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Sarcopenia in type 2 Diabetes mellitus among Asian populations: prevalence and risk factors based on AWGS- 2019: a systematic review and meta-analysis

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Abstract

Background Sarcopenia is increasingly recognized as a significant complication in type 2 diabetes mellitus (T2DM), yet its prevalence and risk factors in Asian populations remain incompletely understood using the updated Asian Working Group for Sarcopenia (AWGS) 2019 criteria. The present review aimed to evaluate the prevalence of sarcopenia among Asian T2DM patients and identify associated risk factors using AWGS-2019 criteria through systematic review and meta-analysis.

Methods A comprehensive systematic review of PubMed, SCOPUS, Crossref, Google Scholar, Semantic Scholar, and OpenAlex followed PRISMA guidelines to identify observational studies assessing the magnitude of sarcopenia in type-2 Diabetes mellitus. Random-effect models were used to estimate pooled prevalence and odds ratios (OR) for associated factors. Heterogeneity was quantified using I^2 statistics and Cochran's Q test, where I^2 values of 25%, 50%, and 75% indicated low, moderate, and high heterogeneity, respectively. Subgroup analyses and meta-regression explored heterogeneity sources across all studies. The quality of the studies was assessed by the Joanna Briggs Institute (JBI) criteria. Publication bias was assessed by funnel plot and Egger's test.

Findings.

Thirty nine studies, including approximately 19,902 participants, were analyzed. The pooled prevalence of confirmed sarcopenia was 23% (95% CI: 18%-27%, $p < 0.001$) among Asian T2DM patients, with notably higher rates of possible sarcopenia at 61% (95% CI: 28%-86%, $p < 0.001$) and lower rates of severe sarcopenia at 12.1% (95% CI: 8.4%-16.7%, $p < 0.001$). Regional variations showed a higher prevalence in Southeast Asia (37.46%) compared to Western Pacific (21.95%). Meta-analysis revealed significant risk factors including older age (OR: 1.13, 95% CI: 1.11–1.16, $p < 0.0001$), male gender (OR: 2.37, 95% CI: 1.33–4.21, $p = 0.0033$), hypertension (OR: 3.65, 95% CI: 1.06–12.65, $p = 0.0409$), diabetes duration (OR: 1.35, 95% CI: 1.05–2.13, $p = 0.02$), and reduced physical activity (OR: 2.54, 95% CI: 1.92–3.36, $p < 0.0001$). Higher BMI (OR: 0.63, 95% CI: 0.53–0.75, $p < 0.0001$) and better vitamin D levels (OR: 0.91, 95% CI: 0.87–0.95, $p < 0.001$) demonstrated protective effects. Recent studies (2023–2024) showed a higher prevalence than pre-2022 studies

Comprehensive assessment of parameters in myeloma

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(27.85% vs 18.42%, $p = 0.0440$). DXA-based measurements yielded higher prevalence estimates than BIA-based assessments (29.86% vs 19.52%, $p = 0.7121$).

Interpretation.

Sarcopenia affects nearly one-quarter of Asian T2DM patients, with significant regional variations. Age, male gender, hypertension, and physical inactivity were key risk factors, while maintaining a healthy BMI and good nutrition appeared protective. These findings emphasize the importance of regular screening and early intervention strategies, particularly for high-risk patients.

Keywords Sarcopenia, Type 2 Diabetes Mellitus, Asian Population, AWGS- 2019, Meta-Analysis, Risk Factors

Research in context

Evidence before this study

Prior to this systematic review and meta-analysis, published studies indicated varied prevalence rates of sarcopenia among Asian type 2 diabetes mellitus (T2DM) patients. The 2019 updated Asian Working Group for Sarcopenia (AWGS) criteria established new diagnostic standards, but their application in T2DM patients remains incompletely understood. Previous evidence suggested links between T2DM and accelerated muscle loss, with regional variations in prevalence and risk factors. However, no comprehensive meta-analysis has synthesized sarcopenia prevalence using the AWGS- 2019 criteria, specifically in Asian T2DM populations, leaving uncertainty about the true burden and associated factors in this growing patient group.

Added Value of This Study

This systematic review and meta-analysis provides the first comprehensive synthesis of sarcopenia incidence in Asian T2DM patients via the standardized AWGS- 2019 criteria. By analysing 39 studies across diverse Asian regions, we established a pooled prevalence of 23%, with significant regional variations between Southeast Asia (37.46%) and the Western Pacific (21.95%). Our analysis uniquely identified both nonmodifiable risk factors (age, male sex, hypertension) and modifiable factors (physical inactivity, nutritional status), providing a comprehensive risk profile. The study revealed important methodological considerations, demonstrating how measurement tools influence prevalence estimates (DXA: 29.86% vs. BIA: 19.52%). Additionally, we identified a temporal trend of increased prevalence in recent years (27.85% from 2023–2024 vs. 18.42% before 2022), suggesting either improved detection or increasing disease burden. This comprehensive analysis provides robust evidence for clinical decision-making and healthcare planning in Asian populations with T2DM.

Implications of All the Available Evidence

The findings from this meta-analysis have substantial implications for clinical practice and public health policy in Asian countries. The high prevalence of sarcopenia in T2DM patients, particularly in certain regions, necessitates the integration of routine screening into diabetes care protocols. Our identification of modifiable risk factors provides clear targets for intervention strategies, emphasizing the importance of physical activity promotion and nutritional optimization. The significant regional variations in prevalence suggest the need for tailored approaches to screening and intervention programs, particularly in Southeast Asian populations, where the burden appears higher. Healthcare systems should consider implementing standardized assessment protocols using the AWGS- 2019 criteria while allocating resources for preventive strategies targeting identified risk factors. The temporal increase in prevalence rates underscores the growing importance of this health issue and suggests a need for increased awareness among healthcare providers and patients alike. Future research should focus on longitudinal studies to establish causality and intervention studies targeting modifiable risk factors while maintaining standardized reporting via the AWGS-2019 criteria to ensure comparability across studies.

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by insulin resistance and impaired insulin secretion that affects millions of people worldwide [1]. With an aging global population, the prevalence of T2DM continues to rise, particularly in Asian countries [2]. This demographic trend has increased the focus on age-related complications of T2DM, such as sarcopenia and sarcopenic obesity.

Sarcopenia, which is characterized by the progressive loss of muscle mass, strength, and functionality due to aging, has emerged as a significant health issue in older adults [3]. The Asian Working Group for Sarcopenia (AWGS) has defined specific diagnostic criteria for Asian populations, with the latest updates introduced in 2019 (AWGS- 2019) [4]. These criteria consider the unique physiological and lifestyle factors influencing Asian muscle health.

Sarcopenia, marked by the progressive loss of muscle mass, strength, and functionality, has traditionally been viewed primarily as an age-related condition. However, emerging evidence indicates that sarcopenia is not merely a consequence of aging but a complex condition that interacts bidirectionally with chronic metabolic disorders such as T2DM. This interaction can accelerate muscle deterioration through pathophysiological mechanisms beyond those seen in normal aging, including insulin resistance, chronic inflammation, oxidative stress, and microvascular complications. The relationship between T2DM and sarcopenia is deeply interconnected and reciprocal. T2DM has been linked to accelerated muscle loss and weakened strength, potentially driven by factors such as insulin resistance, chronic inflammation, and oxidative stress [5]. Conversely, sarcopenia can exacerbate the onset and progression of T2DM by reducing insulin-sensitive tissue and impairing glucose metabolism [6, 7].

Despite growing awareness of the importance of sarcopenia in T2DM, data on its prevalence in Asian populations remains limited. This scarcity stems from several factors, including regional differences in healthcare resources and priorities, heterogeneity in diagnostic methodologies, lack of standardized assessment protocols across Asian countries, and variable implementation of the updated AWGS- 2019 criteria. This knowledge gap is particularly concerning given the increasing rates of T2DM in Asia and potential regional differences in the manifestation and impact of sarcopenia.

