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Risk Factors and Screening Model for Sarcopenia among Community-Dwelling Older Adults: Development and Internal Validation with a WeChat Mini-Program Tool

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Research Article

Keywords: community-dwelling older adults, sarcopenia, risk factors, screening model, WeChat mini-program

Posted Date: August 7th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10171949/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

Sarcopenia impairs elderly health, yet routine large-scale community screening is limited by costly equipment. This study developed a convenient sarcopenia screening model and supporting WeChat mini-program based on regular physical examination data.

Methods

A total of 626 community-dwelling older adults ≥ 60 years from XX were enrolled and randomly split into development (n = 438) and internal validation (n = 188) cohorts at a 7:3 ratio. Binary logistic regression identified independent risk factors to build the predictive model. Model performance was assessed via AUC, Hosmer–Lemeshow test and Youden index.

Results

Overall sarcopenia prevalence was 15.8%. Female sex, lower BMI, infrequent exercise, shorter single exercise duration, reduced serum albumin and total cholesterol were independent risk factors. The model achieved excellent discrimination (AUC = 0.983 for derivation, AUC = 0.947 for validation) and good calibration. A WeChat mini-program was established for rapid risk calculation with an optimal cut-off of 45.22%.

Conclusions

This easy-operating screening model and matched mini-program facilitate non-invasive primary care sarcopenia screening; further external multi-centre validation is needed.

1. Introduction

Sarcopenia is an age-related geriatric syndrome characterised by the progressive loss of skeletal muscle mass and function, and it substantially increases older adults' risk of falls, frailty, disability, hospitalisation and death. Reported prevalence among community-dwelling older adults in China varies widely, from approximately 4.2% to 38.8%, with an overall estimate of around 17% [1, 2]. Within primary health care systems, the ongoing management of chronic disease and the monitoring of functional status in older adults—together with the early identification of conditions such as sarcopenia—are largely undertaken by community and primary care nurses, making early detection an important responsibility of community nursing. However, because it has an insidious onset and is often mistaken for normal ageing, sarcopenia receives little attention from community-dwelling older adults and their families. In addition, the high cost and operational complexity of the equipment needed to assess muscle mass, strength and

physical performance, together with shortages of specialist staff, make it difficult for community nurses to undertake large-scale active screening within their routine work.

The internationally accepted diagnostic criteria depend on three assessments—muscle mass, muscle strength and physical performance—that are difficult to perform routinely in community nursing settings. Existing brief screening tools such as the SARC-F questionnaire have some value but require separate administration, depend on older adults' cooperation, and add to an already heavy community nursing workload; in Asian older populations the SARC-F has been reported to have a sensitivity of only approximately 30%–50%, with a correspondingly high risk of missed cases [3]. Although recent studies have sought to develop sarcopenia risk models, most rely on a single category of variables or are presented in formats—such as nomograms—that remain insufficiently intuitive and convenient for primary care nursing practice, and are therefore difficult to embed in nurses' daily workflows. A risk-screening tool is therefore needed that requires no additional testing and that community nurses can apply directly within existing health-check and follow-up workflows.

Under China's National Basic Public Health Service Programme, the routine health examinations of adults aged 65 years and older are conducted largely with the involvement of community and primary care nurses, and the relevant indicators—anthropometric measurements, lifestyle enquiries and blood biochemistry, among others—are already obtained as part of routine nursing care, requiring no additional testing. Against this background, the present study aimed to (1) identify factors independently associated with prevalent sarcopenia in community-dwelling older adults; (2) develop and internally validate a sarcopenia risk-identification model based on the routine health-check indicators already collected by nurses; and (3) translate this model into a WeChat mini-program suitable for point-of-care use by community nurses, providing rapid, non-invasive and visual risk assessment to support nurse-led opportunistic screening and early nursing intervention.

2. Materials and Methods

2.1 Study design and participants

This was a single-centre cross-sectional study reported in accordance with the TRIPOD (Transparent Reporting of a multivariable prediction model for Individual Prognosis Or Diagnosis) statement[4]. Because the outcome was prevalent (rather than incident) sarcopenia, the model is best characterised as a diagnostic identification model rather than a prognostic prediction model. From December 2021 to July 2022, a combined random cluster and convenience sampling strategy was used to recruit community-dwelling adults aged ≥ 60 years from two community health-service centres (XX) in XX.

Inclusion criteria were: (1) age ≥ 60 years and long-term residence in the community; (2) complete personal and clinical data; (3) basic ability to communicate and understand; and (4) provision of written informed consent. Exclusion criteria were: (1) comorbid wasting diseases such as malignant tumours; (2) acute changes in body composition (e.g. dehydration or oedema); (3) recent use of diuretics or other

metabolism-modifying medications; (4) presence of metallic implants (e.g. cardiac pacemakers or metal plates); (5) overt physical disability (e.g. inability to grip or walk, or limb amputation); and (6) severe cardiac, hepatic or renal disease.

2.2 Sample size calculation and grouping

Sample size was justified from two perspectives: prevalence estimation and screening-model construction.

For the cross-sectional prevalence estimation, the following formula was applied: $n = u_{\alpha/2}^2 * pq/d^2$, where n is the required sample size, $u_{\alpha/2} = 1.96$, the previously reported prevalence of sarcopenia among community-dwelling older adults in mainland China was 17%[1] ($p = 0.17$ and $q = 1 - p = 0.83$), and the permissible error d was 5%. This yielded n = 217; after adjustment for an anticipated 15%-20% loss to follow-up, approximately 261 participants were required. With a 7:3 split between development and validation cohorts, the validation cohort required approximately 112 participants, giving a minimum total of 373.

For the screening-model perspective, the events-per-variable (EPV) principle was applied. In the development cohort, 71 sarcopenia events were observed and 7 degrees of freedom were ultimately retained in the regression model, yielding EPV ≈ 10 and meeting the commonly used EPV ≥ 10 threshold. The study finally enrolled 626 participants (development cohort, n = 438; validation cohort, n = 188), satisfying the requirements above.

