Maturitas 180 (2024) 107902

Contents lists available at ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Review article

Quality of life in sarcopenia measured with the SarQoL questionnaire: A meta-analysis of individual patient data

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https://doi.org/10.1016/j.maturitas.2023.107902
Received 21 August 2023; Received in revised form 4 December 2023; Accepted 11 December 2023
Available online 15 December 2023

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ARTICLE INFO

Keywords:
Sarcopenia
Health-related quality of life
SarQoL
Individual-patient data meta-analysis

ABSTRACT

Age-related sarcopenia, resulting from a gradual loss in skeletal muscle mass and strength, is pivotal to the increased prevalence of functional limitation among the older adult community. The purpose of this meta-analysis of individual patient data is to investigate the difference in health-related quality of life between sarcopenic individuals and those without the condition using the Sarcopenia Quality of Life (SarQoL) questionnaire. A protocol was published on PROSPERO. Multiple databases and the grey literature were searched until March 2023 for studies reporting quality of life assessed with the SarQoL for patients with and without sarcopenia. Two researchers conducted the systematic review independently. A two-stage meta-analysis was performed. First, crude (mean difference) and adjusted (beta coefficient) effect sizes were calculated within each database; then, a random effect meta-analysis was applied to pool them. Heterogeneity was measured using the Q-test and I^2 value. Subgroup analyses were performed to investigate the source of potential heterogeneity. The strength of evidence of this association was assessed using GRADE. From the 413 studies identified, 32 were eventually included, of which 10 were unpublished data studies. Sarcopenic participants displayed significantly reduced health-related quality of life compared with non-sarcopenic individuals (mean difference = −12.32; 95 % CI = [−15.27; −9.37]). The model revealed significant heterogeneity. Subgroup analyses revealed a substantial impact of regions, clinical settings, and diagnostic criteria on the difference in health-related quality of life between sarcopenic and non-sarcopenic individuals. The level of evidence was moderate. This meta-analysis of individual patient data suggested that sarcopenia is associated with lower health-related quality of life measured with SarQoL.

1. Introduction

Sarcopenia, consequential from the involuntary loss of muscle mass and function [1], is now recognized as a disease entity and figures in The International Statistical Classification of Diseases and Related Health Problems - Clinical Modification Code (ICD-10-CM, code M62.84) [2]. This multifactorial disease is associated with increased morbidity, mortality, falls, and physical disability and is currently suggested to impact health-related quality of life (HRQoL) [3–7].

Patient-reported outcome measures (PROMs) provide valuable insights into patients' health perspectives for clinicians. Among PROMs, health-related Quality of life can be measured using generic or specific HRQoL questionnaires. While generic tools offer the advantage of applying to any population group allowing comparison between them, specific tools are more sensitive to change as they were developed to evaluate certain diagnostic groups and/or patient populations [8]. Recognizing the need for a specific tool to assess HRQoL in sarcopenia accurately, Beaudart et al. developed the Sarcopenia and Quality of Life (SarQoL) questionnaire [9].

SarQoL is a self-administered questionnaire developed in 2013 comprising 55 items distributed over 22 questions rated on a 4-point Likert scale. The questionnaire is scored, through a scoring algorithm, on 100 points, with higher scores reflecting a better quality of life. Items are organized into seven domains of HRQoL: domain 1 "Physical and Mental Health"; domain 2 "Locomotion"; domain 3 "Body Composition"; domain 4 "Functionality"; domain 5 "Activities of daily living", domain 6 "Leisure activities" and domain 7 "Fears". SarQoL is freely available for clinical and research purposes from the website www.sarqol.org. Up to now, SarQoL is the only validated specific HRQoL questionnaire for sarcopenia [10]. Since its development, SarQoL has been used worldwide thanks to its translation into 35 languages, from which 19 were validated in a sarcopenic population [10]. The psychometric properties of this questionnaire were analyzed according to the taxonomy of the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) [11], which revealed that SarQoL is a reliable tool for assessing HRQoL of patients with sarcopenia.

A recent meta-analysis of 43 published observational studies reported lower quality of life in sarcopenic individuals than in non-sarcopenic individuals, using both generic and specific HRQoL questionnaires. As the authors combined both types of questionnaires, they generated a standardized mean difference (SMD) as an effect size. The pooled SMD of −0.76 (95 % CI −0.95, −0.57) found in this paper represents a significant reduction in HRQoL in sarcopenia [6]. As a limitation of their work, they recognized that, as they only performed an aggregate meta-analysis at the study level, they could not perform some subgroup analyses as they needed access to the individual patient data (IPD) of the included studies [12,13]. Therefore, the purpose of this work was to perform an IPD meta-analysis focusing only on HRQoL measured with the specific SarQoL questionnaire in order to 1) provide more precise outcome measures in the populations for which they were designed, 2) be able to report the mean difference (MD) as an effect size, which is much easier for clinicians to understand and use compared to the SMD, 3) perform subgroup analyses and adjust estimates for confounding factors, and 4) as developers of the SarQoL questionnaire, we have developed collaborations with SarQoL users and believed they would be willing to share their databases with us, allowing us to pooled published and unpublished evidence in our work. This IPD meta-analysis aims to assess the difference in HRQoL between sarcopenic and non-sarcopenic individuals using the SarQoL questionnaire, and to assess the impact of sarcopenia on HRQoL.

2. Methods

A protocol was published and is available on PROSPERO (CRD42023436823). This IPD- meta-analysis was written according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses of individual participant data Statements (PRISMA-IPD) [14]. The completed PRISMA checklist can be found in Appendix A1.

2.1. Search strategy, selection of studies, and data extraction

MEDLINE, Allied and Complementary Medicine (AMED), EMB Review – ACP Journal Club, EBM Review - Cochrane Central of Register of Controlled Trials, APA PsychInfo (via OVID platform for all the mentioned bibliographic databases), EMBASE and Scopus were searched in March 2023 for any study who have used the SarQoL questionnaire to measure HRQoL in individuals with and without sarcopenia. The search strategies for each database can be found in Appendix A2. No language or publication date restriction was applied.

[1] Co-first authors.

Additionally, a manual search within the bibliography of relevant papers was performed. Forward references searching of included studies were conducted using Web of Science to identify other research that has referenced any article of interest. Previous systematic reviews and meta-analyses on a similar topic were also searched for backward/forward referencing. Clinical trial registries (www.clinicaltrial.gov) were also searched for potential unpublished studies. Moreover, as the leading investigators of the present study comprised the developers of SarQoL, additional information sources were also used to search for unpublished literature. Researchers that entered over 100 questionnaires on the SarQoL website, those who contacted the SarQoL team to get access to the scoring database, and those who were involved in the translation of the SarQoL in any language were therefore invited to share their databases, even though no results had been published yet.

The search results from the electronic sources and hand-searching were imported into Covidence software for data management. All identified articles were screened for eligibility, first based on their title and abstract, and secondly based on their full text.

The following data of the selected articles were then extracted according to a standardized data extraction form: article information (first author, title, year and journal of publication, objective), population characteristics (description of total population, sarcopenic and non-sarcopenic groups), and the sarcopenia diagnostic tools (criteria used for the diagnosis) as well as physical measurement instruments for muscle mass, muscle strength, and physical performance.

