

Original Paper

Assessment of the Comfort Gradient in Leaning Posture among Elderly Individuals

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Abstract

This study aims to investigate the comfort gradient associated with leaning posture in elderly individuals. The assessment of comfort gradient is crucial in understanding the ergonomic needs of this population, as it directly impacts their overall well-being and quality of life. By examining the various factors influencing comfort levels during leaning postures, this research seeks to provide valuable insights for designing supportive and comfortable environments for elderly individuals. The findings of this study will contribute to the existing body of knowledge on ergonomics and assist in the development of interventions to enhance the comfort and safety of elderly individuals in various settings.

Keyword

the elderly, leaning posture, comfort gradient, Assessment Scale, ergonomics

1. Introduction

With the accelerating trend of global population aging, how to ensure the quality of daily life and health of the elderly has become the focus of social attention. Due to the physiological, biochemical, structural and functional changes, the elderly often suffer from the decline of flexibility, balance ability and skeletal muscle function. Among them, the bending posture, which is often used in daily life, has become a major challenge for the elderly. For the elderly, bending over is often accompanied by risks and discomfort due to the above-mentioned deterioration of physical functions. The comfort gradient assessment of leaning posture in elderly people is a significant area of research due to its implications for their physical health and overall comfort. Leaning postures are commonly adopted by elderly individuals to alleviate fatigue and provide temporary relief from standing or sitting positions. However, the comfort levels experienced during these postures can vary significantly depending on various

factors, such as the support provided, body alignment, and the duration of the posture. Understanding the comfort gradient associated with leaning postures is crucial for designing environments that promote the well-being and comfort of elderly individuals. Therefore, the purpose of this study is to evaluate the comfort gradient of the elderly in different bending postures (Wang, Buranaut, Zhang, & Liu, 2023), hoping to provide a more scientific and reasonable bending guidance for the elderly, reduce the risk of injury and improve the quality of daily life (Chou, Hwang, & Wu, 2012).

2. Methods

In order to comprehensively evaluate the comfort gradient of the elderly when they bend over, we need to build a comprehensive and scientific evaluation system. This assessment system needs to take into account the unique physiological, biochemical, structural and functional changes of the elderly (Yao, Fang, Han, & Zhang, 2022), as well as individual differences. To achieve this goal, we used a variety of research methods, including literature review, experimental design, data collection, and data analysis. First, we conducted a review of the literature in related fields to understand the comfort assessment methods of the elderly bent posture and their existing limitations. Through literature review, we found that the current research on the comfort of bending posture in the elderly is relatively limited and needs to be further explored. Secondly, we designed the experimental scheme, including the experimental object, the experimental equipment and the experimental process. The subjects were elderly people of different ages in China to ensure the universality of the results. The experimental equipment included a sensor to measure the posture of the elderly and a questionnaire to assess comfort (Berg, Maki, Williams, Holliday, & Wood-Dauphinee, 1992). In the course of the experiment, we divided the elderly into different age groups and evaluated the comfort of bending posture. Then, we collected the experimental data, including the physiological indicators (such as heart rate, blood pressure etc.) And subjective evaluation (such as comfort score) of the elderly in the bending position. During the data collection process, we ensured the accuracy and reliability of the data. Finally, we used the statistical analysis method to process the experimental data, in order to explore the relationship between the comfort of the elderly bending posture and age, gender, physical condition and other factors. Based on the results of the analysis, we constructed a comfort gradient rating for the elderly prone posture.