Handling of missing data. In accordance with the inclusion criteria, only participants with complete data were enrolled; thus, a complete-case analysis was performed and no variable entered into the analysis contained missing values.

2.3 Measurements and instruments

All data were derived from the older-adult health-examination component of China's National Basic Public Health Service specifications and supplemented by a systematic literature review to determine the candidate variables. These included general information (age, sex, ethnicity, occupation, education, marital status), personal information (BMI, waist circumference, blood pressure, etc.), lifestyle (frequency of physical exercise, duration of each exercise session, dietary habits, smoking, alcohol use, etc.) and laboratory investigations (haemoglobin, serum albumin, total cholesterol, etc.). The measurement and collection of candidate predictors were carried out independently of the outcome assessment, with data captured by routine community health-examination workflows, in order to minimize measurement bias.

2.4 Diagnostic criteria for sarcopenia

Sarcopenia was diagnosed by licensed clinicians according to the 2019 Asian Working Group for Sarcopenia (AWGS) criteria[5], and outcome assessment was performed independently of candidate predictor collection. Three components were evaluated simultaneously. Muscle mass was assessed by

bioelectrical impedance analysis (Tanita BC-601) to measure appendicular skeletal muscle mass, and the skeletal muscle mass index (SMI) was calculated as appendicular skeletal muscle mass divided by height squared. Muscle strength was assessed by handgrip strength of the dominant hand measured with an electronic dynamometer (Camry EH101), with the higher of two measurements retained. Physical performance was assessed by 6-metre usual-pace gait speed measured with a stopwatch, with the average of repeated measurements retained. The cut-offs were: low muscle mass, SMI < 7.0 kg/m² for men and < 5.7 kg/m² for women; low muscle strength, handgrip < 28 kg for men and < 18 kg for women; and low physical performance, 6-metre gait speed < 1.0 m/s. Participants with low muscle mass plus low muscle strength and/or low physical performance were diagnosed with sarcopenia.

2.5 Statistical analysis

Data were analysed using SPSS version 25.0. Continuous variables with a normal distribution were expressed as mean ± standard deviation and compared between groups using the independent-samples t-test; non-normally distributed continuous variables were expressed as median (interquartile range) and compared using the Mann-Whitney U test. Categorical variables were expressed as frequency (percentage) and compared using the χ^2 test.

Variable selection and model building. With prevalent sarcopenia as the dependent variable, variables with $P < 0.05$ in univariate analyses were entered into a stepwise binary logistic regression, and odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. The reference categories for categorical variables were as follows: sex, female (female = 0, male = 1); frequency of physical exercise, “exercising every day”. The screening model was constructed from the regression coefficients as $Z=\text{constant} + \Sigma(\beta i \times Xi)$, with risk probability $P = 1 / [1 + \exp(-Z)]$.

Model performance. (1) Discrimination was assessed by plotting the ROC curve and calculating the AUC and its 95% CI, together with sensitivity and specificity. (2) Calibration was assessed by the Hosmer-Lemeshow test and the calibration plot. (3) Clinical utility was assessed using the Youden index to determine the optimal cut-off.

Model validation. Internal validation was performed using the random split-sample (7:3) approach: data from the validation cohort were input into the model and the above discrimination and calibration assessments were repeated. No independent external cohort was available, so external validation was not performed. All tests were two-sided, and statistical significance was set at $\alpha = 0.05$.

2.6 Development of the WeChat mini-program

The mini-program was built on the HTML5 platform, with source code written in JavaScript, compiled and debugged in HBuilderX, and then uploaded to the WeChat Developer Platform for release. Based on the logistic regression model described above, the mini-program automatically computes an individual’s risk probability of sarcopenia from six input variables: sex, BMI, frequency of physical exercise (daily / ≥1 time per week / occasional), duration of each exercise session (minutes), serum albumin (g/L) and total

cholesterol (mmol/L). When the output probability exceeds the optimal cut-off (P = 45.22%), the user is alerted that the individual is at high risk.

2.7 Ethics approval

This study was approved by the Medical Ethics Committee of XX University (approval number: XX). All participants provided written informed consent, and the study was conducted in accordance with the principles of the Declaration of Helsinki.

3. Results

3.1 Baseline characteristics of participants

A total of 626 community-dwelling older adults aged 60–95 years (mean age 71.72 ± 5.38 years) were enrolled, including 258 men (41.2%) and 368 women (58.8%). The sample was randomly split at a 7:3 ratio into a development cohort (n = 438) and an internal validation cohort (n = 188). There were no statistically significant differences in baseline characteristics,including age, sex, ethnicity, education and marital status, between the two cohorts ($P > 0.05$), indicating good comparability (**Supplementary Table S1**). The baseline characteristics of the development cohort are presented in Table 1.

Table 1
Baseline characteristics of community-dwelling older adults (development cohort).

Variable	Participants (n = 438)
Age (years), mean ± SD	71.47 ± 5.31
Sex, n (%)	
Male	182 (41.6)
Female	256 (58.4)
Ethnicity, n (%)	
Han	285 (65.1)
Bai	122 (27.9)
Other	31 (7.0)
Former occupation, n (%)	
Public-sector / enterprise managers	9 (2.1)
Professional / technical staff	44 (10.0)
Clerical staff	51 (11.6)
Commerce / service industries	52 (11.9)
Agriculture / forestry / animal husbandry / fishery	214 (48.9)
Production / transport equipment operators	53 (12.1)
Military	0 (0.0)
Unclassified	4 (0.9)
Unemployed	11 (2.5)
Education, n (%)	
Postgraduate	0 (0.0)
Bachelor’s	4 (0.9)
Junior college	11 (2.5)
Secondary specialised school	44 (10.0)
Technical school	6 (1.4)
Senior high school	47 (10.7)
Junior high school	94 (21.5)

Variable	Participants (n = 438)
Primary school	187 (42.7)
Illiterate / semi-illiterate	45 (10.3)
Marital status, n (%)	
Unmarried	0 (0.0)
Married	374 (85.4)
Divorced	30 (6.8)
Widowed	34 (7.8)
Not specified	0 (0.0)

3.2 Prevalence of sarcopenia

In the full sample, 99 participants were diagnosed with sarcopenia, giving an overall prevalence of 15.8%. The prevalence was 11.2% (29/258) in men and 19.0% (70/368) in women, with women being significantly more affected than men. The prevalence was 16.2% (71/438) in the development cohort and 14.9% (28/188) in the validation cohort.

