

RESEARCH

Open Access



Research on the construction of a Chinese indicator system for college students' multidimensional health

Zhenning Liang^{1,2†}, Chenxi Wang^{1†}, Qingping Zhou^{1†}, Yusupujiang Tuersun¹, Yao Yu¹, Siyuan Liu^{1,3}, Yuying Xie⁴ and Yi Qian^{1*}

Abstract

Background The trends of subhealth and disease in college students are obvious, and overall health is not good. The college years are a critical stage for the formation of self-health management habits and awareness, which have a profound impact on future development. The existing health assessment tools do not accurately reflect students' health status because of vague definitions and inconsistent standards. Therefore, the establishment of a multidimensional health indicator system is very important to cultivate awareness of the self-health management of college students.

Methods An initial version of the Chinese indicator system for college students' multidimensional health was constructed on the basis of a literature review, the brainstorming. method, and focus group. discussion. A Delphi questionnaire was designed, and two rounds of consultation were conducted with 21 experts in the field of college student health. The weights of the indicator system obtained after two rounds of Delphi expert consultation were confirmed via the entropy weighting. method. A questionnaire survey of college students was conducted at a university via the purposive sampling. method to preliminarily validate the indicator system.

Results The recovery rates of the two rounds of Delphi questionnaires were 100%, the expert authority coefficients were 0.85 and 0.86, and the Kendall coefficients were 0.138 and 0.157, respectively ($P < 0.001$). After two rounds of Delphi expert consultation, the Chinese indicator system for college students' multidimensional health ultimately retained 6 dimensions and 60 items, including physical health, mental health, lifestyle, environmental health, moral health, and vocational ability, with weights of 0.149, 0.086, 0.298, 0.173, 0.178 and 0.116, respectively. A total of 366 college students were surveyed, and the Cronbach's alpha coefficient was 0.934.

Conclusion The Chinese indicator system for college students' multidimensional health has a certain degree of scientificity and reliability and can be used as a tool for evaluating the health level of college students. This system can help college students understand their own health status comprehensively, provide a basis for colleges and

[†]Zhenning Liang, Chenxi Wang and Qingping Zhou contributed equally to this work.

*Correspondence:
Yi Qian
qianyi_smu@163.com

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

universities to formulate more scientific and reasonable health education programs, and provide a reference for the government and the community to formulate relevant policies.

Keywords Delphi method, College students, Multidimensional evaluation of health, Indicator system

Introduction

China's educational philosophy is deeply influenced by Confucian culture [1, 2], and college students are under pressure from their parents' expectations and social future careers. Their physical and mental health during their time at school is crucial to their life and learning throughout their university years and may even have a profound impact on their lives [3]. In recent years, the trend of subhealth among college students and the increasing number of diseases associated with a younger age alert us to the urgent need to strengthen the health management of college students [4]. According to research, the physical health of college students has been declining, the incidence of subhealth is high, and the overall level of mental health is not positive [5, 6]. Moreover, the self-health awareness of the college student population is relatively weak, and personal health management needs to be strengthened, so it is necessary to establish a favorable atmosphere for the maintenance of health between the school or unit, peers and individuals [7]. All of the above must be based on comprehensive, whole-process health assessment work for a special group of college students.

In 2016, China issued the "Healthy China 2030 Planning Outline" [8], which clearly pointed out that the core of building a healthy China lies in the improvement of health level and put forward the concept of whole-cycle health management, with the "big health concept" as the center to promote people's health, an overview of a wide range of health influencing factors, and the whole life cycle and all-round maintenance of people's health. On May 20, 2022, the State Council issued the "14th Five-Year Plan" National Health Plan [9], which requires "continuous promotion of the development mode from treatment-centered to people's health-centered, providing the masses with all-round and full-cycle health services, and continuously improving people's health." The health level of college students is an important embodiment of the implementation effect of the Healthy China strategy. As a representative of the younger generation, the health quality of college students is directly related to the overall health level of the country. By engaging in physical exercise, maintaining good eating habits, getting enough sleep and engaging in other healthy lifestyles, college students can improve their physical fitness and resistance and reduce the occurrence of diseases [10]. This not only is conducive to the healthy growth of individuals but also provides strong support for the implementation of the Healthy China strategy [11].

As the concept of health has changed from focusing only on biological aspects to considering multidimensional factors such as psychology and society, the health evaluation index has also changed from a single negative index to a comprehensive positive index system. To monitor development, assess performance, allocate resources and make international comparisons, many international organizations and countries have established a variety of health evaluation systems for population health as important aspects of strategic planning. Among them, the health evaluation index system of college students, an emerging adult group, has attracted much attention from all walks of life in recent years, and the research direction covers physical health, mental health and other aspects; relevant investigations, designs and research are also being carried out [12, 13].

In the early days, many college students' health evaluation scales for psychology and personality, such as the self-rating anxiety scale (SAS) and self-rating depression scale (SDS) compiled by Zung [14], the Eysenck personality questionnaire (EPQ) [15], the Minnesota multiphasic personality inventory (MMPI) [16] and Cattell's sixteen personality factor questionnaire (16PF), were compiled abroad. The University Personality Inventory (UPI) is a group of Japanese university counselors and psychiatrists from the National Association of University Health Care Management; it includes four dimensions, namely, personality characteristics, social skills, self-awareness, and coping skills, and is used by many colleges and universities around the world to screen the mental health status and personality characteristics of college students and graduate students [17]. The multidimensional health locus of control (MHLC) scale has also been used as a representative mental health evaluation scale in recent years. The original health locus of control (HLC) scale was developed by Wallston and others [18], and the criterion for judging health is whether health is determined by behavior. In subsequent studies, scholars refined the scale, eventually forming the Multidimensional Health Psychological Source of Control Scale (MHLC) [19, 20]. Multidimensional health control sources are considered important constructs for understanding and predicting health behaviors [21], and they help us better understand the important role that beliefs play in health behaviors, health outcomes, and health care [22].

In recent years, some cutting-edge research has been carried out abroad, which has further promoted the development of the research field of college students' health evaluation. For the first time in the United States,

the perceived stress scale (PSS) and the generalized anxiety disorder 7 (GAD-7) were introduced into the physical activity intervention process of college students, and they were comprehensively statistically analyzed in terms of exercise intensity and form. A three-dimensional evaluation system was established to simultaneously evaluate the physical and mental health of college students [23]. On the basis of the development framework of the Canadian campus wellbeing survey (CCWS), Faulkner G et al. [24]. formulated a multidimensional evaluation system based on nine indicators, including college students' campus life experience, college students' mental health deficits, college students' health service utilization, college students' physical health and health behaviors, and related content. The multidimensional health evaluation tool for college students was extended to the practical level of systematic promotion.

Researchers have explored the relationships between various influencing factors and the health status of college students from different research perspectives, such as physical health, mental health, social health, moral health, and health literacy, and constructed a unique health evaluation tool for college students.

With the deepening of research and the accumulation of experience, in recent years, some scholars have shifted the focus of research from "single-factor" college students' health evaluation to "multidimensional" college students' health evaluation, with the aim of considering college students' health from a more comprehensive perspective. Among them, the more representative studies are those based on the theory of "three-dimensional health", that is, physical health, mental health, and social adaptability. Luo Jiabing [25] constructed an evaluation model for college students' physical and mental health. Jia Xiuwen et al. [26]. proposed an evaluation index system for college students' physical and mental health. Shang Ningning [27] used a variety of mathematical methods, such as the analytic hierarchy process and dimensionlessness, to construct a three-dimensional health evaluation system. Guo et al. [28]. compiled a 62-item health status assessment form for college students. In addition, Zhang Ruilin et al. [29]. constructed an evaluation index system for graduate students' physical education and health, including physical health, mental health, sports awareness and behavior, motor skills, and social adaptability. Zhu Jianmin et al. [30]. compiled a complete health self-rating scale for college students based on four dimensions: physical exercise, sleep quality, eating habits, and leisure activities. Chen Jing [31] evaluated the subhealth status of college students in four dimensions: physical, psychological, and social discomfort; subhealth; and overall health. Yan Zhenlong et al. [32]. conducted a comprehensive evaluation of college students from four aspects—physical health, mental health, social health,

and moral health—and established a comprehensive evaluation system for college students' health. Quality of life is the result of American economist J. J., a concept developed by K Calbraith to describe and evaluate health. Miao et al. [33] developed a questionnaire on the quality of life of college students (QOLCS-51) on the basis of the relevant concepts of quality of life and the evaluation framework of five dimensions: physical health, mental health, behavioral health, environmental health, and social support health.

