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Research on the Construction of a Risk Identification Index System for Physical Exercise Among the Elderly in Zhaoqing City

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Abstract

This study employs methods such as factor analysis to construct an indicator system for identifying risks associated with physical exercise among the elderly in Zhaoqing City, providing a basis for addressing issues related to the risks and identification of such risks among the elderly in Zhaoqing City. The results indicate that the first-level indicators for identifying physical exercise risks among the elderly in Zhaoqing City include 4 items, the second-level indicators include 14 items, and the third-level indicators include 28 items. Among these, the first-level indicators and their respective weights are: physical health status (0.35), exercise behavior characteristics (0.25), environmental and safety measures (0.20), and psychological and cognitive abilities (0.20); The secondary indicators and their weight rankings are: chronic disease status (0.12), physical fitness foundation (0.1), history of sports injuries (0.07), cardiovascular health (0.06), exercise frequency (0.08), exercise intensity (0.07), exercise method selection (0.05), exercise persistence (0.05), Facility Safety (0.07), Use of Wearable Devices (0.07), Community Support and Guidance (0.06), Exercise Risk Perception (0.08), Exercise Motivation and Willingness (0.07), Emotional and Mental Health (0.05); The tertiary indicators and their weighting order are: hypertension, diabetes, and coronary heart disease diagnosis status (0.02), medication and disease management status (0.02), walking ability test (0.02), balance ability test (0.02), number of exercise-related injuries in the past year (0.01), post-injury recovery status (0.01), heart rate monitoring (0.01), blood pressure measurement (0.01), number of exercise sessions per week (0.01), duration of each exercise session (0.01), heart rate range during exercise (0.01), subjective physical exertion score (0.01), proportion of aerobic exercise participation (0.01), proportion of strength training participation (0.01), Number of consecutive months of exercise (0.01), statistics on reasons for exercise interruptions (0.01), facility integrity rate (0.01), anti-slip and fall prevention measures at the facility (0.01), wearing rate (0.01), data upload and monitoring frequency (0.01), participation rate in community health lectures (0.01), Professional guidance service coverage rate (0.01), Risk knowledge questionnaire score (0.01), Pre-exercise risk assessment behavior incidence rate (0.01), Subjective willingness to participate in exercise score (0.01), Exercise goal setting status (0.01), Depression and anxiety self-assessment scale score (0.01), Perceived social support score (0.01).

Keywords

Exercise risk; indicator system; Delphi method; hierarchical analysis; Zhaoqing City

1. Introduction

As China's population ages rapidly, health issues among the elderly have become increasingly prominent, attracting significant societal attention. Under the "Healthy China" strategy, physical exercise for the elderly has been assigned a new mission for the times. It is not only a crucial means to enhance the physical fitness and quality of life of the elderly but also a key measure to achieve active aging and delay the onset of chronic diseases [1,2]. However, insufficient physical exercise has become the fourth leading risk factor for mortality globally, with the elderly population being particularly affected [3]. In recent years, domestic and international scholars have conducted extensive research on the benefits of physical exercise for the elderly, confirming that moderate physical exercise can effectively reduce the incidence of chronic diseases such as ischemic stroke and cardiovascular disease, extend lifespan, and improve mental health and social adaptation abilities [4]. However, older adults also face numerous risks when participating in physical exercise, such as sports injuries, cardiovascular accidents, and fractures. Especially in the context of declining physical fitness and the high prevalence of chronic diseases, physical exercise is akin to a "double-edged sword" [5]. Existing research has primarily focused on the relationship between exercise methods, intensity, and health benefits, with limited systematic identification and quantitative assessment of the risks associated with physical exercise for the elderly. Additionally, personalized intervention mechanisms tailored to the varying physical conditions and health statuses of the elderly remain underdeveloped [6,7]. As a typical aging city, Zhaoqing faces a complex landscape regarding elderly physical exercise, with some groups actively participating while others exhibit insufficient awareness of exercise risks and a lack of scientific guidance. Previous studies have limitations in the construction of risk identification indicator systems, exercise capacity assessment, and process monitoring, primarily manifested in incomplete indicator systems, lack of scientific rigor in assessment methods, and insufficient targeting and real-time applicability of intervention measures, making it difficult to meet the diverse and dynamic health needs of the elderly.

