Development of a Sarcopenia Score for Sarcopenia Screening in Community-Dwelling Older Adults

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Abstract

Background: Sarcopenia is common among community-dwelling older adults and is associated with increased risks of falls, disability, and mortality. Although several screening tools exist, many require specialized equipment or show limited diagnostic accuracy in community settings. Practical clinical prediction models using easily obtainable variables are therefore needed.

Objective: To develop and internally validate a simple clinical prediction model and scoring system for screening sarcopenia in community-dwelling older adults.

Materials and Methods: A cross-sectional study was conducted among 1,474 adults aged ≥60 years in Nan Municipality, Thailand (January to December 2024). Sarcopenia was defined using handgrip strength according to the Asian Working Group for Sarcopenia (AWGS) 2019 criteria. Clinical variables included sex, age, body mass index (BMI), Timed Up and Go (TUG) test, and SARC-F questionnaire score. Logistic regression analysis was used to identify independent predictors of sarcopenia. A sarcopenia score (SS) was derived from multivariate beta coefficients and internally validated using receiver operating characteristic (ROC) analysis.

Results: Sarcopenia was identified in 731 participants (49.6%). Independent predictors included male sex (adjusted OR 3.43), age ≥70 years (adjusted OR 2.78), BMI <20 kg/m^2 (adjusted OR 1.82), TUG ≥12 seconds (adjusted OR 2.50), and SARC-F score ≥4 (adjusted OR 3.34) (all p<0.001). The SS ranged from 0 to 8.5 points and demonstrated good discrimination (AUC 0.756; 95% CI: 0.732–0.781). An optimal cut-off score of 2.25 yielded a sensitivity of 60.1% and specificity of 78.1%. The SS showed higher overall accuracy (69.1%) than TUG or SARC-F alone.

Conclusion: The SS is a simple, low-cost, and practical screening tool that may support early identification of sarcopenia among community-dwelling older adults in primary care settings.

Keywords: Predictive model; Sarcopenia; Screening; Handgrip strength; Older adults

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Sarcopenia, an age-related loss of skeletal muscle mass and strength, is a common condition among older adults. Sarcopenia is characterized by a progressive decline in muscle quantity and function with advancing age and represents a major public health concern in aging societies. The global prevalence of sarcopenia has been reported to range from approximately 9.9% to 40.4%, depending on the diagnostic criteria and population studied[1-5]. Sarcopenia has substantial clinical consequences, including an increased risk of falls, physical disability, reduced quality of life, and long-term mortality. Therefore, effective screening strategies are essential for the early identification of

What is already known about this topic?

Sarcopenia is a common yet under-recognized public health problem among community-dwelling older adults and is strongly associated with adverse outcomes, including falls, functional decline, disability, and mortality. Early identification is essential for prevention and timely intervention; however, standard diagnostic approaches often require specialized equipment, trained personnel, and substantial resources, limiting their applicability in primary care and community settings. Although simple screening tools, such as the SARC-F questionnaire and physical performance tests, are widely used, their limited sensitivity when applied as standalone tools reduces their effectiveness for population-level screening. Consequently, there is a need for feasible, accurate, and resource-efficient screening approaches that can be integrated into routine primary care and public health services, particularly in community-based and resource-limited settings such as India.

What does this study add?

This study proposes a simple and clinically applicable SS using routinely available variables. The score demonstrated good discrimination for identifying the risk of sarcopenia in community-dwelling older adults. This supports early risk stratification in primary care and community screening settings. These findings provide practical evidence for population-based sarcopenia screening in resource-limited contexts.

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sarcopenia among older adults and for facilitating timely intervention.