The Newcastle-Ottawa Quality Assessment Scale (NOS) adapted for cross-sectional studies (developed by Patra et al. [15] and accessible at: https://www.kcgg.ugent.be/pdf/NEWCASTLE-OTTAWA_QUALITY_ASSESSMENT_SCALE.pdf) was used to assess the Quality of these studies, with a maximum of 7 stars. A null score was given to the item of comparability when a significant difference was found between sarcopenic and non-sarcopenic for one or more characteristic variable(s) but was not further explored in multivariate models for its impact on HRQoL.

Study procedure, data extraction, and risk of bias assessment were carried out by two independent reviewers (TN & BC), and any conflicts were resolved by consensus.

2.2. Inclusion and exclusion criteria

The inclusion criteria are summarized in Table 1. Studies were excluded if they did not meet the inclusion criteria; included persons with acute sarcopenia (1); only a screening tool (e.g., the SARC-F) was applied without further diagnosing the condition; investigated pre-/post-operative hospitalized; and sarcopenic obesity was the only objective of the study. If a study database included individuals younger than 60, the latter were excluded from the analyses. Only participants with complete data available for the diagnosis of sarcopenia, for SarQoL and older than 60 years old, were included in the analyses.

Table 1
Inclusion criteria.

Participants	Community-dwelling older adults, hospitalized patients, and/or residents in assisted living facilities over 60 years of age. Participants should be divided into two groups according to the presence of sarcopenia.
Sarcopenia condition	Sarcopenia diagnosis based on at least two biomarkers (e.g., muscle mass + (muscle strength or physical function)) and according to one consensus definition such as EWGSOP1/2 [1,21], Asian Working Group for Sarcopenia (AWGS) [22], Foundation for the National Institutes of Health (FNIH) [23] or any other recognized criteria.
Outcome	HRQoL was measured in all participants (i.e. sarcopenic and non-sarcopenic) using the SarQoL questionnaire
Study design	Observational studies (cross-sectional, prospective cohorts, retrospective cohorts, and case-control studies) Interventional studies with two groups (sarcopenia vs. non-sarcopenic); baseline data were used

2.3. Independent patient data collection

The authors of the eligible published and unpublished studies were contacted via e-mail with a letter of invitation outlining the project goals and asking if they would be willing to collaborate by sharing the specific raw data from their eligible trial. After one month of no reply, the authors were contacted again, and a third attempt was made approximately 15 days following the second contact. All IPDs were checked for integrity. In case of any doubts, authors were contacted for further clarification or to provide us with missing or correct incorrect data. If they are unable to do so, these are considered unavailable.

2.4. Statistical analysis

A two-stage meta-analysis using a random effect model was carried out. The first and second stage analyses were run in the Statistical Package for the Social Sciences (SPSS) version 28.01.0 (142) and R software version R 4.2.3, respectively. A two-sided p-value of 0.05 or less was considered a statistical significance level for all results, except for the heterogeneity, which was significant if the p-value was <0.1 [16].

In the first stage, the mean difference (MD) of HRQoL between sarcopenic and non-sarcopenic was used as effect size, along with its corresponding 95 % confidence interval (95 % CI). To account for potential confounding factors, a multiple linear regression was run within each database using HRQoL as a dependent variable and age, gender, number of drugs, comorbidities, and sarcopenia status as independent variables. Beta coefficients (β) and standard error (SE) from the regressions were reported.

The interaction estimates (MD and beta values) were synthesized in the second stage to produce a summary interaction estimate using a random-effects meta-analysis since heterogeneity was expected across studies. Heterogeneity was assessed using Cochran's Q test and the I^2 statistic. Subgroup analyses were performed according to gender, age, ethnicity, clinical setting, sarcopenia diagnosis criteria, continent, region, publication status, and Quality of studies. As some studies used different diagnosis criteria, we developed a strict procedure to standardize the diagnosis criteria used across trials. For any published studies, the sarcopenia diagnosis criteria used by the authors of original papers was used in our analyses. Nevertheless, when a study provides a prevalence of sarcopenia using multiple diagnostic criteria including the EWGSOP2 criteria, this updated EWGSOP2 criteria was used in the main analyses. For any non-published data, the EWGSOP2 or AWGS criteria were used for Caucasian and Asian populations respectively.

The robustness of the results was evaluated using a sensitivity analysis performed by removing one study at a time (i.e. one-study removed sensitivity analysis). Another sensitivity analysis was performed to investigate the potential influence of aggregate data on the findings. Publication bias was tested using the generation of a funnel plot and the Egger regression test. The Trim and Fill method was applied to estimate its impact on the effect size.

The GRADE (Grading of Recommendations, Assessments, Development, and Evaluation) assessment [17] was used to evaluate the level of evidence (LoE) of the primary outcome. Starting with a high level of evidence, the association was downgraded if the IPD- meta-analysis met one of the following criteria: (1) a high risk of bias (i.e., NOS scale < 2 points) in >75 % of the included studies; (2) significant heterogeneity ($I^2 > 50$ %) that could not be explained, proving inconsistency; (3) factors limiting the generalizability of the results, thus indicating indirectness; (4) imprecise estimates with wide 95 % CI, leading to potential alterations in the recommendations if the actual effect lies within the 95 % CI; (5) significant publication bias.

3. Results

3.1. Characteristics of included studies and participants

The strategy searches conducted identified 358 published articles, including 168 duplicates. From the 190 studies screened based on their title/abstract, 73 were further assessed based on their full text. Ultimately, 19 met the inclusion criteria, and four additional references were unearthed manually. From these 23 published studies, we were able to obtain the individual patient database for 22 of them. Indeed, Le et al. [18] were unable to share their databases due to institutional restrictions. In addition, 51 unpublished studies were identified and requested for retrieval. Of these 51, 15 researchers never responded to our emails, 23 were unable to share the database as they were still collecting data, and 13 agreed to share their database including unpublished data. However, only 10 met our inclusion criteria, as three of these studies diagnosed sarcopenia using different criteria than those accepted for this paper. Consequently, this IPD meta-analysis included 32 studies, 10 of which contained unpublished data (Fig. 1).

Twenty-four studies (i.e., 75 %) used EWGSOP criteria to diagnose sarcopenia (EWGSOP1: n = 8; EWGSOP2: n = 16). AWGS criteria were used in 7 studies and the last study used FNIH criteria (Table 2). In regards of study quality, out of the 22 published studies, two obtained 3 points, seven obtained 4 points, seven obtained 5 points, five obtained 6 points, and one obtained the maximum score of 7 points (NOS scores).

The IPD of 5116 participants was obtained, including 3576 females and 1540 males, with a mean age of 73.74 ± 6.98 years (Table 3). Among those 5116 participants, 1259 (i.e., 24.6 %) individuals were diagnosed with sarcopenia. All of the included studies had a cross-sectional design, no longitudinal studies were identified.