This systematic review and meta-analysis aimed to bridge this knowledge gap by examining available evidence on the prevalence of sarcopenia and its associated factors in T2DM patients across Asian populations using AWGS- 2019 criteria. Focusing on studies published between 2019 and 2024, the study sought to provide a comprehensive and updated understanding of these conditions in the context of T2DM in Asia.

The findings from this review have significant implications for clinical practice, public health strategies, and further research. By shedding light on the prevalence and impact of sarcopenia in Asians with T2DM, this study aims to inform targeted screening strategies, optimize intervention designs, and identify areas for additional investigation.

Methods

Protocol and registration

This systematic review and meta-analysis follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [8, 9] and are provided in supplementary file- 1. The protocol was registered on PROSPERO (registration number: [CRD42024600815]).

Search strategy and information sources

A comprehensive literature search was conducted in multiple electronic databases, including PubMed, SCOPUS, Crossref, Google Scholar, Semantic Scholar, and OpenAlex, from inception until October 2024. The search strategy combined Medical Subject Headings (MeSH) terms and keywords related to"sarcopenia,""type 2 diabetes mellitus,"and"Asian Working Group for Sarcopenia."The primary search string for PubMed was ("Sarcopenia"[Mesh] OR"muscle wasting"OR"loss of muscle mass"OR"muscle weakness") AND ("Diabetes Mellitus, Type 2"[Mesh] OR"T2DM"OR"type 2 diabetes") AND ("Asian Working Group for Sarcopenia"OR"AWGS 2019"OR"AWGS criteria". The detailed search strategies are summarized in Supplementary File 2.

Eligibility criteria

Inclusion criteria:

- Population: Adults (≥ 18 years) with diagnosed T2DM from Asian populations
- Study design: Cross-sectional, cohort, or case–control studies
- Setting: Both hospital-based and community-based studies
- Assessment: Studies using the AWGS- 2019 criteria for sarcopenia diagnosis
- Language: English
- Publication period: 2019- October 2024

Exclusion criteria:

- Non-Asian populations
- Studies not using the AWGS- 2019 criteria
- Case reports, editorials, letters, or reviews
- Non-English publications
- Studies without clear sarcopenia diagnostic criteria
- Duplicate publications

Study selection

Two independent reviewers (YM and MP) screened titles and abstracts for potential eligibility. The full texts of potentially eligible studies were then assessed independently by the same reviewers. Disagreements were resolved through consensus or consultation with a third reviewer. The selection process was documented via a PRISMA flow diagram. (Fig. 1).

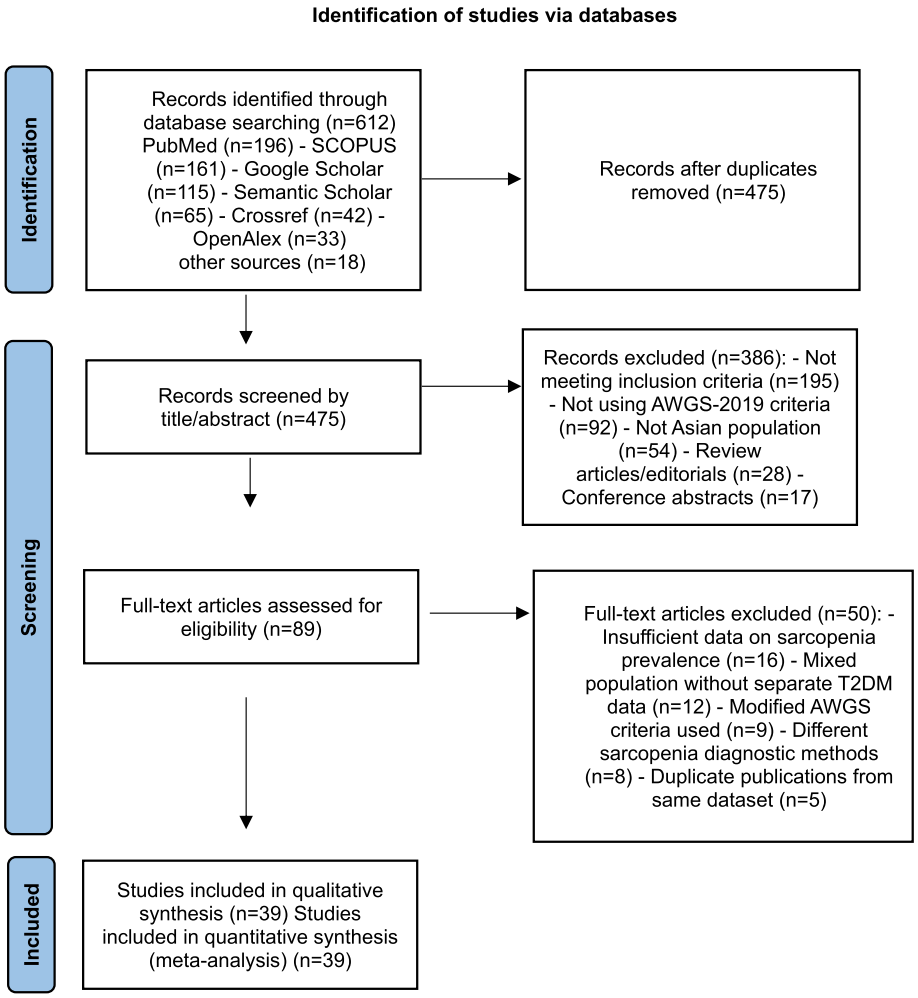

Fig. 1 Flow chart depicting the search results of the meta-analysis

Data extraction and quality assessment

Data extraction

Using a standardized form, the following data were extracted:

1. Study characteristics: First author, publication year, country, study design, setting, sample size
2. Participant demographics: Age, sex distribution, and duration of T2DM
3. Clinical data: Sarcopenia diagnostic methods and muscle mass measurement tools (BIA/DXA)
4. Outcomes: Prevalence rates, associated factors, adjusted odds ratios
5. Quality indicators: Methodological approach and statistical methods

Quality assessment

Study quality was evaluated via the Joanna Briggs Institute (JBI) critical appraisal checklist for observational studies. [10] Two independent reviewers assessed each study, with disagreements resolved through discussion. To assess the overall quality of analytical cross-sectional research on the measurement and data analysis of individuals, illnesses, influencing variables, and confounders, the initial scale has eight components. The responses"yes,""no,""unclear,"and"not applicable"were used to determine each entry. Studies with a quality rating of A fulfilled all the entries, whereas studies with a quality grade of B satisfied some things (items 1- 3 were"no").