To address these issues, this study targets the elderly population in Zhaoqing City, based on risk identification theory, to systematically construct a risk identification indicator system for elderly physical exercise. The aim is to achieve a scientific and quantitative assessment of the risks and capabilities associated with elderly physical exercise, and to use this as a basis for classifying the elderly population, exploring intervention mechanisms for physical activity among different groups of the elderly.

The study will integrate wearable device technology to monitor the physical exercise process of the elderly in real time, enhancing the scientific rigor and timeliness of risk avoidance. It will also establish a physical exercise database for the elderly in Zhaoqing City, providing data support for personalized health interventions and scientific exercise guidance. Through risk identification and graded interventions, this approach not only helps ensure the safety and effectiveness of physical exercise for the elderly, maximizing exercise benefits, but also provides a theoretical basis for governments, communities, and sports professionals to formulate scientific policies and service plans for elderly physical exercise. The significance of this research lies in promoting the scientific and precise development of physical exercise for the elderly, enhancing their health levels, contributing to the realization of the "Healthy China" strategic goal, and providing references for theoretical innovation and practical exploration in related fields.

2. Research Objectives and Methods

2.1. Research Objectives

The risk identification index system and its weights for physical exercise among the elderly in Zhaoqing City.

2.2. Research Methods

2.2.1. Literature Review Method

First, the research theme and keywords were identified, and a comprehensive search was conducted in domestic and international databases, libraries, and authoritative journals to collect literature related to risk identification, capability assessment, and intervention mechanisms for physical exercise among the elderly. Second, the collected literature is screened and categorized, with duplicate or irrelevant content excluded, focusing on high-quality, authoritative research findings; Third, content analysis is employed to conduct an in-depth interpretation of the literature, summarizing the theoretical perspectives, methodological frameworks, and practical experiences of previous studies, and identifying the shortcomings and gaps in existing research; Finally, combine the literature materials with the actual situation of this study to provide theoretical support and reference basis for the construction of the indicator system, method selection, and data analysis, thereby ensuring the scientific and systematic nature of the study.

2.2.2. Delphi Method

Combine literature materials and expert interviews to systematically construct the risk identification indicator system for physical exercise among the elderly in Zhaoqing City. The specific operational process is as follows: first, based on the results of prior literature review and expert interviews, design an indicator question-

naire covering theoretical and practical content related to physical exercise risks. Subsequently, invite experts and scholars with extensive experience in the field of sports development to participate in the questionnaire evaluation. Experts will independently and anonymously score each indicator based on their professional knowledge and practical experience, ensuring the objectivity and authority of the evaluation process. The questionnaire used a five-point Likert scale for scoring. After two rounds of expert evaluations, the weighted coefficients for each indicator were calculated, and the evaluation results were analyzed. Indicators with scores below the set threshold ($X \geqslant 4$) were excluded, ultimately forming a scientific and reasonable risk identification indicator system. A total of five Delphi method questionnaires were distributed, all of which were returned valid, achieving a 100% response rate, providing a solid data foundation for the optimization and improvement of the subsequent indicator system.

Table 1. Questionnaire Survey on the Risk Identification Index System for Physical Exercise Among the Elderly in Zhaoqing City (n=5)

name	sexes	title	work unit	years of experience in the field
Yang XX	male	professor	universities	20
Li XX	male	professor	universities	17
Tan XX	male	professor	universities	15
Liu XX	females	associate professor	universities	13
Wang XX	male	associate professor	research institute	7

2.2.3. Analytic Hierarchy Process (AHP)

In this study, the Analytic Hierarchy Process (AHP) was employed to scientifically determine the weight coefficients of various indicators for identifying physical exercise risks among the elderly in Zhaoqing City. This method treats complex multi-objective decision-making problems as a systematic process, breaking down the overall objective into multiple criteria and sub-indicators through hierarchical decomposition. By constructing a hierarchical structural model, it systematically conducts qualitative and quantitative analyses of indicators at each level. In the implementation process, the research team designed a survey questionnaire titled "Zhaoqing City Elderly Physical Exercise Risk Identification Indicator Pairwise Comparison Matrix Model" based on the final established indicator system. They invited university faculty members and experts with professional backgrounds in elderly physical exercise and risk research to participate in the assessment. The experts conducted pairwise comparisons of each indicator, assigning relative importance scores based on their own experience and professional judgment, thereby forming a judgment matrix. Subsequently, the researchers used the analytic hierarchy process to process the expert scoring data, calculating the weight coefficients for each indicator to ensure the scientific and reasonable allocation of weights. A total of five questionnaires were distributed, all of which were effectively returned, achieving a 100% response rate, providing robust data support for determining the weights of the risk indicator system for elderly physical exercise in Zhaoqing City.