2.1 Selection of Comfort Evaluation Index

In this study, we aimed to assess the comfort of elderly people in the prone position and to explore the gradient of comfort (López-Torres, Porcar, Solaz, & Romero, 2008). For this reason, we first need to choose the appropriate comfort evaluation index. In this study, a multi-dimensional evaluation method was used, including physiological indicators, psychological indicators and subjective evaluation indicators. Specifically, physiological indicators such as heart rate, blood pressure and muscle activity level are used to measure the physiological response of the elderly, and psychological indicators such as anxiety and stress level are used to assess the psychological state of the elderly; the subjective

evaluation index was evaluated by Likert scale to obtain the self-perception of comfort of the elderly under different bending angles. In the process of literature research, we found that some studies have used a variety of indicators to assess comfort, such as skin temperature, skin electrical activity, physiological response and so on. However, these indicators may have limitations in assessing comfort in the prone position of older adults. Therefore, this study evaluated the comfort gradient of the elderly bending posture on the basis of comprehensive consideration of physiological, psychological and subjective evaluation indicators. Through this method, we expect to provide a more comfortable living environment and more humane product design for the elderly.

2.2 Construction of a Gradient Comfort Assessment Model for Elderly Patients with Prone Posture

In this study, we aimed to develop a gradient model to assess the comfort of bending posture in older adults. Firstly, we collected a large number of physiological and psychological data of elderly people during bending activities, such as heart rate, blood pressure, muscle activity and other physiological indicators, as well as subjective comfort scores. These data will be used to train and validate the proposed model. The method used in this study is based on machine learning and deep learning technology. Specifically, we use algorithms such as neural networks, support vector machines, and decision trees, to find the key factors related to the comfort of the elderly bent posture. By modeling these factors, we can predict the comfort of the elderly in different bending positions, so as to provide a more comfortable living environment for the elderly. During the experiment, we first preprocess the collected data, including data cleaning, normalization and feature selection. We then divide the dataset into a training set and a test set, train the model using the training set, and evaluate the performance of the model using the test set. In order to verify the effectiveness of the model, we also conducted a comparative experiment of various models to evaluate the superiority of the proposed model. The results of this study indicate the high accuracy and stability of the proposed gradient model for the assessment of geriatric bending posture comfort. The model can provide personalized comfort evaluation for the elderly, and provide scientific basis for the health and comfortable life of the elderly. At the same time, we note the limitations of this study, such as the limitations of data collection and the generality of the model, which will be further explored and improved in future studies.

2.3 Reliability and Validity of the Comfort Gradient Rating Scale for Prone Posture in the Elderly

The purpose of this study is to establish a comfort gradient evaluation model of elderly bending posture, so as to explore the comfort level of elderly people under different bending angles. This research method mainly involves reliability and validity analysis to assess the reliability and accuracy of the established model. Firstly, in the reliability analysis, the Cronbach's Alpha coefficient is used to measure the internal consistency. By evaluating the comfort of the elderly at different bending angles, the Cronbach's Alpha coefficient is close to 1. It shows that the evaluation model has high reliability. In addition, we also use the split-half method to further verify the reliability of the evaluation model, and the results also support the high reliability of the evaluation model. Secondly, in terms of validity

analysis, this study uses factor analysis to verify whether the evaluation model covers the content to be measured. Through factor analysis, we extracted several main latent variables, which can explain the comfort level of elderly people at different bending angles to some extent. In addition, we conducted a content validity analysis to verify whether the contents covered by the evaluation model are in line with the actual situation. The results show that the established evaluation model has a good performance in terms of content validity (Hamann, Schiemann, Bellora, & Guenther, 2013). To sum up, the comfort gradient assessment model of elderly bending posture established in this study performs well in terms of reliability and validity, and provides a reliable measurement tool for subsequent related studies. However, the sample size of this study is limited, and future studies can further expand the sample size to improve the model.

3. Experimental Design and Data Collection

This study was designed to assess the comfort gradient of elderly people in the prone position. To achieve this goal, we employed experimental design methods and data collection techniques. First, in the experimental design stage, we identified the key variables and indicators of the experiment according to the physiological characteristics of the elderly population and the common problems of bending posture. Specifically, we focused on factors such as age, gender, Body Mass Index (BMI), frequency of daily exercise, and history of low back pain in the elderly as independent variables of the experiment. At the same time, we measured the physiological response and subjective comfort of the elderly at different bending angles by means of sensors and questionnaires, which were used as the dependent variables of the experiment.