A comparison of the structures of various health-related concepts and evaluation scales reveals that the dimension division boundaries of different scholars or different scales are not uniform and that different division methods can form different dimension names, even if the content involved is the same; however, the naming methods are different. Previous studies have carried out many studies in the field of health evaluation [34–36], but at the same time, owing to the vague definitions of related health concepts, different emphases or different research standards, the health evaluation tools developed by scholars have the problem of singleness or incompleteness, which often leads to the fact that the actual health status of college students cannot be well reflected [37]. How to comprehensively, systematically, scientifically and accurately evaluate the health of college students has become a difficult problem for researchers [38]. In this case, the establishment of an indicator system for college students' multidimensional health will have very important guiding significance for cultivating modern college students to develop a good sense of self-health management, analyze and evaluate the health status of college students through multidimensional health evaluation tools, analyze the multifaceted reasons that affect their health, cultivate college students to consciously form healthy behaviors, and enhance their awareness of self-health management.

Methodology

Indicator system design Idea

As people's understanding of health intensifies, so does the definition of health. In the middle of the 18th century, health and disease were understood from a biological perspective, and the development of medicine entered a biomedical mode. In The 1970s, the American medical scientist Engel [39] first proposed that people's understanding of the medical model should be changed from the biomedical model to the biopsychosocial medical model, which includes various factors that affect human health so that people's overall understanding of health has fundamentally changed. In 1947, the World Health Organization (WHO) proposed a new concept of health: "Health is not just the absence of disease or disability, but the complete state of being in good condition

in all aspects of physical, mental and social aspects” and proposed ten criteria, including abundant energy, optimism, and strong adaptability [40]. In addition, owing to the wide scope of health, involving sociology, medicine and other related fields, scholars from various disciplines have also tried to introduce relevant concepts and research methods from different perspectives to understand and evaluate health [41, 42].

In this study, the characteristics and typical indicators of college students are combined with the health definition based on the WHO and the health-related concepts proposed by authoritative experts. Following literature research, brainstorming and the focus group discussion method, the group summarizes and organizes the evaluation dimensions of college students’ health and adopts the Delphi expert consultation method to screen numerous preselected entries used to evaluate college students’ health. On the basis of the results of the two rounds of Delphi expert consultation, the entropy weight method was used to confirm the weights of the indicator system, from which a questionnaire was designed and a survey was conducted at a university through the purposive sampling method as a means of preliminary validation of the indicator system.

The establishment of an indicator system for college students’ multidimensional health is highly important for comprehensively improving the health of college students. This study can help college students gain a comprehensive understanding of their health status and identify and improve existing problems in time. This study can also provide a basis for colleges and universities to formulate more scientific and reasonable health education plans and promote improvements in the health level of college students. This study can also provide a reference for the government and all walks of life to formulate relevant policies and promote the sustainable development of college students’ health.

Overview of the research process

The Delphi expert consultation method consists of back-to-back consultations with panel members through the creation of questionnaires by the investigators [43, 44]. After several consultations, revisions and feedbacks, the expert opinions converge. In the process of constructing the scale item pool, the Delphi expert consultation method is used to screen and determine the items, which can ensure the scientific validity and reliability of the research [45, 46].

Building a pool of evaluation entries

The literature review at home and abroad was conducted via the Southern Medical University Library, CNKI, Wanfang Database, PubMed, the Web of Science database and the internet. The search terms used

were “health evaluation”, “OR”, “health assessment”, “OR”, “health measurement” and “health management”. The relevant literature related to health-related concepts, evaluation dimensions and evaluation scales in the fields of medical and health policies, laws and regulations was included, and the contents were summarized. Students, student administrators and members of the research group are invited to list items that affect the health of college students. College students and experts in the fields of health management, sports, human science and psychology were selected to evaluate the importance of the evaluation items collected by brainstorming. Combined with the results of the two evaluations, the items whose importance scores did not meet the criteria were deleted, and the specific details of the items were repeatedly discussed and adjusted [47].

Design of the questionnaire for inquiry

The questionnaire consists of four parts: (1) introducing the relevant information of the research and completing the examples; (2) providing personal information of the experts; (3) the content of the consultation includes dimensions and items and sets “importance scores”, “modifications, supplements, and deletion of opinions”; and (4) the expert self-assessment form includes the basis for judgment and familiarity with the questionnaire.

Consultation methods

From August to October 2023, the consultation form will be issued to experts through email and WeChat, and the collection time will be within one month from the date of issuance. In this study, two rounds of consultation were conducted, the expert opinion reached a consensus, and the consultation was stopped [48]. Encourage experts to provide comments or suggestions on each indicator, especially when they disagree with the draft indicator or propose additional indicators to be added [49].

In the first round, according to the screening results, an expert preconsultation form was created, and the candidate evaluation items of college students’ health assessment were sent to the selected experts via email or WeChat as the content of the first round of consultation, which explained the purpose of the research and solicited opinions extensively (as shown in supplementary material 1). Second round: According to the feedback of the first round, modify, supplement or delete the entries to form the second round of the expert consultation form, and send it to the experts who reply to the form via email or WeChat (as shown in supplementary material 2).

Metric calculations

The importance of each item is calculated to assign the mean, standard deviation, and maximum score (out of 5). The level of expert motivation is expressed through the

effective recovery rate of the request form. The authority of the expert is determined by two aspects: one is the basis for the expert to judge the importance of each item in the questionnaire, which is expressed by the judgment coefficient (Ca), and the other is the expert's familiarity with the item, which is expressed by the familiarity coefficient (Cs). The authority of the experts is expressed by the authority coefficient (Cr), and the calculation formula is $Cr = (Ca + Cs) / 2$, where $Cr \geq 0.7$ indicates that the authority of the experts is relatively high [50]. The experts assigned quantitative coefficients of 0.9, 0.7, 0.5, 0.3, and 0.1 to five levels of familiarity: very familiar, more familiar, average, less familiar, and very unfamiliar, respectively. Furthermore, they assigned quantitative coefficients of 0.8, 0.6, 0.4, and 0.2 to the theoretical analysis, work experience, understanding of domestic and foreign peers, and intuition, respectively, as the basis for their judgments. The value of the Kendall coordination coefficient W and the coefficient of variation (CV) were used to reflect the degree of coordination of expert opinions. When the value of the Kendall coordination coefficient W is closer to 1, the degree of coordination is better. A $CV < 0.20$ indicates a high degree of acceptance of the indicator [51]. Differences for which $P < 0.05$ were considered statistically significant.

Item filtering criteria

The cutoff value method was used to screen the items, and the full score ratio of each item, the mean and standard deviation of the index importance evaluation score and the coefficient of variation were calculated [52]. The cutoff value of the index importance evaluation score was calculated as follows: cutoff value = mean - standard deviation, and the items with a value greater than the cutoff value were selected. The cutoff value of the coefficient of variation is calculated as follows: cutoff value = mean standard deviation, and the value is less than the cutoff value. If none of the three meet the standard, it will be deleted directly; for one of the items that does not meet the standard, combined with expert opinions, according to the scientific principle of index selection, the research team decides to delete or retain it after full discussion [53].

Weight analysis

The entropy weight method is used to confirm the weight of the indicator system. The entropy weight method can be based on the amount of information to determine the weight of the indicator; the greater the difference is, the smaller the entropy weight value is, and the greater the weight [54].

