



Knowledge, attitude, and practice toward sarcopenia among older adults in two cities in Zhejiang province, China

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ABSTRACT

Objective: To explore the knowledge, attitudes, and practice (KAP) towards sarcopenia among older adults in Zhejiang province, China.

Methods: This cross-sectional study was conducted between April 2023 and January 2024 among older community residents who participated in a physical examination in Shaoxing People's Hospital Physical Examination Center, Shaoxing Yuecheng District Fushan Street Community Health Service Center, Shaoxing Yuecheng District Beihai Street Community Health Service Center, Shaoxing City, and Outpatient Department of Yongkang First People's Hospital. Their demographic characteristics and KAP towards sarcopenia were collected by a self-designed questionnaire. Structural equation modeling (SEM) was used to explore the relationship among KAP dimensions.

Results: A total of 1092 valid questionnaires were included. The median knowledge, attitude, and practice scores were 0 (0, 0) (possible range: 0–22), 31 (30, 31) (possible range: 8–40), and 17 (15, 21) (possible range: 6–30), respectively. The SEM showed that knowledge directly positively influenced attitude ($\beta = 0.121$, $P < 0.001$) and practice ($\beta = 0.171$, $P < 0.001$). Attitude directly positively influenced practice ($\beta = 0.116$, $P < 0.001$); therefore, the knowledge showed an indirect influence on practice via attitude.

Conclusion: Older adults in two cities in Zhejiang province, China, showed insufficient knowledge but moderate attitude and practice towards sarcopenia. It is imperative to design interventions to improve knowledge about sarcopenia and improve self-management and patient outcomes.

1. Background

Sarcopenia is the progressive, age-related loss of skeletal muscle mass and quality resulting in muscle weakness, and it is common among older adults ≥ 65 years old (Cruz-Jentoft et al., 2019; Marzetti et al., 2017). Sarcopenia is generally defined as a clinically determined decrease in muscle strength, physical performance, and skeletal muscle mass (Cespedes Feliciano et al., 2020; Cui et al., 2023). Most adults are reported to lose muscle mass at a rate of 1%–2% per year after the age of 50 years (Anton et al., 2015). The age-related loss of muscle mass and quality is primarily due to progressive atrophy and loss of type II muscle fibers and motor neurons (Anton et al., 2015). The reported prevalence of sarcopenia can vary widely, from 0% to 15% in healthy older adults

and from 10% to 76% in acutely hospitalized older adults, depending on the diagnostic criteria and methods used (Pacífico et al., 2020; Reijnierse et al., 2015). The pooled mean prevalence is higher among persons with cardiovascular disease (31.4%), dementia (26.4%), diabetes mellitus (31.1%), and respiratory disease (26.8%) (Pacífico et al., 2020). In China, the reported prevalence of sarcopenia in community-dwelling adults > 65 years old is 17.4% (Ren et al., 2022), or 12.9% in men and 11.2% in women, raising to 29.7% in hospitalized men and 23.0% in hospitalized women (Chen et al., 2021). Nursing homes show the highest prevalence of sarcopenia in China, at 26.3% in men and 33.7% in women (Chen et al., 2021). Sarcopenia is associated with increased risks of falls and fractures, mobility disorders, physical frailty, functional disability, loss of independence, and mortality (Cruz-Jentoft

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et al., 2019). Therefore, the prevention of sarcopenia plays an important role in the quality of life among older adults. The diagnosis of sarcopenia involves several examinations. The initial screening can be performed using clinical signs and symptoms or a screening questionnaire. If the initial screen is positive, muscle strength assessment can be performed using grip strength or chair stand test. If the grip strength or chair stand test is positive, muscle mass testing can be performed using dual-energy x-ray absorptiometry (DEXA) (Cruz-Jentoft et al., 2019).