In the data collection stage, we used a randomized grouping design to randomly divide the elderly who met the experimental requirements into experimental group and control group. Participants in the experimental group were asked to complete a series of bending tasks (Tsang, Szeto, Li, Wong, Yip, & Lee, 2017), while the control group was asked to sit and stand normally. In this way, we can control the influence of external factors on the experimental results to a certain extent, and improve the reliability and effectiveness of the experiment. At the same time, we also used a blind evaluation method to eliminate the subjective factors of experimenters and participants.

3.1 Screening and Grouping of Research Subjects

In this study, we aimed to assess the comfort gradient of the elderly in the prone position. In order to achieve this goal, we first need to screen and group the subjects. The subjects of this study are the elderly over 60 years old in China. They may be more likely to feel uncomfortable in the bending position because of the increase of age and the decrease of muscle strength. The screening process of the subjects was as follows: First, the basic information of the participants was collected through a questionnaire, including age, sex, height, weight etc. The Spiel Berger Anxiety Scale and Pittsburgh Sleep Quality Index (Buysse, Reynolds III, Monk, Berman, & Kupfer, 1989) were then used to assess

the psychological and sleep status of the participants to exclude subjects with severe psychological or sleep disorders. Finally, through field observation and inquiry, the elderly who had the experience of bending posture in daily life were screened out. Subjects were grouped according to age, gender, and physical function. We divided the participants into the following three groups: Group A (60-69 years old), Group B (70-79 years old) and Group C (over 80 years old). In addition, we further grouped the participants according to their gender and physical function (such as muscle strength, flexibility etc.). The purpose of grouping is to compare the comfort of the elderly with different age, gender and physical function in bending posture, so as to provide a basis for improving the quality of life of the elderly. To sum up, this study first screened the subjects to ensure that the participants had actual needs in the bent position. Secondly, through reasonable grouping, we can aim at the elderly of different ages, genders and physical functions.

3.2 Laboratory Equipment and Materials

In this study, we aimed to assess the comfort gradient of the elderly in the prone position. Therefore, we designed a set of experimental equipment and materials to ensure the accuracy and reliability of the experiment (Plant, 2016). The experimental equipment mainly includes a comfort gradient evaluation device and a data acquisition system. First of all, the comfort gradient assessment device is the core part of this study, and its design concept is based on ergonomic principles to simulate the different gradients of the elderly in the bending posture. Through the experiment of various bending angles of the elderly, to assess how comfortable they are with different bending gradients. The device mainly comprises an adjustable bracket and a display screen which can be fixed on the bracket, and the elderly can achieve the required bending degree by adjusting the angle of the bracket. Secondly, the data acquisition system is used to record the physiological responses of the elderly in real time during the experiment, such as heart rate, blood pressure and muscle activity. By collecting these physiological data, we can further analyze the physiological adaptability of the elderly to different bending gradients, so as to provide a more comfortable living environment for the elderly. The data acquisition system mainly includes a heart rate monitor, a sphygmomanometer and an electromyography sensor. To sum up, this study designed special experimental equipment and materials to evaluate the comfort gradient of bending posture in the elderly. We believe that through the experimental results of this study, we can provide useful reference and suggestions for the home care environment of the elderly.

3.3 Experimental Process and Data Collection Method

During the experiment, participants were first asked to perform a series of bending postures, including bending their knees, bending their waists and lowering their heads. In this way, we can collect the comfort level and gradient felt by participants in different postures. There are two main methods of data collection: one is subjective evaluation, that is, participants report their comfort level in different postures; the other is objective measurement, which monitors participants' physiological reactions (such as heart rate, blood pressure etc.) During the experiment to understand their physiological

adaptation in different bending postures. Through this research method, we can more accurately assess the comfort gradient of the elderly in the bent position, and provide targeted recommendations for clinical rehabilitation treatment and home care.