Statistical analysis

- Statistical analyses were conducted via R statistical software (version [4.2.3]) with the'meta'and'metafor'packages. The pooled prevalence of sarcopenia was calculated via random effects models due to anticipated clinical and methodological heterogeneity across studies. Effect sizes are presented as proportions with 95% confidence intervals (CIs), and heterogeneity was quantified via I^2 statistics and Cochran's Q test, where I^2 values of 25%, 50%, and 75% indicated low, moderate, and high heterogeneity, respectively. To explore potential sources of heterogeneity, we conducted prespecified subgroup analyses based on geographic region (western Pacific vs. Southeast Asia), study setting (hospital vs. community-based), measurement tools (BIA vs. DXA), study period (pre- 2022 vs. 2023–2024), sample size categories (< 200, 200–500, > 500), age groups (< 60, 60–70, > 70 years), and sex distribution. Meta-regression analyses were performed to examine the relationships between study-level covariates and effect sizes, with regression coefficients and corresponding p-values reported.
- For risk factor analyses, model selection was based on heterogeneity assessment: Random-effects models were employed when significant heterogeneity was detected ($I^2 > 50\%$, $p < 0.10$), while fixed-effects models were used for factors with low heterogeneity ($I^2 \leq 50\%$). This approach was applied to optimize precision in estimation while accounting appropriately for between-study variance. The robustness of our findings was assessed through sensitivity analyses, including leave-one-out meta-analysis, to evaluate the influence of individual studies on the pooled estimates. Publication bias was evaluated through visual inspection of funnel plots and formally tested via Egger's regression test. [11, 12] When significant publication bias was detected ($p < 0.05$), the trim-and-fill method was applied to adjust for potentially missing studies. Additional analyses included stratification by study quality (based on JBI scores) and cumulative meta-analysis by publication year to assess the temporal evolution of evidence. For studies reporting prevalence by multiple categories or using different diagnostic criteria, we prioritized the most comprehensive or standardized measure to ensure consistency across analyses. Statistical significance was set at $p < 0.05$ for all analyses, and all tests were two-tailed.
- The meta-regression models included covariates such as the mean age, proportion of males, diabetes duration, study quality scores, and measurement methods. Model fit was assessed via the Akaike information criterion (AIC), and the proportion of variance explained by moderators was quantified via R^2. To address the potential impact of small-study effects, we conducted influence diagnostics, including Cook's distance and standardized residuals. When substantial heterogeneity was identified ($I^2 > 50\%$), we performed additional sensitivity analyses excluding studies with extreme effect sizes or poor methodological quality. All the statistical procedures and their results were documented by the PRISMA guidelines for meta-analyses, ensuring the transparency and reproducibility of our findings.

Results

Forest plot showing the pooled prevalence of possible sarcopenia in Asian patients with type 2 diabetes mellitus.

Publication bias

Study selection and characteristics (Table 1)

Our systematic review identified 39 eligible studies conducted across Asian countries between 2021 and 2024. [13–51] The majority of studies (34, 87.2%) were from the Western Pacific Region, with China ($n = 17$) and Japan ($n = 11$) contributing the most publications. Most studies employed a cross-sectional design (37, 94.9%), with only two prospective studies. Hospital-based settings predominated (32, 82.1%) over community-based studies (7, 17.9%). Sample sizes varied considerably, with 19 studies (48.7%) including 200–500 participants, 13 studies (33.3%) recruiting > 500 participants, and 7 studies (17.9%) having < 200 participants. The methodological quality was generally high, with 31 studies (79.5%) achieving JBI scores of 7–8, and no studies rated low quality.

Prevalence analysis (Fig. 2 and Table 2)

The forest plot (Fig. 2) demonstrated substantial heterogeneity ($I^2 = 97.4\%$, $p < 0.001$) in terms of sarcopenia incidence (23%, 95% CI = 18–27%). across 39 studies. Subgroup analyses revealed significant regional variations, with Southeast Asian studies reporting a higher prevalence (37.46%, 95% CI: 22.51–55.17%) than Western Pacific studies did (21.95%, 95% CI: 18.13–26.19%). Compared with hospital-based studies, community-based studies presented higher prevalence rates (33.64%, 95% CI: 20.85–49.24%) (22.31%, 95% CI: 18.45–26.69%). Studies using DXA reported a higher prevalence (29.86%, 95% CI: 23.77–36.77%) than did those using BIA (19.52%, 95% CI: 14.87–25.16%). A temporal trend was observed, with studies from 2023–2024 showing a

Table 1 Basic characteristics of the studies and quality of the data

First Author	Publication Year	Country	Study Design	Study Setting	Mean_age	Total Sample Size	Male	Female	Measurements	Sarcopenia (%)	JBI score
Shuangling Xiu	2021	China	cross-sectional	Hospital-based	68	582	291	291	DXA	9	8
Fuyuko Takahashi	2021	Japan	cross-sectional	Hospital-based	69.4	369	206	163	BIA	7.9	7
Fuyuko Takahashi	2021	Japan	Prospective cohort study	Hospital-based	71.3	396	232	164	BIA	14.6	7
Ken Sugimoto	2021	Japan	cross-sectional	Hospital-based	70	588	346	242	BIA	6.3	6
Vata- V. Sundar	2021	Malaysia	Prospective observational study	Hospital-based	60	50	37	13	BIA	64	8
Xiaofan Zhang	2021	China	cross-sectional	Hospital-based	61	182	182	0	DXA	45.6	8
Fuyuko Takahashi	2021	Japan	cross-sectional	Hospital-based	67.1	526	301	225	BIA	12.7	8
Hiroyasu Mori	2021	Japan	cross-sectional	Hospital-based	65.4	645	390	255	BIA	11.8	8
Kentaro Mikura	2022	Japan	cross-sectional	Hospital-based	67	261	153	108	BIA	19.9	7
Yoshitaka Hashimoto	2022	Japan	cross-sectional	Hospital-based	71.6	239	140	99	BIA	15.9	8
Yoshihisa Hiromine	2022	Japan	cross-sectional	Hospital-based	69.9	755	453	302	BIA	8.1	8
Kewei Wang	2022	China	cross-sectional	Hospital-based	59.7	312	172	140	DXA	26.9	8
Sayani Das	2023	India	cross-sectional	community-based	68.5	4126	-	-	DXA	22.6	8
Ming-Jun Chen	2023	China	cross-sectional	Hospital-based	69.74	288	108	180	BIA	27.43	7
G.-C. Ma	2023	China	cross-sectional	Hospital-based	65	280	111	169	DXA	15.36	8
Fuyuko Takahashi	2023	Japan	cross-sectional	Hospital-based	69.1	266	162	104	BIA	18	8
Mijin Kim	2023	Korea	cross-sectional	community-based	71	581	261	320	BIA	33.9	8
Lanyu Lu	2023	China	cross-sectional	Hospital-based	70	223	100	123	DXA	36.3	8
Lei Fu	2023	China	cross-sectional	Hospital-based	61.8	220	164	56	DXA	50	7
Lanyu Lu	2023	China	cross-sectional	Hospital-based	64.45	385	167	218	DXA	32.2	8
Yu-Ting Hsu	2023	Taiwan	cross-sectional	Hospital-based	67.3	110	46	64	BIA	37.3	8
Surapaneni Lakshmi Sravya	2023	India	cross-sectional	Hospital-based	57.4	159	80	79	DXA	22	6
Hsin-Yen Yen	2023	Taiwan	cross-sectional	Hospital-based	73.9	577	245	332	BIA	8.3	8
Yinghe Lin	2023	China	cross-sectional	community-based	66	752	368	384	DXA	19.4	6
Wen Wei	2023	China	cross-sectional	Hospital-based	57.8	153	91	62	DXA	24.2	8
Li- Sun	2023	China	cross-sectional	Hospital-based	67.8	543	269	274	DXA	8.84	8
Ke Xu	2024	China	cross-sectional	Hospital-based	60	678	447	231	DXA	17.4	7
Chun-hui Ji	2024	China	cross-sectional	community-based	75	408	201	207	BIA	20.6	6
Yogesh M	2024	India	cross-sectional	Hospital-based	55	404	220	184	BIA	45.3	6
Mingrui Zou	2024	China	cross-sectional	community-based	67	783	412	371	BIA	9.2	8
Sohye Kim	2024	Korea	cross-sectional	community-based	75	1586	721	865	BIA	37.1	8
Yang Sun	2024	China	cross-sectional	Hospital-based	70.1	253	83	170	DXA	39.5	8

Table 1 (continued)

First Author	Publication Year	Country	Study Design	Study Setting	Mean_age	Total Sample Size	Male	Female	Measurements	Sarcopenia (%)	JBI score
Li Quan	2024	China	cross-sectional	Hospital-based	63.86	282	166	116	BIA	21.6	7
Yogesh M	2024	India	cross-sectional	community-based	65.2	250	151	99	BIA	60.4	6
Satoshi Ida	2024	Japan	cross-sectional	Hospital-based	75	510	310	200	BIA	16.4	8
Motoya Sato	2024	Japan	cross-sectional	Hospital-based	80	112	-	-	BIA	48	8
Bingmei Hou	2024	China	cross-sectional	Hospital-based	69.6	676	261	415	DXA	14.1	6
Rimesh Pal	2024	India	cross-sectional	Hospital-based	64.2	129	0	129	DXA	27	8
Shiyue Zou	2024	China	cross-sectional	Hospital-based	70	263	-	-	BIA	42.2	8