International consensus guidelines, such as those proposed by the Asian Working Group for Sarcopenia (AWGS)[2], recommend that the diagnosis of sarcopenia should be based on a combination of muscle strength assessment (e.g., handgrip strength), physical performance measures (e.g., gait speed and the Timed Up and Go test), and evaluation of muscle mass using dual-energy X-ray absorptiometry (DXA) or bioelectrical impedance analysis (BIA). However, the use of DXA and BIA in community settings is often limited by high costs, the need for specialized equipment, and limited feasibility in primary care or field-based screening environments. As a result, simple screening tools such as the SARC-F questionnaire, which comprises items on strength, assistance with walking, rising from a chair, climbing stairs, and falls, have been widely adopted in community settings. Despite its simplicity and practicality, SARC-F has demonstrated limited diagnostic performance, particularly with a low sensitivity for identifying probable sarcopenia, which restricts its effectiveness as a standalone community screening tool[6]. In contrast, handgrip strength is widely recognized as a core indicator of overall muscle strength and a key component in the diagnosis of sarcopenia. Moreover, handgrip strength is non-invasive, inexpensive, quick to perform, and feasible in community and primary care settings, making it a practical reference standard for screening sarcopenia. Evidence from systematic reviews and meta-analyses further supports the strong relationship between low handgrip strength and sarcopenia across diverse populations, underscoring its value for integration into clinical prediction models aimed at improving community-based screening strategies[7].

Previous studies have identified several clinical factors that are significantly associated with sarcopenia, including advanced age, male sex, low body mass index (BMI), and impaired functional mobility, as assessed by the Timed Up and Go (TUG) or similar tests. These factors provide an opportunity to develop clinical prediction models that integrate readily available clinical information to improve the early detection of the disease. Evidence from Asian populations, including studies conducted in Taiwan, has shown that older age, male sex, and poorer performance on mobility tests, such as the 8-foot up-and-go test, are important predictors of sarcopenia among older adults[8]. Nevertheless, despite the availability of multiple screening approaches, there is a lack of simple, low-cost, and accurate clinical prediction models specifically designed for community use. Models that combine basic demographic variables (age, sex, BMI), functional performance measures (e.g., TUG), and screening questionnaires (e.g., SARC-F), while using handgrip strength as a reference standard, are still limited.

Thailand is rapidly transitioning into an aging society, making sarcopenia an increasingly important public health issue[9]. National studies in Thai community-dwelling older adults have demonstrated that low BMI, older age, and prolonged TUG time are strongly associated with sarcopenia[10,11]. However, these factors have not yet been integrated into a practical clinical prediction model suitable for real-world community screening purposes. Evidence from China using the AWGS 2019 framework has shown that "screening-to-diagnosis" approaches combining SARC-F, calf circumference, handgrip strength, and BIA can be effective in community-based preventive services[12]. However, similar integrated models adapted to the Thai community context are lacking.

Therefore, developing a simple, cost-effective, and accurate clinical prediction model for screening sarcopenia among community-dwelling older adults is both timely and necessary. Such a model has the potential to support proactive community-based screening, facilitate early intervention, and ultimately reduce functional decline and disability in the aging population.

Materials and Methods

This cross-sectional study was conducted using a retrospective chart review of data obtained from a community-based older adult screening program carried out between January 1 and December 31, 2024. The study population consisted of community-dwelling older adults aged ≥60 years residing in Nai Wiang Subdistrict, Mueang Nan District, Nan Province, Thailand. According to the Health Data Center (HDC), a total of 4,729 older adults were eligible in the study area. 1,749 individuals participated in a community-based screening program, and their data were extracted from the electronic medical record database of Nan Hospital. Eligible participants were those who were able to attend and complete the screening assessment. The exclusion criteria were as follows: 1) diagnosed cognitive impairment or dementia that limited the ability to understand and cooperate with the screening procedures, 2) acute or exacerbated musculoskeletal disorders of the lower extremities, and 3) inability to ambulate safely at a normal walking speed on a flat

surface. In addition, participants with incomplete data on key variables, including the TUG test, handgrip strength, or SARC-F questionnaire, were excluded from the analysis. After applying these criteria, a total of 1,474 participants were included in the final analysis.

Data Collection and Assessment Tools: Functional mobility was assessed using the TUG test. Participants were instructed to rise from a standard armchair, walk 3 m to a marked line, turn, walk back, and sit down. The time required to complete each task was recorded in seconds. A TUG time ≥12 seconds was defined as indicating impaired mobility and increased fall risk. The risk of sarcopenia was assessed using the five-item SARC-F questionnaire, which evaluates strength, assistance with walking, rising from a chair, climbing stairs, and falls. The total score ranges from 0 to 10, with higher scores reflecting greater functional difficulty. A SARC-F score ≥4 was considered a positive screen for sarcopenia risk. Handgrip strength was measured using a hydraulic hand dynamometer, according to standardized protocols. Measurements were performed with the participants seated, the shoulder adducted, and the elbow flexed at 90°. Each participant performed three maximal isometric contractions for each hand with a 30-second rest interval between trials. The highest value obtained from the dominant hand was used for the analyses.