3.3 Univariate analyses

In the development cohort, univariate analyses were carried out using the presence of sarcopenia as the dependent variable. Compared with the non-sarcopenia group, the sarcopenia group differed significantly with respect to age, sex, BMI, waist circumference, frequency of physical exercise, mode of exercise, duration of each exercise session, length of time exercise had been sustained, dietary habits, smoking status, haemoglobin, serum albumin, total cholesterol and dentition (all $P < 0.05$) (**Supplementary Table S2**).

3.4 Multivariable logistic regression and construction of the screening model

Variables that were statistically significant in the univariate analyses were entered into a stepwise binary logistic regression; variable coding is shown in **Supplementary Table S3**. Six variables were identified as independent factors associated with sarcopenia in community-dwelling older adults: lower BMI (OR = 0.496, 95% CI 0.364–0.677, $P < 0.001$); sex (with women as the reference, OR = 0.149, 95% CI 0.033–0.671, $P = 0.013$); frequency of physical exercise - occasional (with “exercising every day” as the reference, OR = 13.902, 95% CI 2.538–76.155, $P = 0.002$) and ≥ 1 time per week but not daily (OR = 13.722, 95% CI 1.058-178.054, $P = 0.045$); shorter duration of each exercise session (OR = 0.905, 95% CI 0.849–0.964, $P = 0.002$); lower serum albumin (OR = 0.930, 95% CI 0.866–0.999, $P = 0.045$); and lower total cholesterol (OR = 0.348, 95% CI 0.189–0.639, $P = 0.001$) (Table 2).

Table 2
Binary logistic regression analysis of factors associated with sarcopenia in community-dwelling older adults.

Variable	*β*	*SE*	*Wald* χ^2	*P*	*OR*	*95% CI*
Constant	23.595	8.503	7.701	0.006	—	—
BMI	−0.701	0.158	19.582	< 0.001	0.496	0.364–0.677
Sex	−1.906	0.769	6.145	0.013	0.149	0.033–0.671
Frequency of physical exercise	—	—	10.539	0.005	—	—
Occasional (1)	2.632	0.868	9.200	0.002	13.902	2.538–76.155
≥ 1 time per week (2)	2.619	1.308	4.011	0.045	13.722	1.058–178.054
Duration of each exercise session	−0.100	0.033	9.481	0.002	0.905	0.849–0.964
Serum albumin	−0.073	0.036	4.003	0.045	0.930	0.866–0.999
Total cholesterol	−1.056	0.311	11.576	0.001	0.348	0.189–0.639

Based on the regression coefficients above and $P = 1 / [1 + \exp(-Z)]$, the model was specified as:Z = 23.595–0.701×BMI − 1.906×Sex(male = 1,female = 0) + 2.632×[Frequency of exercise (occasional)] + 2.619×[Frequency of exercise (≥ 1 time per week)] − 0.100×Duration of each exercise session (minutes) − 0.073 × Serum albumin (g/L) − 1.056 × Total cholesterol (mmol/L).

3.5 Model performance in the development cohort

Calibration was assessed by the H-L test, which yielded χ^2=3.649 and P = 0.887 (> 0.05), indicating that the model fitted the observed occurrence of sarcopenia well in community-dwelling older adults. The calibration plot showed close agreement between the observed and the ideal (45°) line, again indicating good calibration (Fig. 1). Discrimination was assessed by plotting the ROC curve and calculating the AUC (Fig. 2); the AUC was 0.983 (95% CI 0.971–0.995, P < 0.001), indicating excellent discrimination. The maximum Youden index was 0.865, corresponding to an optimal cut-off probability of 0.452, sensitivity of 0.873, specificity of 0.992, a positive likelihood ratio of 109.130 and a negative likelihood ratio of 0.130, supporting the model's clinical utility.

3.6 Model validation in the internal validation cohort

The 188 participants in the validation cohort were entered into the model for internal validation; baseline characteristics of the development and validation cohorts are compared in **Supplementary Table S1**.

Calibration. The H-L test yielded P = 0.927, indicating good goodness-of-fit. The calibration plot showed substantial overlap between the two curves, indicating good calibration and a high level of agreement between the predicted probabilities and the actual occurrence of sarcopenia (**Supplementary Figure S1**).

Discrimination. The AUC of the ROC curve was 0.947 (95% CI 0.894–0.998), with a maximum Youden index of 0.873, sensitivity of 0.929 and specificity of 0.944, indicating that the model retained good discrimination in the validation cohort **(**Fig. 3).

Using the optimal cut-off, the model classified 37 participants in the validation cohort as high risk and 151 as low risk for sarcopenia; the actual diagnoses comprised 28 cases with prevalent sarcopenia and 160 without. Cross-tabulation (Table 3) showed 26 true positives, 11 false positives, 2 false negatives and 149 true negatives, giving a positive predictive value of 26/37 = 70.27%, a negative predictive value of 149/151 = 98.67%, an overall accuracy of (26 + 149)/188 = 93.08% and Cohen's kappa of 0.759, indicating good agreement between the model classification and the actual diagnosis.

Table 3
Cross-tabulation of actual and model-classified sarcopenia status in the validation cohort.