3.2. IPD meta-analysis

A significant difference of 12.37 out of 100 (95 % CI = [−15.36; −9.39]) in HRQoL was obtained between sarcopenic and non-sarcopenic individuals. There was significant heterogeneity (I^2 = 89 %; p < 0.01) (Fig. 2). The multivariate model further confirmed the reduction of HRQoL in sarcopenia, independently of age, gender, number of drugs and number of concomitant diseases (β = −9.40; 95 % CI = [−12.00; −6.80]) (Appendix A3).

The robustness of the results was proven by the leave-one-out analysis, in which the effect sizes remained significant despite removing one study at a time (Appendix A4). We also performed another sensitivity analysis by including the aggregate data study by Le et al. [18] in the model, as these authors were unable to share their individual-patient data. The addition of this study did not modify the significance of the association (MD = −13.00; 95 % CI = [−16.17; −9.84]; p-value<0.01).

All domains of SarQoL showed a significant decrease in HRQoL for sarcopenic persons (Appendix A5). Indeed, the MD of scores ranged from −6.41 (Domain 7) to −14.49 (Domain 5) units. This observation suggests that domain 7 has a smaller disparity between sarcopenic and non-sarcopenic participants, whereas domain 5 has a greater disparity.

The funnel plot showed asymmetry (Fig. 3), which Egger's test confirmed (p = 0.0064). This result indicates a publication bias within the meta-analysis. Using the Trim and Fill method, 14 potential missing studies were identified. However, their inclusion did not modify the overall outcome and remained unchanged, as a significant reduction in HRQoL between sarcopenic and non-sarcopenic individuals was still observed (MD = -18.82; 95 % CI = [−22.58; −15.06]; I^2 = 93.3 %; p < 0.0001). Notably, this difference in HRQoL was even more substantial than the original findings.

Table 4 summarizes subgroup analyses. Regions showed significant subgroup interactions. Substantial difference in the decrease in HRQoL between sarcopenic and non-sarcopenic was found in South Asia (MD = -23.99; 95 % CI = [−26.50; −21.47]) followed by North Asia and Central Europe with an equal MD of −13.38 points (95 % CI = [−21.25; −5.51] vs 95 % CI = [−18.42; −8.34]). Northern Europe was the next in line (MD = -11.61; 95 % CI = [−16.56; −6.66]) followed by Southern America (MD = -10.80; 95 % CI = [−29.04; 7.43]). Southern Europe obtained the smallest difference in HRQoL score of −8.69 (95 % CI = [−13.21; −4.17]). Regions within Europe did not reveal a significant difference among them (p = 0.38) (Appendix A6), while South Asia obtained a significantly lower HRQoL score compared to North Asia (p = 0.01) (Appendix A7).

The criteria used to diagnose sarcopenia also showed an impact on the differences in HRQoL between the two groups (p = 0.09), with a more considerable difference associated with the AWGS criterion (MD = -17.65; 95 % CI = [−23.63; −11.67]).

The clinical setting significantly affected the difference in HRQoL between individuals with and without sarcopenia. In the community,

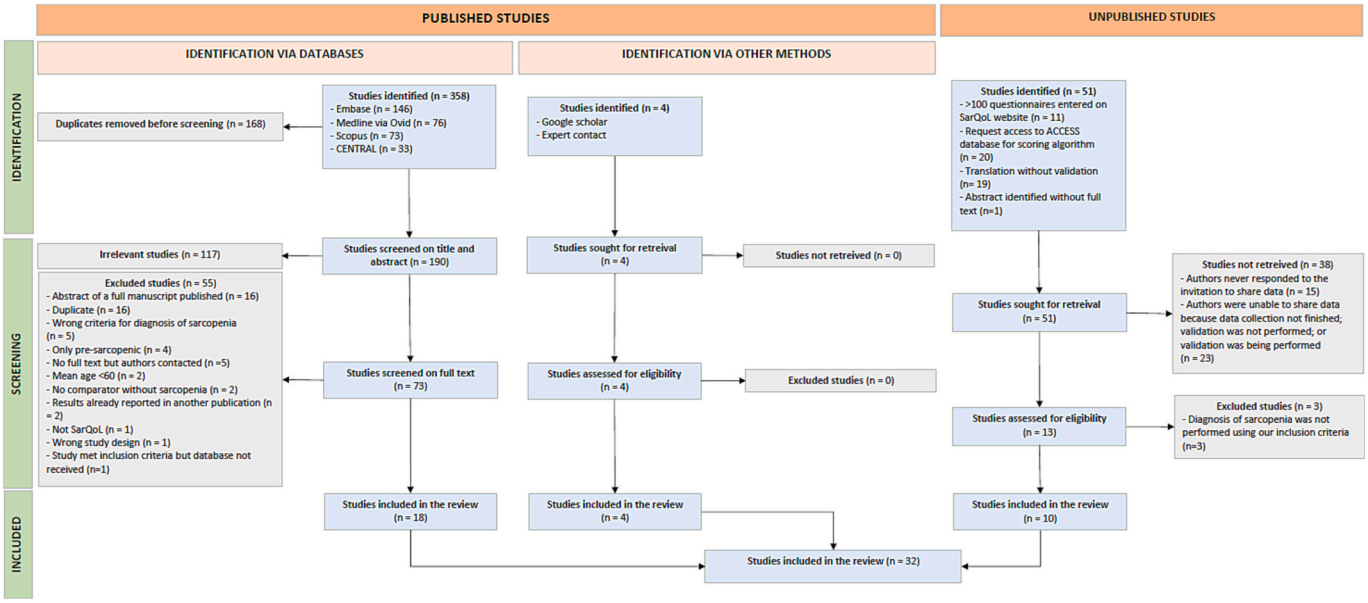

Fig. 1. Flowchart of study selection.

Table 2
Characteristics of included studies.