First, an evaluation matrix with n rows and m columns is constructed, in which (X_{ij}) denotes the data of the jth evaluation index of the ith dimension ($i = 1, 2, 3, \dots, n$; $j = 1, 2, 3, \dots, m$). The calculation formula is as follows:

$$Z_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^n X_{ij}^2}}$$

The information entropy value (E_j) and coefficient of variation (d_j) of each index are then calculated to determine the entropy weight (W_j). The calculation formula is as follows:

$$E_j = -k \sum_{i=1}^n f_{ij} \ln f_{ij}, f_{ij} = \frac{X_{ij}}{\sum_{i=1}^n X_{ij}}, k = \frac{1}{\ln n}$$

$$d_j = 1 - E_j$$

$$W_j = \frac{d_j}{\sum_{j=1}^m d_j}, 0 \leq W_j \leq 1, \text{ and } \sum_{j=1}^m W_j = 1$$

Initial validation of the indicator system

From November to December 2023, the evaluation entries initially screened by the Delphi expert solicitation method were used to design a college student health status questionnaire, and a questionnaire survey of college students was conducted at a university via purposive sampling to conduct preliminary validation of the indicator system [55]. The questionnaire included the students' gender, grade level, and self-assessed health status. The self-assessed health status in the questionnaire corresponds to the question "How do you feel about your own health now?" [56]. There are five levels of "very bad", "bad", "fair", "good" and "very good", with values of 1, 2, 3, 4 and 5, respectively.

Statistical analysis

Excel was used to summarize the questionnaires answered by the experts, and Word was used to categorize the recommendations made by the experts. All the quantitative analyses were conducted via IBM SPSS 23. The results of the entropy weight method were analyzed via Stata 18. Descriptive statistics were analyzed for each item using the mean, standard deviation or coefficient of variation. The reliability and validity of the Delphi method were evaluated by calculating the expert positivity coefficient, authority coefficient, coordination coefficient, and consensus of expert opinions. The reliability of the indicator system was reflected by the Cronbach's alpha coefficient method.

Results

Drafting the evaluation indicator system

A total of 7084 articles were retrieved from the CNKI and PubMed databases. After the exclusion of duplicate studies, studies unrelated to the research in the fields of medical and health policies, laws and regulations, such

as environmental science, and the reading of abstracts to exclude studies that did not match the research content, 259 relevant studies related to health-related concepts, evaluation dimensions and evaluation scales in the fields of medical and health policies and laws and regulations were included, and the contents of health-related concepts, evaluation dimensions and evaluation scales were summarized and sorted (see Fig. 1).

The brainstorming method [57] was used to collect and sort out the factors and items that may affect the health of college students, combined with the results of the literature review and the relevant items in the representative health evaluation scale, eliminate duplicate dimensions

and items [58], and obtain a total of 10 dimensions and 301 items related to physical health, mental health, behavioral health, environmental health, social support health, moral health, emotional health, intellectual health, mental health and occupational health.

On the one hand, students, student administrators and members of the research group evaluate the importance of dimensions and items [59], and the mean value of importance assignment is recorded as "A". On the other hand, 5 experts in the field of health management were selected to evaluate the importance of dimension items, and the mean value of importance assignment was recorded as "B". In the end, the mean value assignment

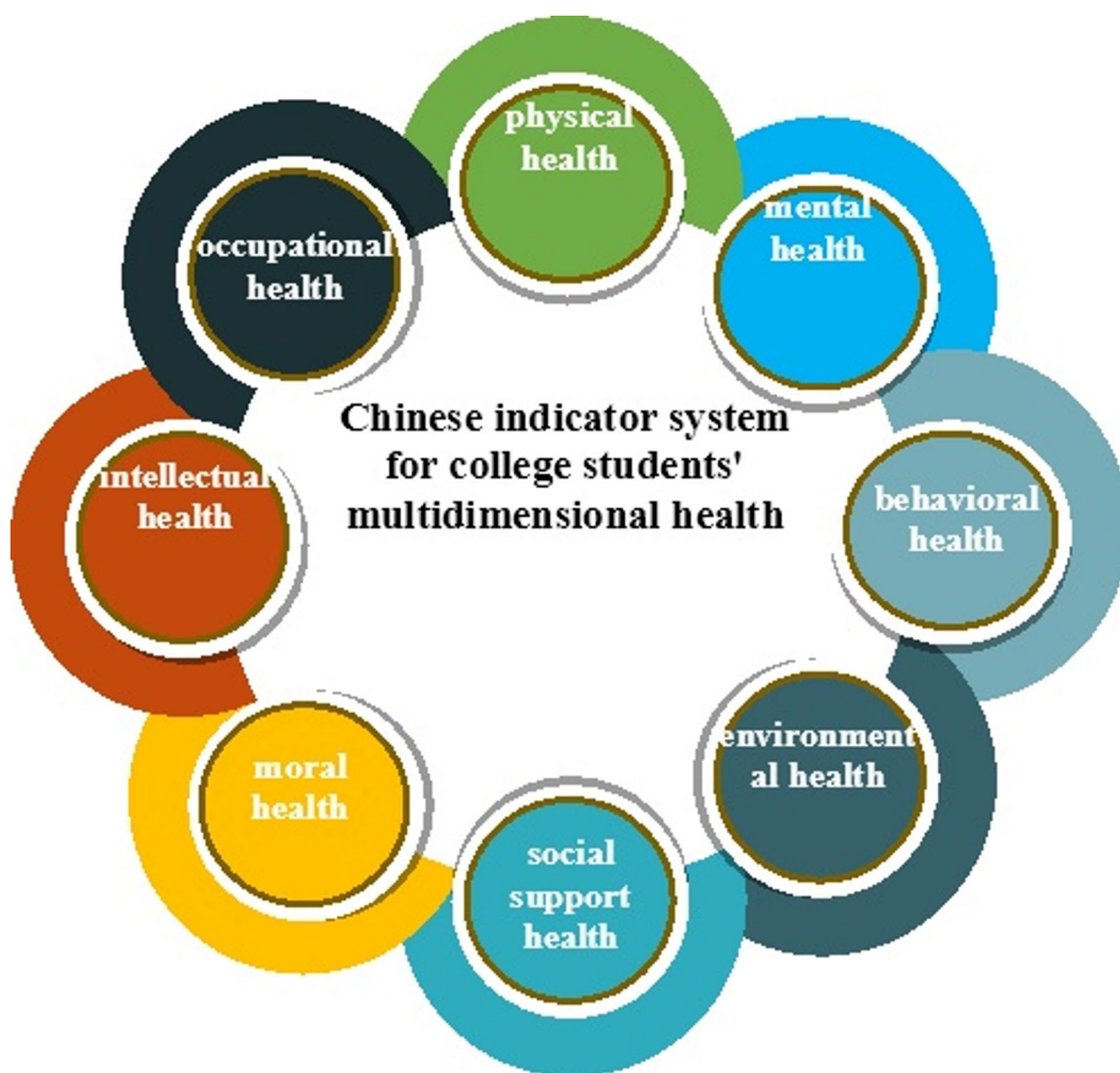


Fig. 1 Literature screening flowchart

for each dimension and item is noted as “C”. $C = (0.4 \times A + 0.6 \times B) / 2$ (0.6 and 0.4 are the weights of expert and student status), and a dimension and item with “C” greater than 3 are selected [60, 61]. Combining the discussion results with health-related theories, a Chinese indicator system for college students’ multidimensional health consisting of 8 dimensions and 126 items related to physical health, mental health, behavioral health, environmental health, social support health, moral health, intellectual health and occupational health was preliminarily constructed (see Fig. 2).

Basic information on the experts involved in the Delphi method of expert advice

This study involved two rounds of expert consultation. In the first round, 21 experts from seven academic fields, including medical education management, social medicine, sports human science, psychology, health policy, public administration, and health management, were invited. These experts came from 15 research institutions

spread across six provinces and municipalities. Among the 21 experts, 13 held doctoral degrees (61.90%), 4 held master’s degrees (19.05%), and 4 held bachelor’s degrees (19.05%). Eighteen experts had senior professional titles, whereas three had associate senior professional titles. The average years of work experience were 29.33 years. In the second round of expert consultation, questionnaires were sent to 21 of the experts from the first round (Table 1).