Model classification	Actual sarcopenia: Yes	Actual sarcopenia: No	Total
High risk	26	11	37
Low risk	2	149	151
Total	28	160	188

3.7 WeChat mini-program

Based on the logistic regression model described above, a WeChat mini-program for screening sarcopenia risk in community-dwelling older adults was developed (**Supplementary Figure S2**). Users only need to enter six indicators,sex, BMI, frequency of physical exercise, duration of each exercise session, serum albumin and total cholesterol ,and the mini-program automatically computes the individual's risk probability (P) of sarcopenia. When P exceeds 45.22%, the user is alerted that the individual is at high risk of sarcopenia. The QR code for the mini-program is provided in **Supplementary Figure S3.**

4. Discussion

In this study, the prevalence of sarcopenia among community-dwelling older adults in XX, was 15.8%, broadly consistent with the prevalence of approximately 17% reported in previous Chinese studies. Binary logistic regression identified six independent risk factors for sarcopenia: lower BMI, female sex, lower frequency of physical exercise, shorter duration of each exercise session, lower serum albumin and lower total cholesterol. The screening model constructed from these variables showed excellent discrimination and calibration in both the development cohort (AUC = 0.983; Fig. 2) and the internal

validation cohort (AUC = 0.947; Fig. 3) (Fig. 1; **Supplementary Figure S1**). The accompanying WeChat mini-program (**Supplementary Figures S2 and S3**) provides community health workers with a convenient and non-invasive screening tool. It should be noted that, because of the cross-sectional design, the model identifies prevalent rather than incident sarcopenia and should therefore be regarded as a diagnostic identification tool, not a tool for predicting future onset.

4.1 Prevalence of sarcopenia among community-dwelling older adults

The overall prevalence in this study was 15.8% (11.2% in men and 19.0% in women), which is similar to results from several Chinese studies. The systematic review by Wu et al. estimated a prevalence of approximately 12% in community-dwelling older adults in China; the meta-analysis by Jiang et al. of 23,378 individuals reported 17.00%; and the study by Zhang in the XX area reported 16.83%, all closely consistent with the present results [1, 6, 7]. In our study, the prevalence in women was significantly higher than in men ($P = 0.013$), which is directionally consistent with Zou et al. (approximately 2.46-fold higher risk in women) and with Han et al. (approximately 21.07-fold higher risk in women) [8, 9]. Possible mechanisms include the ability of oestrogen to stimulate regeneration of muscle tissue, enhance myogenin expression and inhibit disuse-related muscle atrophy; postmenopausal women show a marked decline in oestrogen and a weakening of its protective effects on muscle, making older women more susceptible to sarcopenia [10]. International reports of prevalence vary widely (from 1% to 29%), probably reflecting differences in diagnostic criteria (IWGS, EWGSOP, AWGS), assessment tools (DXA, BIA), population characteristics and regional or cultural differences [11].

4.2 Independent factors associated with sarcopenia

4.2.1 Lower BMI

Lower BMI was one of the strongest independent factors in this study (OR = 0.496, 95% CI 0.364–0.677, $P < 0.001$); each one-unit increase in BMI was associated with an approximately 50% reduction in the odds of prevalent sarcopenia. Wu et al. found that each 1 kg/m² increase in BMI was associated with a reduced risk of sarcopenia [12], and the meta-analyses by Luo et al. and Zou et al. confirmed that low BMI is an important risk factor for sarcopenia in community-dwelling older adults [8, 13]. As a simple indicator of nutritional status, low BMI reflects a risk of malnutrition: inadequate intake impairs muscle protein synthesis and reduces muscle mass, whereas higher BMI is associated with greater intramuscular fat infiltration, which may exert a buffering effect [14]. Clinically, attention should also be paid to “sarcopenic obesity”, in which BMI is elevated but muscle mass is reduced; the excess adiposity produces pro-inflammatory cytokines that can indirectly drive skeletal-muscle breakdown [15, 16]. Longitudinal monitoring of BMI and individualized assessment are therefore particularly important.

4.2.2 Sex

With women as the reference, the odds of prevalent sarcopenia were significantly lower in men (OR = 0.149, 95% CI 0.033–0.671, *P* = 0.013), indicating that female sex was an independent risk factor,a finding that is consistent with most studies in China. As noted above, oestrogen plays a key protective role in muscle metabolism; Cheng et al. showed that oestrogen can activate satellite cells and promote muscle regeneration via oestrogen-receptor signalling, and that the sharp drop in oestrogen after menopause reduces muscle protein synthesis while increasing breakdown[17]. Hansen suggests that, after rigorous assessment, hormone replacement therapy may be considered in older women with a particularly rapid decline in oestrogen[18]. It is worth noting that some international studies (such as Chatzipetrou et al.) have identified male sex as the risk factor, whereas the large meta-analysis by Gao et al. found no association between sex and sarcopenia[19, 20, 21], suggesting that the effect of sex may show regional and population-specific variation.

4.2.3 Lower frequency of physical exercise

Compared with participants who exercised every day, both occasional exercisers (OR = 13.902) and those exercising ≥ 1 time per week but not daily (OR = 13.722) had a significantly higher risk of prevalent sarcopenia. A systematic review by Beaudart et al. of 34 randomized controlled trials reported that exercise improved muscle mass, muscle strength and physical performance in most studies[22]. The molecular mechanisms by which exercise protects muscle include attenuating mitochondrial oxidative stress and dysfunction, increasing skeletal-muscle respiratory capacity and energy synthesis, and reducing the rate of muscle catabolism [23]. Regular exercise can also maximize improvements in overall mitochondrial function, thereby enhancing skeletal-muscle performance[24]. However, gains in muscle mass are not stable: once exercise stops, accumulated muscle mass is gradually lost and can no longer be maintained one year later[25]. Older adults should therefore maintain a regular exercise frequency tailored to their tolerance.