The prevention of sarcopenia involves engaging in regular physical activity, adopting good dietary habits (including adequate energy and protein intake), and maintaining body weight in the normal range (Cruz-Jentoft et al., 2019). In many cases, the diagnosis of sarcopenia is made after the patient reports a feeling of strength loss to the physician, prompting further investigations (Cui et al., 2023). Hence, being aware of the proper lifestyle habits to maintain and knowing that it is correct to consult when feeling less fit than usual are important to diagnosing and managing sarcopenia (Ooi and Welch, 2024). A deficiency of knowledge about sarcopenia may prevent timely diagnosis and management, resulting in a poorer prognosis (Ooi and Welch, 2024). Although physicians can inform their patients about sarcopenia, the prevention of sarcopenia involves actions taken throughout the daily life of the patients, and the patients remain the primary actors in ensuring their health through self-management.

Hence, adequate knowledge of sarcopenia, its diagnosis, and management is required in the population to limit the damage of sarcopenia. Still, limited data about the knowledge, attitudes, and practices (KAP) towards sarcopenia are available. A qualitative study examined the KAP toward physical activity in patients with diabetes and sarcopenia and reported specific barriers to physical activity (Che et al., 2022). Hammouh et al. (Hammouh et al., 2023) reported poor KAP toward an adequate diet among older Jordanian adults. A study in the Netherlands reported limited knowledge of sarcopenia but a relatively good willingness to participate in treatment and prevention among community-dwelling adults (Van Ancum et al., 2020). Studies also reported a limited KAP among healthcare providers (Lu et al., 2023; Reijnierse et al., 2017; Silva et al., 2020).

KAP studies are particularly useful in identifying the gaps, misunderstandings, and misconceptions that constitute barriers to properly implementing a specific action in a specific population (Andrade et al., 2020; World Health Organization, 2008). The knowledge gaps can then be targeted by educational interventions to improve attitudes and practice (Andrade et al., 2020; World Health Organization, 2008). Still, it is necessary to identify those gaps, misunderstandings, and misconceptions to be able to design an intervention to improve the KAP of the target population.

Therefore, this study aimed to explore the KAP towards sarcopenia among older adults in Shaoxing and Yongkang, China.

2. Methods

2.1. Study design and participants

This cross-sectional study was conducted between April 2023 and January 2024 in Yongkang and Shaoxing (Outpatient Department of Yongkang First People's Hospital, and Shaoxing People's Hospital Physical Examination Center, Shaoxing Yuecheng District Fushan Street Community Health Service Center, Shaoxing Yuecheng District Beihai Street Community Health Service Center) among older community residents who participated in physical examination. The inclusion criteria were 1) ≥ 65 years of age, 2) voluntarily participated in the study, and 3) could cooperate in completing the survey. The exclusion criteria were 1) aphasia, delirium, or inability to communicate due to severe cognitive dysfunction, 2) intellectual disabilities or mental illnesses that prevent them from communicating normally, or 3) unstable medical conditions. This study was approved by the Ethics Committee of Shaoxing People's Hospital (IEC-K-AF-067-1.0). Written informed consent was obtained

from the study participants before completing the survey.

2.2. Questionnaire and quality control

The questionnaire was designed with reference to the literature (Petroni et al., 2021; Ter Beek et al., 2016). For validity, after the initial design, the questionnaire was reviewed by two senior professors in geriatric (with > 20 years of working experience). The inappropriate, unclear, or incorrect questions were excluded, guaranteeing content validity. A pilot study (30 copies) showed good internal consistency (Cronbach's $\alpha = 0.909$). During the pilot study, there were no items with feedback of uncertainty or confusion, suggesting face validity.

