ORIGINAL RESEARCH

Healthcare Professionals' Knowledge, Attitudes, and Practices Towards Stem Cell Therapy for Sarcopenia: A Cross-Sectional Study in Beijing

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Background: Sarcopenia significantly impacts the aging population, and this study investigates healthcare professionals' knowledge, attitudes, and practices (KAP) towards stem cell therapy for sarcopenia.

Methods: A cross-sectional study was conducted between January 1, 2024, and March 10, 2024, in medical institutions across Beijing. The study included healthcare professionals aged 18–70 years who completed a self-designed KAP questionnaire (Cronbach's α=0.917). Positive KAP was defined as scoring above 80% of the total score for each dimension.

Results: A total of 451 healthcare professionals participated in the study, with 66.7% female and 41.0% aged 40–49 years. The knowledge, attitude, and practice were 18.00 [10.00, 24.00] (possible range: 12–24), 25.00 [23.00, 30.00] (possible range: 6–30), and 21.00 [16.00, 30.00] (possible range: 7–35), respectively. Of these respondents, 13.7% were healthcare workers in the geriatrics department, who had a positive knowledge score of 22.00 [14.00, 24.00] and a positive attitude score of 29.50 [24.00, 30.00], but their practice scores remain moderate at 27.00 [20.00, 35.00]. Additionally, 140 (31.0%) had treated sarcopenia patients within six months and 277 (61.4%) were employed at public tertiary hospitals with positive knowledge. Multivariate logistic regression indicated that not having treated patients with sarcopenia in the past six months was independently associated with poor knowledge (OR = 0.30, 95% CI: [0.15, 0.62], p = 0.001). Mediating effect analysis showed that knowledge directly affected both attitude (β = 0.475, p < 0.001) and practice (β = 0.127, p = 0.004), and indirectly influenced practice through attitude (β = 0.296, p < 0.001).

Conclusion: Healthcare professionals exhibited inadequate knowledge, positive attitudes and inactive practices towards stem cell therapy for sarcopenia. Disease-related healthcare has positive knowledge, but moderate practice. Educational programs are essential to improve knowledge and foster proactive practices among healthcare professionals regarding stem cell therapy for sarcopenia.

Keywords: knowledge, attitude, practice, healthcare professional, stem cell therapy, sarcopenia

Introduction

Sarcopenia is a syndrome characterized by a progressive decrease in skeletal muscle mass associated with aging, accompanied by a decline in muscle strength and/or function. This condition increases the risk of disability in activities of daily living and predisposes individuals to adverse outcomes such as falls, fractures, and even mortality.[1–4] Sarcopenia can be categorized into primary, which is age-related, and secondary, which is related to activity levels, disease, or nutrition, although these categories often lack clear boundaries.[5]

The prevalence of sarcopenia varies widely, influenced by differing definitions of the condition. Recent epidemiological data suggest that in older populations in Asian countries, prevalence ranges from 5.5% to 25.7%, with a tendency to increase with age.[6,7] The condition is more common in males compared to females (21.0% vs 16.3%) and imposes a significant financial burden due to increased likelihood of institutionalization, hospitalization, prolonged hospital stays, and higher daily care costs.[1,8,9]

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Current interventions to improve outcomes in sarcopenic patients include resistance exercise and optimal nutritional intake. A 2018 international guideline strongly recommends resistance-based training and conditionally recommends increasing protein and caloric intake, including protein supplementation if necessary.[10] In addition, pharmacological interventions, such as hormonal therapies and agents targeting muscle metabolism, have shown potential in enhancing muscle function and mitigating sarcopenia symptoms.[11] In the realm of regenerative medicine, cell-based therapies show great promise. As mature muscle cells lack the capability for mitosis, stem cells represent the only viable option for muscle regeneration. Mesenchymal stem cells, which can regulate immunity, suppress inflammation, and activate endogenous stem cells to facilitate tissue repair through the secretion of bioactive substances, are particularly promising.[12,13] Wharton's jelly-derived mesenchymal stem cells are considered an ideal source for these cells.[14] Stem cell therapy holds potential as a novel therapeutic approach to alleviate sarcopenia. However, the majority of evidence supporting this therapy remains in preclinical stages, with limited clinical trials available. Challenges include high costs, ethical considerations, potential immune reactions, and a lack of robust clinical data demonstrating efficacy. Despite these barriers, preclinical studies and applications in other diseases suggest that stem cell therapies could offer transformative benefits for patients with sarcopenia.[15] Further research, particularly large-scale clinical trials, is required to establish their safety and effectiveness in clinical practice. In the realm of regenerative medicine, cell-based therapies show great promise. As mature muscle cells lack the capability for mitosis, stem cells represent the only viable option for muscle regeneration. Mesenchymal stem cells, which can regulate immunity, suppress inflammation, and activate endogenous stem cells to facilitate tissue repair through the secretion of bioactive substances, are particularly promising.[11] Wharton's jelly-derived mesenchymal stem cells are considered an ideal source for these cells due to their high availability and low immunogenicity. Stem cell therapy holds potential as a novel therapeutic approach to alleviate sarcopenia. While this therapy offers advantages such as its ability to target underlying biological mechanisms and promote muscle regeneration, challenges remain, including high costs, potential immune reactions, and ethical considerations.[16] Furthermore, large-scale clinical trials are necessary to establish its safety and efficacy in sarcopenia patients.