4.2.4 Duration of each exercise session

A longer duration of each exercise session was associated with a lower risk of prevalent sarcopenia (OR = 0.905, 95% CI 0.849–0.964, *P* = 0.002). Because older adults' exercise tolerance is reduced, low-to-moderate intensity is generally preferred; appropriately extending the duration of each session to compensate for the lower intensity is particularly important. Wu et al. recommended approximately 30 minutes of moderate-intensity resistance training 2–3 times per week and approximately 60 minutes of low-intensity aerobic exercise ≥ 3 times per week [26]. Quantitative research on the specific exercise duration required in sarcopenia interventions for older adults remains limited; choices are largely based on individuals' self-perceived tolerance and are therefore somewhat subjective [27]. Future studies could use muscle-oxygen monitoring [28] to derive individualized exercise intensity and duration by measuring the relative haemoglobin concentration in muscle microcirculation during exercise, thereby optimizing the prevention and treatment of sarcopenia.

4.2.5 Lower serum albumin

In our study, serum albumin was a protective factor against sarcopenia (OR = 0.930, 95% CI 0.866–0.999, *P* = 0.045). A systematic review and meta-analysis by Picca et al. of 4,904 older adults from nine countries confirmed a negative association between albumin and sarcopenia [29]. The meta-analysis by Silva-Fhon et al. (14 studies) similarly found higher albumin levels in non-sarcopenic older adults[30]. Wang recommended serum albumin as a reference blood biochemical indicator for both the diagnosis and treatment of sarcopenia[31].

Albumin is an important indicator of inflammatory and nutritional status. Low albumin levels may reflect malnutrition or chronic inflammation, both of which are important drivers of sarcopenia. Papadopoulou et al. emphasized that nutritional intervention is one of the core non-pharmacological strategies for preventing sarcopenia[32]. In clinical practice, close attention should be paid to serum albumin levels in older adults so that nutritional risk can be assessed in a timely manner. However, the meta-analysis by Chen et al. in older patients with type 2 diabetes mellitus found no association between sarcopenia and albumin[33], suggesting that in specific disease populations the association may be masked by other factors and warrants further investigation.

4.2.6 Lower total cholesterol

In our study, total cholesterol was also a protective factor against sarcopenia (OR = 0.348, 95%CI 0.189–0.639, *P* = 0.001). A meta-analysis by Du et al. of 16 studies (803,022 participants) similarly found a close association between total cholesterol and sarcopenia, with lower total cholesterol levels in individuals with sarcopenia[34]. Findings from Lai et al. and others support the same conclusion [35, 36, 37, 38].

Cholesterol is a precursor of adrenocortical hormones, growth hormone and sex hormones (such as oestradiol and testosterone), all of which play key roles in promoting muscle growth [39, 40]. In addition, as an indicator of nutritional status, cholesterol levels can indirectly reflect the nutritional state of older adults. Some studies, however, have reported opposite findings. Gong et al. found that total cholesterol was higher in individuals with sarcopenia than in controls, and Hida et al. reported similar findings[41, 42]. These discrepancies may be related to differences in laboratory assay methods, instrument precision and participants' physiological states, and warrant further investigation.

4.3 Performance of the screening model

The sarcopenia screening model constructed in this study had an AUC of 0.983 in the development cohort (sensitivity0.873, specificity0.992) and 0.947 in the validation cohort (sensitivity 0.929, specificity 0.944). Both indicators were markedly superior to those reported in comparable studies: the machine-learning model of Kang et al. had an AUC of 0.780–0.820 [43], the nomogram of Mo et al. had an AUC of 0.755–0.827[44], and the Taiwan Risk Score for Sarcopenia by Tseng et al. had an AUC of 0.757[45].

The model also performed well in terms of calibration: the H-L test yielded P = 0.887 in the development cohort and *P* = 0.927 in the validation cohort, and the calibration plots (Fig. 1; **Supplementary Figure S1**) showed close agreement between the predicted probabilities and the observed rates. By contrast, the

studies by Kang et al. and Tseng et al. did not report H-L test results, which limits the credibility of their models[43, 45].

It should be acknowledged, however, that the relatively high AUC of the model may in part reflect the fact that the development and validation sets were obtained by random splitting of a single sample drawn from the same centre and population; as this constitutes internal validation only, the model's true discriminative ability may be overestimated. In addition, the large point estimate and wide confidence interval for physical-activity frequency suggest possible data sparsity or quasi-separation for this variable. The robustness and generalisability of the model therefore require further testing in independent populations (see Limitations). From a nursing perspective, the model's high negative predictive value (98.67%) is particularly useful, as it reliably rules out low-risk older adults and allows community nurses to concentrate their limited staffing and follow-up resources on those at genuinely high risk.

4.4 Relevance to Clinical Practice

The principal value of the model and its accompanying WeChat mini-program lies in their ability to be embedded within community nurses' existing workflows. During the older-adult health examinations conducted under the National Basic Public Health Service Programme, nurses need only enter the six routinely collected indicators (sex, BMI, physical-activity frequency, duration of each exercise session, albumin and total cholesterol), and the mini-program automatically computes each individual's risk probability and flags high or low risk (cut-off P = 45.22%). Because this requires no additional tests, equipment or questionnaires, it adds virtually nothing to the nursing workload, enabling community nurses to identify older adults at high risk of sarcopenia as a routine part of follow-up—that is, to perform "opportunistic screening".

Second, most of the factors included in the model are modifiable—physical-activity frequency and duration, together with the nutritional status reflected by albumin and cholesterol—and these are precisely the targets of nursing intervention and health education. Guided by risk stratification, nurses can prioritise exercise counselling, nutritional assessment and, where necessary, referral for high-risk older adults, thereby linking screening directly to intervention. Third, the high negative predictive value allows nurses to reliably exclude low-risk individuals, improving the efficient use of resources. Finally, the WeChat mini-program is more intuitive than nomograms or scoring formulae, is readily disseminated in primary care nursing, and can serve as a visual aid for nurse–patient communication and health education. Taken together, this study offers community nurses a burden-free, practical and scalable pathway for sarcopenia screening and early intervention, with tangible implications for advancing nurse-led health management of older adults.