First author's name, year of publication	Country	Participants (type of population, sample size, age, and gender ratio)	Main diagnosis of sarcopenia used by authors	Quality assessment[a]
Alekna, 2019 [24]	Lithuania	Community-dwelling **TP**: n = 176; 78.38 ± 6.33 years; 59.7 % of women **SP**: n = 58 (32.95 %); 80.24 ± 6.54 years; 43.1 % of women **NSP**: n = 118 (67.05 %); 77.46 ± 6.04 years; 67.8 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* SPPB	★★★★★☆☆
Baptista, unpublished	Portugal	Community-dwelling **TP**: n = 101; 74.11 ± 7.19; 75.73 % of women **SP**: n = 2 (0.02 %); 84 ± 2.83 years; 50 % of women **NSP**: n = 99 (99.98 %); 73.91 ± 7.11 years; 76.77 % of women	EWGSOP2 *Muscle mass:* BIA *Physical performance:* Gait speed	
Beaudart, 2017 [19]	Belgium	Community-dwelling **TP**: n = 296; 74.23 ± 6.07 years; 57.01 % of women **SP**: n = 43 (14.53 %); 77.61 ± 6.8 years; 65.12 % of women **NSP**: n = 253 (85.47 %); 73.65 ± 5.75 years; 55.73 % of women	EWGSOP1 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* SPPB	★★★★★☆☆
Beaudart, 2017 [25]	United Kingdom	Community-dwelling TP: n = 235; 79.25 ± 2.57 years; 44.68 % of women **SP**: n = 14 (5.96 %); 79.64 ± 2.85 years; 28.57 % of women **NSP**: n = 221 (94.04 %); 79.23 ± 2.56 years; 45.25 % of women	EWGSOP1 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★★★☆☆
Cheng, unpublished	Hong Kong, China	Community-dwelling **TP**: n = 157; 69.41 ± 3.75 years; 64.97 % of women **SP**: n = 31 (19.75 %); 68.87 ± 3.4 years; 100 % of women **NSP**: n = 126 (80.25 %); 69.55 ± 3.83 years; 56.35 % of women	AWGS Muscle mass: Lee formula Muscle strength: Dynamometer Physical performance: SPPB	
Dzhus, 2020 [26]	Ukraine	Community-dwelling TP: n = 49; 72.57 ± 5.94 years; 40.82 % of women **SP**: n = 28 (57.14 %); 74.21 ± 6.49 years; 42.86 % of women **NSP**: n = 21 (42.86 %); 70.38 ± 4.38 years; 38.1 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★☆☆☆☆
Drey, unpublished	Germany	Community-dwelling TP: n = 185; 79.80 ± 6.09 years; 76.2 % of women **SP**: n = 51 (27.57 %); 81.31 ± 6.37 years; 52.9 % of women **NSP**: n = 134 (72.43 %); 79.23 ± 5.90 years; 85.1 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed and SPPB	
Emin, unpublished	Turkey	Community-dwelling TP: n = 84; 71.69 ± 6.07 years; 100 % of women **SP**: n = 28 (33.33 %); 74.61 ± 5.93 years; 100 % of women **NSP**: n = 56 (66.66 %); 70.23 ± 5.64 years; 100 % of women	EWGSOP1 *Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* Timed get-up-and-go test	
Erdogan, 2021 [27]	Turkey	Community-dwelling **TP**: n = 100. 74.68 ± 6.1 years; 71 % of women **SP**: n = 5 (5 %); 75.6 ± 8.88 years; 40 % of women **NSP**: n = 95 (95 %); 74.63 ± 5.98 years; 72.63 % of women	EWGSOP2 *Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★★★★☆
Fábrega-Cuadros, 2020 [28]	Spain	Community-dwelling **TP**: n = 252; 74.5 ± 5.95 years; 82.54 % of women **SP**: n = 66 (26.91 %); 76.67 ± 6.28 years; 74.24 % of women **NSP**: n = 186 (73.81 %); 73.73 ± 5.65 years; 85.48 % of women	EWGSOP2 *Muscle mass:* BIA *Muscle strength:* Dynamometer	★★★★★☆☆
Fornari Laurindo, unpublished	Brazil	Setting not mentioned **TP**: n = 31; 72.61 ± 8.11 years; 51.61 % of women **SP**: n = 14 (45.16 %); 74.93 ± 8.71 years; 57.14 % of women	EWGSOP1 *Muscle mass:* BIA	

(*continued on next page*)

Table 2 (*continued*)

First author's name, year of publication	Country	Participants (type of population, sample size, age, and gender ratio)	Main diagnosis of sarcopenia used by authors	Quality assessment[a]
		NSP: n = 17 (54.84 %); 70.71 ± 7.28 years; 47.06 % of women		
Gasparik, 2017 [29]	Romania	Setting not mentioned	EWGSOP1	★★★★★★★
		TP: n = 100; 73.5 ± 8.14 years; 69 % of women **SP**: n = 13 (13 %); 80.54 ± 8.77 years; 53.85 % of women **NSP**: n = 87 (87 %); 72.45 ± 7.55 years; 71.26 % of women	*Muscle mass:* Lee equation *Muscle strength:* Dynamometer *Physical performance:* Gait speed	
Geerinck, 2018 [30]	Belgium	Community-dwelling	EWGSOP1	★★★★★☆☆
		TP: n = 92; 79.51 ± 6.81 years; 43.48 % of women **SP**: n = 30 (32.61 %); 81.03 ± 6.85 years; 43.3 % of women **NSP**: n = 62 (67.39 %); 78.76 ± 6.71 years; 43.5 % of women	*Muscle mass*: BIA *Muscle strength*: Martin Vigorimeter *Physical performance*: Gait speed	
Guillamon-Escudero, 2022 [31]	Spain	Community-dwelling	EWGSOP2	★★★★☆☆☆
		TP: n = 202; 72.75 ± 5.02 years; 81.19 % of women **SP**: n = 15 (7.43 %); 76.53 ± 4.32 years; 80 % of women **NSP**: n = 187 (92.57 %); 72.44 ± 4.96 years; 81.28 % of women	*Muscle mass:* BIA *Muscle strength:* Dynamometer and chair rising *Physical performance:* Gait speed	
Şimşek, unpublished	Turkey	Care home	EWGSOP2	
		TP: n = 141; 81.35 ± 7.13 years; 65.96 % of women **SP**: n = 45 (31.91 %); 80.87 ± 7.41 years; 75.56 % of women **NSP**: n = 96 (68.09 %); 81.57 ± 7.02 years; 61.15 % of women	*Muscle mass:* BIA	
Iacob, 2022 [32]	Romania	Hospitalized	EWGSOP2	★★★★☆☆☆
		TP: n=31[b]; 65.68 ± 5.29 years; 38.71 % of women **SP**: n = 21 (67.74 %); 66.05 ± 5.79 years; 33.33 % of women **NSP**: n = 10 (32.26 %); 64.9 ± 4.2 years; 50 % of women	*Muscle mass:* CT scan *Muscle strength:* Dynamometer	
Kumar, 2023 [33]	India	Community-dwelling	AWGS	★★★★★☆☆
		TP: n = 114; 69.6 ± 6.49 years; 40.35 % of women **SP**: n = 45 (39.47 %); 72.22 ± 6.71 years; 44.44 % of women **NSP**: n = 69 (60.53 %); 67.88 ± 5.78 years; 37.68 % of women	*Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* Five-time sit-to-stand	
Konstantynowicz, 2018 [34]	Poland	Community-dwelling	EWGSOP2	★★★★★☆☆
		TP: n = 106; 73.31 ± 5.94 years; 65.1 % of women **SP**: n = 60 (56.6 %); 74.8 ± 6.05 years; 71.67 % of women **NSP**: n = 46 (43.4 %); 71.35 ± 5.24 years; 56.52 % of women	*Muscle mass:* Lee equation *Muscle strength:* Dynamometer	
Lee, 2023 [35]	Taiwan	Community-dwelling	AWGS	★★★★★★☆
		TP: n = 100; 76.43 ± 8.11 years; 72 % of women **SP**: n = 50 (50 %); 81.18 ± 7.95 years; 70 % of women **NSP**: n = 50 (50 %); 71.68 ± 4.85 years; 74 % of women	*Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* SPPB, gait speed, and chair rising test	
Mahmoodi, 2022 [36]	Iran	Community-dwelling	AWGS	★★★★★★☆
		TP: n = 128; 74.78 ± 5.05 years; 41.41 % of women **SP**: n = 88 (68.75 %); 76.05 ± 5.16 years; 42 % of women **NSP**: n = 40 (31.25 %); 72 ± 3.47 years; 40 % of women	*Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	
Matijevic, 2020 [37]	Serbia	Community-dwelling	EWGSOP2	★★★★☆☆☆
		TP: n=694[c]; 71.01 ± 5.32 years; 72.48 % of women **SP**: n = 12 (1.73 %); 75.5 ± 6.71 years; 75 % of women **NSP**: n = 682 (98.27 %); 70.93 ± 5.26 years; 72.43 % of women	*Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	