Reliability of the two rounds of Delphi consultation

The expert motivation coefficient is the recovery rate of the questionnaire, and if the recovery rate exceeds 70%, the expert motivation is high [62]. In both rounds, 21 questionnaires were distributed, and 21 were recovered, with an effective recovery rate of 100%, indicating that the experts were highly motivated. In addition, all the complete questionnaires collected were considered valid for subsequent analysis. The mean coefficients of authority (Cr) of the two rounds of consultation were 0.85 and

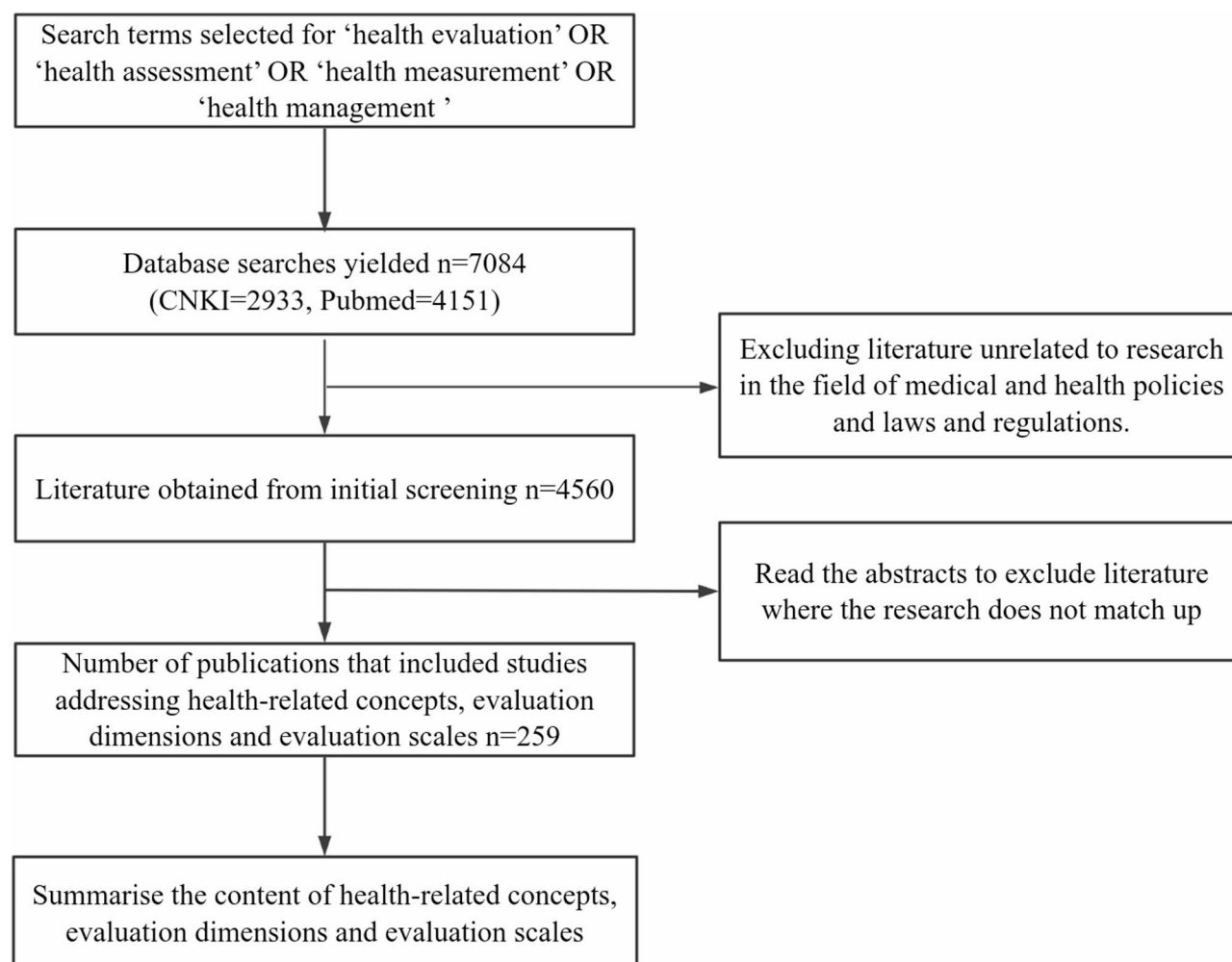


Fig. 2 Initial construction of the Chinese indicator system for college students’ multidimensional health

Table 1 Characteristics of consulting experts via the Delphi method [n (%)]

Characteristics	Round 1 and Round 2
Educational background	
Bachelor degree	4(19.05%)
Master degree	4(19.05%)
Doctor degree	13(61.90%)
Age	
40~	7(33.33%)
50~	5(23.81%)
60~	9(42.86%)
Working years	
10–19 years	1(4.77%)
20–29 years	7(33.33%)
30–39 years	7(33.33%)
≥ 40 years	6(28.57%)
Professional title level	
Senior	18(85.71%)
Vice-senior	3(14.29%)
Total	21(100.00%)

0.86, respectively, indicating that the experts had a high degree of authority over the consultation items and that the consultation results were reliable (see Table 2). The value of the Kendall coordination coefficient W and the coefficient of variation (CV) were used to reflect the degree of coordination of expert opinions. The coordination coefficient calculated in this study did not score high, with the Kendall coordination coefficient W values of 0.138 and 0.157 in the two rounds of expert consultation. As experts come from units with different types of work, there may be differences in the importance attached to some indicators, which may lead to changes in the results of the assessment. However, after the second round of coordination, the coefficient has improved compared with that of the first round, which reflects the continuous improvement of the indicator system and the enhancement of consensus among experts [63, 64]. The chi-square test was statistically significant ($P < 0.001$), and the coefficient of variation of the importance score of the items was 0.11 ~ 0.19, indicating that the degree of

collaboration between experts for the whole evaluation item pool tended to be consistent (see Table 2).

Revision of the draft indicator system after the first round of Delphi consultation

The cutoff value method was used to screen the items; the average importance score of all the items was 3.33 ~ 4.91, and the average score was 4.30. According to the inclusion criteria of the cutoff method (see Table 3), combined with expert opinions, the following adjustments were made to the level 1 indicators: “Intellectual Health” was deleted, “Behavioral Health” was replaced by ‘Lifestyle’, “Occupational Health” was replaced by “Vocational Competence”, “Environmental health” and “Social support health” were merged into “Environmental health”. For the secondary indicators, 37 entries were deleted, and 15 new entries were added, resulting in 6 dimensions and 82 entries, as detailed in Supplementary Material 1.

Further revisions after the second round of Delphi consultation

The mean importance score of all the items ranged from 3.43 ~ 4.86, and the average score was 4.21. According to the inclusion criteria of the cutoff value method, combined with the actual situation of the expert opinion topic, the collective evaluation and discussion of the research group formed a revised opinion. In the first level of indicators, the term “vocational competencies” has been replaced by “professional ability”; in the second level of indicators, 22 entries have been deleted. An indicator system containing 6 dimensions (physical health, mental health, lifestyle, environmental health, moral health and professional ability) and 60 items (see Table 4) has been obtained.

Construction of a Chinese indicator system for college students’ multidimensional health

Applicable objects and the filling method

This scale is applicable to current college students. The scale is a self-assessment scale that is to be completed by the test subjects themselves. When testing, it should be noted that the evaluation time of the scale is the past

Table 2 Expert authority level and expert opinion coordination coefficient of the two-round expert consultation questionnaire

Consultation rounds	Ca	Cs	Cr	Number of entries	Kendall’s ω	χ^2	P
Round 1	0.90	0.80	0.85	126	0.138	361.038	<0.001
Round 2	0.96	0.77	0.86	82	0.157	287.136	<0.001

Table 3 Table of cutoff values

Consultation	Hierarchical level	Mean importance score	Full marks ratio	Coefficient of Variation
Round 1	First-level	3.85	0.23	0.23
	Second-level	3.67	0.23	0.26
Round 2	First-level	4.08	0.28	0.16
	Second-level	3.97	0.26	0.20