5. Innovations

The novelty of this study lies chiefly at the level of nursing application. First, unlike previous models that focused mainly on demographic and anthropometric indicators, this study incorporated two serum

biochemical markers—albumin and total cholesterol—into community-based sarcopenia screening, all of which are derived from data already collected by nurses during routine health examinations. Second, physical activity was disaggregated into two dimensions, "frequency" and "duration per session", rather than a general notion of "exercise habit", providing nurses with more specific targets for tailored exercise counselling. Third, the model was built entirely on routine health-check data specified by the National Basic Public Health Service standards, requires no additional workload for community nurses, and is therefore highly feasible in practice. Fourth, the use of a WeChat mini-program in place of traditional formats such as nomograms is better suited to point-of-care use and health education in primary care nursing **(Supplementary Figures S2 and S3)**. It should be emphasised that the principal contribution of this study lies not in the novelty of the modelling algorithm itself, but in proposing a nurse-led, burden-free pathway for opportunistic sarcopenia screening that can be embedded within existing workflows.

6. Limitations

This study has several limitations. First, the sample was drawn from only two community health-service centres in XX; sample representativeness is therefore limited, and the generalizability of the model needs to be further evaluated by external validation in additional regions and larger samples. Second, the cross-sectional design precludes causal inferences regarding the relationships between the identified risk factors and sarcopenia; the model is intended for the identification of prevalent rather than incident disease. Third, some predictors (such as the frequency of physical exercise and duration of each exercise session) were collected by self-report, which may be subject to recall bias; the wide confidence intervals for these variables also raise the possibility of data sparsity or quasi-separation, and the results should therefore be interpreted with caution. Fourth, potentially important variables such as dietary nutrient intake (e.g. protein and vitamin D) were not included; these variables may have important effects on the occurrence of sarcopenia. Fifth, only a random split-sample internal validation in the same population was performed; an independent external validation cohort is lacking, and the calibration slope and intercept and the decision-curve analysis were not reported.

7. Conclusions and Significance

In conclusion, among community-dwelling older adults in China, lower BMI, female sex, lower physical-activity frequency, shorter duration of each exercise session, lower albumin and lower total cholesterol were independently associated with prevalent sarcopenia. A risk-identification model built on these indicators—already collected by community nurses during routine health examinations—showed good discrimination and calibration in both the development and internal validation sets. It should be noted that the model is designed to identify prevalent sarcopenia and is thus a diagnostic identification model rather than a tool for predicting future incidence.

The practical significance of this study is that the accompanying WeChat mini-program enables community nurses to identify older adults at high risk of sarcopenia within their existing workflows, without additional testing or workload, and to deliver risk-stratified exercise counselling, nutritional

assessment and early health education—thereby supporting nurse-led community health management of older adults in line with the goals of Healthy China and active ageing. Given that this was a single-centre, cross-sectional study with internal validation only, and that the high AUC may reflect optimism bias while some variables suggest data sparsity or quasi-separation, the model's robustness and generalisability still need to be confirmed in independent, multicentre, prospective populations—incorporating penalised regression with optimism correction, external validation and decision curve analysis—before it can be safely applied more widely in community nursing practice.

Relevance to Clinical Practice

The principal clinical value of this study lies in its direct applicability to community nursing practice. The sarcopenia risk-identification model is constructed entirely from six indicators that are already collected as part of routine older-adult health examinations under China's National Basic Public Health Service Programme: sex, BMI, frequency of physical exercise, duration of each exercise session, serum albumin and total cholesterol. Because no additional testing, specialist equipment or questionnaire administration is required, adoption imposes virtually no extra burden on community nurses and is therefore feasible at scale.

The accompanying WeChat mini-program operationalises the model for point-of-care use. During or immediately after the routine health check, a nurse enters the six values and receives an automatically computed sarcopenia risk probability; a probability exceeding the optimal cut-off (45.22%) triggers a high-risk alert. This enables opportunistic screening to be embedded within existing follow-up workflows—that is, sarcopenia risk can be flagged at the same visit as other chronic-disease monitoring, without a separate appointment or referral pathway.

The modifiable nature of most risk factors identified in this model—physical-activity frequency, exercise duration, serum albumin and total cholesterol—means that identification of high-risk individuals can be coupled directly to targeted nursing intervention. Guided by the model output, community nurses can deliver tailored exercise counselling, initiate nutritional assessment and, where appropriate, refer high-risk individuals for further evaluation or multidisciplinary intervention, thereby linking screening to early intervention in a single workflow step. The model's high negative predictive value (98.67%) further enables nurses to reliably exclude low-risk individuals, improving the efficient allocation of the limited community nursing workforce.

Although developed in a Chinese primary care context, the core approach—building a validated screening model from routinely collected health-examination data and delivering it through a mobile digital tool—is transferable to other health systems where community nurses conduct periodic older-adult health checks. The model should nonetheless be prospectively validated in independent, multicentre cohorts before broader implementation, and the mini-program should be adapted to local workflows and regulatory requirements in other settings.

Declarations

Data Availability

The datasets generated and analyzed during the current study are not publicly available due to privacy restrictions on participant data, but are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Medical Ethics Committee of Dali University (approval number: MECDU-202111-7) and was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants.

Author Contributions

MJZ conceived and designed the study. MJZ and TTS ,XQM collected the data. MJZ performed the statistical analysis and interpreted the results. MJZ developed the WeChat mini-program. MJZ and TTS drafted the manuscript. TTS supervised the study and critically revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Funding

This work was supported by the Department of Education of Yunnan Province (grant number 2022Y878). The funder had no role in study design, data collection and analysis, the decision to publish, or preparation of the manuscript.

Conflict of Interest

The authors declare that they have no competing interests.