The final questionnaire was in Chinese and contained four dimensions: demographic characteristics, knowledge, attitude, and practice. The demographic characteristics included age, gender, body mass index (BMI), residence, education, medical-related profession, physical labor, monthly income, medical insurance, comorbidities, self-care, smoking, and drinking. The knowledge dimension consisted of 11 questions, with scores of 2, 1, and 0 for "understand", "partially understand", and "don't understand", respectively, and the total score of knowledge was calculated by adding scores of the 11 questions, with scores ranging from 0 to 22. The attitude dimension consisted of eight questions on a 5-point Likert scale. Items A1-A6 were positively scored, ranging from strongly agree (5 points) to strongly disagree (1 point), while items A7 and A8 were negatively scored, ranging from strongly disagree (5 points) to strongly agree (1 point). The total score of attitude was calculated by adding scores of the eight questions, with total scores ranging from 8 to 40. The practice dimension consisted of six questions using a 5-point Likert scale ranging from always (5 points) to often (1 point); the total score of practice was calculated by adding scores of the six questions, with total scores ranging from 6 to 30. Knowledge, attitude, and practice were considered insufficient, negative, and inappropriate, respectively, if their scores were $< 60\%$ of the total score, moderate if the score was $60\% - 80\%$ of the total score, and sufficient, positive, and appropriate, respectively, if their scores were $> 80\%$ of the total score (Akalu et al., 2020).

The survey was conducted by distributing paper questionnaires by trained research assistants. For the participants who had difficulty answering the questions, the research assistants asked the questions, recorded the answers, and explained the questions that the participants could not understand. At the end of the survey, the research assistants collected the questionnaires, registered them, and verified them.

2.3. Statistical analysis

The continuous variables were tested for normal distribution using the Kolmogorov-Smirnov test, and the KAP scores were found to have a skewed distribution. Hence, they were presented as median (interquartile range [IQR]) and analyzed using the Wilcoxon-Mann-Whitney test or Kruskal-Wallis analysis. The categorical variables were expressed as n (%) and analyzed using the chi-square test or Fisher's exact test. Spearman correlation analysis was used to examine the correlations between KAP dimensions. The present study was cross-sectional, which cannot provide conclusions about causal relationships. A SEM provides some surrogate results about causality among KAP dimensions (Beran and Violato, 2010; Fan et al., 2016; Kline, 2023). The SEM was based on the following hypotheses related to the KAP theory (Andrade et al., 2020; World Health Organization, 2008): 1) knowledge affects attitude, 2) attitude affects practice, and 3) knowledge affects practice. A post hoc confirmatory factor analysis (CFA) was conducted to test the construct validity of our questionnaire. The model fit was evaluated using Root Mean Square Error of Approximation (RMSEA) (< 0.08 indicated model fit was good), Incremental Fit Index (IFI) (indicated model fit was good), Tucker-Lewis Index (TLI) (> 0.8 indicated model fit was good), and Comparative Fit Index (CFI) (indicated model fit was good). A two-sided $P < 0.05$ was considered

statistically significant. SPSS 26.0 (IBM, Armonk, NY, USA) and Stata (StataCorp LP, College Station, TX, USA) were used for statistical analysis.

3. Results

3.1. Characteristics of the participants

A total of 1247 questionnaires were collected, of which 158 did not meet the age criterion, and 7 had logical errors. Hence, 1092 valid

Table 1

Demographic characteristics and knowledge, attitude, and practice toward sarcopenia among older adults in two cities (Yongkang and Shaoxing) in Zhejiang Province, China (n = 1092), April 2023 – January 2024.