Table 4 Dimensionality and item composition of the Chinese indicator system for college students' multidimensional health

dimension	entry	Importance score	Coef-ficient of Variation	Full score ratio	Infor-mation entropy	Weight	Port-folio weights
physical health		4.86 ± 0.36	0.08	0.86	0.953	0.149	/
	1. You often feel unwell, including pain, that prevents you from doing what you need to do.	4.52 ± 0.60	0.13	0.57	0.963	0.070	0.010
	2. You often feel tired, tired, or visibly unwell.	4.67 ± 0.48	0.11	0.67	0.905	0.180	0.027
	3. You will experience shortness of breath and chest tightness after moderate (sweaty) exercise.	4.48 ± 0.51	0.11	0.48	0.853	0.279	0.042
	4. When you are quiet, you will feel palpitations and palpitations.	4.57 ± 0.68	0.15	0.67	0.956	0.084	0.012
	5. You often have diarrhea, abdominal pain, or a change in bowel habits (toilet time, frequency, shape, etc.).	4.10 ± 0.77	0.17	0.33	0.923	0.147	0.022
	6. Your weight has changed a lot in the past month (the degree of change has attracted the attention of others, and the weight has changed by more than 10% of your original weight).	4.38 ± 0.74	0.16	0.52	0.943	0.108	0.016
	7. You have a lot of energy.	4.24 ± 0.83	0.18	0.43	0.965	0.066	0.010
	8. How do you feel about your overall physical health compared to your peers/classmates?	4.33 ± 0.86	0.19	0.52	0.965	0.066	0.010
mental health		4.86 ± 0.48	0.10	0.91	0.973	0.086	/
	1. You are easily anxious and upset.	4.57 ± 0.60	0.13	0.62	0.964	0.041	0.004
	2. You are often mentally stressed and have a hard time relaxing.	4.43 ± 0.68	0.15	0.52	0.953	0.054	0.005
	3. You can handle or control your emotions.	4.33 ± 0.66	0.14	0.43	0.952	0.055	0.005
	4. You will suffer from frequent insomnia.	4.48 ± 0.60	0.13	0.52	0.962	0.043	0.004
	5. Do you lose control over doing certain things repeatedly, such as constantly checking that the door is closed, washing your hands or counting constantly, etc.	4.19 ± 0.75	0.16	0.38	0.932	0.077	0.007
	6. You feel like very few people understand you.	4.24 ± 0.83	0.18	0.48	0.922	0.089	0.008
	7. When you're feeling down, you can find ways to help you relax.	4.52 ± 0.51	0.11	0.52	0.866	0.153	0.013
	8. In your daily life, you will feel sullen and depressed.	4.24 ± 0.83	0.18	0.48	0.922	0.089	0.008
	9. You feel that your daily life is meaningful.	4.24 ± 0.77	0.17	0.43	0.932	0.077	0.007
	10. You tend to concentrate on one thing.	4.29 ± 0.85	0.18	0.52	0.923	0.088	0.008
	11. Do you often feel powerless and helpless, that is, you want to make changes but feel unmotivated?	4.24 ± 0.70	0.15	0.38	0.942	0.066	0.006
	12. Do you express your feelings in a way that does not hurt others (e.g., I can express anger instead of anger).	4.05 ± 0.80	0.18	0.33	0.912	0.101	0.009
	13. How do you think your current level of mental health is compared to your peers (classmates)?	4.33 ± 0.73	0.16	0.48	0.943	0.066	0.006
lifestyle		4.67 ± 0.48	0.11	0.67	0.905	0.298	/
	1. You regularly smoke or use tobacco substitutes (≥ 1 cigarette per day or passive smoking > 15 min/day, > 1 day/week).	4.52 ± 0.68	0.15	0.62	0.955	0.077	0.023
	2. You often drink too much alcohol (drunk) (drink > 2 taels of liquor per day, pure alcohol > 40 g/day).	4.38 ± 0.67	0.15	0.48	0.952	0.081	0.024
	3. You will do more than 30 min of vigorous (sweaty) exercise (excluding warm-up time) at least three days a week.	4.76 ± 0.54	0.12	0.81	0.969	0.052	0.016
	4. You have your own methods (such as games, entertainment, or meditation, etc.) to destress.	4.33 ± 0.58	0.13	0.38	0.961	0.065	0.019
	5. You will stick to a regular healthy routine.	4.57 ± 0.60	0.13	0.62	0.964	0.061	0.018
	6. You will drink 1500–1700 ml of water every day (approximately 8 cups in a typical paper cup).	4.38 ± 0.74	0.16	0.52	0.943	0.096	0.029
	7. When you feel unwell, you can seek medical advice in time.	4.24 ± 0.62	0.14	0.33	0.952	0.081	0.024
	8. After seeking medical treatment, you will follow the doctor's instructions and cooperate with the treatment.	4.38 ± 0.67	0.15	0.48	0.952	0.081	0.024
	9. When buying food, you pay attention to the ingredient list of food labels.	4.10 ± 0.77	0.18	0.33	0.923	0.131	0.039
	10. You will eat breakfast every day.	4.33 ± 0.73	0.16	0.48	0.943	0.097	0.029
	11. When your health is threatened, you set the right goals and take certain steps to improve your health.	4.19 ± 0.68	0.15	0.33	0.943	0.097	0.029

Table 4 (continued)

dimension	entry	Importance score	Coef-ficient of Variation	Full score ratio	Infor-mation entropy	Weight	Port-folio weights
environmental health	12. How do you think your current level of lifestyle health compares to your peers (classmates)?	4.38 ± 0.67	0.15	0.48	0.952	0.081	0.024
		4.10 ± 0.62	0.14	0.24	0.945	0.173	/
	1. You are satisfied with the learning conditions on campus (hardware facilities, faculty).	4.24 ± 0.94	0.19	0.52	0.960	0.057	0.010
	2. You are satisfied with the environment of your current place of residence (the city and region where the campus is located).	4.00 ± 0.95	0.18	0.38	0.956	0.062	0.011
	3. You are satisfied with your current dormitory facilities.	4.19 ± 0.81	0.18	0.43	0.922	0.110	0.019
	4. You find it difficult to maintain good interpersonal relationships.	4.43 ± 0.68	0.15	0.52	0.953	0.066	0.011
	5. Do you think it is important to maintain good interpersonal communication?	4.24 ± 0.70	0.15	0.38	0.942	0.081	0.014
	6. You will take the initiative to keep in touch with your family.	4.38 ± 0.80	0.18	0.57	0.934	0.093	0.016
	7. You will be able to adapt to your new living and learning environment quickly.	4.38 ± 0.59	0.13	0.43	0.961	0.054	0.009
	8. When you have troubles, you confide them in your family and friends.	4.38 ± 0.74	0.16	0.52	0.943	0.080	0.014
	9. You enjoy participating in school or small-scale group activities.	4.48 ± 0.51	0.11	0.48	0.853	0.208	0.036
moral health	10. You believe that the current online environment has an impact on your health.	4.10 ± 0.70	0.15	0.29	0.934	0.093	0.016
	11. How do you think your current level of environmental health compared to your peers (classmates)?	4.19 ± 0.75	0.16	0.38	0.932	0.095	0.016
		4.38 ± 0.74	0.16	0.52	0.943	0.178	/
	1. You are aware of the public environment (classrooms, libraries, laboratories, etc.) and the natural environment.	4.43 ± 0.68	0.15	0.52	0.953	0.102	0.018
	2. You can insist on abiding by the relevant rules and regulations of the school.	4.19 ± 0.98	0.18	0.43	0.970	0.065	0.012
	3. You can insist on being strict with yourself.	4.14 ± 0.79	0.17	0.38	0.922	0.169	0.030
	4. You will always pursue your own interests on the premise of obeying the social order.	4.33 ± 0.73	0.16	0.48	0.943	0.125	0.022
	5. You can insist on doing what you say and what you know and doing.	4.05 ± 0.80	0.18	0.33	0.912	0.191	0.034
	6. You will help students who have personal shortcomings and are not satisfied with their studies.	4.10 ± 0.62	0.14	0.29	0.945	0.120	0.021
	7. You will often miss the people who helped you in your new environment.	4.19 ± 0.68	0.15	0.33	0.943	0.124	0.022
	8. How do you think your level of moral health compares to your peers (classmates)?	4.29 ± 0.64	0.14	0.38	0.952	0.104	0.019
professional ability		4.00 ± 0.80	0.18	0.24	0.963	0.116	/
	1. You are confident in your ability to learn.	4.52 ± 0.60	0.13	0.57	0.963	0.073	0.009
	2. You are confident in your ability to innovate.	4.05 ± 0.92	0.20	0.38	0.935	0.128	0.015
	3. You are confident in your communication skills.	4.19 ± 1.00	0.20	0.38	0.932	0.133	0.016
	4. You are satisfied with your performance once you enter the university.	4.40 ± 1.02	0.18	0.38	0.922	0.154	0.018
	5. You will strive to make yourself a person with strong overall qualities.	4.19 ± 0.94	0.19	0.33	0.943	0.113	0.013
	6. You are aware of how your strengths and weaknesses relate to your career choice.	4.19 ± 1.04	0.19	0.43	0.922	0.154	0.018
	7. You are willing to do a good job of organization and coordination while completing team tasks.	4.10 ± 0.95	0.18	0.29	0.934	0.131	0.015
	8. How do you think your level of professional competence compares to your peers (classmates)?	4.29 ± 0.98	0.18	0.43	0.942	0.114	0.013

month, and the scale should be filled out according to the actual situation of one's own health in the previous month; the meaning of the entries should be understood accurately, and the expression of the reverse scoring entries should be clarified. When questionnaires are collected, it should be ensured that the test subjects have completed the questionnaires as much as possible, and if they have not done so, they should be asked for reasons and asked to complete the questionnaires as much as possible.