The Knowledge, Attitudes, and Practices (KAP) survey serves as a diagnostic tool that sheds light on a group's understanding, beliefs, and actions regarding a specific topic, especially within health literacy. This survey is based on the premise that knowledge positively influences attitudes, which subsequently shape behaviors.[17–19] The KAP model is particularly significant in modifying physicians' practice patterns.[20] Healthcare providers play an essential role in adopting new therapies; their perspectives and readiness to integrate such treatments into clinical practice directly affect patient outcomes. As sarcopenia primarily impacts the elderly and increases the burden on healthcare systems, exploring healthcare professionals' perspectives on stem cell therapy is vital. Identifying gaps in current knowledge and practices can provide critical insights for developing targeted educational programs aimed at enhancing the clinical application and effectiveness of stem cell therapies for sarcopenia. For researchers, addressing these gaps can guide the design of future studies, particularly focusing on clinical trials and the translational potential of stem cell therapies. Clinicians stand to benefit from tailored training initiatives, enabling them to adopt evidence-based approaches in sarcopenia management. Furthermore, improving healthcare professionals' understanding and practices may enhance patient care, ensuring access to cutting-edge therapies that could significantly improve quality of life and mitigate disease burden.

Methods
Study Setting
Research Background and Objectives
Sarcopenia poses significant challenges for healthcare systems, particularly in aging populations. This study aimed to evaluate the knowledge, attitudes, and practices of healthcare professionals toward stem cell therapy for sarcopenia.

Selection of Participants
The inclusion criteria for participants in the study were as follows: (1) healthcare professionals who were either working or studying in Beijing. (2) individuals aged between 18 and 70 years. The exclusion criteria included: (1) refused to participate in the study; (2) participants who provided incomplete questionnaire responses; and (3) responses where the questionnaire was completed in less than 90 seconds or more than 1800 seconds.

Time and Place of Data Collection

This cross-sectional study was carried out between January 1, 2024, and March 10, 2024, across various medical institutions in Beijing. The participants were healthcare professionals in the Beijing area, including those currently pursuing further education within the region.

Data Collection Methods

A snowball sampling technique was employed to disseminate questionnaires within social networks, specifically leveraging platforms like medical WeChat groups. This approach allowed for an organic expansion of the survey's reach, as initial participants shared the questionnaire with their contacts, who in turn did the same, thus cascading through the medical community. Participants accessed the questionnaire by scanning a QR code sent via WeChat, and completed it online.

Measures to Ensure Data Quality

To ensure data quality, we have implemented several measures. Firstly, each participant is allowed to submit the questionnaire only once, preventing duplicate submissions. All collected questionnaires will undergo thorough checks by our research team for completeness, internal consistency, and rationality. Additionally, to guarantee the validity of the questionnaires, only those completed within a reasonable time frame (90 to 1800 seconds) are considered valid. Prior to the main data collection, we conducted a pilot study with 30 participants, which yielded a Cronbach's α coefficient of 0.917, indicating good internal consistency of the questionnaire. Through these steps, we strive to ensure the high quality of the data collected.

Statement of Ethics

Ethical approval for the study was granted by the Ethics Committee of Beijing Tongren Hospital Mentougou Campus, Capital Medical University (Approval No. [2024-KY-010], Date: [January 1, 2024]). Informed consent was obtained from the participants for the study through an online questionnaire.

Introduction to the Questionnaire

The questionnaire was developed based on a comprehensive literature review and refined following input from several experts in the relevant field. This process resulted in a pilot questionnaire, which was initially distributed to 30 individuals for testing. The reliability of the questionnaire was confirmed with a Cronbach's α coefficient of 0.917 for the total scale. Specifically, the coefficients were 0.799 for the knowledge dimension, 0.975 for the attitude dimension, and 0.929 for the practice dimension.

The final questionnaire comprised four sections: demographic information (such as education level, gender, institutional type, and professional title), and three dimensions assessing knowledge, attitude, and practice (Details of the questionnaire can be found in the Appendix). The knowledge dimension included 12 questions on topics such as sarcopenia, stem cell therapy, and the application of stem cells in treating sarcopenia. Responses were scored with correct answers receiving 2 points and incorrect or unclear answers receiving 1 point, leading to a total possible score range of 12–24 points. The attitude dimension consisted of seven questions (A1-A6), utilizing a five-point Likert scale from very positive (5 points) to very negative (1 point), resulting in a score range of 6–30 points. Question A7 was included as a non-scored item. Similarly, the practice dimension included seven questions, also on a five-point Likert scale from always (5 points) to never (1 point), with a total score range of 7–35 points. Participants scoring above 80% of the total possible points were categorized as having adequate knowledge, a positive attitude, and proactive practice. Those scoring between 60% and 80% were classified as having moderate knowledge, attitude, and practice.[21]

Sample Size Calculation

Sample size calculation was performed using the following formula:

$$n = \left(Z_{(1-\alpha/2)}/\delta\right)^2 \times p \times (1-p)$$

In this formula, n represents the required sample size, while p is assumed to be 0.5, ensuring the largest possible sample size. The Type I error (α) was set to 0.05, corresponding to $Z_{(1-\alpha/2)} = 1.96$. The standard error (δ) was assumed to be

0.05. Considering an effective questionnaire recovery rate of 90%, the final target was set at collecting at least 430 completed questionnaires.