Sarcopenia in this study was defined as probable sarcopenia based on low muscle strength, assessed using handgrip strength in accordance with the AWGS 2019 criteria. The cut-off values were <28 kg for men and <18 kg for women. Muscle mass was not assessed using imaging techniques such as DXA or BIA due to their limited availability in community-based screening programs and primary care settings in the study area. Therefore, this study focused on identifying individuals with probable sarcopenia, consistent with the "screening-first" approach recommended by current international guidelines.

The following clinical variables were collected: sex, age, body weight, height, BMI, TUG time, and SARC-F score. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m²). Variables were categorized as follows: age (60-69 years vs. ≥70 years), BMI (<20 kg/m² vs. ≥20 kg/m²), TUG (<12 seconds vs. ≥12 seconds), and SARC-F score (<4 vs. ≥4). Importantly, SARC-F was not used in the diagnostic criteria for sarcopenia but was included as an independent predictor variable in the model. The outcome (probable sarcopenia) was defined solely based on handgrip strength according to the AWGS 2019 criteria.

The sample size was calculated to support the development of a clinical prediction model using logistic regression analysis. The calculation was based on the events per variable (EPV) principle, which recommends a minimum of 10 outcome events per independent variable to ensure model stability[13]. Five candidate predictors (age, sex, BMI, TUG, and SARC-F) were planned for inclusion, resulting in a minimum requirement of 50 probable sarcopenia events. Assuming a prevalence of probable sarcopenia of approximately 15% among community-dwelling older adults, the required sample size was calculated as $50 / 0.15 \approx 334$ participants. To account for potential missing or incomplete data, an additional 10% was added, yielding the minimum required sample size of 372 participants.

The sarcopenia score (SS) was developed using a three-step statistical analysis. First, univariate logistic regression analyses were performed to examine the association between each clinical variable and probable sarcopenia. Variables with a p-value less than 0.20 were entered into a multivariate logistic regression model using the enter method. Variables with p-values less than 0.05 in the multivariate model were retained as final predictors. Second, a point-based scoring system was constructed by dividing each regression coefficient (beta) by the smallest coefficient among the selected predictors and rounding to the nearest 0.5 to facilitate its clinical applicability. Third, the scoring system was internally validated using receiver operating characteristic (ROC) curve analysis. Model discrimination was assessed using the area under the ROC curve (AUC), and the optimal cutoff point was determined using Youden's index.

The clinical characteristics were summarized using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Independent samples t-tests were used to compare the continuous variables between the groups. Logistic regression analyses were performed to identify the predictors of probable sarcopenia, with results presented as adjusted odds ratios (ORs) and 95% confidence intervals (CIs). The diagnostic performance of the SS was evaluated using ROC curve analysis, including sensitivity and specificity. Statistical significance was set at p-value less than 0.05. All analyses were performed using standard statistical software.

This study was approved by the Research Ethics Committee of Nan Hospital (Nan Hos. REC No.062/2567). All data were anonymized before analysis to ensure participant confidentiality.

Table 1. Baseline characteristics of participants stratified by sarcopenia status (n=1,474)

Clinical factors	n (%)			p-value
	Number of populations	Number of sarcopenia	Number of non-sarcopenia	
Sex: male	576 (39.1)	368 (63.9)	208 (36.1)	<0.001
Age group ≥70 years	658 (44.6)	442 (67.2)	216 (32.8)	<0.001
BMI <20 kg/m^2	235 (15.9)	151 (64.3)	84 (35.7)	<0.001
TUG ≥12 seconds	395 (26.8)	278 (70.4)	117 (39.6)	<0.001
SARC-F ≥4	127 (8.6)	105 (82.7)	22 (17.3)	<0.001

BMI=body mass index; TUG=Timed Up and Go test

Table 2. Univariate logistic regression analysis of clinical factors associated with sarcopenia