(*continued on next page*)

Table 2 (*continued*)

First author's name, year of publication	Country	Participants (type of population, sample size, age, and gender ratio)	Main diagnosis of sarcopenia used by authors	Quality assessment[a]
Matveeva, unpublished	Russia	Multiple settings (community-dwelling. hospitalized. care home) **TP**: n = 102; 72.3 ± 8.23 years; 79.41 % of women **SP**: n = 4 (3.92 %); 82.23 ± 6.26 years; 50 % of women **NSP**: n = 98 (96.08 %); 71.9 ± 8.06 years; 80.06 % of women	EWGSOP2 *Muscle mass:* BIA *Physical performance:* SPPB, Chair rising test, and Gait speed	
Merle, 2023 [38]	France	Other settings **TP**: n=17[d]; 0.68.66 ± 6.61 years; 52.94 % of women **SP**: n = 2 (11.76 %); 80.58 ± 6.63 years; 50 % of women **NSP**: n = 15 (88.24 %); 67.07 ± 4.87 years; 46.67 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★★☆☆
Montero-Errasquin, 2022 [39]	Spain	Community-dwelling **TP**: n = 86; 77.62 ± 5.32 years; 80.23 % of women **SP**: n = 16 (18.6 %); 78 ± 6.26 years; 68.75 % of women **NSP**: n = 70 (81.4 %); 77.53 ± 5.13 years; 82.86 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* SPPB	★★★☆☆☆
Orlandi, 2023 [40]	Brazil	Community-dwelling TP: n=224[e]; 69.44 ± 7.04 years; 67.86 % of women **SP**: n = 55 (24.55 %); 73.27 ± 8.08 years; 60 % of women **NSP**: n = 166 (75.1 %); 68.2 ± 6.2 years; 71.69 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★★☆☆
Pap, 2023 [41]	Hungary	Community-dwelling **TP**: n=84[f]; 68.95 ± 5.49 years; 100 % of women **SP**: n = 25 (29.76 %); 70.04 ± 6.24 years; 100 % of women **NSP**: n = 59 (70.24 %); 68.49 ± 5.13 years; 100 % of women	EWGSOP2 *Muscle mass:* DXA *Muscle strength:* Dynamometer	★★★★★★☆
Peng, unpublished	China	Setting not mentioned **TP**: n = 257; 70.09 ± 5.54 years; 66.54 % of women **SP**: n = 146 (56.81 %); 71.41 ± 5.44 years; 66.44 % of women **NSP**: n = 111 (43.19 %); 68.35 ± 5.21 years; 66.67 % of women	AWGS *Muscle mass:* DXA	
Safonova, 2019 [42]	Russia	Community-dwelling **TP**: n=102[g]; 74.55 ± 6.43 years; 69.61 % of women **SP**: n = 50 (49.02 %); 75.38 ± 6.65 years; 70 % of women **NSP**: n = 52 (52.98 %); 73.75 ± 6.17 years; 62.23 % of women	EWGSOP1 *Muscle mass:* DXA *Muscle strength:* SPPB *Physical performance:* SPPB	★★★★★★☆
Topinkova, unpublished	Czech Republic	Community-dwelling **TP**: n = 126; 79.8 ± 6.67 years; 85.22 % of women **SP**: n = 81 (64.29 %); 81.94 ± 6.1 years; 81.48 % of women **NSP**: n = 45 (35.71 %); 75.96 ± 5.94 years; 68.89 % of women	FNIH *Muscle mass:* DXA *Physical performance:* SPPB, gait speed, and chair rising test	
Tsekoura, 2020 [43]	Greece	Other settings **TP**: n = 176; 71.1 ± 7.99 years; 77.84 % of women **SP**: n = 50 (28.41 %); 72.10 ± 7.7 years; 74 % of women **NSP**: n = 126 (71.59 %); 70.7 ± 8.09 years; 79.37 % of women	EWGSOP1 *Muscle mass:* BIA *Muscle strength:* Dynamometer *Physical performance:* Gait speed	★★★★☆☆
Ruby, unpublished	China	Community-dwelling **TP**: n = 118; 72.47 ± 4.7 years; 71 % of women **SP**: n = 58 (49.15 %); 73.76 ± 5.41 years; 68.97 % of women **NSP**: n = 60 (50.85 %); 71.22 ± 3.52 years; 70.97 % of women	AWGS *Muscle mass:* BIA *Physical performance:* Gait speed and chair rising test	

(*continued on next page*)

Table 2 (*continued*)

First author's name, year of publication	Country	Participants (type of population, sample size, age, and gender ratio)	Main diagnosis of sarcopenia used by authors	Quality assessment[a]
Yoo, 2021 [44]	Korea	Community-dwelling **TP**: n = 450; 73.91 ± 6.57 years; 89.33 % of women **SP**: n = 53 (11.78 %); 79.08 ± 7.08 years; 88.68 % of women **NSP**: n = 397 (88.22 %); 73.22 ± 6.19 years; 89.42 % of women	AWGS *Muscle mass:* DXA *Physical performance:* Dynamometer	★★★★☆☆☆

TP: total participants; SP: sarcopenic participants; NSP: non-sarcopenic participants.

[a] Total score of 7 points for cross-sectional studies (adapted NOS scale for cross-sectional studies). The quality assessment was done for published studies only.

[b] Sample differed from the article because 40 individuals younger than 60 were removed.

[c] Sample size differed from the article because two individuals younger than 60 were removed. Three other individuals did not have muscle mass measurement and low muscle strength. Hence a diagnosis of sarcopenia was not possible.

[d] Sample size different from the article because 86 individuals younger than 60 years old were removed.

[e] Sample size differed from the article because three individuals were included in the authors' patient bank after the analysis was run.

[f] Sample size differed from the article because 16 individuals younger than 60 years old were removed.

[g] Sample size differed from the article because two additional individuals were included in the study after the study group characteristics were presented. These were, however, included in the statistical analysis.

the setting with the largest number of participants, a difference of −12.87 (95 % CI = [−16.42; −9.32]) was observed. Studies in multiple environments showed the slightest difference in HRQoL (MD = −3.87; CI 95 % = [−8.03; 0.28]), while studies with hospitalized patients, in-home care and other environments were the ones that showed the most remarkable difference in HRQoL between participants with and without sarcopenia (MD = −13.17; 95 % CI = [−19.32; −7.01]).

No differences in sarcopenia diagnosis related to gender, age group, ethnicity, continent, study publication and study quality were observed.

3.3. Strength of evidence

Based on the GRADE assessment, LoE was graded as moderate. The IPD-meta-analysis was only downgraded because of significant heterogeneity in the subgroups analyses that remained unexplained.