Statistical Analysis

Statistical analysis was conducted on the demographic data and the scores of each dimension. Descriptive analysis included testing the normality of score distributions for each dimension. For data adhering to a normal distribution, means and standard deviations were used to describe the scores; for non-normal distributions, medians along with the 25th and 75th percentiles were utilized. Count data regarding different demographic characteristics were presented as N (%).

Comparison of score differences across various dimensions among individuals with differing demographic characteristics was performed as follows: For continuous variables that were normally distributed, the t-test was employed for comparing two groups; for those not normally distributed, the Wilcoxon-Mann–Whitney test was used. For comparing three or more groups of continuous variables, ANOVA was utilized if the data were normally distributed and variance was homogeneous; otherwise, the Kruskal–Wallis test was applied. Correlation analysis between scores in various dimensions was conducted using the Pearson correlation coefficient for normally distributed data, and the Spearman correlation coefficient for non-normally distributed data.

Single-factor and multi-factor regression analyses were performed with scores in various dimensions serving as dependent variables to analyze the relationship between demographic data and scores. In this analysis, 80% of the total score for each dimension was used as the cutoff for categorizing the dependent variable. Variables with a p-value < 0.1 in single-factor analysis were included in the multi-factor regression model. P-values were reported to three decimal places, and a two-sided p < 0.05 was considered statistically significant. R software version 4.3.2 was utilized for this analysis.

Within the framework of the KAP model, a structural equation model (SEM) was used to examine whether attitudes mediated the relationship between knowledge and practical behaviors. Indirect effects were calculated and compared against direct effects, with goodness-of-fit indices for the SEM model set at RMSEA < 0.08, SRMR < 0.08, TLI > 0.8, and CFI > 0.8. Path analysis was conducted to test for mediation effects. Statistical analyses for the SEM were performed using Stata 18.0.

Results

A total of 451 questionnaires were collected, and the Cronbach's α coefficient for the formal experiment feedback total scale was 0.950 (Cronbach's α coefficient for knowledge dimension was 0.939, for attitude dimension was 0.953, and for practice dimension was 0.960). Among them, 301 (66.7%) were female, 185 (41.0%) were aged 40–49 years, 40–49 had bachelor's degree, 40–49 were physicians, 277 (61.4%) were from public tertiary hospitals, 179 (39.7%) had been working in their present department for at least 20 years, 301 (66.7%) had access to cases of sarcopenia every half a year or more, 140 (31.0%) had treated sarcopenia patients within six months. The median [25%,75%] knowledge, attitude, and practice scores were 18.00 [10.00, 24.00] (possible range: 12–24), 25.00 [23.00, 30.00] (possible range: 6–30), and 21.00 [16.00, 30.00] (possible range: 7–35), respectively. The knowledge score varied from participants with different institution nature (P = 0.032), frequency of contact with sarcopenia in your department (P = 0.001), frequency of diagnosing and treating sarcopenia (P = 0.001), and whether treated patients with sarcopenia in the past six months (P < 0.001). The attitude score varied from participants with different education (P = 0.028). The difference of practice score were found among patients with different education (P = 0.027), professional title (P = 0.023), current department (P = 0.004), duration of work in the current department (P = 0.025), and whether treated patients with sarcopenia in the past six months (P = 0.008) (Table 1).

The distribution of knowledge dimension revealed that the question with the highest number of participants choosing the "Very familiar" option were "Sarcopenia is one of the syndromes associated with aging, leading to weakness, decreased quality of life, physical disability, and, in severe cases, death". (K6), with 78.9%. The question with the highest number of participants choosing the "Heard of" option were "Lack of exercise and malnutrition are considered primary risk factors for sarcopenia". (K3), with 3.5%. The question with the highest number of participants choosing the "Unclear" option were "Research has shown that stem cell transplantation can reduce inflammation and oxidative stress in skeletal muscles of malnourished mice, improving muscle cell regeneration capacity". (K10), with 46.3% (Table 2).