Clinical factors	Number of sarcopenia n (%)	Odds ratio	95% confidence interval	p-value*
Sex: male	368 (63.9)	2.61	2.101 to 3.236	<0.001
Age ≥70 years	442 (67.2)	3.73	3.004 to 4.635	<0.001
BMI <20 kg/m^2	151 (64.3)	2.04	1.530 to 2.727	<0.001
TUG ≥12 seconds	278 (70.4)	3.28	2.564 to 4.206	<0.001
SARC-F ≥4	105 (82.7)	5.50	3.429 to 8.812	<0.001

BMI=body mass index; TUG=Timed Up and Go test

Results

A total of 1,474 community-dwelling older adults were included in the analysis, comprising 576 men (39.1%) and 898 women (60.9%). The mean age was 69.7±6.5 years, with more than half of the participants aged 60-69 years (55.4%). The mean BMI was 23.6±3.8 kg/m², and 235 participants (15.9%) had a BMI <20 kg/m². The mean TUG time was 11.4±4.6 seconds, and 395 participants (26.8%) had TUG times ≥12 seconds. SARC-F score ≥4 was observed in 127 participants (8.6%). Baseline characteristics are summarized in Table 1. The mean handgrip strength of the dominant hand was 21.8±6.9 kg. For descriptive purposes, the mean handgrip strengths of the left and right hands were 20.2±6.8 kg and 20.8±7.1 kg, respectively. The dominant-hand value was used for defining sarcopenia and for all statistical analyses, whereas bilateral measurements were reported for descriptive purposes only. Based on the handgrip strength criteria, 731 participants (49.6%) were classified as having probable sarcopenia.

In univariate logistic regression analyses, sex, age, BMI, TUG performance, and SARC-F score were all significantly associated with probable sarcopenia (all p<0.05) (Table 2). These variables were subsequently included in a multivariate logistic regression model. After adjustment for potential confounders, all five factors remained independently associated with probable sarcopenia, confirming their robust and independent contributions to sarcopenia risk (Table 3). Significant independent predictors included male sex (adjusted OR 3.43, p<0.001), age ≥70 years (adjusted OR 2.78, p<0.001), BMI <20 kg/m² (adjusted OR 1.82, p<0.001), TUG ≥12 seconds (adjusted OR 2.50, p<0.001), SARC-F score ≥4 (adjusted OR 3.34, p<0.001), A clinical risk score, termed the SS, was developed based on the beta coefficients from the final multivariate logistic regression model. Each coefficient was standardized by dividing by the smallest coefficient and rounded to the nearest 0.5 to enhance clinical usability. The resulting SS ranged from 0 to 8.5 points, with higher scores indicating an increased risk of sarcopenia.

ROC curve analysis demonstrated good discrimination of the SS, with AUC of 0.756 (95% CI 0.732 to 0.781, p<0.001) (Figure 1). Using Youden's index, the optimal cut-off value was 2.25 points, yielding a sensitivity of 60.1% and specificity of 78.1% (Table 4). At this cut-off, the SS demonstrated a sensitivity of 72.9%, specificity of 66.5%, positive predictive value of 60.1%, negative predictive value of 78.1%, and an overall accuracy of 69.1%.

Compared with the individual screening tools, the SS showed a superior overall performance

Table 3. Multivariate logistic regression analysis of clinical factors associated with sarcopenia

Clinical factors	Beta coefficients	Adjusted odds ratio	95% confidence interval	p-value*	Ratio	Score
Sex: male	1.231	3.43	2.690 to 4.361	<0.001	2.07	2.0
Age ≥70 years	1.021	2.78	2.187 to 3.526	<0.001	1.71	2.0
BMI <20 kg/m^2	0.596	1.82	1.315 to 2.506	<0.001	1.00	1.0
TUG ≥12 seconds	0.915	2.50	1.865 to 3.339	<0.001	1.54	1.5
SARC-F ≥4	1.205	3.34	1.983 to 5.614	<0.001	2.02	2.0

BMI=body mass index; TUG=Timed Up and Go test
* p<0.05, considered statistically significant
Total sarcopenia score=8.5