4. Discussion

In this IPD- meta-analysis, including 32 studies, individuals with sarcopenia had significantly lower HRQoL than those without, particularly in the activities of daily life domain, closely followed by the one of locomotion. Similar results were concluded in a recently published meta-analysis not using IPD [6] and sarcopenia has been recognized as the primary contributor to many adverse health outcomes, including the reduction of musculoskeletal function. Indeed, sarcopenic individuals progressively loose mobility and become increasingly dependent on external aids to move around. The fear domain showed the lowest difference between the groups. This domain encompasses only 4 out of the 55 items that SarQoL consists of and has been shown to have a lesser discriminative power [19].

Among the regions studied, sarcopenic individuals in South Asia showed the greatest differences in HRQoL compared to their non-sarcopenic peers. These results were associated with non-significant heterogeneity, confirming the significant impact of sarcopenia on HRQoL in this particular region of the world. This may underline the difference in socioeconomic status between Asia and Europe and within Asia itself. Indeed, Asia is the second less developed continent, characterized by lower socioeconomic status and limited healthcare infrastructures, therefore diminishing access to healthcare and preventive measures for individuals living in Asian regions, which may partially explain these results.

The AWGS criterion revealed a larger difference in HRQoL between individuals with and without sarcopenia than the other criteria. This disparity might be explained by the characteristics of the populations they are administrated to. EWGSOP and FNIH criteria are used in European countries, while AGWS are employed in Asian countries. Since FNIH was employed in only one study, caution must be exercised when interpreting the results.

Surprisingly, the MD of HRQoL between sarcopenic individuals and not sarcopenic ones does not appear to be affected by the living context. The observed MD for individuals in care homes or hospitals are comparable to those found in community-dwelling individuals. Consequently, one might hypothesize that it is sarcopenia itself, rather than the living situation, that influences the quality of life. Regardless of

Table 3
Clinical characteristics of the included participants displayed as mean ± standard deviation.

	All sample (n = 5116)	Participants with sarcopenia (n = 1259)	Participants without sarcopenia (n = 3857)
Age (years)	73.74 ± 6.98	76.00 ± 7.47	73.00 ± 6.65
Gender			
Women	3576 (69.9 %)	827 (65.69 %)	2749 (71.27 %)
Men	1540 (30.1 %)	432 (34.31 %)	1108 (28.73 %)
BMI (kg/m^2)	27.23 ± 5.98	24.74 ± 6.71	28.04 ± 5.48
Number of drugs	4 (2–6)	4 (2–7)	3 (1–6)
Number of concomitant diseases	2 (1–4)	2 (1–4)	2 (1–4)
Sarcopenia biomarkers			
Muscle strength (kg)	24.19 ± 10.43	18.87 ± 8.48	26.10 ± 10.40
ALM (kg)	20.74 ± 10.29	16.72 ± 7.79	21.96 ± 10.64
ASMI (kg/m^2)	6.77 ± 1.77	5.94 ± 1.72	7.15 ± 1.67
Gait speed (m/s)	1.03 ± 1.51	1.02 ± 3.22	1.04 ± 0.41
SPPB score (/12)[a]	9 (7–11)	7 (4–9)	10 (8–11)
Chair rising test (s)	14.89 ± 8.57	18.59 ± 11.96	13.57 ± 6.51

BMI, body mass index; ALM, appendicular lean mass; ASMI, appendicular skeletal muscle index; SPPB, Short Physical Performance Battery.

[a] These variables were expressed in median (25th–75th percentile) since a skewed distribution was expected.

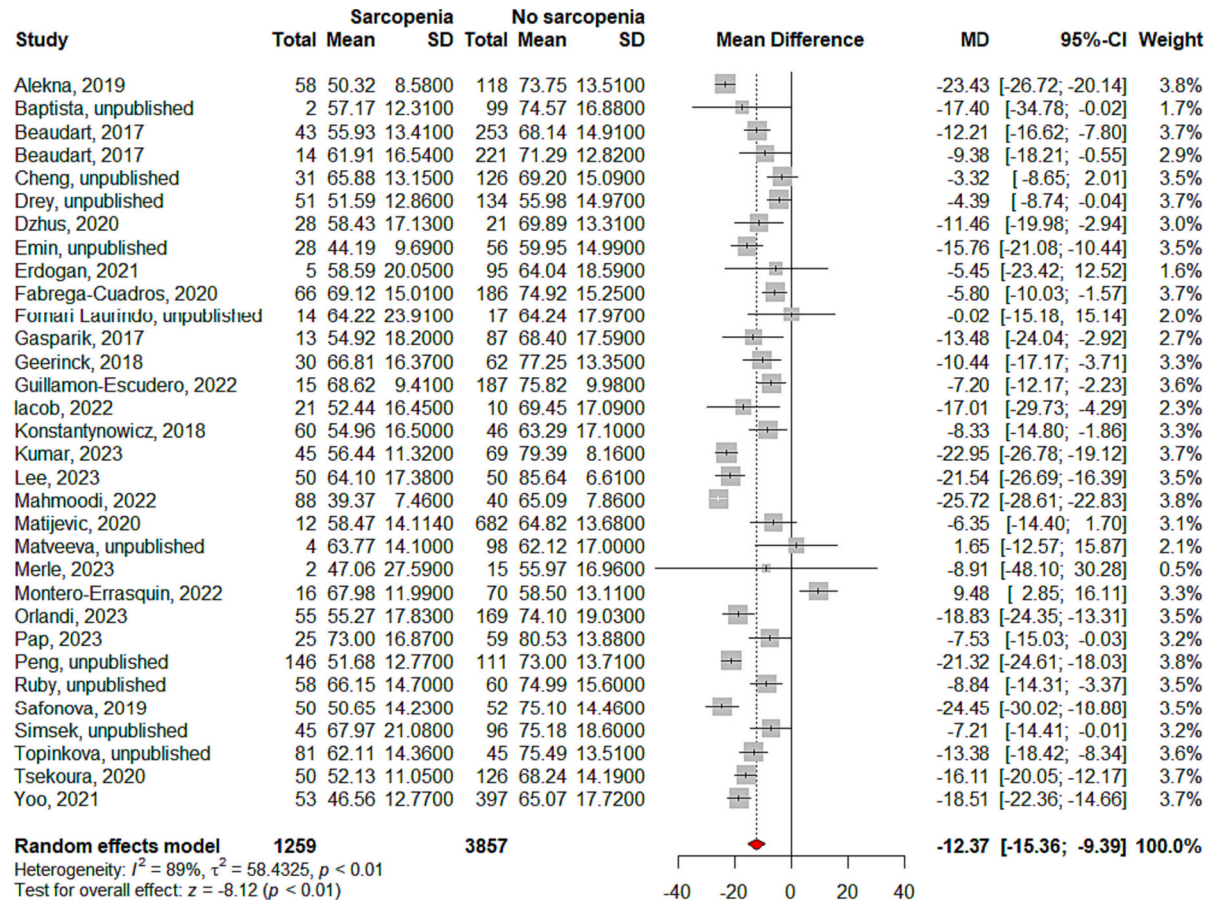

Fig. 2. Forest plot displaying the health-related Quality of life of sarcopenic and non-sarcopenic participants using the SarQoL questionnaire in all 32 included studies. SD, standard deviation; MD, mean difference; 95 % CI, 95 % confidence interval.

whether individuals with sarcopenia reside in care homes, are hospitalized, or still live in the community, they tend to exhibit lower HRQoL compared to their non-sarcopenic counterparts.