Determination of weights

The indicator system uses the entropy weight method to confirm the weights. The weights of the six dimensions of physical health, mental health, lifestyle, environmental health, moral health and professional ability were 0.149, 0.086, 0.298, 0.173, 0.178 and 0.116, respectively. The results of the information entropy, weights and combination weights for each dimension and indicator are detailed in Table 4.

Scoring method

The Chinese indicator system for college students' multidimensional health contains 6 dimensions and 60 entries, and each entry uses a five-point Likert scale (1 = not in line with, 5 = very much in line with), in which the test subjects score according to the degree of conformity between the expressions of the entries and their own health conditions in the recent month, and 15 entries need to be reverse scored. The total score of the scale is calculated by adding the scores of each entry according to the weights, and the total score ranges from 20 to 100; the higher the score is, the better the multidimensional evaluation of college students' health.

Initial validation of the indicator system

A total of 400 questionnaires were distributed, and 384 were recovered, for a recovery rate of 96.00%. After the questionnaires that were judged to be unqualified or unfinished were discarded, 366 valid questionnaires were obtained, and the validity rate of the questionnaires was 95.31%. Among them, 123 are male college students, accounting for 33.61%, and 243 are female college students, accounting for 66.39%; 166 are below the third grade, accounting for 45.36%; and 200 are above the third grade (including the third grade), accounting for 54.64%.

The evaluation scores of college students' multidimensional health were calculated on the basis of the weights, and the average score was 73.24 ± 9.03 . The Pearson correlation coefficient between the evaluation scores of college students' multidimensional health and their self-assessed health status was calculated, and the results revealed that the Pearson correlation coefficient was 0.467 ($P < 0.001$), which can be regarded as a positive

correlation between the evaluation scores of college students' multidimensional health and their self-assessed health status. The Cronbach's alpha coefficient for this survey was 0.934.

Discussion

This study used the Delphi method to construct a Chinese indicator system for college students' multidimensional health. The system includes 6 level 1 indicators and 60 entries on physical health, mental health, lifestyle, environmental health, moral health and professional competence. In previous studies, explorations of college students' health evaluation tools have tended to focus on one particular aspect of health, which has led to limitations in the research and the inability to reflect the health status of the college student population in a comprehensive and multidimensional way. Therefore, it is particularly necessary to construct an indicator system for college students' multidimensional health. Through such a system, we can perform a more detailed and comprehensive analysis of the health status of college students. On the basis of these evaluation dimensions, we can provide a theoretical basis for behavioral change and then help college students consciously cultivate and maintain healthy habits and enhance their awareness of self-health management. This is highly important for the cultivation of physically, mentally and psychologically healthy and positive modern college students, which will help them become useful talents in society.

The Chinese indicator system for college students' multidimensional health constructed in this study is reliable, scientific and reasonable. First, the theoretical basis for the construction of the indicator framework is reliable. The first draft of the indicator system was developed after an extensive literature review, brainstorming and focus group discussion methods and a series of seminars were conducted. Relevant panelists were screened on the basis of specific characteristics such as age, field of expertise, title, and years of experience in the field. These panellists are influential and representative of the fields of medical teaching management, social medicine, sports and human sciences, psychology, health policy, public administration, health management, etc. The modifications proposed by the panellists were carefully considered and integrated to ensure that the constructed evaluation system is more scientific and reasonable. Second, the study shows that the Delphi method is appropriate for selecting 15 to 50 experts and that two rounds of expert consultation are generally sufficient to obtain more reliable results [65]. The authority coefficients of the expert panel members (0.85 and 0.86, respectively) and the questionnaire response rate (100%) were within the acceptable range, and the expert coordination coefficient for each entry reached 0.157 after two rounds of solicitation, $P < 0.001$,

which indicated that the results of the synergistic degree of the expert's opinion were credible. Third, the evaluation index system takes the multidimensional evaluation index system of college students' health as a whole, treats each level of dimension and its subordinate items as a subsystem, reflects the connection between each dimension and health by means of empowerment, and the indicators of each level are interdependent, interconnected, subject to each other, and fully considers the influence of the environment on the health of college students to evaluate college students' health comprehensively, which is both comprehensive and systematic. It is comprehensive and systematic. In addition, the index system considers the characteristics of the college student group and typical indicators and fully considers the influence of physical condition, the external environment and personal ability on health to expand and deepen the evaluation dimensions of college students' health and effectively evaluate the health status of college students.

Our study has several strengths. First, although there are numerous studies on college students' health, fewer studies have comprehensively and accurately evaluated college students' health in multiple dimensions [66, 67]. The characteristics of college students are prominent, with dependence and independence coexisting, individuality and submissiveness coexisting, and stability and conflict depending on each other, which makes them difficult to investigate. The establishment and application of a scientific and effective indicator system will undoubtedly provide the necessary technical means to better guarantee the health level of college students. Therefore, the Chinese indicator system for college students' multidimensional health constructed in this study fills the gaps in research related to the multidimensional evaluation of college students' health to a certain extent, which is innovative and significant. Second, the term 'multidimensional health assessment' refers to multidimensional analyses and management advice on health, while multidimensional assessment tools have previously been used in the management of geriatric health [68–73]. Focusing on college students, this study combines the close relationship between the multiple health factors affecting college students and the context of the Healthy China Strategy, thus overcoming the limitations of the traditional single-dimensional study of physical health and mental health. This project will integrate health assessment resources and combine online and offline research methods to achieve the goal that college students can develop a positive sense of self-care through self-assessment of health management, which will provide a reference for subsequent health management practices. Third, the Delphi method is an appropriate method for constructing a Chinese indicator system for college students' multidimensional health. As a mature prediction

method, the Delphi method plays an important role in various decision-making activities [74]. In this study, the classical Delphi method was used as the main method of indicator construction, which ensures the scientific validity and reliability of the study and expands the application of the Delphi method in the fields of medicine and health. In addition, this study integrates the importance, operability and sensitivity of the entries, demonstrating the multidimensionality and relevance of the indicator system.

The limitations of this study mainly lie in the inherent problems of purposeful selection of expert enquirers and nonresponse bias in the Delphi method [75]. However, in general, the Chinese indicator system for college students' multidimensional health constructed in this study on the basis of scientific process and methodology is practical and scientific, which can be used to evaluate the health level of college students from multiple dimensions and provide a reliable tool for related research on college students' health. In subsequent research, the Chinese indicator system for college students' multidimensional health will be further revised and improved by using empirical survey data to ensure scientific validity and rationality.

Conclusion

On the basis of the Delphi method of scientific design, a Chinese indicator system for college students' multidimensional health has been established, which can be used as a tool for evaluating the health level of college students. The indicator system provides specific, objective and quantitative standards for evaluation. This study will help college students understand their health status comprehensively and discover and improve existing problems in time; it can also provide a basis for colleges and universities to formulate more scientific and reasonable health education programs and promote improvements in college students' health levels; and it can also provide a reference for the government and all sectors of society to formulate relevant policies and promote the sustainable development of college students' health.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-24294-8>.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Acknowledgements

We are grateful to the participants and experts in this survey who made this study possible.

Authors' contributions

Yi Qian, Zhenning Liang, and Chenxi Wang designed the study. Zhenning Liang, Chenxi Wang, and Qingping Zhou checked the data quality and performed the statistical analysis. Qingping Zhou, Yusupujiang-Tuersun, Yao Yu, and Siyuan Liu managed and checked all the data. Yi Qian, Zhenning Liang, Chenxi Wang, Qingping Zhou, and Yuying Xie participated in drafting, editing, reviewing, and revising the manuscript. All authors read, revised, and approved the final manuscript.