Variables	n (%)	Knowledge		Attitude		Practice	
		Median [IQR]	P	Median [IQR]	P	Median [IQR]	P
Total	1092	0 (0, 0)		31 (30, 31)		17 (15, 21)	
Age (years)	73.20 ± 5.51						
Gender			0.392		0.009		0.001
Male	470 (43.04)	0 (0, 0)		30 (30, 31)		18 (15, 22)	
Female	622 (56.96)	0 (0, 0)		31 (30, 32)		17 (15, 20)	
Body mass index (kg/m²)			0.146		0.089		0.095
<23.9	571 (52.29)	0 (0, 0)		31 (30, 31)		18 (15, 21)	
≥24	521 (47.71)	0 (0, 0)		31 (30, 31)		17 (15, 20.75)	
Residence			0.308		<0.001		0.214
Urban	1051 (96.25)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
Non-Urban	41 (3.75)	0 (0, 0)		30 (27, 30)		18 (15, 19)	
Education			<0.001		0.490		<0.001
Primary school and below	471 (43.13)	0 (0, 0)		31 (30, 31)		16 (15, 20)	
Middle school, high school, and technical secondary school	569 (52.11)	0 (0, 0)		31 (30, 31)		18 (15, 21)	
Junior college, undergraduate, and above	52 (4.76)	0 (0, 1.75)		31 (30, 36)		21 (16.25, 23)	
Medical related profession			0.150		0.993		<0.001
Yes	69 (6.32)	0 (0, 1)		30 (30, 32)		21 (19, 22.50)	
No	1023 (93.68)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
Physical labor profession			0.415		0.535		<0.001
Yes	227 (20.77)	0 (0, 1)		30 (30, 32)		21 (19, 22)	
No	865 (79.14)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
Monthly income (Yuan)			<0.001		<0.001		0.390
<2,000	22 (2.01)	0 (0, 0)		30 (29.75, 30)		18.50 (14, 22.25)	
2,000–5,000	770 (70.51)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
5,000–10,000	249 (22.80)	0 (0, 1)		35 (30, 39)		18 (15, 20)	
>10,000	51 (4.67)	0 (0, 7)		36 (30, 40)		19 (16, 21)	
Medical insurance			0.002		0.005		<0.001
Yes	1031 (94.41)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
No	61 (5.59)	0 (0, 0)		30 (30, 31)		21 (18, 22)	
Number of comorbidities			0.005		0.092		0.034
None	289 (26.47)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
1	519 (47.53)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
2	241 (22.07)	0 (0, 1)		30 (30, 33)		18 (15, 21)	
3	36 (3.30)	0 (0, 1)		33 (30, 39.75)		16 (13, 18)	
4	7 (0.64)	0 (0, 1)		34 (30, 36)		20 (16, 22)	
Self-care			0.101		<0.001		0.093
Yes	1047 (95.88)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
No	45 (4.12)	0 (0, 1)		30 (29, 30)		17 (12.50, 21)	
Smoking			0.481		0.005		0.848
Yes	109 (9.98)	0 (0, 0)		30 (30, 31)		17 (15, 21)	
No	983 (90.02)	0 (0, 0)		31 (30, 31)		17 (15, 21)	
Drinking			0.373		0.129		0.947
Yes	244 (22.34)	0 (0, 0)		30 (30, 31)		17 (15, 21)	
No	848 (77.66)	0 (0, 0)		31 (30, 31)		17 (15, 21)	

SD: standard deviation. Comparison was performed using Wilcoxon-Mann-Whitney test (between two groups) or Kruskal-Wallis analysis (among 3 or more groups).

questionnaires were included in the analysis. The post hoc CFA indicated that the questionnaire fits the KAP model well (Supplementary Fig. S1 and Supplementary Table S1). The participants were 73.20 ± 5.51 years old, and the majority were females (622 [56.96 %]), living in urban areas (1051 [96.25 %]), with middle school/high school/technical secondary school education (569 [52.11 %]), were not in a medical-related profession (1023 [93.68 %]), were not in a physical labor profession (865 [79.14 %]), with medical insurance (1031 [94.41 %]), with comorbidities (803 [73.53 %]), able to self-care (1047 [95.88 %]), not smoking (983 [90.02 %]), and not drinking (848 [77.66 %]) (Table 1).

3.2. Knowledge

The median knowledge score was 0 (IQR: [0,0]) (possible range: 0–22), and the majority of participants had a knowledge score “0”, indicating insufficient knowledge. Higher knowledge scores were more likely to be observed in participants with higher education (P < 0.001), higher income (P < 0.001), and with medical insurance (P = 0.021) (Table 1). All knowledge items were with insufficient awareness, with the poorest being K7 (9.16 %; “Are you aware of the ways of self-screening for sarcopenia?”) and the best being K1 (15.76 %; “Sarcopenia is a disease associated with increasing age and is mainly characterized by loss of muscle mass and muscle strength”) (Supplementary Table S2).