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Figures

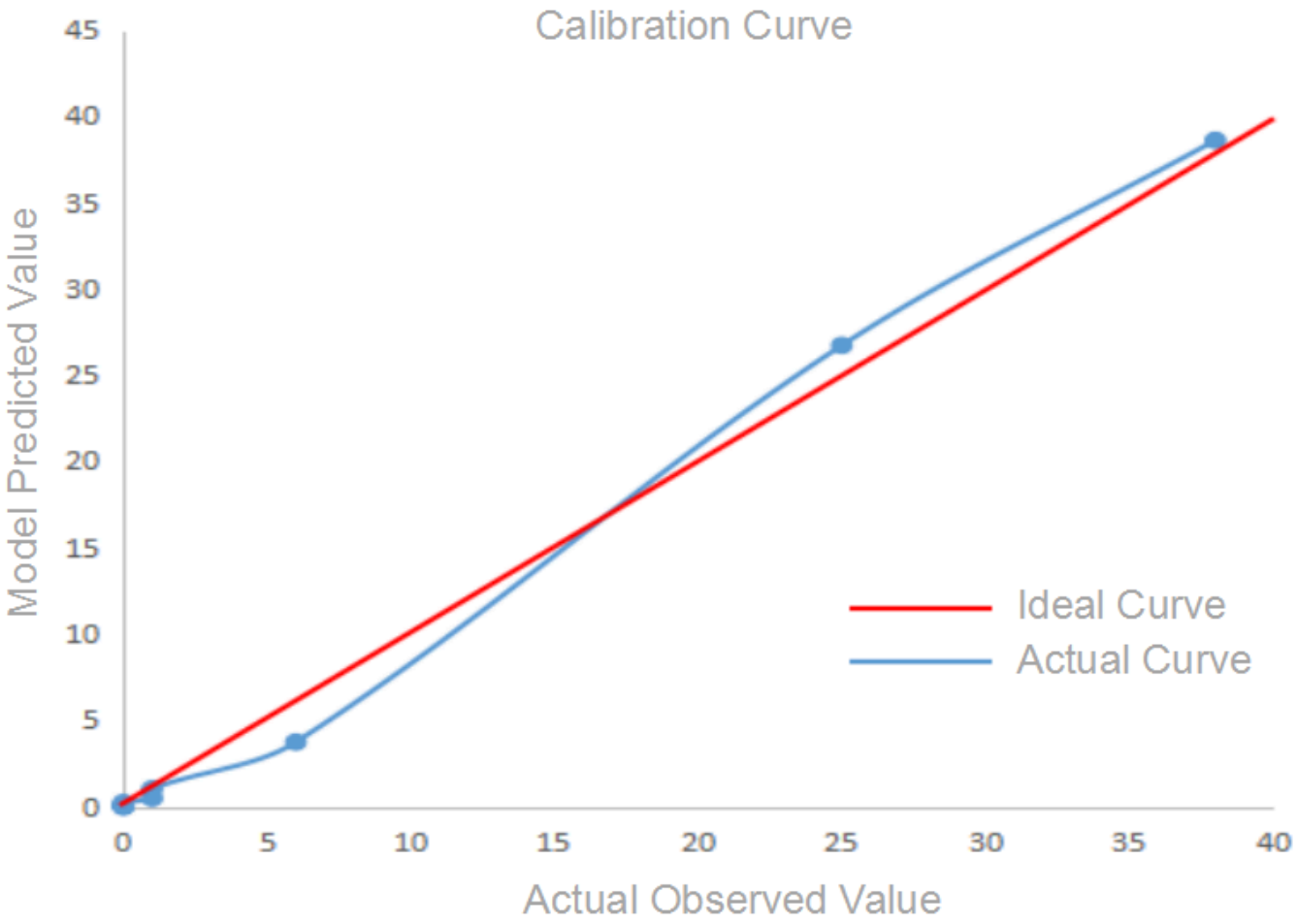


Figure 1

Calibration plot of the logistic regression model in the development cohort.