No difference for gender, ethnicity, continent, publication status, Quality of studies, or age groups was found. These results fill in the knowledge gap by suggesting that both genders are equally impacted by sarcopenia, confirming the reliability of SarQoL in assessing HRQoL in both females and males. The same conclusion was drawn in the previously published meta-analysis [6] regarding the age groups' findings.

4.1. Strength and limitations

This study represents the first meta-analysis to explore the relationship between HRQoL and sarcopenia using IPD. Unlike the previous meta-analysis relying on aggregate data, IPD allowed gender-specific analyses and exploration of regional and ethnic influence on HRQoL in sarcopenia. Better control for potential confounding factors in the relation under investigation was also provided in the IPD meta-analysis. The present study solely focused on the SarQoL questionnaire, making this study SarQoL-specific. About 93.75 % of the studies included in this work consistently showed a reduction in HRQoL in individuals with sarcopenia compared to those without sarcopenia. This aspect not only supports the detrimental effects of the condition on the overall well-being and HRQoL of affected individuals but also shows high consistency between studies in terms of the sense of the evidence. Another strength of this work is that we did not limit the search to studies published in English and to studies published in the scientific literature, which allows us to reduce inclusion bias considerably.

Several limitations inherent to this study should also be mentioned. The heterogeneity remained unexplained even after conducting subgroup analyses, limiting the maximization of the LoE. The multifactorial nature of sarcopenia makes identifying a factor that could explain this heterogeneity challenging. Quality of life in sarcopenia according to the etiology of sarcopenia, for example, has not been assessed and could partially explain the heterogeneity found. Furthermore, no strict inclusion criteria regarding the sampling methodology were developed, which led to a wide variation in the reported prevalence of sarcopenia due to the different strategies used. It is noteworthy that inconsistency was the only reason why the LoE was downgraded. Another limitation of this study is the low positive response rate when retrieving information from unpublished studies. Of the 51 authors contacted, 27 (i.e., 52.94 %) responded, and 10 (i.e., 37.04 %) could share their data. However, including unpublished studies within this IPD-meta-analysis is also a strength as it allowed the results to be based on a larger sample of individuals, further enhancing the generalizability of the findings and allowing subgroup analysis based on the publication status. Another limitation concerns the low inclusion of solely cross-sectional studies, preventing an exploration of the causal relationship between sarcopenia and HRQoL. Even if both cross-sectional and longitudinal studies were considered eligible, no prospective studies were identified by our systematic search, indicating a scarcity of data on the longitudinal evolution of HRQoL in individuals with sarcopenia. The limited presence of prospective studies underscores the need for more research in this area to allow for a more in-depth investigation into the causal relationship between sarcopenia and HRQoL. Ultimately, since our focus was specifically on age-related sarcopenia, we did not assess the quality of life in individuals under the age of 60. It's important to acknowledge that results may differ within this younger population. Nevertheless, considering that SarQoL was explicitly designed for age-related sarcopenia, we posit that employing SarQoL for assessing

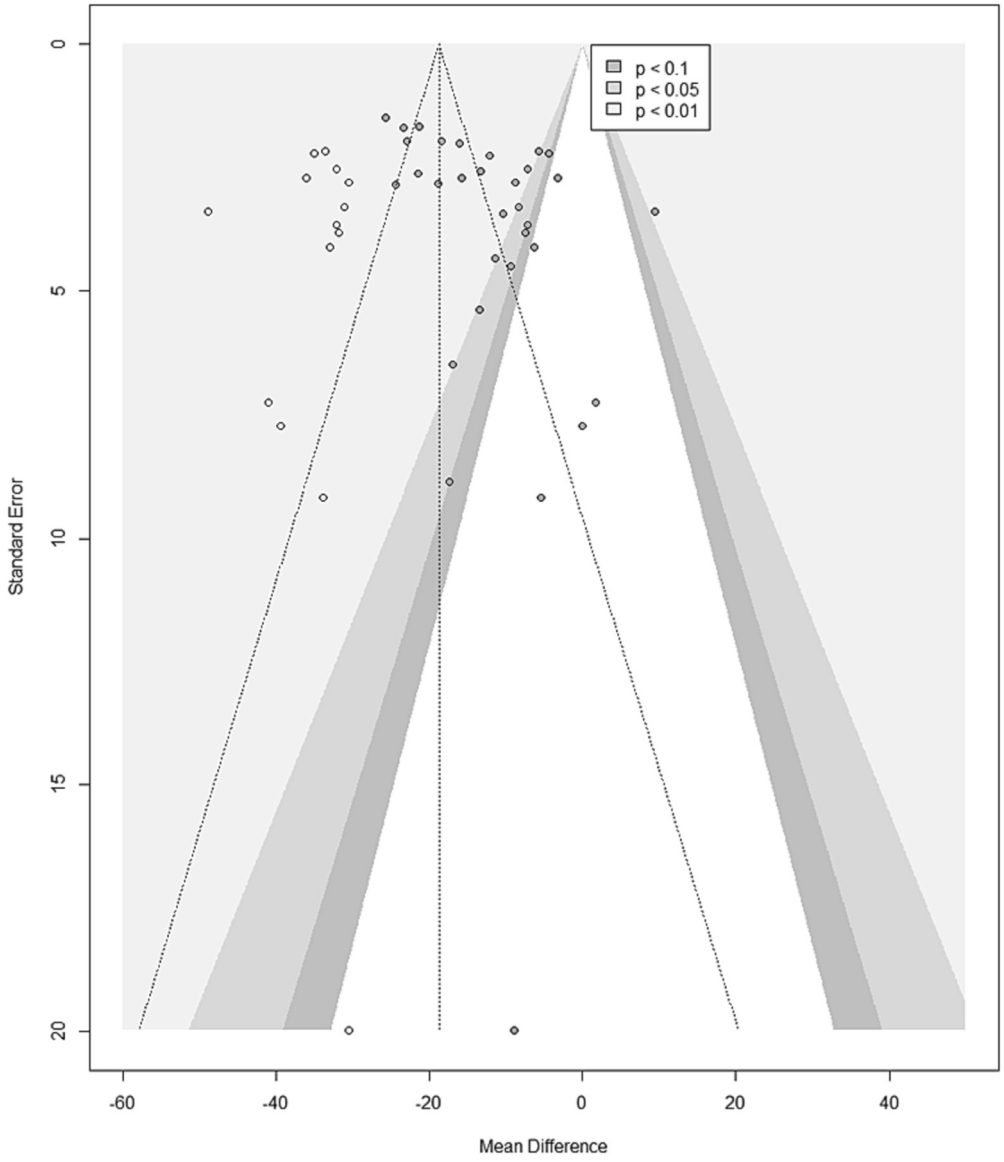

Fig. 3. Trim and Fill method: Funnel plot on HRQoL assessed with SarQoL between individuals with and without sarcopenia – the unfilled dots represent the 14 imputed studies.