3.3. Attitudes

The median attitude score was 31 (IQR: [30, 31]) (possible range: 8–40), suggesting moderate attitude. Higher attitude scores were more likely to be observed in females (P = 0.009), participants with urban residence (P < 0.001), higher monthly income (P < 0.001), medical insurance (P = 0.005), able to self-care (P < 0.001), and not smoking (P = 0.005) (Table 1). The item with the lowest attitude score was A7 (2.61 ± 1.02; “I would feel uncomfortable if I had to change my habits to prevent/treat sarcopenia”), while the items with the highest score were A5 (4.14 ± 0.58; “All the elderly have to be prevented from developing sarcopenia”) and A6 (4.14 ± 0.57; “Sarcopenia is a preventable and treatable disease”) (Supplementary Table S3).

3.4. Practices

The median practice score was 17 (IQR: [15, 21]) (possible range: 6–30), indicating moderate practice. Higher practice scores were more likely to be observed in participants with male gender (P = 0.001), higher education (P < 0.001), a career in the medical field (P < 0.001), work involving physical labor (P < 0.001), those without medical insurance (P < 0.001), and with four comorbidities (P = 0.034) (Table 1). The item with the lowest score was P3 (2.23 ± 1.14; “I will undergo regular nutritional risk assessment and receive nutritional interventions as prescribed by my doctor.”), while the item with the highest score was P2 (3.73 ± 0.85; “The frequency of my consumption of high-protein foods [e.g., meat, eggs, milk, soya products, etc.]”) (Supplementary Table S4).

3.5. Correlations among KAP dimensions

Spearman correlation analysis showed the knowledge scores were correlated with the attitude (r = 0.142, P < 0.001) and practice (r =

0.230, P < 0.001) scores, and the attitude scores were correlated with the practice scores (r = 0.153, P < 0.001) (Table 2).

3.6. Structural equation modeling

The SEM showed that knowledge directly positively influenced attitude (β = 0.121, P < 0.001) and practice (β = 0.171, P < 0.001). Attitude directly positively influenced practice (β = 0.116, P < 0.001); therefore, the knowledge showed an indirect influence on practice via attitude (Fig. 1 and Table 3). The model fit was good (RMSEA=0, IFI=1, TLI=1, and CFI=1).

4. Discussion

This cross-sectional study examined the KAP towards sarcopenia among older adults in two cities in Zhejiang province, China. The results showed that the participants had insufficient knowledge but moderate attitudes and practices toward sarcopenia. Knowledge positively influenced attitude and practice, while attitude positively influenced practice. This study is clinically significant as it emphasizes the fact that older adults are not aware of the symptoms, possible complications and health impacts, and prevention and management of sarcopenia. Since sarcopenia has significant negative influences on the quality of life and life expectancy of older adults, it is imperative to design interventions to improve knowledge about sarcopenia to improve self-management and patient outcomes.

The available data about the KAP toward sarcopenia is limited and is mostly indirect. Indeed, Che et al. (Che et al., 2022) performed a qualitative study that reported specific barriers to physical activity in patients with diabetes and sarcopenia. In Jordania, Hammouh et al. (Hammouh et al., 2023) reported poor KAP toward an adequate diet among older adults. Physical inactivity and a poor diet are two major factors involved in sarcopenia (Cruz-Jentoft et al., 2019). A study in The Netherlands reported limited knowledge of sarcopenia but a relatively good willingness to participate in treatment and prevention among community-dwelling adults (Van Ancum et al., 2020), supporting the present study. A study in China showed that a higher score of dietary knowledge was protective in maintaining muscle mass in adults ≥ 60 years old (Liu et al., 2023). Indeed, the present study reported very insufficient knowledge but moderate attitude and practice, suggesting that older adults generally follow advice without understanding it. Nevertheless, the daily management of sarcopenia is mainly centered on the individuals (i.e., having good life habits), and adequate knowledge is required to check for warning signs for consultation and perform proper prevention.