Table 1 Basic Information of Participants and KAP Score

N=451	N (%)	Knowledge	P	Attitude	P	Practice	P
		Median [25%,75%] or Mean (± SD)		Median [25%,75%] or Mean (± SD)		Median [25%,75%] or Mean (± SD)	
Total score		18.00 [10.00, 24.00]		25.00 [23.00, 30.00]		21.00 [16.00, 30.00]	
1. Age:			0.157		0.050		0.068
18–29	88(19.5)	16.00 [7.75, 24.00]		25.00 [22.00, 30.00]		20.00 [11.50, 34.25]	
30–39	94(20.8)	19.50 [10.00, 24.00]		26.00 [24.00, 30.00]		23.50 [18.25, 32.25]	
40–49	185(41.0)	20.00 [10.00, 24.00]		24.00 [23.00, 30.00]		21.00 [16.00, 28.00]	
≥50	84(18.6)	18.00 [8.00, 23.00]		24.00 [21.00, 30.00]		20.50 [15.00, 28.00]	
2. Gender:			0.709		0.775		0.922
Male	150(33.3)	20.00 [9.25, 24.00]		25.50 [23.00, 30.00]		21.00 [16.00, 28.00]	
Female	301(66.7)	18.00 [10.00, 24.00]		25.00 [23.00, 30.00]		21.00 [16.00, 30.00]	
3. Marital status:			0.095		0.753		0.098
Single	85(18.8)	14.00 [7.00, 24.00]		25.00 [22.00, 30.00]		20.00 [10.00, 28.00]	
Married	350(77.6)	20.00 [10.00, 24.00]		25.00 [23.00, 30.00]		21.00 [17.00, 30.00]	
Divorced	16(3.5)	22.50 [16.50, 24.00]		25.00 [21.50, 30.00]		23.00 [16.75, 28.75]	
4. Education:			0.937		0.028		0.027
College	73(16.2)	20.00 [8.00, 24.00]		27.00 [23.00, 30.00]		21.00 [10.00, 35.00]	
Bachelor's degree	242(53.7)	19.50 [10.00, 24.00]		25.00 [23.00, 30.00]		22.00 [17.00, 30.00]	
Master's degree and above	136(30.2)	18.00 [10.00, 24.00]		24.00 [22.00, 29.00]		20.00 [15.00, 26.25]	
5. Occupation:			0.092		0.054		0.088
Physician	304(67.4)	20.00 [10.00, 24.00]		24.00 [23.00, 30.00]		21.00 [16.00, 27.25]	
Nurse	126(27.9)	18.00 [8.00, 24.00]		27.00 [23.25, 30.00]		24.50 [14.00, 35.00]	
Technician	21(4.7)	10.00 [6.00, 20.00]		26.00 [23.00, 30.00]		27.00 [19.00, 31.00]	
6. Professional title:			0.345		0.220		0.023
No title	53(11.8)	14.00 [8.00, 23.00]		25.00 [22.00, 30.00]		21.00 [8.00, 31.00]	
Junior	83(18.4)	20.00 [9.00, 24.00]		26.00 [23.50, 30.00]		26.00 [17.00, 35.00]	
Intermediate	143(31.7)	19.00 [10.00, 24.00]		25.00 [23.00, 30.00]		22.00 [17.00, 28.50]	
Associate senior	117(25.9)	20.00 [10.00, 24.00]		24.00 [22.00, 30.00]		20.00 [15.00, 26.00]	
Senior	55(12.2)	18.00 [9.00, 24.00]		24.00 [24.00, 30.00]		20.00 [15.50, 29.50]	
7. Nature of your current institution:			0.032		0.274		0.676
Public Level One	28(6.2)	9.00 [0.00, 22.00]		23.00 [20.75, 30.00]		20.00 [10.50, 35.00]	
Public Level Two	106(23.5)	18.00 [8.00, 24.00]		25.00 [23.00, 30.00]		21.00 [17.00, 28.00]	
Public Level Three	277(61.4)	20.00 [10.00, 24.00]		25.00 [23.00, 30.00]		21.00 [16.00, 31.00]	
Private Hospital	40(8.9)	17.00 [10.00, 23.25]		24.00 [22.75, 28.00]		21.00 [14.00, 27.25]	
8. Current department:			0.182		0.119		0.004
Geriatrics Department	62(13.7)	22.00 [14.00, 24.00]		29.50 [24.00, 30.00]		27.00 [20.00, 35.00]	
Orthopedics Department	20(4.4)	17.00 [9.50, 24.00]		24.00 [22.00, 28.50]		23.50 [15.00, 28.00]	
Nutrition Department	15(3.3)	24.00 [17.00, 24.00]		24.00 [23.00, 30.00]		22.00 [18.00, 31.00]	
Oncology Department	8(1.8)	22.50 [10.00, 24.00]		24.00 [21.50, 27.25]		21.00 [18.75, 27.75]	
Rehabilitation Medicine Department	18(4.0)	20.00 [10.00, 23.00]		26.00 [24.00, 29.75]		20.50 [16.00, 26.50]	
Endocrinology Department	14(3.1)	19.50 [7.00, 24.00]		25.00 [23.00, 28.75]		21.50 [19.00, 33.75]	
Respiratory Department	33(7.3)	18.00 [8.00, 22.00]		26.00 [22.00, 30.00]		19.00 [15.00, 27.00]	
Alzheimer's Disease Ward	9(2.0)	20.00 [16.00, 24.00]		26.00 [24.00, 28.00]		13.00 [9.00, 24.00]	
General Surgery Department	21(4.7)	18.00 [2.00, 22.00]		24.00 [23.00, 27.00]		18.00 [14.00, 22.00]	
Other Departments	251(55.7)	18.00 [8.00, 24.00]		24.00 [23.00, 30.00]		21.00 [15.00, 28.00]	
9. Duration of work in the current department:			0.201		0.114		0.025
6–10 years	163(36.1)	18.00 [8.00, 24.00]		25.00 [23.00, 30.00]		21.00 [14.00, 30.50]	
10–20 years	109(24.2)	20.00 [10.00, 24.00]		26.00 [24.00, 30.00]		23.00 [18.00, 30.00]	
≥20 years	179(39.7)	18.00 [9.50, 24.00]		24.00 [22.00, 30.00]		20.00 [15.00, 28.00]	