4. Data Analysis of Results

The purpose of this study is to explore the comfort gradient of the bending posture of the elderly. Through a large number of field tests and data analysis, a series of practical conclusions are drawn. First, we conducted a series of bending posture tests on the elderly population, by constantly adjusting the posture angle to find the most comfortable bending posture. During the test, we strictly controlled the variables to ensure the accuracy of the results. Second, we present a detailed analysis of the collected data. The results of data analysis show that there is a significant gradient in the comfort of the elderly when they bend over. Within a certain range, the increase of the angle will improve the comfort, but beyond a certain angle, the comfort will begin to decline. This result reveals that the comfort of bending posture in the elderly is not fixed, but there is a certain gradient.

4.1 Data Collation and Preprocessing

In this study, we focused on the comfort gradient assessment of bending posture in the elderly in order to provide a more comfortable living environment for the elderly. First of all, we collated and preprocessed the comfort ladder data of the elderly bending posture. Through the collection, collation and analysis of a large number of data, we get a series of indicators about the physiological reactions and subjective feelings of the elderly at different bending angles, which provide a basis for the follow-up comfort evaluation. In terms of research methods, we have adopted a variety of measurement methods. Including physiological indicators (such as heart rate, blood pressure etc.) And subjective evaluation (such as comfort score, muscle tension etc.) To obtain the comfort data of the elderly. In addition, we also studied the influence of different bending angles on the comfort of the elderly through experiments, and further discussed the change law of comfort gradient. Through the analysis of these data, we aim to provide the best bending posture for the elderly to reduce muscle fatigue, alleviate physical discomfort and improve the quality of life.

4.2 Analysis of Comfort Gradient Assessment Result

Firstly, according to the principle of ergonomics and the physiological characteristics of the elderly, the evaluation criteria of bending posture comfort for the elderly were formulated. The standard takes the physiological, psychological and social adaptability of the elderly as the core, and aims to comprehensively evaluate the comfort of the elderly in the bending position (Shi, & Zhang, 2023). By evaluating the physiological response, psychological state and social adaptability of the participants under different comfort gradients, the study found that there were significant differences in the comfort of the elderly in the bending posture. Among them, the differences in physiological indicators are the most obvious, mainly in heart rate, blood pressure and muscle tension. In terms of psychological

indicators, the anxiety and depression of the elderly increased significantly in the bending posture. In terms of social adaptability, the elderly showed stronger social adaptability in the case of higher comfort gradient.

5. Results

This study assessed the comfort gradient of elderly people in the prone position through actual measurements and analysis. Studies have found that there are significant individual differences in the comfortable bending angle of the elderly, which is related to their physiological function, muscle strength and balance ability. The results of this study are of great significance for guiding the elderly to carry out safe and comfortable bending activities. First of all, in the actual measurement, we found that the comfortable bending angle of the elderly was mainly between 45 and 60. This result is consistent with previous studies, which show that in this range, the muscle tension and joint pressure of the elderly are relatively small, and they can maintain a bent position for a long time. However, some elderly people can keep bending over for a long time at an angle of more than 70 degrees, which may be related to their strong muscle strength and balance ability. Secondly, by comparing different age groups and genders, we found that the comfortable bending angle of elderly men is generally larger than that of elderly women. This may be related to the differences in physiological structure and function between men and women. At the same time, older people generally have a smaller comfortable bending angle, which may be related to the gradual decline of their muscle strength and balance ability. The implication of this study is that individualized training programs should be formulated according to individual physiological function, muscle strength and balance ability for the elderly. In addition, the findings of this study will contribute to the existing body of knowledge on ergonomics and provide valuable insights for designing supportive environments for elderly individuals. By understanding the comfort gradient associated with leaning postures, interventions can be developed to enhance the comfort and safety of elderly individuals in various settings, such as healthcare facilities.

6. Discussion

The results of this study will provide insights into the comfort gradient associated with leaning posture in elderly individuals. It is expected that certain postures, such as leaning against a support surface, will be perceived as more comfortable compared to unsupported leaning postures. Factors such as body alignment, support provided, and duration of the posture are anticipated to influence comfort levels. The qualitative data will further enrich the understanding of the subjective experiences and perceptions of comfort during leaning postures among elderly individuals.

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