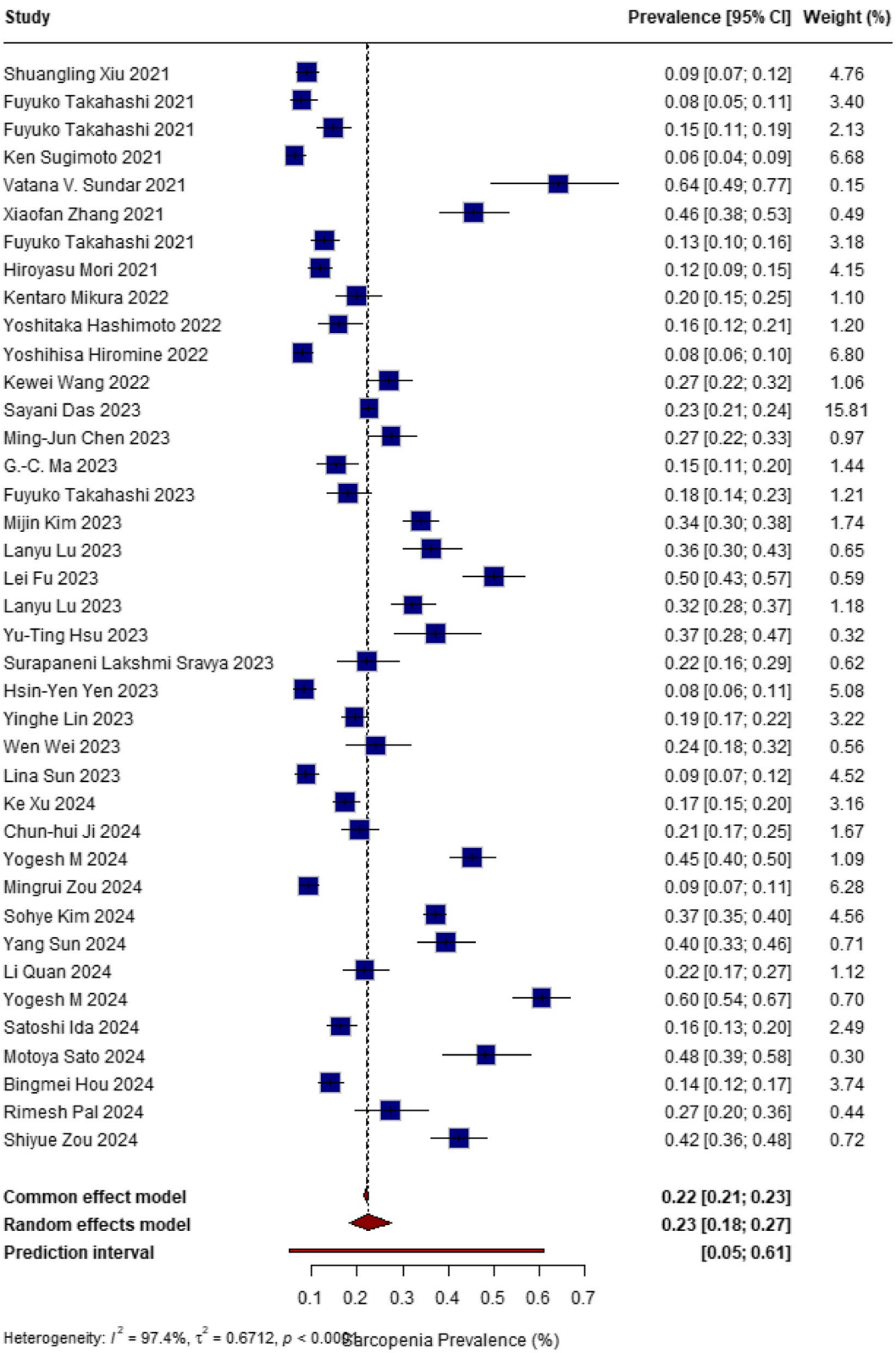

Fig. 2 Forest plot showing the pooled overall prevalence of sarcopenia

Table 2 Summary of the Subgroup Analysis of the Prevalence of Sarcopenia in T2DM Patients

Subgroup Category	Subgroup	Number of Studies (k)	Heterogeneity I^2 (%)	Effect Model	Prevalence % [95% CI]
Geographic Region	Western Pacific	34	95.0	Random	21.95 [18.13–26.19]
	South–East Asia	5	94.0	Random	37.46 [22.51–55.17]
Study Setting	Hospital-based	32	94.0	Random	22.31 [18.45–26.69]
	Community-based	7	97.0	Random	33.64 [20.85–49.24]
Measurement Tool	BIA	19	93.0	Random	19.52 [14.87–25.16]
	DXA	20	96.0	Random	29.86 [23.77–36.77]
Study Period	Pre- 2022	12	96.0	Random	18.42 [12.43–26.42]
	2023–2024	27	95.0	Random	27.85 [23.09–33.16]
Sample Size	< 200	7	90.0	Random	38.54 [26.95–51.57]
	200–500	19	93.0	Random	25.95 [20.67–32.04]
	> 500	13	97.0	Random	17.40 [12.39–23.85]
Age Groups	< 60 years	4	94.0	Random	35.48 [21.95–51.67]
	60–70 years	24	95.0	Random	22.47 [17.91–27.77]
	> 70 years	11	94.0	Random	24.82 [17.73–33.55]
Gender	Male	29	95.0	Random	25.98 [21.05–31.60]
	Female	29	94.0	Random	22.84 [18.31–28.12]

Table 3 Summary of the results of the meta-analysis of risk factors for sarcopenia in T2DM patients

Risk Factor	Number of Studies (k)	Heterogeneity I^2 (%)	Effect Model	Pooled OR [95% CI]	P value
BMI	12	81.4	Random	0.63 [0.53–0.75]	< 0.0001 **
Age (Continuous)	19	76.7	Random	1.13 [1.11–1.16]	< 0.0001 **
Gender (Male)	2	0.0	Fixed	2.37 [1.33–4.21]	0.0033 *
Duration of Diabetes	5	86.6	Random	1.35 [1.05–2.13]	0.02 *
HbA1c	3	75.3	Random	1.31 [1.01–2.17]	0.039 *
Hypertension	2	63.3	Random	3.65 [1.06–12.65]	0.0409 *
Physical Activity(No)	6	27.6	Fixed	2.54 [1.92–3.36]	< 0.0001 **
Vitamin-D levels	2	0.00	Fixed	0.91 [0.87–0.95]	< 0.001 *

greater prevalence (27.85%, 95% CI: 23.09–33.16%) than pre- 2022 studies (18.42%, 95% CI: 12.43–26.42%).