(*Continued*)

Table 1 (Continued).

N=451	N (%)	Knowledge	P	Attitude	P	Practice	P
		Median [25%,75%] or Mean (± SD)		Median [25%,75%] or Mean (± SD)		Median [25%,75%] or Mean (± SD)	
10. Frequency of contact with sarcopenia in your department:			0.001		0.782		0.055
Every six months or longer	301(66.7)	18.00 [6.00, 24.00]		25.00 [23.00, 30.00]		21.00 [16.00, 28.00]	
Quarterly	35(7.8)	20.00 [13.00, 23.00]		24.00 [23.00, 29.00]		21.00 [15.00, 26.50]	
Monthly	33(7.3)	22.00 [10.00, 24.00]		24.00 [22.00, 30.00]		21.00 [15.00, 35.00]	
Weekly	28(6.2)	18.00 [14.00, 24.00]		24.50 [22.50, 29.25]		20.00 [13.00, 26.25]	
Daily	54(12.0)	22.50 [16.50, 24.00]		25.50 [23.00, 30.00]		26.50 [19.25, 33.50]	
11. Frequency of diagnosing and treating sarcopenia:			0.001		0.497		0.145
Every six months or longer	322(71.4)	18.00 [6.25, 24.00]		25.00 [23.00, 30.00]		21.00 [16.00, 28.00]	
Quarterly	36(8.0)	22.00 [17.50, 24.00]		25.50 [23.00, 30.00]		21.00 [16.25, 31.25]	
Monthly	26(5.8)	21.00 [10.00, 24.00]		24.00 [21.00, 26.00]		20.50 [14.25, 32.25]	
Weekly	30(6.7)	19.00 [14.00, 24.00]		25.00 [24.00, 29.50]		20.00 [13.00, 26.75]	
Daily	37(8.2)	24.00 [16.00, 24.00]		26.00 [23.00, 30.00]		27.00 [20.00, 34.00]	
12. Treated patients with sarcopenia in the past six months:			<0.001		0.097		0.008
Yes	140(31.0)	22.50 [16.00, 24.00]		26.00 [23.00, 30.00]		24.00 [17.75, 34.25]	
No	311(69.0)	16.00 [6.00, 24.00]		24.00 [23.00, 30.00]		20.00 [15.50, 28.00]	

Table 2 Knowledge Dimension of the Participants

Knowledge	N		
	Very Familiar	Heard of	Unclear
1. Sarcopenia is characterized by age-related loss of skeletal muscle mass, strength, or physical function.	328(72.7%)	13(2.9%)	110(24.4%)
2. Sarcopenia is one of the syndromes associated with aging, leading to weakness, decreased quality of life, physical disability, and, in severe cases, death.	356(78.9%)	10(2.2%)	85(18.8%)
3. Lack of exercise and malnutrition are considered primary risk factors for sarcopenia.	341(75.6%)	16(3.5%)	94(20.8%)
4. Clinical practices for treating sarcopenia include supplementation of proteins, amino acids, vitamin D, creatine, and HMB, as well as resistance training to increase muscle mass and strength.	341(75.6%)	4(0.9%)	106(23.5%)
5. The pathogenesis of sarcopenia is associated with decreased muscle cell regeneration ability, increased oxidative stress, and inflammatory response.	308(68.3%)	3(0.7%)	140(31%)
6. Stem cell therapy is a form of regenerative medicine aimed at repairing damaged cells within the body by reducing inflammation and modulating the immune system.	288(63.9%)	8(1.8%)	155(34.4%)
7. Stem cell therapy utilizes stem cells or their derivatives to stimulate the body's own healing processes and repair damaged, diseased, or injured tissues.	290(64.3%)	3(0.7%)	158(35%)
8. Mesenchymal stem cells can regulate immunity, suppress inflammation, and activate endogenous stem cells to facilitate tissue repair through the secretion of bioactive substances.	263(58.3%)	4(0.9%)	184(40.8%)
9. Wharton's jelly-derived mesenchymal stem cells are considered an ideal source of mesenchymal stem cells.	242(53.7%)	9(2%)	200(44.3%)
10. Research has shown that stem cell transplantation can reduce inflammation and oxidative stress in skeletal muscles of malnourished mice, improving muscle cell regeneration capacity.	237(52.5%)	5(1.1%)	209(46.3%)
11. Mesenchymal stem cells have entered clinical research stages for many diseases.	242(53.7%)	9(2%)	200(44.3%)
12. Stem cell therapy has the potential to become a new therapeutic intervention for alleviating sarcopenia.	267(59.2%)	6(1.3%)	178(39.5%)