In this study, a higher monthly income and a higher education were positively associated with knowledge, consistent with a higher health literacy observed in individuals with a higher socioeconomic status (Svendensen et al., 2020). Notably, most participants had a low or middle education, a low income, and could care for themselves. Still, the population is representative of the Zhejiang area, where the socioeconomic status is lower than in large cities like Beijing.

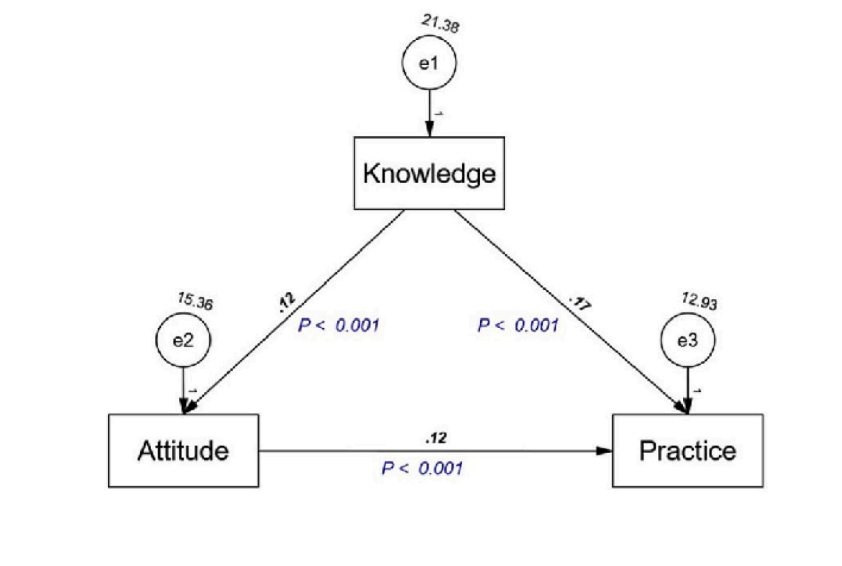
Still, despite the disparity between knowledge and attitude and practice scores, improving knowledge should also improve attitude and practice. Indeed, according to the KAP theory, knowledge is the basis for practice, while attitude is the driving force supporting practice. The SEM analysis showed direct influences of knowledge on attitude and practice. Therefore, improving the knowledge of older adults on sarcopenia should also improve their attitude and practice, which could translate into a better prognosis. Adequate educational material and interventions should be designed.

The willingness to perform self-management is essential to the adequate prevention of sarcopenia. A previous study showed that 71 % of the participants were willing to increase their protein intake and physical activity level to prevent sarcopenia, while 8 % were unwilling to make any changes (Van Ancum et al., 2020). The patients remain the

Table 2

Correlation analysis of knowledge, attitude, and practice toward sarcopenia among older adults in two cities (Yongkang and Shaoxing) in Zhejiang Province, China (n = 1092), April 2023 – January 2024.

	Knowledge	Attitude	Practice
Knowledge	1		
Attitude	0.142 (P < 0.001)	1	
Practice	0.230 (P < 0.001)	0.153 (P < 0.001)	1



Indicator	Reference	Results
RMSEA	<0.08 is good	0
IFI	>0.8 is good	1
TLI	>0.8 is good	1
CFI	>0.8 is good	1

Fig. 1. The structural equation modeling of knowledge, attitude, and practice toward sarcopenia among older adults in two cities (Yongkang and Shaoxing) in Zhejiang Province, China (n = 1092), April 2023 – January 2024.

Table 3

Structural equation modeling of knowledge, attitude, and practice toward sarcopenia among older adults in two cities (Yongkang and Shaoxing) in Zhejiang Province, China (n = 1092), April 2023 – January 2024.