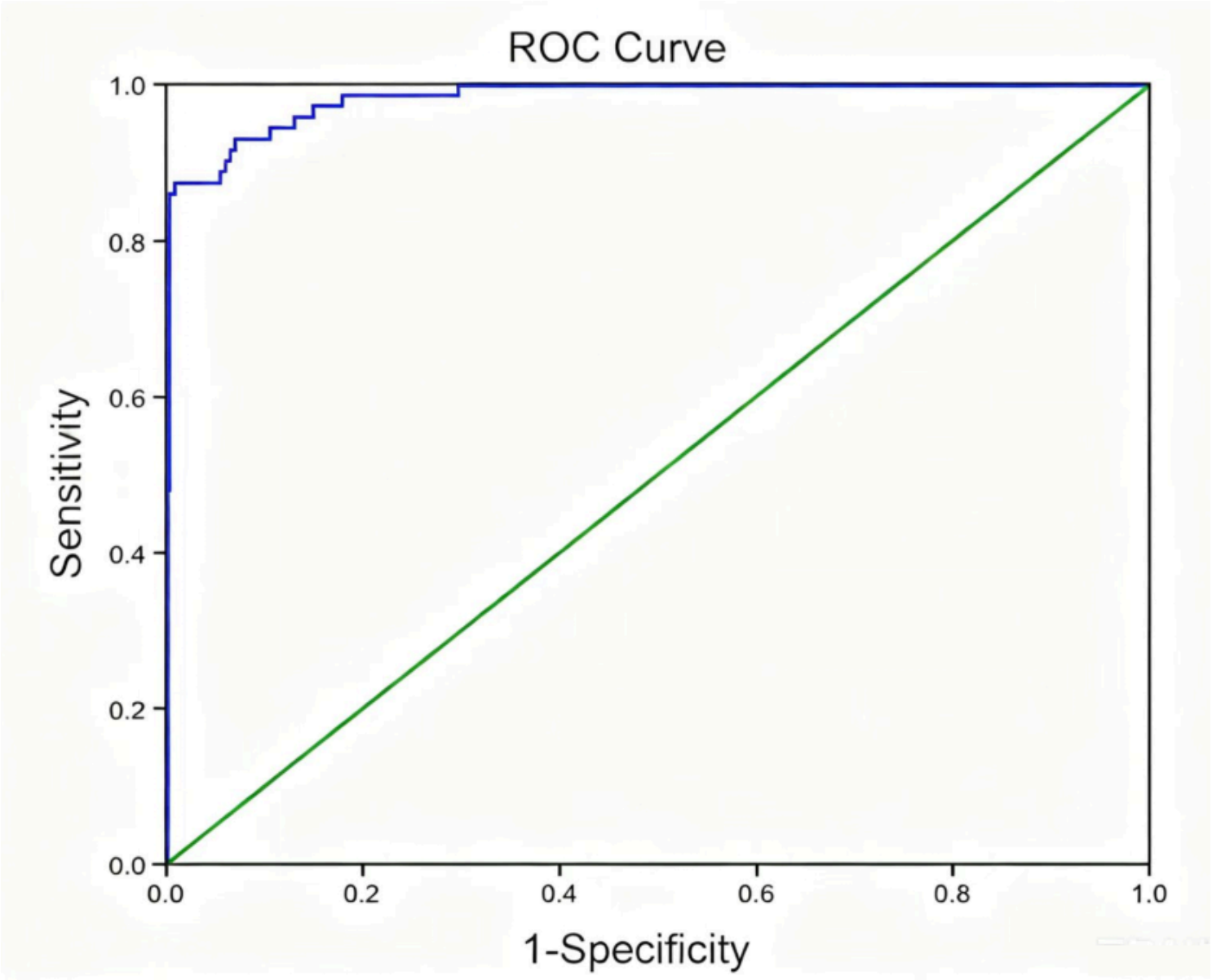


Figure 2

ROC curve of the sarcopenia screening model in the development cohort.

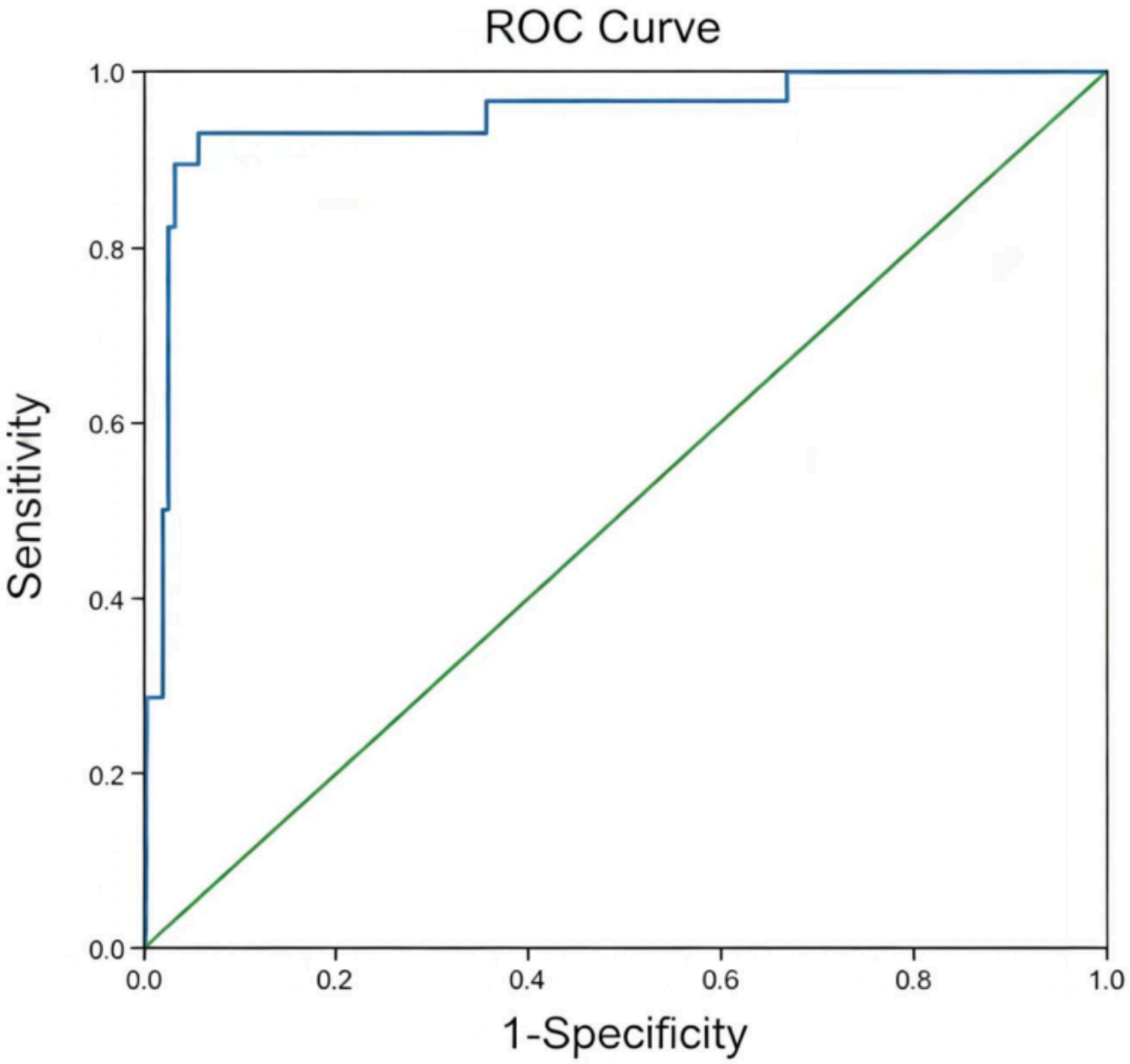


Figure 3

ROC curve of the sarcopenia screening model in the validation cohort.

Supplementary Files

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