Table 2. Survey experts (n=5) on the pairwise comparison matrix model of risk identification indicators for physical exercise among the elderly in Zhaoqing City

name	sexes	title	work unit	years of experience in the field
Deng XX	male	professor	universities	23
Luo XX	male	professor	universities	20
Tan XX	male	professor	universities	15
Liu XX	females	Associate professor	universities	13
Wang XX	male	associate professor	research institute	7

3. Results

3.1. Establishment of an Evaluation System for Risk Identification Indicators in Physical Exercise Among the Elderly in Zhaoqing City

Based on the principle of comprehensiveness in selecting indicators, we conducted an in-depth qualitative analysis based on relevant literature and theories, establishing four primary evaluation indicators. We listed the risk identification indicators for physical exercise among the elderly in Zhaoqing City at each level and established 16 secondary evaluation indicators, thereby preliminarily constructing an evaluation system for risk identification indicators in physical exercise among the elderly in Zhaoqing City. Additionally, considering the principle of operational feasibility in indicator selection, the initial indicators faced practical issues such as excessive complexity. To accurately reflect the objective issues within the risk identification indicator system for elderly physical exercise in Zhaoqing City, the Delphi method was applied to conduct a secondary screening of the initial indicators, ultimately establishing 14 secondary evaluation indicators and 28 tertiary indicators. See Table 3 below.

Table 3. Risk identification index system for physical exercise among elderly people in Zhaoqing City in this study

Primary indicators	Secondary indicators	Tertiary indicators
Physical health status	Chronic disease status	Hypertension, diabetes, and coronary heart disease diagnosis status
		Medication and disease management status
	Physical fitness level	Walking ability test
		Balance ability test
	History of sports injuries	Number of sports injuries in the past year
		Post-injury recovery status
	Cardiovascular health	Heart rate monitoring
		Blood pressure measurement
Exercise behavior characteristics	Exercise frequency	Number of weekly exercises
		Duration of each exercise
	Exercise intensity	Heart rate range during exercise
		Subjective physical exertion score
	Exercise method selection	Aerobic exercise participation rate
		Strength training participation rate
	Exercise consistency	Number of consecutive months of exercise
		Statistics on reasons for exercise interruption
Environment and safety	Facility safety	Facility integrity rate
		Anti-slip and fall prevention measures in facilities
	Use of wearable devices	Wear rate
		Data upload and monitoring frequency
	Community support and guidance	Participation rate in community health lectures
		Coverage rate of professional guidance services
Psychological and cognitive abilities	Exercise risk awareness	Risk knowledge questionnaire score
		Incidence of pre-exercise risk assessment behavior

	Exercise motivation and willingness	Subjective willingness to participate in exercise
		Exercise goal setting status
	Emotional and mental health	Depression and anxiety self-assessment scale score
		Perceived social support score

As can be seen, the risk identification indicator system for elderly physical exercise in Zhaoqing City established in this study encompasses four primary indicators: physical health status, exercise behavior characteristics, environmental and safety measures, and psychological and cognitive abilities. This system comprehensively reflects the multidimensional risk factors influencing elderly physical exercise. In terms of physical health status, four secondary indicators have been established: chronic disease status, physical fitness foundation, history of sports injuries, and cardiovascular health. These are further broken down into tertiary measurable indicators such as hypertension, diabetes, coronary heart disease diagnosis, medication and disease management, walking ability test, balance ability test, number of sports injuries in the past year, post-injury recovery status, heart rate monitoring, and blood pressure measurement, providing a comprehensive assessment of the elderly population's baseline health levels and potential risks. Exercise behavior characteristics include exercise frequency, exercise intensity, exercise method selection, and exercise persistence. These are quantified through tertiary indicators such as weekly exercise frequency, duration of each exercise session, heart rate range during exercise, subjective physical exertion score, proportion of aerobic exercise and strength training participation, consecutive months of exercise, and reasons for exercise interruption, reflecting the regularity and scientific nature of elderly individuals' physical activities. Environmental and safety measures are assessed from three aspects: venue safety, wearable device usage, and community support and guidance. These are further broken down into venue facility integrity rate, anti-slip and fall prevention measures, device wearing rate, data upload and monitoring frequency, health lecture participation rate, and professional guidance service coverage rate, ensuring the safety of the exercise process and external support. Psychological and cognitive abilities encompass exercise risk perception, exercise motivation and willingness, and emotional and mental health. These are assessed through indicators such as risk knowledge questionnaire scores, the incidence of pre-exercise risk assessment behaviors, subjective willingness scores, exercise goal setting, depression and anxiety self-assessment scale scores, and perceived social support scores, focusing on the psychological motivation and cognitive levels of elderly exercise. This system has a scientific structure and clear hierarchy, providing comprehensive and precise theoretical basis and practical guidance for identifying risks, implementing graded interventions, and promoting health in elderly physical exercise in Zhaoqing City.

