). The covariance values between the three factors were quite high; 0.78 for physical fatigue and cognitive fatigue, 0.72 for cognitive fatigue and emotional fatigue, and 0.73 for physical and emotional fatigue.

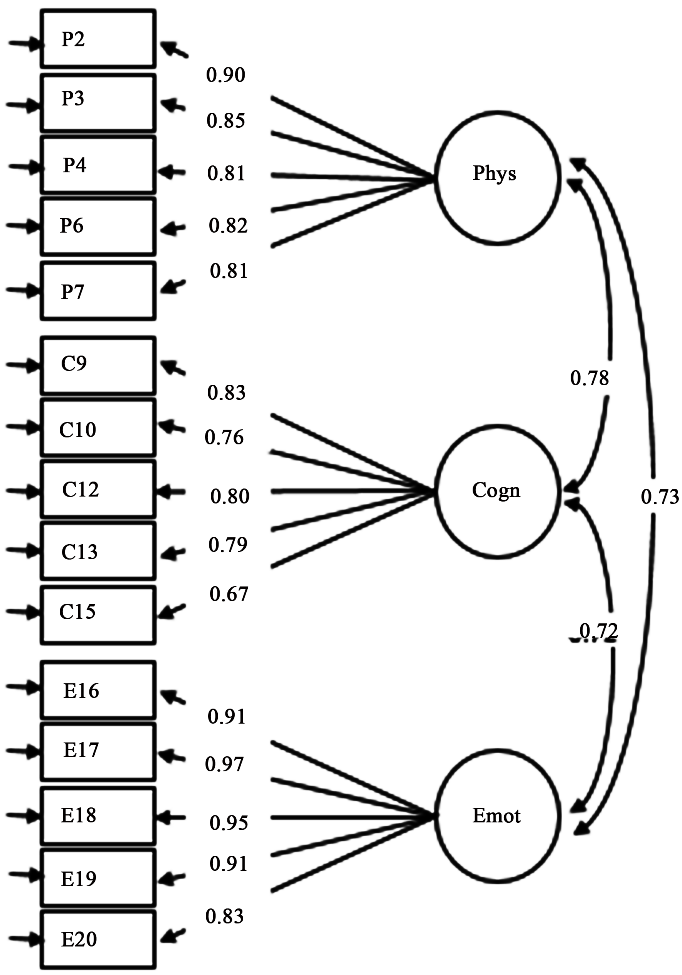

Figure 1. The three-factor model with covariances among the three factors.

Because the intercorrelations between the factors indicated an underlying commonality representing the same construct, a latent global fatigue factor—a higher-order model representing a global fatigue factor—was tested. This model was just as suitable as the three-factor model; χ^2 (87, N = 141) =126.376, CFI (0.972), SRMR (0.049) and RMSEA (=0.057). This test of a hypothesized higher-order factor should be carefully interpreted, because such statistical models should preferably rely on at least four first-order factors. Nevertheless, the factor loadings on the global factor were high: *physical fatigue* = 0.89, *cognitive fatigue* = 0.88 and *emotional fatigue* = 0.82 (Figure 2). Thus, when the factor loadings are generally high on both levels, it is reasonable to use a total summary score of the scale, in this case reflecting a post-MI fatigue global dimension.

The results from analyses of convergent and discriminant validity showed that the PMFS was positively correlated with the MFI-20 scale and negatively correlated with the CSE scale, conforming the second hypothesis that the PMIF was associated with external variables in expected directions. The strongest associations were found between PMIF-physical fatigue and MFI-20 and PMIF-emotional fatigue and CSE scale (Table 2). The correlation between depression (MADRs) and fatigue (PMFS) was r = 0.50, indicating that there are differences between these two symptoms, but also an overlap because, according to DSM-V [14], one of the symptoms of depression is fatigue.

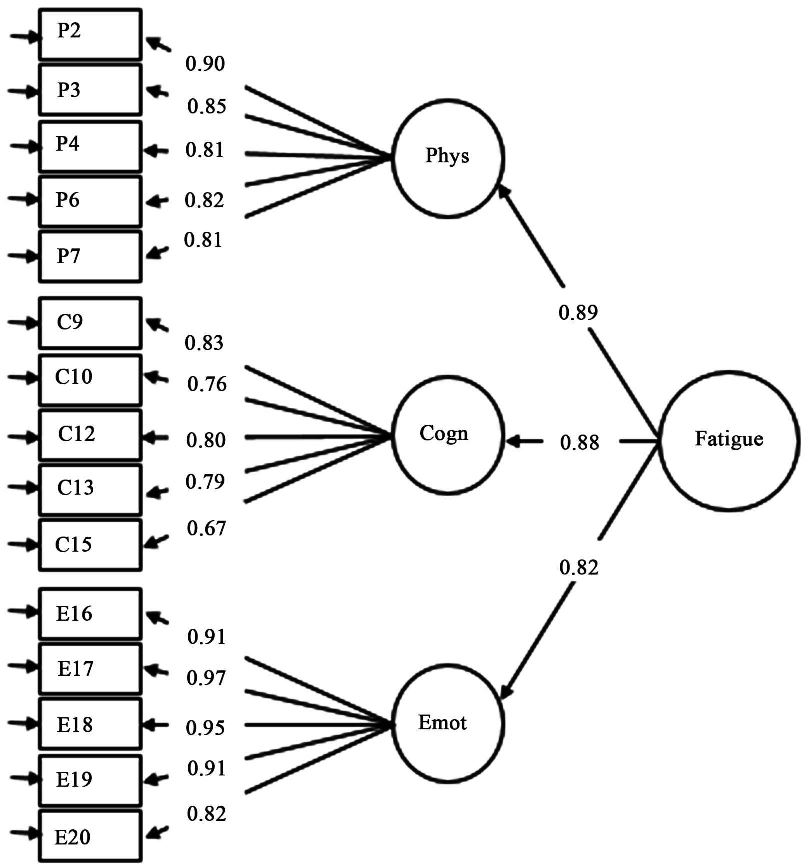

Figure 2. The second-order model.