HRQoL in younger individuals with sarcopenia may not be relevant to our study's objectives.

5. Conclusion

This IPD- meta-analysis confirmed that the older adults with sarcopenia exhibited lower HRQoL than those without sarcopenia. Regions, clinical settings, and diagnostic criteria influenced disparities between both groups. Future clinical trials aiming at managing sarcopenia should consider the inclusion of HRQoL among primary outcomes, given the detrimental effects of sarcopenia on the overall well-being and HRQoL.

Contributors

Charlotte Beaudart conceived the study, drafted the protocol, was the leader of this project, prepared all the files necessary for data collection, contacted personally all contributors, managed communication with other authors, ran the analyses, and drafted the manuscript.

Noémie Tilquin collected the data, developed the databases and drafted the manuscript.

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Table 4
Subgroup analysis.

	Number of studies	Number of individuals	MD [95 % CI]	I^2 (%)	p-Value for heterogeneity	p-Value for interaction
Gender (n = 57[a])						p = 0.60
Female	30	3491	−12.26 [−15.38; −9.13]	85	p < 0.01	
Male	27	1452	−13.58 [−17.45; −9.72]	87	p < 0.01	
Age of participants (n = 32)						p = 0.68
<70 years	6	627	−13.78 [−21.23; −6.32]	88	p < 0.01	
>70 years	26	4489	−12.07 [−15.39; −8.76]	90	p < 0.01	
Age of participants (n = 32)						p = 0.45
<75 years	24	3975	−13.28 [−16.41; −10.14]	87	p < 0.01	
>75 years	8	1141	−10.22 [−17.46; −2.98]	94	p < 0.01	
Ethnicity (n=34[b])						p = 0.12
Caucasian	24	3551	−10.31 [−13.61; −7.02]	85	p < 0.01	
Asian	6	1196[c]	−16.24 [−22.60; −9.89]	90	p < 0.01	
African American	2	35	−15.74 [−46.68; 15.20]	73	p = 0.05	
Other	2	203	−15.96 [−19.88; −12.05]	0	p = 0.51	
Continent (n = 32)						p = 0.12
Europe[d]	21	3333	−10.07 [−13.25; −6.89]	84	p < 0.01	
Asia	9	1528	−17.01 [−22.85; −11.16]	90	p < 0.01	
America	2	255	−10.80 [−29.04; 7.43]	81	p = 0.02	
Region (n = 32)						p < 0.01
Northern Europe	8	1156	−11.61 [−16.56; −6.66]	88	p < 0.01	
Southern Europe	12	2051	−8.69 [−13.21; −4.17]	80	p < 0.01	
Central Europe	1	126	−13.38 [−18.42; −8.34]			
Northern Asia	6	1186	−13.38 [−21.25; −5.51]	91	p < 0.01	
Southern Asia	3	342	−23.99 [−26.50; −21.47]	20	p = 0.29	
Southern America	2	255	−10.80 [−29.04; 7.43]	81	p = 0.02	
Sarcopenia diagnosis (n = 32)						p = 0.09
EWGSOP1	8	1116	−14.17 [−18.15; −10.19]	65	p < 0.01	
EWGSOP2	16	2550	−8.65 [−13.03; −4.26]	88	p < 0.01	
AWGS	7	1324	−17.65 [−23.63; −11.67]	92	p < 0.01	
FNIH	1	126	−13.38 [−18.42; −8.34]			
Settings (n=29[e])						p < 0.01
Community-dwelling	23	4076	−12.87 [−16.42; −9.32]	91	p < 0.01	
Multiple settings	2	287	−3.87 [−8.03; 0.28]	0	p = 0.43	
Other[f]	4	365	−13.17 [−19.32; −7.01]	37	p = 0.19	
Publication status (n = 32)						p = 0.21
Published	22	3814	−13.57 [−17.30; −9.85]	90	p < 0.01	
Not published	10	1302	−11.68 [−14.39; −5.08]	86	p < 0.01	
Quality of included studies (n=22[g])						p = 0.26
<5 points on NOS	9	1929	−10.96 [−17.44; −4.49]	88	p < 0.01	
>5 points on NOS	13	1885	−15.47 [−19.81; −11.13]	90	p < 0.01	

[a] The study population of each study was divided according to gender. Two studies (Merle, 2023 and Baptista) were removed because no SD could be calculated in one of the groups. Hence, a comparison between females and males was not possible.
[b] Two studies (Orlandi et al. and Fornari Laurindo) included participants from multiple ethnicities, and one did not mention the ethnicity of the participants (Mahmoodi, 2022).
[c] Three individuals within the Asian ethnicity were removed in the study of Orlandi et al. because the non-sarcopenic group only had one patient; hence no SD could be calculated. A comparison with sarcopenia was, therefore, not possible.
[d] Turkey (n = 3) was considered part of Europe because they used the EWGSOP criteria rather than the AWGS ones.
[e] Three studies did not mention from which setting the participants were.
[f] This setting consists of the following setting groups: care home (n = 2), hospitalized (n = 1), and other (n = 2).
[g] Only published studies were assessed with the Newcastle-Ottawa Quality Assessment Scale.

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Funding

The authors received no funding from an external source.

Provenance and peer review

This article was not commissioned and was externally peer reviewed.

Research data (data sharing and collaboration)

All materials related to this work (i.e., databases, forest plots for the subgroup analyses, R script) are freely available on the Open Science Framework deposit (https://osf.io/kh7rf/).

Declaration of competing interest

B.C., B.O., and R.J.Y. are shareholders of the SarQoL sprl. However, they never received any financial compensation for this role. The other authors declare they have no competing interest.

Acknowledgment

We want to thank the authors who have shared their databases sincerely. Their collaboration and commitment to transparency significantly impact the advancement of scientific research in this field.

Lucas Fornari Laurindo would like to acknowledge and express his gratitude to the colleagues who assisted in collecting the data during the study. He would like to acknowledge the invaluable assistance of Profa Dra Sandra Maria Barbalho and Profa Karina Quesada.

Prabal Kumar would like to thank his supervisors, Dr. Girish N and Dr. Shashikiran Umakanth, for their unwavering support during the study. Additionally, he would like to thank everyone who assisted in the process and the participants who made this possible.

Clio Y.M. Cheng would like to inform that part of this work was supported by the Theme-based Research Scheme under The University Grants Committee [#T42-717/20-R].

Vivan W.Q. Lou would like to recognize the contributions of Dr. K. Chen from Zhejiang University, Miss C. Cheng, and Professor N. Xi from The University of Hong Kong.

Yuliya Safonova would like to thank different people that took part in the study of validation: Olga Lesnyak, MD, Dr. Med Sci, Professor, Family Medicine Department, North Western State Medical University, named after I.I. Mechnikov, Russian Federation.

Fatima Baptista would like to thank the collaboration of other researchers in the SarQoL translation and validation process, participant recruitment and data collection: Filomena Carnide and Vera Zymbal (Portugal).

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.maturitas.2023.107902.

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