3.2. Establishment of Weighting for Risk Identification Indicators in Elderly Physical Exercise in Zhaoqing City

Using the principles and calculation steps of the layered analysis method, the

weights assigned by experts to the indicators in this study were determined (see Table 4). As shown in the table, the primary indicators and their weight rankings are: physical health status (0.35), exercise behavior characteristics (0.25), environmental and safety (0.20), and psychological and cognitive abilities (0.20); The secondary indicators and their weight rankings are: chronic disease status (0.12), physical fitness foundation (0.1), history of sports injuries (0.07), cardiovascular health (0.06), exercise frequency (0.08), exercise intensity (0.07), exercise method selection (0.05), exercise persistence (0.05), Facility Safety (0.07), Use of Wearable Devices (0.07), Community Support and Guidance (0.06), Exercise Risk Perception (0.08), Exercise Motivation and Willingness (0.07), Emotional and Mental Health (0.05); The tertiary indicators and their weighting order are: hypertension, diabetes, and coronary heart disease diagnosis status (0.02), medication and disease management status (0.02), walking ability test (0.02), balance ability test (0.02), number of exercise-related injuries in the past year (0.01), post-injury recovery status (0.01), heart rate monitoring (0.01), blood pressure measurement (0.01), number of exercise sessions per week (0.01), duration of each exercise session (0.01), heart rate range during exercise (0.01), subjective physical exertion score (0.01), proportion of aerobic exercise participation (0.01), proportion of strength training participation (0.01), Number of consecutive months of exercise (0.01), statistics on reasons for exercise interruptions (0.01), facility integrity rate (0.01), anti-slip and fall prevention measures at the facility (0.01), wearing rate (0.01), data upload and monitoring frequency (0.01), participation rate in community health lectures (0.01), Professional guidance service coverage rate (0.01), Risk knowledge questionnaire score (0.01), Pre-exercise risk assessment behavior incidence rate (0.01), Subjective willingness to participate in exercise score (0.01), Exercise goal setting status (0.01), Depression and anxiety self-assessment scale score (0.01), Perceived social support score (0.01).

Table 4. Overview of the weighting of risk identification indicators for physical exercise among the elderly in Zhaoqing City in this study

Primary indicators	weights	Secondary indicators	weights	Tertiary indicators	weights
Physical health status	0.35	Chronic disease status	0.12	Hypertension, diabetes, and coronary heart disease diagnosis status	0.02
				Medication and disease management status	0.02
		Physical fitness level	0.1	Walking ability test	0.02
				Balance ability test	0.02
		History of sports injuries	0.07	Number of sports injuries in the past year	0.01
				Post-injury recovery status	0.01
		Cardiovascular health	0.06	Heart rate monitoring	0.01
				Blood pressure measurement	0.01
Exercise behavior characteristics	0.25	Exercise frequency	0.08	Number of weekly exercises	0.01
				Duration of each exercise	0.01
		Exercise intensity	0.07	Heart rate range during exercise	0.01
				Subjective physical exertion score	0.01
		Exercise method selection	0.05	Aerobic exercise participation rate	0.01
				Strength training participation rate	0.01
		Exercise consistency	0.05	Number of consecutive months of exercise	0.01
				Statistics on reasons for exercise interruption	0.01
Environment and safety	0.20	Facility safety	0.07	Facility integrity rate	0.01
				Anti-slip and fall prevention measures in facilities	0.01
		Use of wearable devices	0.07	Wear rate	0.01
				Data upload and monitoring frequency	0.01
		Community support	0.06	Participation rate in community health lectures	0.01

		and guidance		Coverage rate of professional guidance services	0.01
Psychological and cognitive abilities	0.20	Exercise risk awareness	0.08	Risk knowledge questionnaire score	0.01
				Incidence of pre-exercise risk assessment behavior	0.01
		Exercise motivation and willingness	0.07	Subjective willingness to participate in exercise	0.01
				Exercise goal setting status	0.01
		Emotional and mental health	0.05	Depression and anxiety self-assessment scale score	0.01
				Perceived social support score	0.01