Table 2. Descriptive data and correlations.

	Mean (SD)	1	2	3	4	5	6
1) PMIF: physical fatigue	5.81 (4.75)						
2) PMIF: cognitive fatigue	4.26 (3.92)	0.69**					
3) PMIF: emotional fatigue	4.61 (4.60)	0.70**	0.67**				
4) PMIF: global score	14.68 (11.83)	0.90**	0.87**	0.89**			
5) MFI-20 interval scores	59.22 (11.74)	0.72**	0.59**	0.63**	0.73**		
6) CSE	33.24 (8.59)	−0.47**	−0.44**	−0.53**	−0.53**	−0.51**	

**$p < 0.01$.

4. Discussion

The main purpose of the present study was to develop and psychometrically evaluate a scale for assessment of fatigue in persons treated for MI. The process of studying this phenomenon and creating the PMIF scale progressed from the verbal expressions of fatigue symptoms made by patients treated for MI, as well as statements from healthcare professionals, to research questions and hypotheses developed during the years in our research group. The present paper shortly describes these steps, including ideas and knowledge about post-MI fatigue, ending in development of scale items tested here. In the present evaluation of this new scale, the number of items was reduced from 32 to 15, resulting in a stable multi-factor solution. Our hypothesis that the PMIF represents three dimensions—physical, cognitive and emotional fatigue—has been confirmed. This solution was achieved by summing the five items in each dimension. Moreover, the hierarchical structure evaluation supported the legitimacy of summing the 15 items into a total score to obtain a post-MI global fatigue dimension. In tests of convergent and discriminant validity, the correlation analyses showed expected results, confirming the second hypothesis.

Fatigue can cause disability, and patients consider it a distressing symptom [3] [27]. Ordinary coronary care rehabilitation programs include advice about diet, smoking, physical activity and emotions. Thus, for all those whose daily activities are limited by fatigue, standard rehabilitation care cannot help them in this regard. Consequently, to alleviate the negative consequences of fatigue, a person-centered care plan [37], emphasizing subjective symptom experiences [38], should be a useful tool. Early identification of fatigue, together with health behavior support, may prevent progression toward a more severe state of fatigue or vital exhaustion [22] [39].

Many fatigue scales have been developed over the years to measure fatigue both in the general population and in populations of persons with different chronic diseases [11] [21]. Still, there is a lack of disease-specific scales designed to measure fatigue after MI. In our earlier research, we have used and evaluated the MFI-20, originally developed to measure fatigue in different populations, but not patients with coronary heart disease. These assessments had acceptable results, but one of the five dimensions (reduced motivation) did not function as expected [26]. Therefore, we wanted to start again by constructing a fatigue scale based on the experiences and statements of persons treated for MI. The present PMIF is a first attempt to develop a fatigue assessment for persons treated for acute coronary heart disease. Fatigue is often neglected in treatment, because its etiology is unknown and because the symptom appears to be unrelated to disease severity and process [21].

Mental distress has been found to be overrepresented among patients with coronary heart disease [40]. Symptoms of fatigue and depression after MI tend to overlap, as one of the cardinal symptoms of depression is fatigue or loss of energy [14]. Depressed people need medical treatment to prevent a poor prognosis [41]. Notably, some patients recovering from myocardial infarction report fatigue without concomitant symptoms of depression [15]. When a person experiences fatigue after MI, without a coexisting diagnosis of depression, self-care strategies to improve health should be identified [22]. Health behaviors, e.g., physical activity, may have influences on prognosis and morbidity and should be considered in relation to recuperation from fatigue, as research suggests that post-MI fatigue is likely to lead to decreased physical activity [5].

In the present study, we have included aspects such as internal, convergent and discriminate validity. One limitation is that we did not evaluate sensitivity to change over time and possible cutoff scores. Fatigue is a subjective experience and the items in the PMIF cover the phenomenology of fatigue experiences, often experienced by persons in the post-MI rehabilitation phase. Summing all items to obtain a global score gives an indication of who is experiencing fatigue. Further, future research and development of the scale will be needed to ensure identification through cutoff scores. In addition, our earlier research indicates that fatigue increases during a period up to four months after MI [4]. Thus, if we are to learn more about the sensitivity of the PMIF and when fatigue relief support will have its optimal effects, further research is needed on how fatigue changes over time.

Moreover, by summing the item scores for the three dimensions—physical, cognitive and emotional fatigue—a multi-dimensional fatigue profile for each person can be defined, providing a basis for offering person-centered support. Further, when fatigue interferes negatively with desired activity, it could be referred to as fatigability [20]. Understanding a person's fatigability requires an assessment of fatigue itself, but also identification of daily life ability and activity. Consequently, a fatigue relief intervention could be developed that affects both symptoms and function [42]. For this reason, in further development of the PMIF, the concept of fatigability should be considered.

5. Conclusion

Fatigue is often neglected in treatment, because its etiology is unknown and because the symptom appears to be unrelated to disease severity and process. Early identification of fatigue, together with health behavior support, might be useful in promoting fatigue relief. In this work, the PMIF scale—a brief and easily completed scale—may be useful for identifying persons experiencing post-MI fatigue.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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