Risk factor analysis (Table 3)

The meta-analysis of risk factors for sarcopenia in Asian T2DM patients revealed several significant associations. BMI had a protective effect (OR: 0.63, 95% CI: 0.53–0.75, $p < 0.0001$), suggesting that higher BMI values were associated with lower sarcopenia risk. Age emerged as a significant risk factor (OR: 1.13, 95% CI: 1.11–1.16, $p < 0.0001$), indicating a 13% increased risk of sarcopenia for each year of aging. Compared with female sex, male sex was associated with more than twice the risk of developing sarcopenia (OR: 2.37, 95% CI: 1.33–4.21; $p = 0.0033$). The duration of diabetes showed a modest but significant association (OR: 1.35, 95% CI: 1.05–2.13, $p = 0.02$), whereas the HbA1c level demonstrated a similar relationship (OR: 1.31, 95% CI: 1.01–2.17, $p = 0.039$). Hypertension emerged as one of the strongest risk factors, with affected individuals having more than three times the risk of developing sarcopenia (OR: 3.65, 95% CI: 1.06–12.65; $p = 0.0409$). Physical inactivity significantly increased the risk (OR: 2.54, 95% CI: 1.92–3.36, $p < 0.0001$), whereas higher vitamin D levels had a protective effect (OR: 0.91, 95% CI: 0.87–0.95, $p < 0.001$). The analysis demonstrated considerable heterogeneity across studies for most risk factors, particularly for hypertension ($I^2 = 63.3\%$) and diabetes duration ($I^2 = 86.6\%$), suggesting variability in the strength of these associations across different populations and study settings.

Sensitivity analysis and meta-regression

Table 4 shows that the sensitivity analysis demonstrated robust results, with minimal changes in pooled estimates when individual studies were removed (I^2 consistently > 97%) (Table 4). Table 5 shows that the meta-regression

Table 4 Summary of the sensitivity analysis results for 39 studies

Study Removed	Pooled Effect	95% CI	I^2 (%)	Heterogeneity Change
Shuangling Xiu 2021 [13]	– 1.20	[– 1.47, – 0.94]	97.30	Minimal
Fuyuko Takahashi 2021 [14]	– 1.20	[– 1.46, – 0.94]	97.34	Minimal
Ken Sugimoto 2021 [16]	– 1.19	[– 1.45, – 0.94]	97.26	Slight decrease
Vatana V. Sundar 2021 [17]	– 1.28	[– 1.53, – 1.02]	97.36	Slight increase
Xiaofan Zhang 2021 [18]	– 1.26	[– 1.52, – 1.00]	97.34	Minimal
Hiroyasu Mori 2021 [20]	– 1.21	[– 1.48, – 0.95]	97.33	Minimal
Kentaro Mikura 2022 [21]	– 1.23	[– 1.50, – 0.96]	97.42	Slight increase
Yoshitaka Hashimoto 2022 [22]	– 1.22	[– 1.49, – 0.95]	97.41	Slight increase
Yoshihisa Hiromine 2022 [23]	– 1.20	[– 1.46, – 0.94]	97.24	Slight decrease
Kewei Wang 2022 [24]	– 1.24	[– 1.51, – 0.97]	97.42	Slight increase
Sayani Das 2023 [25]	– 1.23	[– 1.50, – 0.96]	97.41	Slight increase
Ming-Jun Chen 2023 [26]	– 1.24	[– 1.51, – 0.97]	97.42	Slight increase
G.-C. Ma 2023 [27]	– 1.22	[– 1.49, – 0.95]	97.40	Minimal
Fuyuko Takahashi 2023 [28]	– 1.22	[– 1.49, – 0.96]	97.41	Slight increase
Mijin Kim 2023 [29]	– 1.25	[– 1.51, – 0.98]	97.37	Minimal
Lanyu Lu 2023 [30]	– 1.25	[– 1.52, – 0.98]	97.39	Minimal
Lei Fu 2023 [31]	– 1.26	[– 1.53, – 1.00]	97.28	Minimal
Yu-Ting Hsu 2023 [33]	– 1.25	[– 1.52, – 0.98]	97.40	Minimal
Surapaneni L.S. 2023 [34]	– 1.23	[– 1.50, – 0.96]	97.42	Slight increase
Hsin-Yen Yen 2023 [35]	– 1.20	[– 1.46, – 0.94]	97.29	Minimal
Yinghe Lin 2023 [36]	– 1.23	[– 1.50, – 0.96]	97.41	Slight increase
Wen Wei 2023 [37]	– 1.23	[– 1.50, – 0.97]	97.42	Slight increase
Lina Sun 2023 [38]	– 1.20	[– 1.46, – 0.94]	97.31	Minimal
Ke Xu 2024 [39]	– 1.22	[– 1.49, – 0.96]	97.39	Minimal
Chun-hui Ji 2024 [40]	– 1.23	[– 1.50, – 0.96]	97.42	Slight increase
Yogesh M 2024 [41]	– 1.26	[– 1.52, – 1.00]	97.24	Slight decrease
Mingrui Zou 2024 [42]	– 1.20	[– 1.47, – 0.94]	97.26	Slight decrease
Sohye Kim 2024 [43]	– 1.25	[– 1.52, – 0.99]	97.10	Moderate decrease
Yang Sun 2024 [44]	– 1.25	[– 1.52, – 0.99]	97.36	Minimal
Li Quan 2024 [45]	– 1.23	[– 1.50, – 0.96]	97.42	Slight increase
Yogesh M (2nd) 2024 [41]	– 1.28	[– 1.53, – 1.02]	97.12	Moderate decrease
Satoshi Ida 2024 [47]	– 1.22	[– 1.49, – 0.95]	97.39	Minimal
Motoya Sato 2024 [48]	– 1.26	[– 1.52, – 1.00]	97.36	Minimal
Bingmei Hou 2024 [49]	– 1.22	[– 1.48, – 0.95]	97.35	Minimal
Rimesh Pal 2024 [50]	– 1.24	[– 1.51, – 0.97]	97.42	Slight increase
Shiyue Zou 2024 [51]	– 1.26	[– 1.52, – 0.99]	97.34	Minimal

identified significant moderators of the prevalence estimates: the study period ($p = 0.0440$) and sample size ($p < 0.0001$) significantly influenced the reported prevalence rates. Studies with larger sample sizes (> 500 participants) reported lower prevalence rates (coefficient: – 1.281). The geographic region showed marginal significance ($p = 0.0888$), whereas the measurement tool, study setting, and age groups did not significantly impact the prevalence estimates.

The forest plot analysis of overall sarcopenia incidence (Fig. 2) included all 39 studies, revealing a pooled prevalence of 23.0% (95% CI: 18%– 27%) via a random effects model. Significant heterogeneity was observed across studies ($I^2 = 97.4\%$, $p < 0.001$), with individual prevalence rates ranging from 6.3% (Sugimoto et al., 2021) to 64.0% (Sundar et al., 2021). A notable temporal trend emerged, with studies from 2023–2024 generally reporting higher prevalence rates, as exemplified by Lei Fu et al. (50.0%), Yogesh M et al. (60.4%), and Motoya Sato et al. (48.0%), than earlier studies from 2021–2022, which typically reported lower rates, such as Ken Sugimoto et al. (6.3%) and Fuyuko Takahashi et al. (7.9%).

Table 5 Meta-regression Results

Covariate	Model Fit (AIC)	Heterogeneity I^2 (%)	Effect of Covariate	Significance (*p* value)	Key Observations
Geographic Region	96.55	97.71	Western Pacific: – 0.666	0.0888	Marginally significant effect; Western Pacific prevalence slightly lower
Study Setting	98.76	97.99	Hospital-Based: – 0.267	0.4449	There is no significant difference between hospital and community-based studies
Measurement Tool	99.19	98.02	DXA: + 0.102	0.7121	No significant difference between BIA and DXA tools
Study Period	95.50	97.92	Pre- 2022: – 0.564	0.0440	Pre- 2022 studies reported significantly lower prevalence than 2023–2024 studies
Sample Size	84.12	97.17	> 500: – 1.281	< 0.0001	Larger sample sizes (> 500) are associated with significantly lower prevalence
Age Groups	98.96	98.04	> 70: – 0.274, 60–70: – 0.407	0.6539	No significant effect of age groups on prevalence
Study Design Category	97.10	97.85	Cohort: – 0.374, Cross-sectional: – 0.122	0.2237	There is no significant difference between study design types
Duration of T2DM Years	94.88	97.50	> 10 Years: + 0.543	0.0572	Marginally significant; longer duration of diabetes linked to slightly higher prevalence