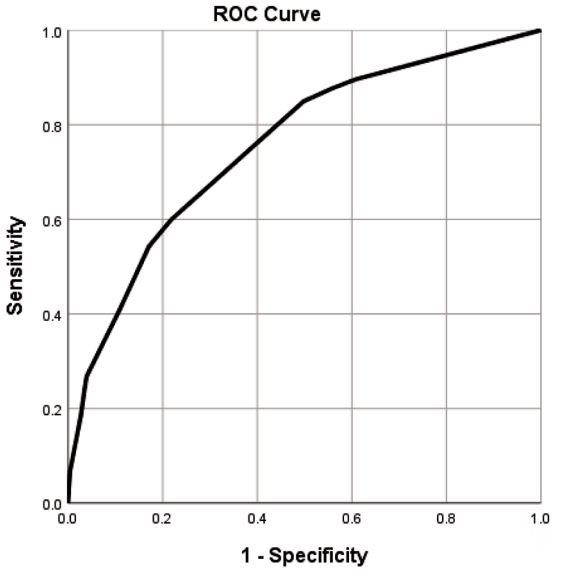

Figure 1. Receiver operating characteristic (ROC) curve of the sarcopenia score derived from the predictive model for sarcopenia.

Table 4. The optimal cutoff value for the sarcopenia score in predicting sarcopenia using Youden's index

Sarcopenia score	Sensitivity (%)	Specificity (%)	Youden's index
1.250	87.7	44.1	0.318
1.750	85.0	50.2	0.352
2.250	60.1	78.1	0.381*
2.750	59.8	78.3	0.381
3.250	54.3	82.9	0.372
3.750	40.9	89.1	0.300

* Cutoff value of sarcopenia score=2.25, sensitivity=60.1%, specificity=78.1%

Table 5. Comparison of the predictive performance of the sarcopenia score with the use of TUG or SARC-F alone for predicting sarcopenia

Clinical factor	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Sarcopenia score ≥2.25	72.9	66.5	60.1	78.1	69.1
TUG ≥12 seconds	70.4	58.0	38.0	84.3	61.3
SARC-F ≥4	82.7	53.5	14.4	97.0	56.0

TUG=Timed Up and Go test; PPV=positive predictive value; NPV=negative predictive value

(Table 5). A TUG score ≥12 s alone yielded a sensitivity of 70.4%, specificity of 58.0%, and accuracy of 61.3%, whereas a SARC-F score ≥4 demonstrated high sensitivity (82.7%) but low specificity (53.5%) and accuracy (56.0%).

Overall, the SS provided a more balanced diagnostic performance than either TUG or SARC-F alone for identifying sarcopenia in community-dwelling older adults.

Discussion

This study developed and validated a simple clinical prediction score for sarcopenia in community-dwelling older adults using routinely available clinical variables. The proposed SS, which incorporates sex, age, BMI, TUG test, and SARC-F questionnaire, demonstrated good discriminative ability with an AUC of 0.756 and outperformed commonly used single screening tools such as TUG or SARC-F alone[14,15]. These findings support the utility of a combined, clinically pragmatic approach to sarcopenia screening in community and primary care settings[16,17].

All five clinical factors included in the final model were independently associated with sarcopenia. Male sex emerged as the strongest predictor, consistent with prior evidence suggesting that age-related declines in muscle mass and strength may be more pronounced in older men, particularly after retirement and a reduction in physical activity[18]. Advanced age (≥70 years) is also strongly associated with sarcopenia, reflecting cumulative physiological changes, including hormonal alterations, neuromuscular degeneration, and chronic inflammation[18,19]. A low BMI (<20 kg/m²) was independently associated with sarcopenia, highlighting the role of undernutrition and reduced energy reserves in muscle wasting. Although BMI does not directly measure muscle mass, it remains a readily available surrogate marker in community settings[2,19]. Functional impairment, as measured by TUG ≥12 seconds, reflects deficits in lower extremity strength, balance, and coordination, which are key components affected early in sarcopenia[20,21]. Similarly, a SARC-F score ≥4, despite its known limitations in sensitivity[22,23], remained an important predictor when combined with objective and anthropometric measurements[14,23].