Funding

The research is supported by the National Social Science Foundation project of China (project number 21BGL301), entitled "A Multidimensional Evaluation of College Students' Health and the Development of an Evidence-Based Intervention Model in the Context of the Healthy China Strategy".

Data availability

The data that support the fundings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

All procedures performed in the study involving human participants were in accordance with the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards. The survey was approved by the Southern Medical University Ethics Review Board (2023) No. 46. Before the start of the survey, the participants and their guardians provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹School of Health Management, Southern Medical University, No.1023, Shatai South Road, Guangzhou 510515, Guangdong, China

²Department of Education, The Seventh Affiliated Hospital, Sun Yat-sen University, Shenzhen, China

³School of Public Health, Southern Medical University, Guangzhou, China

⁴Shenzhen Longhua District Maternity and Child Health Hospital, Shenzhen, China

Received: 28 April 2025 / Accepted: 5 August 2025

Published online: 06 October 2025

References

- Shek DT, Yu L, Fu X. Confucian virtues and Chinese adolescent development: a conceptual review. *Int J Adolesc Med Health*. 2013;25(4):335–44.
- Cheng SK. Understanding the culture and behaviour of East Asians—a Confucian perspective. *Aust N Z J Psychiatry*. 1990;24(4):510–5.
- Chen YC. Chinese values, health and nursing. *J Adv Nurs*. 2001;36(2):270–3.
- Wang S, Niu Z, Xiong J, Chai G, Ye X. The relationship between physical activity and psychological sub-health among high altitude region Tibetan college students. *Front Psychol*. 2024;15: 1465845.
- Hou H, Feng X, Li Y, Meng Z, Guo D, Wang F, Guo Z, Zheng Y, Peng Z, Zhang W, et al. Suboptimal health status and psychological symptoms among Chinese college students: a perspective of predictive, preventive and personalised health. *EPMA J*. 2018;9(4):367–77.
- Liang J, Zhang X, Wang Y. The relationship between mindfulness and suboptimal health status: a chain/serial mediation model. *Front Psychol*. 2024;15: 1354975.
- Chang J, Yuan Y, Wang D. [Mental health status and its influencing factors among college students during the epidemic of COVID-19]. *Nan Fang Yi Ke Da Xue Xue Bao*. 2020;40(2):171–6.
- The. Healthy China 2030 Plan Outline.
- The State Council has issued the. 14th Five-Year Plan for National Health.
- Zhang D, Zhan W, Zheng C, Zhang J, Huang A, Hu S, Ba-Thein W. Online health information-seeking behaviors and skills of Chinese college students. *BMC Public Health*. 2021;21(1).
- Liu Y, Zhai X, Zhang Y, Jiang C, Zeng J, Yang M, Xie X, Zhou F, Xiang B. The promoting effect of exercise motivation on physical fitness in college students: a mediation effect model. *BMC Public Health*. 2023;23(1):2244.
- Fang L. Construction of Physical Education Quality Evaluation Index and Analysis with Wearable Device. *COMPUT INTEL NEUROSC* 2022. 2022;2022:1190394.
- Lattie E, Cohen KA, Winquist N, Mohr DC. Examining an app-based mental health self-care program, Intellicare for college students: single-arm pilot study. *JMIR Ment Health*. 2020;7(10): e21075.
- Wang S, Li H, Chen X, Yan N, Wen D. The mediating role of psychological capital in the association between life satisfaction and depressive and anxiety symptoms among Chinese medical students during the COVID-19 pandemic: a cross-sectional study. *BMC Psychiatry*. 2023;23(1): 398.
- Sato T. The Eysenck personality questionnaire brief version: factor structure and reliability. *J Psychol*. 2005;139(6):545–52.
- Derogatis LR, Rickels K, Rock AF. The SCL-90 and the MMPI: a step in the validation of a new self-report scale. *Br J Psychiatry*. 1976;128:280–9.
- Sugawara N, Yasui-Furukori N, Sayama M, Shimoda K. Factor structure of the university personality inventory in Japanese medical students. *BMC PSYCHOL*. 2020;8(1): 103.
- Wallston KA, Wallston BS, DeVellis R. Development of the multidimensional health locus of control (MHLC) scales. *Health Educ Monogr*. 1978;6(2):160–70.
- Wallston KA, Stein MJ, Smith CA. Form c of the MHLC scales: a condition-specific measure of locus of control. *J Pers Assess*. 1994;63(3):534–53.
- Rodríguez-Rosero JE, Ferriani M, Dela CM. [Multidimensional health locus of control scale -- MHLC: validation study]. *REV LAT-AM ENFERM*. 2002;10(2):179–84.
- Sayar SE, Capik C. The effect of health belief model-based creative drama education on health locus of control and smoking perception in adolescents: a randomized controlled trial. *Public Health Nurs*. 2025. <https://doi.org/10.1111/phn.13550>.
- Gacek M, Wojtowicz A, Banasik M. Selected determinants of diet health quality among female athletes practising team sports. *Nutrients*. 2024. <https://doi.org/10.3390/nu16193294>.
- Kosugi T, Ninomiya A, Nagaoka M, Hashimoto Z, Sawada K, Park S, Fujisawa D, Mimura M, Sado M. Effectiveness of Mindfulness-Based cognitive therapy for improving subjective and Eudaimonic Well-Being in healthy individuals: A randomized controlled trial. *FRONT PSYCHOL*. 2021;12:700916.
- Faulkner G, Ramanathan S, Kwan M. Developing a coordinated Canadian post-secondary surveillance system: a Delphi survey to identify measurement priorities for the Canadian campus wellbeing survey (CCWS). *BMC Public Health*. 2019;19(1): 935.
- Luo J. Three-dimensional health standards were used to comprehensively evaluate the physical and mental health of college students. *J Wuhan Sports Univ* 2004.
- Jia X, Jia W. Research into the Index System of College Students' Physical and Psychological Health Quality in Shanxi Province. *J of Beijing Sport Univ* 2007(1).
- Shang N. A theoretical study on the development of exercise prescription for general college students based on the concept of three-dimensional health; 2008.
- Guo Y, Ni H, Fang S, Xu L, He Y. A screening study on the items in the college student health status assessment form. *Chin J Health Stat* 2014;31(4).
- Zhang R, Shao G. Sports and health evaluate guide lines of graduate students and its computer sustain system. *J of Shandong Sport Univ* 2005(6).
- Zhu J, Ju W. The Test of Self-Evaluation Scale of College Students and Their Life Style. *Chin Sport Sci* 2008(5).
- Chen J. The compilation of sub-health self-rating scale and the study of sub-health TCM constitution of college students; 2010.
- Yan Z, Lu T, Chen S, Wang Y. Research on comprehensive evaluation system of college students health. *J Xi'an Jiaotong Univ(Soc Sci)* 2012;32(6).
- Miao C, Liu S, Huang X. Development of special scales for the evaluation of college students' quality of life. *Chin J School Health* 2014;35(6).
- Haraldstad K, Wahl A, Andenaes R, Andersen JR, Andersen MH, Beisland E, Borge CR, Engebretsen E, Eismann M, Halvorsrud L, et al. A systematic review of quality of life research in medicine and health sciences. *Qual Life Res*. 2019;28(10):2641–50.
- Fumicelli L, Mazzo A, Martins J, Mendes I. Quality of life and ethics: a concept analysis. *Nurs Ethics*. 2019;26(1):61–70.
- Panzini RG, Mosquero BP, Zimpel RR, Bandeira DR, Rocha NS, Fleck MP. Quality-of-life and spirituality. *Int Rev Psychiatry*. 2017;29(3):263–82.