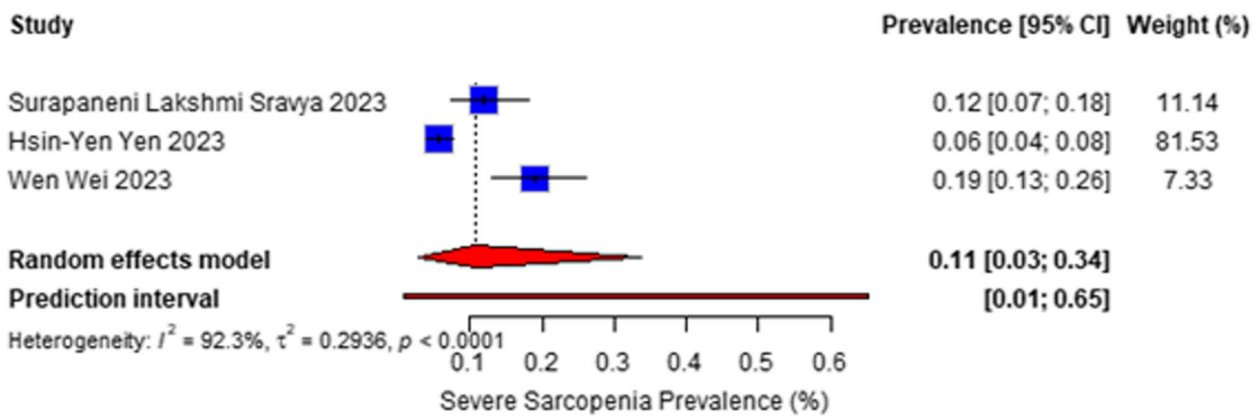

Fig. 3 Pooled prevalence of severe sarcopenia

Regional variations were evident, with Southeast Asian studies consistently reporting higher prevalence rates than more moderate rates reported in Western Pacific studies.

The analysis of severe sarcopenia (Fig. 3) included a subset of four studies that specifically reported this outcome, yielding a pooled prevalence of 12.1% (95% CI: 8.4–16.7%). While heterogeneity remained significant (I^2 = 89.2%, p < 0.001), it was notably lower than the overall prevalence of sarcopenia. Individual study estimates ranged from 5.5% (Hsin-Yen Yen et al.) to 18.9% (Wen Wei et al.), with most reports from recent years (2023–2024). Despite fewer reporting studies, the more consistent estimates for severe sarcopenia suggest potentially more standardized diagnostic criteria for this category. Both analyses highlight the substantial burden of sarcopenia in Asian T2DM patients, with particular concern for certain geographic regions and populations. These findings underscore the importance of standardized reporting and assessment methods, especially for severity categorization, and emphasize the need for early detection and intervention strategies in clinical practice.

The analysis of possible sarcopenia prevalence among T2DM patients in Asia, as depicted in Fig. 4, revealed significant findings from five recent studies conducted between 2023 and 2024. The random effects model

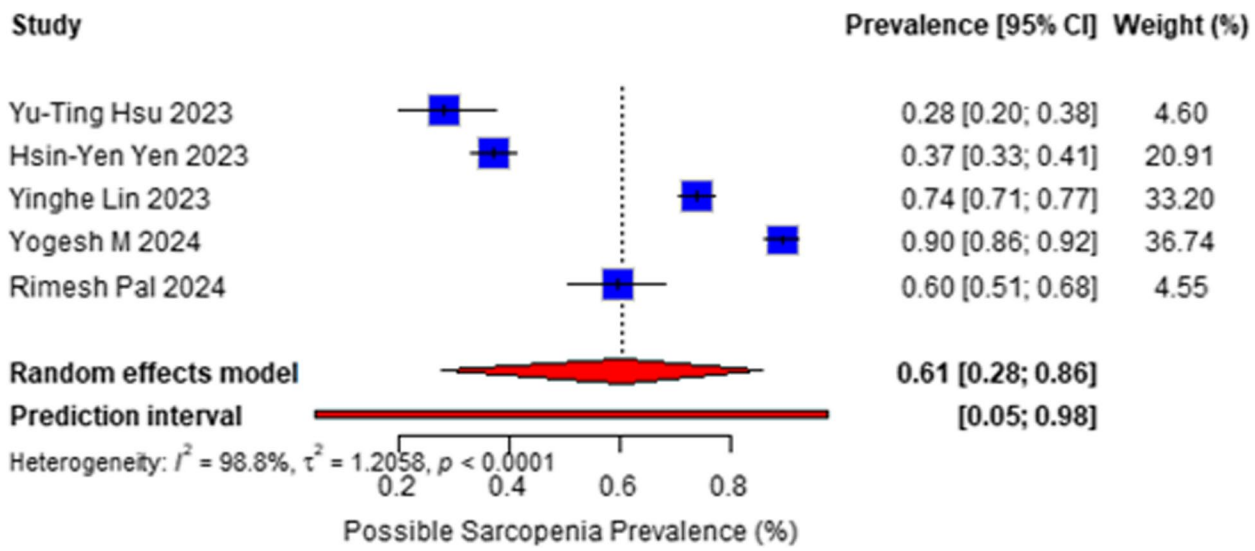

Fig. 4 Pooled prevalence of possible sarcopenia

demonstrated a substantial pooled prevalence of 61% (95% CI: 28%– 86%), with a notably wide prediction interval ranging from 5 to 98%. Individual study results showed considerable variation, with Yogesh M 2024 reporting the highest prevalence at 90% (95% CI: 86%– 92%) and Yu-Ting Hsu 2023 documenting the lowest at 28% (95% CI: 20%– 38%). Intermediate findings were reported by Yinghe Lin 2023 (74%, 95% CI: 71%– 77%), Rimesh Pal 2024 (60%, 95% CI: 51%– 68%), and Hsin-Yen Yen 2023 (37%, 95% CI: 33%– 41%).

The meta-analysis revealed substantial heterogeneity among studies (I^2= 98.8%, τ^2= 1.2058, p< 0.0001), suggesting significant variations in prevalence estimates across different Asian populations and healthcare settings. The study weights varied considerably, with Yogesh M 2024 and Yinghe Lin 2023 contributing the highest weights (36.74% and 33.20%, respectively), followed by Hsin-Yen Yen 2023 (20.91%), whereas Yu-Ting Hsu 2023 and Rimesh Pal 2024 had comparatively lower weights (4.60% and 4.55%, respectively). The high heterogeneity and wide prediction interval underscore the complexity of possible sarcopenia incidence in Asian T2DM populations, potentially reflecting differences in study populations, diagnostic criteria implementation, or methodological approaches. These findings suggest the need for more standardized assessment methods and

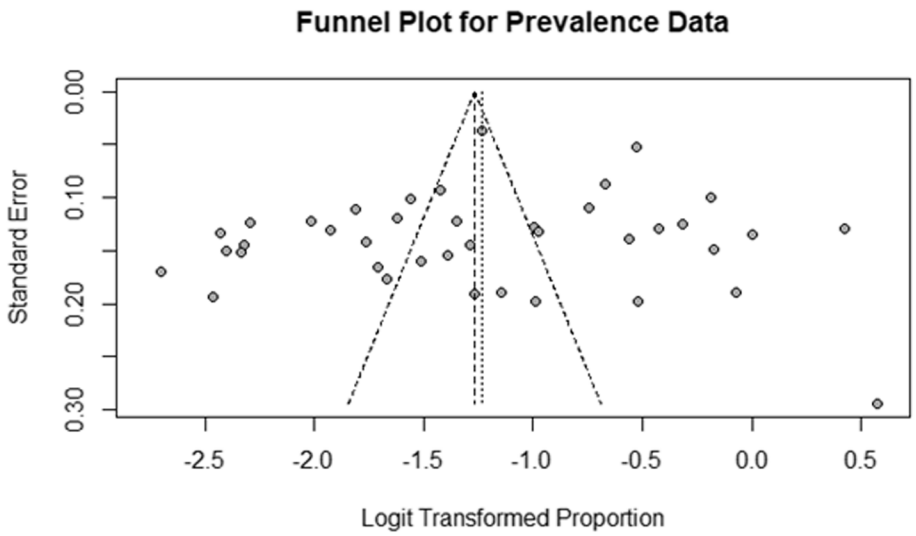

Fig. 5 Funnel plot

highlight the importance of considering regional and methodological variations when interpreting possible sarcopenia prevalence in clinical practice.