The SS demonstrated a more balanced diagnostic performance than the individual tools. Although SARC-F alone showed high sensitivity, its low specificity and positive predictive value limit its use as a standalone screening test[22-24]. Conversely, TUG alone showed moderate sensitivity and specificity but lacked sufficient accuracy[21,25]. By integrating demographic, anthropometric, functional, and self-reported domains, the SS improved the overall predictive accuracy and enabled clinically interpretable risk stratification, consistent with guideline-recommended multidimensional screening approaches[2,19]. The optimal cut-off score of 2.25 points yielded acceptable sensitivity and specificity, aligning with the goal of community-level screening,

where identifying individuals at higher risk for further assessment or intervention is prioritized over definitive diagnosis[19,26]. Importantly, the score relies solely on measures feasible in primary care and community health services without requiring specialized equipment such as DXA or BIA[2,19].

Current international guidelines, including those from the AWGS, recommend a stepwise approach that combines screening, functional assessment, and confirmatory measurement of muscle mass[2,19]. However, implementing these recommendations remains challenging in resource-limited community settings[27]. The SS aligns with the "screening-first" concept but extends existing approaches by providing a quantitative risk score that integrates commonly assessed variables into a single tool[1,2]. Compared with previous prediction models developed in hospital-based or research settings[28,29], this study emphasizes the real-world applicability in community-dwelling older adults. The high prevalence of sarcopenia underscores the need for proactive screening strategies tailored to aging populations, particularly in rapidly aging societies[30].

The key strengths of this study include the large sample size, use of objective functional measures, and development of a clinically intuitive scoring system. The model was derived using multivariate analysis and evaluated using the ROC methodology, supporting its internal validity.

The SS offers a screening tool suitable for use by primary care providers, community health workers, and public health programs. Its adoption could facilitate early identification of older adults at risk, enabling timely interventions such as resistance exercise, nutritional support, and fall prevention strategies. Future studies should focus on external validation, longitudinal prediction of adverse outcomes, and integration of the SS into routine community health services.

Limitation

Several limitations of this study should be acknowledged. First, sarcopenia was defined based on handgrip strength (probable sarcopenia) without the direct measurement of muscle mass, which may lead to potential misclassification in some cases. Second, the cross-sectional design precludes causal inference and limits the ability to predict the long-term incidence of the condition. Third, as this study was conducted in a single municipality, the findings may have limited generalizability to other populations; therefore, external validation in diverse communities and primary care settings is required before widespread implementation. Additionally, certain factors such as physical activity, nutritional intake, and comorbidities were not included in the model, which might have further enhanced its predictive performance. Finally, while SARC-F was utilized as a predictor rather than a diagnostic criterion to avoid incorporation bias, its subjective nature should be considered. Despite these limitations, the use of simple, routinely collected variables supports the practical applicability of this scoring system in real-world public health contexts.

Conclusion

The study successfully developed the SS, a simple, low-cost, and practical screening tool that integrates demographic and functional variables. The SS demonstrated a more balanced diagnostic performance and higher overall accuracy than either the TUG test or the SARC-F questionnaire alone. Consequently, this tool is well-suited to supporting the early identification and proactive screening of sarcopenia among community-dwelling older adults in resource-limited primary care settings.

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Authors Contributions

US conceptualized and designed the study, supervised data collection, performed the statistical analysis, and drafted the manuscript. WS contributed to the study design, data interpretation, and critically revised the manuscript for important intellectual content. Both authors read and approved the final manuscript.

Clinical Trial Registration

Not applicable. This study is a cross-sectional diagnostic and predictive model development study and does not involve any clinical intervention or randomized controlled trial; therefore, clinical trial registration was not required.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request. The data are not publicly available due to privacy and ethical restrictions concerning participant information.

Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Committee of Nan Hospital, Thailand (Nan Hos. REC No. 062/2567). Due to the retrospective nature of the study and the use of anonymized data extracted from existing electronic medical records, the ethics committee waived the requirement for informed consent. The study involved no direct contact with participants, and no identifiable personal information was accessed. All procedures were conducted in accordance with the Declaration of Helsinki and relevant ethical guidelines and regulations.

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Use of Artificial Intelligence

During the preparation of this manuscript, the authors utilized Google Gemini for linguistic refinement and Paperpal for grammatical corrections and plagiarism screening. Following these AI-assisted enhancements, the authors meticulously reviewed and edited the manuscript to ensure accuracy. The authors maintain full responsibility for the final content of the published article.

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