Prediction Effects of Personal, Psychosocial, and Occupational Risk Factors on Low Back Pain Severity Using Artificial Neural Networks Approach in Industrial Workers

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Abstract

Objectives: This study aimed to provide an empirical model of predicting low back pain (LBP) by considering the occupational, personal, and psychological risk factor interactions in workers population employed in industrial units using an artificial neural networks approach.

Methods: A total of 92 workers with LBP as the case group and 68 healthy workers as a control group were selected in various industrial units with similar occupational conditions. The demographic information and personal, occupational, and psychosocial factors of the participants were collected via interview, related questionnaires, consultation with occupational medicine, and also the Rapid Entire Body Assessment worksheet and National Aeronautics and Space Administration Task Load Index software. Then, 16 risk factors for LBP were used as input variables to develop the prediction model. Networks with various multilayered structures were developed using MATLAB.

Results: The developed neural networks with 1 hidden layer and 26 neurons had the least error of classification in both training and testing phases. The mean of classification accuracy of the developed neural networks for the testing and training phase data were about 88% and 96%, respectively. In addition, the mean of classification accuracy of both training and testing data was 92%, indicating much better results compared with other methods.

Conclusion: It appears that the prediction model using the neural network approach is more accurate compared with other applied methods. Because occupational LBP is usually untreatable, the results of prediction may be suitable for developing preventive strategies and corrective interventions. (J Manipulative Physiol Ther 2017;xx:1-8)

Key Indexing Terms: *Prediction; Risk Factors; Low Back Pain; Artificial Neural Networks Approach; Workers*

Introduction

The musculoskeletal disorders are defined as injuries and complications in muscles, nerves, tendons, ligaments, joints, cartilage, and the spinal column.[1] Occupational low back pain is the most prevalent work-related musculoskeletal disorder and has been considered a significant health problem in recent years.[2] Absence from work, treatment costs and the related medical compensation, and considerable socioeconomic effects are the most important and problematic consequences of LBP today.[2,3] Total compensation costs have been estimated at US$100 billion per year. About US$20 billion have been devoted to the musculoskeletal disorders, and a major part has been spent on LBP. It is also known that 5% of worker absenteeism of at least a day per year is due to LBP.[3,4] It is generally believed that occupational LBP is caused by factors related to work.[5] However, it has been noted that LBP reporting has not decreased, despite significant changes and corrective intervention in occupational design (eg, reducing heavy tasks and manual material handling).[6] Therefore, previous studies identified 3 risk factor categories for LBP: personal characteristics (eg, age, gender, etc), occupational factors and workplace parameters (eg, force, working posture, noise, vibration, etc), and psychosocial factors (eg, overtime, stress, etc).[7] Research on each of these risk factors has identified degrees of correlation with LBP.[8] This correlation is most

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likely multidimensional, complex, and interactive. Many of the identified risk factors across categories are not mutually exclusive. Consequently, the study of the risk factors' interaction in the incidence of LBP is obviously essential.[9-11] Further, regression methods, fuzzy approaches, and even the neural network have been used predict LBP.[12] Furthermore, Marras et al.[13] have designed a conceptual model for interaction among of various risk factors of LBP. In spite of the extensive use of the aforementioned techniques in prediction of LBP, previous studies have not simultaneously investigated all 3 broad categories of risk factors.[13] For example, Sari investigated only occupational factors,[14] and other researchers have studied just 1 of these 3 factors alone.[9-11] Moreover, the studies that have investigated nearly all risk factors have used the classical approaches for prediction.[15-17] Hence, one of the most important issues is assigning more accurate and more powerful models that are able to predict the complex relationships among different risk factors. These models can combine a large number of risk factors, and therefore a more realistic prediction could be made of LBP. The artificial neural networks (ANNs) are widely used in basic sciences, medicine, and engineering as an alternative statistical method to predict complicated phenomena.[18,19] Presently this method has been recognized as an innovative and accurate method for modeling in various sciences. The ANN, as one of the most important artificial intelligence techniques, can be called an electronic model of the human brain. It has the intrinsic capability to store and apply empirical data.[20] Its known features are the ability to determine the complex relations among different variables and the capacity of using multiple learning algorithms. Actually, ANNs are powerful methods for fitting a mathematical model into a pattern for a set of observed data and can be used for classification and estimation problems. They can be used in problems where analyses based on discriminant analysis or logistic regression are standard statistical techniques and are capable of learning complex, nonlinear correlations between inputs and outputs.[20] The structure of ANNs is similar to the structure of biological neural networks in the brain and is trained for a specific processing task by applying large amounts of data. ANNs modify their structure by changing the weights between neurons (processing units) to improve their performance on the training data. After training, the neural network can extrapolate to provide solutions to novel input patterns, provided the training data were adequate.[21] In recent years, successful applications of ANN to medical outcomes, especially for LBP, have been reported in many studies. Nonetheless, a few studies have applied them to predict of occupational diseases such as LBP considering all 3 broad categories of risk factors simultaneously. Therefore, this study aimed to present an artificial neural network model, considering the interactive effects of personal, occupational, and psychosocial factors, for prediction of LBP in industrial workers.

Methods

Study Design and Participants

This study was a case-control study that was carried out in different factories located in the west of Iran. Data were collected in September 2015. A total of 160 (114 men, 46 women) participants were employed voluntarily as the study population. A total of 92 participants who were patients, already suffering from LBP as a result of their work, were selected as the case group. In the case group, eligibility criteria were age older than 18 years, participation in manual labor (such as lifting, lowering, pushing, and pulling), prolonged sitting/standing during work, and suffering from LBP. Eligibility also required that occupational medicine confirm LBP of case group participants. Also, 68 participants who did not have LBP were selected as the control group. In the control group, eligibility criteria were age older than 18 years, participation in manual labor (such as lifting, lowering, pushing, and pulling), prolonged sitting/standing during work, and not suffering LBP. All participants were selected from among workers in different parts of heavy industries, including maintenance, blast furnaces, and manual material handling parts of the steelmaking and rubber production factory. The participants signed an informed written consent before participation. This study was approved by the scientific and ethical review committees of the Kurdistan University of Medical Sciences Institutional Review Board.

Description of Model Variables

To process and select the final variables of the model for LBP prediction, the following sequence of steps was performed. A questionnaire was completed mainly by interview and study of workers' periodic medical examinations records to obtain personal and demographic information, identify the occupational risk factors (including application of force, working posture, work duration, repeated task, vibration, etc) and know the pattern of behaviors, including smoking, alcoholism, exercise, and social relations. Also, a questionnaire was used to identify psychosocial risk factors, including job satisfaction, job security, and social relations. A job stress questionnaire from the National Institute of Mental Health was used to assess job stress.[22] The subjective mental workload (SMWL) at work was assessed using a National Aeronautics and Space Administration Task Load Index (NASA-TLX).[23] The Rapid Entire Body Assessment worksheet also was used to identify and assess the occupational risk factors, including force, posture, repetition, and vibration exposures at work. Three general risk factor categories for LBP—personal, psychosocial and occupational—are presented in Table 1.

Body mass index generally was denoted in 3 categories: ideal, overweight, and obese. Family history of LBP, smoking and alcohol consumption, lob satisfaction, and job security were denoted with a "yes" or a "no." Social