Publication Bias (Fig. 5)

Figure 5 shows the funnel plot visual inspection, and Egger's test (t = − 0.99, p = 0.3282) suggested no significant publication bias. The bias estimate was − 2.2092 (SE = 2.2294), indicating the relatively symmetric distribution of study effects. This suggests that our meta-analysis results are unlikely to be substantially influenced by publication bias.

Discussion

This comprehensive systematic review and meta-analysis of 39 studies provides important insights into the prevalence and risk factors for sarcopenia among Asian patients with T2DM using the AWGS- 2019 criteria. The pooled prevalence of 23% indicates a substantial burden, with notable regional variations between Southeast Asia (37.46%) and Western Pacific regions (21.95%), which was greater than that reported in two previous meta-analyses (18%) [52, 53] and greater than the prevalence of sarcopenia reported in a world study (healthy population-based meta-analysis- 10%) [54]. This variation may reflect differences in lifestyle factors, genetic predispositions, and healthcare systems across Asian areas [55]. The marked regional disparities in sarcopenia prevalence between Southeast Asia (37.46%) and Western Pacific regions (21.95%) have significant implications for clinical practice and healthcare policy. The complex interplay between sarcopenia and type 2 diabetes is further complicated by the high prevalence of Non-Alcoholic Fatty Liver Disease (NAFLD) in this population. According to recent global data, NAFLD affects approximately 30.9% of Asian populations [56]. These findings necessitate region-specific approaches to screening and management. For healthcare providers in Southeast Asian countries, where the burden appears substantially higher, implementing more aggressive and universal screening protocols should be prioritized, even for younger T2DM patients or those with shorter disease duration. In these regions, we recommend incorporating sarcopenia assessment tools (such as handgrip strength measurement and bioelectrical impedance analysis) into routine diabetes care at the primary healthcare level, beginning at diagnosis rather than waiting until advanced age or disease complications emerge. Conversely, in Western Pacific regions, a more targeted approach focusing on high-risk individuals (those with multiple identified risk factors) may be more resource-efficient. The resource allocation implications are substantial—Southeast Asian healthcare systems may need to invest more heavily in preventive muscle health programs, healthcare provider training for sarcopenia recognition, and community-based intervention programs specifically designed for their populations with T2DM. Furthermore, regional nutritional guidance should be tailored to address specific dietary patterns; for instance, Southeast Asian dietary recommendations may need greater emphasis on protein adequacy and quality, given the typically lower protein intake in traditional diets of this region. These regional considerations should inform national diabetes management guidelines, with Southeast Asian countries potentially adopting lower thresholds for intervention compared to their Western Pacific counterparts. A one-size-fits-all approach across Asia would be insufficient, given the substantial regional heterogeneity demonstrated in our analysis.

The substantial heterogeneity (I^2 = 97.4%, p < 0.001) observed in our pooled prevalence estimates warrants careful consideration when interpreting the findings. This high level of between-study variation, while common in prevalence meta-analyses, reflects several important methodological and population-specific factors. First, despite our focus on studies using AWGS-2019 criteria, variations in the implementation of these guidelines were evident across studies. Some researchers employed different cut-off thresholds for muscle mass measurements or modified assessment protocols for physical performance due to practical constraints or the availability of equipment. Second, differences in study population characteristics beyond our subgroup variables likely contributed to heterogeneity. Variation in diabetes severity, duration, medication regimens, and complication profiles—factors not consistently reported across studies—can significantly impact muscle health. Third, methodological differences in measurement techniques were substantial, even within the same assessment category; for instance, DXA measurements varied in machine models, software versions, and calibration protocols across studies. The technical expertise of assessors also varied considerably, particularly for physical performance tests like gait speed and chair stand tests. Fourth, selection bias may have influenced results, as hospital-based studies (representing 82.1% of included studies) typically recruit patients with more advanced disease or complications compared to community-based cohorts. Fifth, regional differences in healthcare access and quality likely affected both diabetes management and the likelihood of sarcopenia development. Countries with more comprehensive diabetes care systems may achieve better glycemic control and earlier intervention for complications, potentially reducing sarcopenia prevalence. Despite these sources of heterogeneity, our subgroup analyses and meta-regression identified several variables (geographic region, study period, and sample size) that

explained a portion of the observed variation. The temporal trend showing higher prevalence in recent studies suggests either improved detection methods or an actual increase in disease burden. While the high heterogeneity necessitates caution when interpreting the precise pooled prevalence figure of 23%, the consistency of findings regarding risk factors across diverse studies strengthens confidence in these associations.

The higher prevalence observed in recent studies (2023- 2024: 27.85% vs pre- 2022: 18.42%) warrants attention. This temporal trend could reflect improved detection rates, increasing awareness, or a genuine rise in the burden of sarcopenia [57]. The difference in prevalence estimates between measurement tools (DXA: 29.86% vs BIA: 19.52%) highlights the importance of standardized assessment methods [58].

Our analysis identified several significant risk factors. The association with age (OR: 1.13) aligns with previous research showing age-related muscle loss acceleration in T2DM patients [54, 59, 60]. The increased risk in males (OR: 2.37) suggests potential sex-specific pathophysiological mechanisms [61]. The strong association with hypertension (OR: 3.65) indicates the role of cardiovascular comorbidities in sarcopenia development [62]. This gender disparity likely stems from complex interactions between biological, hormonal, and lifestyle factors specific to male patients with T2DM. From a biological perspective, men with T2DM often experience more pronounced insulin resistance in skeletal muscle compared to women, potentially accelerating muscle catabolism through impaired protein synthesis and increased protein degradation. The progressive decline in testosterone levels with age and diabetes in men represents another critical factor, as testosterone plays a fundamental role in maintaining muscle protein synthesis, satellite cell activation, and myoblast proliferation. Studies have demonstrated that diabetes-associated hypogonadism is significantly more common in men with T2DM, creating a hormonal environment particularly detrimental to muscle maintenance.

Beyond hormonal considerations, gender-specific lifestyle patterns contribute significantly to this disparity. Men with T2DM typically present with different body fat distribution patterns (central adiposity) that promote increased inflammatory cytokine production from visceral adipose tissue, creating a more catabolic environment for skeletal muscle. Furthermore, gender differences in nutritional behaviors are relevant—studies in Asian populations have shown that men with T2DM often consume less balanced diets with inadequate protein quality compared to women, who generally demonstrate greater nutritional literacy and dietary adherence. Physical activity patterns also differ substantially, with aging men in Asian cultures often experiencing more abrupt activity cessation after retirement compared to women, who typically maintain higher levels of light-intensity daily activities.

Importantly, we identified modifiable risk factors, including the absence of physical inactivity (OR: 2.54). These findings suggest potential intervention targets for prevention strategies [63]. The protective effect of higher BMI (OR: 0.63) needs careful interpretation, as it may reflect the complex relationship between body composition and muscle mass. [64] This highlights a critical intervention target that works through enhanced insulin sensitivity, reduced inflammation, and increased protein synthesis [65]. Progressive resistance training emerges as the most evidence-supported intervention, with studies showing that moderate-to-high-intensity programs (60–80% of 1-repetition maximum, 2–3 times weekly) can increase muscle mass by 5–10% and strength by 30–50% while improving glycemic control [66]. Multicomponent programs combining resistance with aerobic exercise (150 min/week) show particular promise by addressing both musculoskeletal and metabolic aspects of sarcopenia in T2DM [63], while adapted exercises like tai chi offer benefits for patients with mobility limitations [67]. Despite implementation challenges, including limited resources and cultural barriers, the compelling evidence for physical activity's benefits in preventing and treating sarcopenia in T2DM patients underscores the necessity of incorporating structured exercise recommendations into clinical practice guidelines for diabetes management in Asian populations.