			β	P
Attitude	<—	Knowledge	0.121	<0.001
Practice	<—	Knowledge	0.171	<0.001
Practice	<—	Attitude	0.116	<0.001

penultimate guarantor of their health, and they should be properly motivated to do so. Wang *et al.* (Wang *et al.*, 2022) reported that an Internet-based intervention was effective in improving both protein intake and muscle mass in older adults with sarcopenia. Hence, finding the right tool to target the right population is key. In the present study, 5.31 % of the participants had a poor willingness to change bad lifestyle habits, 6.78 % toward increasing high-protein foods, 66.48 % toward undergoing nutritional assessments and following the prescribed diet, 52.02 % toward going to the hospital for checkups, 23.72 % toward maintaining a moderate level of physical activity, and 56.32 % toward learning and mastering sarcopenia self-screening. These results suggest points requiring intervention in the general population.

Of note, healthcare providers are a primary source of health-related knowledge for many patients (Alduraywish *et al.*, 2020; Swoboda *et al.*, 2018). The KAP of healthcare providers was not examined in the present study, but previous studies indicated that the KAP toward sarcopenia of healthcare providers in other countries was relatively poor (Lu *et al.*, 2023; Reijnierse *et al.*, 2017; Silva *et al.*, 2020). A review of six papers showed that healthcare providers have a low awareness of sarcopenia, which could be detrimental to the prompt diagnosis and management of sarcopenia (Yao *et al.*, 2022). It should be examined in Zhejiang province in future studies.

This study had limitations. The study was conducted in four medical

centers across two cities in Zhejiang province, resulting in a relatively small sample size, and the study population may not be representative of Zhejiang province. The cross-sectional nature of the survey prevented any conclusion regarding causality. The SEM provided some surrogate results about causality among KAP dimensions and factors, but it must be stressed that the causality was inferred statistically and was not directly observed (Beran and Violato, 2010; Fan *et al.*, 2016; Kline, 2023). In addition, the present study could serve as a historical baseline to examine the impact of a future educational intervention on KAP. Like all KAP studies, the questionnaire was designed by local investigators based on local clinical practice, guidelines, and policies, limiting generalizability. Finally, all qualitative and KAP studies are at risk of social desirability bias, in which the participants answer what they know they should do instead of what they are doing (Bergen and Labonte, 2020; Latkin *et al.*, 2017). Still, that bias is less likely in the present study, considering that knowledge was very insufficient. Finally, cognitive functions can influence the KAP. Mild cognitive impairment is frequent in older adults, but it was not evaluated in the present study.

In conclusion, older adults in Shaoxing and Yongkang (Zhejiang province, China) had insufficient knowledge but moderate attitudes and practices toward sarcopenia. It is imperative to design interventions to improve knowledge about sarcopenia to improve self-management and patient outcomes, particularly in older adults of lower socioeconomic status.

4.1. Ethics approval and consent to participate

This work has been carried out in accordance with the Declaration of Helsinki (2000) of the World Medical Association. This study was approved by the Academic Ethics Committee of Shaoxing People's Hospital [IEC-K-AF-067-1.0], and all participants provided written informed consent.

Consent for Publication

Not applicable.

5. Authors' contributions

Mengqi Li and Chenghui Zhang carried out the studies, participated in collecting data, and drafted the manuscript. Haigang Sun and Suying Shi performed the statistical analysis and participated in its design. Hong Fan and Beiyan Ma participated in the acquisition, analysis, or interpretation of data and drafted the manuscript. All authors read and approved the final manuscript.

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CRedit authorship contribution statement

Hong Fan: Writing – original draft, Investigation, Formal analysis, Data curation. **Mengqi Li:** Writing – original draft, Investigation, Data curation. **Chenghui Zhang:** Writing – original draft, Investigation, Data curation. **Haigang Sun:** Data curation, Conceptualization. **Suying Shi:** Data curation, Conceptualization. **Beiyan Ma:** Writing – original draft, Investigation, Formal analysis, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2024.102833>.

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