Table 3 Attitude Dimension of the Participants

Attitude	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Do you believe it is necessary to continue improving and developing research on stem cell therapy for sarcopenia?	228(50.6%)	156(34.6%)	59(13.1%)	5(1.1%)	3(0.7%)
2. Do you support the future use of stem cell therapy as a treatment option for sarcopenia?	200(44.3%)	183(40.6%)	58(12.9%)	7(1.6%)	3(0.7%)
3. Do you believe that stem cell therapy will have a significant impact on the future treatment of sarcopenia?	181(40.1%)	179(39.7%)	84(18.6%)	4(0.9%)	3(0.7%)
4. Are you willing to or currently conducting research on stem cell therapy for sarcopenia?	174(38.6%)	173(38.4%)	90(20%)	10(2.2%)	4(0.9%)
5. Do you have confidence in research on stem cell therapy for sarcopenia?	177(39.2%)	165(36.6%)	102(22.6%)	4(0.9%)	3(0.7%)
6. Do you think research on stem cell therapy for sarcopenia is meaningful for improving the quality of life of patients in the future?	189(41.9%)	185(41%)	70(15.5%)	4(0.9%)	3(0.7%)
7. Do you think current clinical interventions through nutritional interventions and resistance exercise effectively improve sarcopenia in patients?	171(37.9%)	178(39.5%)	95(21.1%)	4(0.9%)	3(0.7%)

Responses on attitude showed that 50.6% felt that it was very important to continue to improve and develop research on stem cell therapy for sarcopenia (A1), and 44.3% were very supportive of the use of stem cell therapy as a therapeutic option for sarcopenia in the future (A2). Meanwhile, 41% agreed that stem cell therapy for sarcopenia research could have a meaningful impact on improving patients' quality of life in the future (A6). In addition, 22.6% were neutral as to whether they had confidence in stem cell therapy research for sarcopenia (A5) (Table 3).

When it comes to related practices, 31% and 29.5%, respectively, were very proactive in keeping up to date with the latest research on sarcopenia treatment (P2) and stem cell therapy for the disease (P3). However, 28.2% had not suggested the idea of conducting research on stem cell therapy for sarcopenia (P4), and a similar proportion had no plans to conduct research on stem cell therapy for sarcopenia (P5). In addition, 32.4% had never participated in any research or project related to stem cell therapy for sarcopenia (P7) (Table 4).

Table 4 Practice Dimension of the Participants

Practice	Very Consistent	Consistent	Neutral	Inconsistent	Very Inconsistent
1. Would you participate in academic conferences related to stem cell therapy for sarcopenia?	132(29.3%)	111(24.6%)	94(20.8%)	76(16.9%)	38(8.4%)
2. Would you proactively seek out the latest research developments on treatments for sarcopenia?	140(31%)	123(27.3%)	90(20%)	69(15.3%)	29(6.4%)
3. Would you proactively seek out the latest research developments on stem cell therapy for diseases?	133(29.5%)	117(25.9%)	98(21.7%)	74(16.4%)	29(6.4%)
4. Have you ever proposed ideas to conduct research on stem cell therapy for sarcopenia?	107(23.7%)	68(15.1%)	63(14%)	127(28.2%)	86(19.1%)
5. Do you plan to conduct research related to stem cell therapy for sarcopenia?	99(22%)	60(13.3%)	67(14.9%)	127(28.2%)	98(21.7%)
6. Would you proactively educate colleagues about relevant knowledge regarding stem cell therapy for sarcopenia?	115(25.5%)	85(18.8%)	98(21.7%)	92(20.4%)	61(13.5%)
7. Are you currently involved in research or projects related to stem cell therapy for sarcopenia?	96(21.3%)	50(11.1%)	39(8.6%)	120(26.6%)	146(32.4%)

Table 5 Correlation Analysis of KAP Scores

	Knowledge	Attitude	Practice
Knowledge	1.000		
Attitude	0.174(P<0.001)	1.000	
Practice	0.387(P<0.001)	0.374(P<0.001)	1.000

In the correlation analysis, significant positive correlations were found between knowledge and attitude (r = 0.174, P < 0.001), knowledge and practice (r = 0.387, P < 0.001), as well as attitude and practice (r = 0.374, P < 0.001), respectively (Table 5).