4. Discussion

This study focuses on the risks associated with physical exercise among the elderly in Zhaoqing City, successfully establishing a risk identification indicator system and determining corresponding weights. This achievement holds significant theoretical and practical implications. From the perspective of indicator system construction, its comprehensiveness and scientific rigor are commendable. The study adhered to the principle of comprehensiveness, employing in-depth qualitative analysis combined with relevant literature and theories to construct a first-level indicator framework across four dimensions: physical health status, exercise behavior characteristics, environmental and safety measures, and psychological and cognitive abilities. Based on this framework, the study further refined 14 (ultimately established 28) second-level indicators and numerous third-level indicators, forming a well-structured, hierarchically organized system. For example, in terms of physical health status, the framework not only covers conventional aspects such as chronic disease conditions and physical fitness foundations but also delves into specific details such as disease diagnosis, medication management, and walking and balance ability tests, comprehensively assessing the elderly population's baseline health levels and potential risks; exercise behavior characteristics quantify the regularity and scientific nature of the elderly population's physical activity patterns from frequency, intensity, mode selection, to sustainability; environmental and safety measures focus on venues, equipment, and community support to provide external safeguards for exercise safety; Psychological and cognitive abilities focus on exercise risk perception, motivation and willingness, as well as emotional and mental health, examining the psychological drivers and cognitive levels of elderly individuals' exercise. This multi-dimensional indicator framework systematically reflects the complex influencing factors of exercise risks among elderly individuals, providing a rich perspective for subsequent research and practice.

Additionally, during the indicator selection process, the Delphi method was used for a secondary screening of the initial indicators, fully considering the principle of operational feasibility in indicator selection. This addressed practical issues such as the excessive number of initial indicators, ensuring that the final established indicator system more accurately reflects objective conditions and enhances the practicality and specificity of the research. The establishment of indicator weights employed the analytic hierarchy process, assigning reasonable weight values to each indicator. Among the first-level indicators, physical health status has the highest weight (0.35), highlighting the central role of baseline health status in risk identification for elderly

physical exercise. After all, the physical functions of the elderly are relatively weak, and factors such as chronic diseases and physical fitness directly impact the safety and feasibility of their exercise. Exercise behavior characteristics have the next highest weight (0.25), indicating that scientifically reasonable exercise behavior is crucial for risk reduction. Environmental and safety measures and psychological and cognitive abilities have the same weight (both 0.20), indicating that these two aspects are equally important in the exercise process for the elderly. A good environment and safety measures, as well as a positive psychological and cognitive state, are important supports for ensuring that the elderly can exercise continuously and safely. The weighting order of secondary and tertiary indicators further refines the relative importance of each factor in risk identification, providing clear guidance for practical application. However, this study also has certain limitations. Although the indicator system is comprehensive, some indicators may be difficult to obtain in practice. For example, some subjective evaluation indicators related to psychological and cognitive abilities may be affected by the accuracy of data due to differences in the elderly's understanding or expression abilities. Additionally, the establishment of weights is based on expert judgment, which has a certain degree of authority, but there may be subtle differences in the views of different experts. In the future, the sample size of experts could be expanded to enhance the scientific rigor and universality of weight determination. Overall, the risk identification indicator system for physical exercise among the elderly in Zhaoqing City and the established weights provided by this study offer comprehensive and precise theoretical basis and practical guidance for this field, aiding relevant departments and institutions in better identifying risks, implementing graded interventions, promoting healthy exercise among the elderly, and improving their quality of life.

5. Conclusion

This study focused on the risks associated with physical exercise among the elderly in Zhaoqing City. Using methods such as the analytic hierarchy process, it constructed a risk identification indicator system for physical exercise that encompasses four dimensions: physical health status, exercise behavior characteristics, environmental and safety safeguards, and psychological and cognitive abilities. The system includes four first-level indicators, 14 second-level indicators, and 28 third-level indicators, and established reasonable weights for each indicator. This system is comprehensive and scientific, providing theoretical basis and practical guidance for identifying risks, implementing graded interventions, and promoting health in elderly physical exercise. However, obtaining data for some indicators poses challenges, and further optimization is possible in the future.

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