37. El AW, Labeeb S, Moseley L, Kotb S, El-Houfy A. Physical and psychological well-being of university students: survey of eleven faculties in Egypt. *Int J Prev Med*. 2013;4(3):293–310.
38. Hobart J, Cano S. Improving the evaluation of therapeutic interventions in multiple sclerosis: the role of new psychometric methods. *Health Technol Assess*. 2009;13(12):1–177.
39. Engel GL. The need for a new medical model: a challenge for biomedicine. *Science*. 1977;196(4286):129–36.
40. CONSTITUTION of the World Health Organization. *Chron World Health Organ*. 1947;1(1–2):29–43.
41. Bachrach CA, Abeles RP. Social science and health research: growth at the National Institutes of Health. *Am J Public Health*. 2004;94(1):22–8.
42. Kaminskas R, Darulis Z. Peculiarities of medical sociology: application of social theories in analyzing health and medicine. *Medicina-Lithuania*. 2007;43(2):110–7.
43. Jorm AF. Using the delphi expert consensus method in mental health research. *Aust N Z J Psychiatry*. 2015;49(10):887–97.
44. Zhao M, Cheng Z, Chen Z, Wang Q, Liu J. Construction of a performance evaluation index system for the management of chronic diseases based on medical and preventive integration. *BMC Public Health*. 2025;25(1):664.
45. Dong Z, Zhang Y, Qi J, Wu X, Wang Z, Zhang L, Ma X. Construction of Nursing-Sensitive quality indicators for spine surgery under the concept of enhanced recovery after surgery. *J ADV NURS*. 2025.
46. Kraaijkamp J, Persoon A, Chavannes NH, Achterberg WP, Choukou MA, Dockery F, Kim H, Perez LM, Pompeu JE, Topinkova E, et al. Ehealth in geriatric rehabilitation: an international consensus study. *Eur Geriatr Med*. 2025. <https://doi.org/10.1007/s41999-025-01170-7>.
47. Sawan MJ, Gench M, Bond C, Jeon YH, Hilmer SN, Chen TF, Gjnjidic D. Development of a tool to evaluate medication management guidance provided to carers of people living with dementia at hospital discharge: a mixed methods study. *BMJ Open*. 2022;12(5):e58237.
48. Ye J, Li Y, Yang L. Development and validation of the Chinese version of the adult sedentary behavior reduction intention questionnaire based on the theory of planned behavior. *BMC Public Health*. 2025;25(1):1093.
49. Liu M, Yu Q, Liu Y. Developing quality indicators for cancer hospitals in China: a national modified Delphi process. *BMJ Open*. 2024;14(4):e82930.
50. Dima AL, Nabergoj MU, Ribaut J, Hauptenthal F, Barnestein-Fonseca P, Goetzing C, Grant S, Jacome C, Smits D, Tadic I, et al. Stakeholder consensus on an interdisciplinary terminology to enable the development and uptake of medication adherence technologies across health systems: Web-Based Real-Time Delphi study. *J MED INTERNET RES*. 2025;27:e59738.
51. Busetto L. Great expectations: the implementation of integrated care and its contribution to improved outcomes for people with chronic conditions. *Int J Integr Care*. 2016;16(4):16.
52. Terwee CB, Bot SD, de Boer MR, van der Windt DA, Knol DL, Dekker J, Bouter LM, de Vet HC. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60(1):34–42.
53. Nie S, Wang L. Constructing an evaluation index system for clinical nursing practice teaching quality using a delphi method and analytic hierarchy process-based approach. *BMC Med Educ*. 2024;24(1):772.
54. Murphy S, Carter L, Al ST, Queally M, Brennan S, O'Neill S. Exploring the relationship between breastfeeding and the incidence of infant illnesses in Ireland: evidence from a nationally representative prospective cohort study. *BMC Public Health*. 2023;23(1):140.
55. Ghahramani F, Wang J. Intention to adopt mHealth apps among informal caregivers: cross-sectional study. *JMIR Mhealth Uhealth*. 2021;9(3):e24755.
56. Zhu H, Xu P, Wei Y, Zhao C, Zhao D, Li Y, Ma X, Wang M, Kang H. Smoking cessation improves health status of patients with chronic diseases: evidence from a longitudinal study of older adults in China. *BMC Public Health*. 2025;25(1):957.
57. Murphy KM, Glock R, Victorson D, Reddy M, Birken SA, Salsman JM. Co-design of a depression self-management tool for adolescent and young adult cancer survivors: user-centered design approach. *JMIR Form Res*. 2025;9:e67175.
58. Herbell K, Albright N, Berger S, Stanek C, Helsabeck NP. Identifying family engagement priorities in youth residential treatment settings: A group concept mapping study. *CHILD YOUTH SERV REV*. 2025:168.
59. Salma J, Au A, Sayadi G, Kleib M. Digital competence of Arabic-speaking immigrant and refugee older adults enacting agency and navigating barriers: qualitative descriptive study. *J Med Internet Res*. 2025;27:e60547.
60. Wang D, Ou CQ, Chen MY, Duan N. Health-promoting lifestyles of university students in mainland China. *BMC Public Health*. 2009;9:379.
61. Wang D, Xing XH, Wu XB. The healthy lifestyle scale for university students: development and psychometric testing. *AUST J PRIM HEALTH*. 2012;18(4):339–45.
62. Shi C, Zhang Y, Li C, Li P, Zhu H. Using the Delphi method to identify risk factors contributing to adverse events in residential aged care facilities. *Risk Manag Healthc Policy*. 2020;13:523–37.
63. Wu C, Wu P, Li P, Cheng F, Du Y, He S, Lang H. Construction of an index system of core competence assessment for infectious disease specialist nurse in China: a Delphi study. *BMC Infect Dis*. 2021;21(1):791.
64. Wu C, Zhang H, Lin Y, Yuan W, He J, Li L, Jiang D, Ji Z, Lang H. Construction and application of the core competence course training system for infectious disease specialist nurses. *BMC Med Educ*. 2024;24(1):410.
65. Raghav PR, Kumar D, Bhardwaj P. Experience of delphi technique in the process of establishing consensus on core competencies. *Int J Appl Basic Med Res*. 2016;6(3):191–4.
66. Gillison FB, Standage M, Skevington SM. Relationships among adolescents' weight perceptions, exercise goals, exercise motivation, quality of life and leisure-time exercise behaviour: a self-determination theory approach. *Health Educ Res*. 2006;21(6):836–47.
67. Dodd LJ, Al-Nakeeb Y, Nevill A, Forshaw MJ. Lifestyle risk factors of students: a cluster analytical approach. *Prev Med*. 2010;51(1):73–7.
68. Bajenaru L, Balog A, Dobre C, Draghici R, Prada GI. Latent profile analysis for quality of life in older patients. *BMC Geriatr*. 2022;22(1):848.
69. He W, Jiang L, Ge X, Ye J, Yang N, Li M, Wang M, Han X. Quality of life of empty-nest elderly in China: a systematic review and meta-analysis. *Psychol Health Med*. 2020;25(2):131–47.
70. Santana-Berlanga N, Porcel-Galvez AM, Botello-Hermosa A, Barrientos-Trigo S. Instruments to measure quality of life in institutionalised older adults: systematic review. *Geriatr Nurs*. 2020;41(4):445–62.
71. Wildiers H, Heeren P, Puts M, Topinkova E, Janssen-Heijnen ML, Extermann M, Falandry C, Artz A, Brain E, Colloca G, et al. International society of geriatric oncology consensus on geriatric assessment in older patients with cancer. *J Clin Oncol*. 2014;32(24):2595–603.
72. Decoster L, Van Puyvelde K, Mohile S, Wedding U, Basso U, Colloca G, Rostoft S, Overcash J, Wildiers H, Steer C, et al. Screening tools for multidimensional health problems warranting a geriatric assessment in older cancer patients: an update on SIOG Recommendationsdaggr. *ANN ONCOL*. 2015;26(2):288–300.
73. Jolly TA, Deal AM, Nyrop KA, Williams GR, Pergolotti M, Wood WA, Alston SM, Gordon BB, Dixon SA, Moore SG, et al. Geriatric assessment-identified deficits in older cancer patients with normal performance status. *Oncologist*. 2015;20(4):379–85.
74. Shewade HD, Jeyashree K, Kalaiselvi S, Palanivel C, Panigrahi KC. Competency-based tool for evaluation of community-based training in undergraduate medical education in India - a Delphi approach. *Adv Med Educ Pract*. 2017;8:277–86.
75. van Luijckelaar A, Greenwood BM, Ahmed HU, Barqawi AB, Barret E, Bomers J, Brausi MA, Choyke PL, Cooperberg MR, Eggener S, et al. Focal laser ablation as clinical treatment of prostate cancer: report from a Delphi consensus project. *WORLD J UROL*. 2019;37(10):2147–53.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.