Multivariate logistic regression showed that have not treated patients with sarcopenia in the past six months (OR = 0.30, 95% CI: [0.15, 0.62], P = 0.001) was independently associated with poor knowledge (Supplementary Table 1). Meanwhile, knowledge score (OR = 1.09, 95% CI: [1.06, 1.12], P < 0.001) was independently associated with positive attitude (Supplementary Table 2). Furthermore, knowledge score (OR = 1.05, 95% CI: [1.01, 1.09], P = 0.027) and attitude score (OR = 1.61, 95% CI: [1.45,1.78], P < 0.001) were independently associated with proactive practice (Supplementary Table 3).

The structural equation model based on KAP theory showed sufficient goodness of fit (Figure 1). Bootstrap analysis of mediating effect showed that knowledge directly affected attitude (β = 0.475, P < 0.001) and practice (β = 0.127, P = 0.004), attitude directly affected practice (β = 0.624, P < 0.001), and knowledge also indirectly affected practice through attitude (β = 0.296, P < 0.001) (Supplementary Table 4).
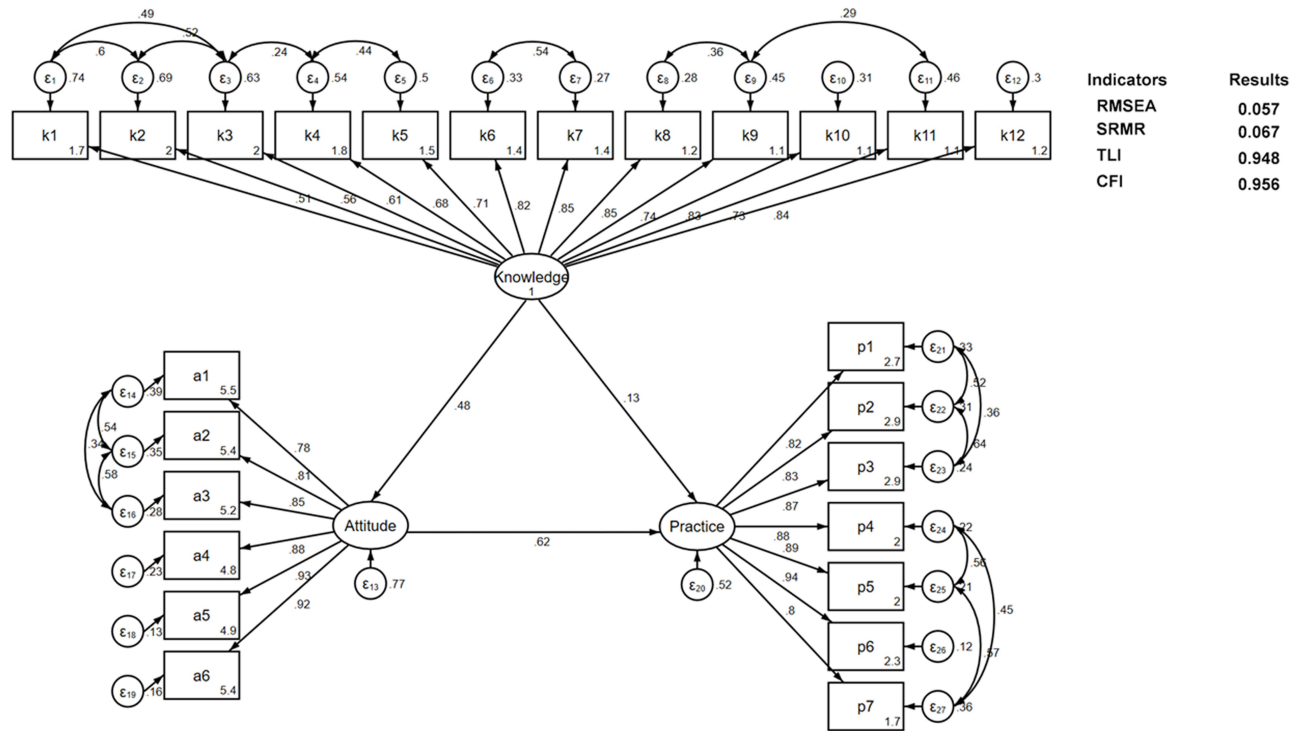

Figure 1 The Structural Equation Model (SEM) Before and After Model Adjustment. Rectangle shows observed variables, ellipses indicate potential variables, and circles represent residual terms.

Discussion

Healthcare professionals demonstrate insufficient knowledge, positive attitudes, and passive practices regarding stem cell therapy for sarcopenia. It is imperative to develop targeted educational programs to enhance healthcare professionals' understanding and encourage proactive engagement with stem cell therapy for sarcopenia.

Our results suggest that clinical exposure significantly influences healthcare professionals' competency in managing sarcopenia, as evidenced by higher knowledge and practice scores among those who had recent interactions with sarcopenia patients. Additionally, our study reveals disparities in KAP scores based on professional title and education level. Contrary to expectations, professionals with junior titles exhibited higher practice scores, possibly indicating a more hands-on approach or greater motivation to implement novel therapies. This finding contrasts with studies suggesting that higher academic qualifications correlate with better clinical practices,[22] highlighting the need for further investigation into the factors driving these differences. Furthermore, the significant associations between knowledge, attitudes, and practices underscore the interdependence of these factors in influencing clinical decision-making and patient care. Our findings support existing literature suggesting that positive attitudes towards a treatment modality are associated with proactive implementation in clinical practice.[23] Moreover, the mediating effect analysis elucidates the pathways through which knowledge influences attitudes and practices, highlighting the pivotal role of attitude as a mediator between knowledge and behavior. This aligns with the Theory of Planned Behavior, which posits that attitudes mediate the relationship between beliefs and behavior.[24]

In analyzing the knowledge dimension, it is notable that while a majority of participants demonstrated familiarity with general concepts related to sarcopenia and stem cell therapy, there were clear variations in understanding across specific items. For instance, items regarding the characteristics and risk factors of sarcopenia received higher agreement rates compared to those related to the mechanisms and therapeutic potential of stem cell therapy. Notably, the lowest scoring item, concerning Wharton's jelly-derived mesenchymal stem cells as an ideal source, underscores gaps in knowledge regarding specific stem cell types and their applicability. Addressing these gaps is crucial for informed decision-making and effective patient care. Therefore, targeted educational interventions focusing on emerging therapies and advancements in stem cell research, particularly highlighting practical applications and evidence-based practices, are recommended. Additionally, collaborative initiatives involving researchers, clinicians, and educators could facilitate knowledge exchange and promote a deeper understanding of stem cell therapy among healthcare professionals.[15,25]

Analysis of the attitude dimension reveals varying degrees of support and optimism towards stem cell therapy for sarcopenia among participants. While a significant proportion expressed favorable attitudes towards the necessity and future use of stem cell therapy, a notable portion remained neutral or skeptical. Particularly noteworthy is the neutral stance towards current clinical interventions for sarcopenia, indicating a potential gap in confidence or satisfaction with existing treatment modalities. To address these challenges, strategies aimed at fostering a supportive and inclusive environment for discussing emerging therapies and encouraging interdisciplinary collaboration are essential.[26,27] Moreover, initiatives to enhance awareness of the potential benefits and risks of stem cell therapy, along with opportunities for engaging in research and clinical trials, could help alleviate concerns and promote greater confidence and enthusiasm among healthcare professionals.[28,29]

In assessing the practice dimension, it is evident that while a portion of participants exhibited proactive behaviors towards staying informed and engaging in research activities related to stem cell therapy, there was a considerable proportion reporting inconsistent or passive practices. Notably, low engagement in proposing or conducting research on stem cell therapy for sarcopenia highlights potential barriers or challenges in translating knowledge and attitudes into tangible actions. To bridge this gap between intention and action, targeted interventions focusing on facilitating research participation and knowledge dissemination are warranted. Providing opportunities for hands-on training, mentorship programs, and incentivizing participation in research projects could empower healthcare professionals to take a more proactive role in advancing stem cell therapy for sarcopenia.[30,31] Furthermore, fostering a culture of continuous learning and quality improvement within healthcare institutions can create an enabling environment conducive to innovation and excellence in patient care.[32,33]

Despite the valuable insights gained from this study, several limitations must be acknowledged. Firstly, the survey was conducted exclusively in medical institutions in Beijing, limiting the generalizability of the findings to healthcare

professionals in other regions or countries. Secondly, the reliance on self-reported data via a questionnaire may introduce response biases and social desirability bias, potentially impacting the accuracy of the results. Thirdly, while we implemented time thresholds (90–1800 seconds) for questionnaire completion to ensure data quality, this approach presented its own limitations. The fixed time window may not have adequately accommodated individual differences in reading speed and comprehension, potentially excluding valid responses from both faster and slower respondents. Additionally, the online questionnaire format meant we could not verify whether participants completed the survey in one continuous session or with interruptions, which might have affected response quality despite falling within the acceptable time range. Lastly, the cross-sectional design of the study precludes establishing causal relationships between knowledge, attitudes, and practices, highlighting the need for longitudinal studies to elucidate the dynamics of healthcare professionals' perceptions and behaviors regarding stem cell therapy for sarcopenia over time.

Conclusion

In conclusion, healthcare professionals demonstrate insufficient knowledge, positive attitudes, and inactive practices regarding stem cell therapy for sarcopenia. Efforts should be directed towards comprehensive educational programs aimed at improving healthcare professionals' knowledge and fostering proactive attitudes and practices towards utilizing stem cell therapy for sarcopenia in clinical settings.

Data Sharing Statement

All data generated or analysed during this study are included in this published article and its Supplementary Information Files.

Ethics Approval and Consent to Participate

Ethical approval for the study was granted by the Ethics Committee of Beijing Tongren Hospital Mentougou Campus, Capital Medical University (Approval No. [2024-KY-010], Date: [January 1, 2024]). Informed consent was obtained from the participants for the study through an online questionnaire. All methods were performed in accordance with the relevant guidelines and regulations.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors declare that they have no competing interests in this work.

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