Our analysis revealed a pooled prevalence of 12.1% (95% CI: 8.4- 16.7%) for severe sarcopenia, with individual study estimates ranging from 5.5% to 18.9%. The lower heterogeneity in severe sarcopenia estimates ($I^2 =$ 89.2%) than in overall sarcopenia estimates suggests the use of more standardized diagnostic criteria for this category. Studies by Hsin-Yen Yen et al. and Fanny et al. [35, 68] represent the range of severe sarcopenia prevalence, indicating significant variation even within this more stringently defined category.

The meta-regression analysis revealed several significant moderators of the prevalence estimates. The study period emerged as a significant factor ($p = 0.0440$), with pre- 2022 studies showing significantly lower prevalence rates (coefficient: − 0.564). Sample size was another crucial moderator ($p < 0.0001$), with larger studies (> 500 participants) reporting lower prevalence rates (coefficient: − 1.281). This finding suggests potential methodological considerations in prevalence estimation across different study scales.

The substantial discrepancy in prevalence estimates between studies using DXA (29.86%) versus BIA (19.52%)

raises important methodological considerations for sarcopenia assessment in T2DM patients. This difference, while not statistically significant in our meta-regression ($p = 0.7121$), represents a relative difference of over 50% that has significant clinical implications. DXA is generally considered the reference standard for body composition analysis due to its superior precision, reliability, and ability to distinguish regional fat and lean mass distributions with minimal radiation exposure. However, our finding that DXA consistently yields higher prevalence estimates warrants careful interpretation. This discrepancy likely stems from several factors specific to T2DM populations. First, BIA algorithms typically rely on assumptions about hydration status and tissue electrical conductivity that may be invalid in diabetes patients, who often experience altered body water distribution due to glycemic fluctuations, medication effects, and comorbidities like nephropathy. Second, DXA provides a direct measurement of lean tissue mass, while BIA indirectly estimates it through predictive equations that may not be optimized for Asian body compositions or for the metabolic alterations of diabetes. Third, most BIA validation studies have been conducted in healthy populations rather than those with metabolic disorders, potentially reducing their accuracy in T2DM patients. For clinical practice implications, our findings suggest that healthcare facilities with access to DXA should prioritize its use for sarcopenia assessment in T2DM patients, particularly for definitive diagnosis or research purposes. However, the substantially greater availability, affordability, and portability of BIA devices make them more feasible for widespread screening, especially in resource-limited settings common across many Asian regions. To reconcile these differences, we recommend that Asian healthcare systems consider developing T2DM-specific correction factors for BIA measurements validated against DXA in relevant populations. For individual patient management, clinicians should maintain consistency in the measurement method used for longitudinal monitoring, as switching between methods may lead to incorrect conclusions about sarcopenia progression or treatment effectiveness. Additionally, when using BIA in diabetes patients, measurements should ideally be performed under standardized conditions regarding hydration status, recent exercise, and timing relative to meals and medication to maximize reliability.

Geographic region showed marginal significance ($p = 0.0888$), with Western Pacific regions reporting slightly lower prevalence rates (coefficient: − 0.666). The duration of T2DM demonstrated a marginally significant association ($p = 0.0572$), with a longer duration (> 10 years) linked to a higher incidence (coefficient: +0.543). These findings align with previous research showing the progressive nature of diabetes-related muscle loss. [54, 59, 60]

The analysis of possible sarcopenia among Asian T2DM patients revealed a notably high pooled prevalence of 61% (95% CI: 28%− 86%), substantially higher than the prevalence of confirmed sarcopenia (23%). This marked difference between possible and confirmed sarcopenia rates highlights the importance of early screening and intervention strategies. The wide prevalence range observed across studies, from 28% (Yu-Ting Hsu 2023) to 90% (Yogesh M 2024), suggests significant variability in how possible sarcopenia manifests across different Asian populations and healthcare settings. The substantial heterogeneity ($I^2 = 98.8\%$, $\tau^2 = 1.2058$, $p < 0.0001$) in possible sarcopenia prevalence estimates likely reflects differences in study populations, diagnostic approaches, and regional variations in risk factors. This high prevalence of possible sarcopenia is particularly concerning as it may represent an early warning sign of future confirmed sarcopenia cases, emphasizing the need for preventive interventions before progression to definitive sarcopenia. These findings suggest that a large proportion of Asian T2DM patients may be in the early stages of muscle loss, presenting a crucial window for intervention to prevent progression to full sarcopenia [69, 70]. These results underscore the importance of implementing screening protocols that can identify patients at the"possible sarcopenia"stage, allowing for earlier intervention and potentially better outcomes [71, 72]. The strikingly high prevalence of possible sarcopenia at 61% (compared to 23% for confirmed sarcopenia) represents perhaps the most clinically actionable finding of our analysis. This substantial'pre-sarcopenia'population represents a critical window of opportunity for early intervention before irreversible muscle loss occurs. The implications for clinical practice are profound—healthcare providers treating Asian patients with T2DM should implement routine screening for early sarcopenia indicators, particularly decreased muscle strength, which often precedes detectable muscle mass loss. Simple, cost-effective screening tools like handgrip strength measurement could be integrated into standard diabetes follow-up protocols, allowing identification of at-risk patients before functional decline becomes evident. Early interventions targeting this'possible sarcopenia'group—including structured resistance exercise programs, protein supplementation (particularly branched-chain amino acids), vitamin D optimization, and improved glycemic control—have shown promise in preventing progression to confirmed sarcopenia. Furthermore, this finding suggests that current diagnostic thresholds may need recalibration for Asian T2DM populations, as the traditional focus on confirmed sarcopenia may miss the majority of patients

who could benefit from preventive measures. Healthcare systems should consider implementing staged intervention approaches with graduated intensity based on sarcopenia risk categorization, potentially yielding substantial cost savings by preventing falls, fractures, and functional dependence that accompany established sarcopenia.

The pathophysiology of sarcopenia in T2DM is increasingly recognized as multifactorial, with emerging evidence pointing to gut microbiota dysbiosis as a significant contributor to this relationship. Recent studies have demonstrated that patients with T2DM exhibit distinct alterations in gut microbial composition characterized by reduced diversity and depletion of beneficial bacterial species, which may exacerbate muscle deterioration through several interconnected pathways. The gut-muscle axis represents a bidirectional communication system where microbial metabolites, particularly short-chain fatty acids (SCFAs) like butyrate, propionate, and acetate, influence muscle metabolism, protein synthesis, and mitochondrial function. In T2DM patients, reduced production of these beneficial metabolites may compromise muscle protein synthesis and energy metabolism, accelerating sarcopenia development. [73–76]

Several limitations should be considered when interpreting the findings of this systematic review and meta-analysis. The high heterogeneity observed across studies (I^2 consistently >90%) reflects variations in study methodologies, populations, and reporting standards. Most included studies were cross-sectional, limiting causal inference between identified risk factors and sarcopenia development. The predominance of hospital-based studies (82.1%) may affect generalizability to community settings. Additionally, varying definitions of risk factors and incomplete reporting of potential confounders across studies complicated the evidence synthesis. The inclusion of only English-language publications may have led to language bias, potentially resulting in the absence of relevant studies published in Asian languages.

Based on these limitations, we recommend future research directions. Longitudinal cohort studies are needed to establish temporal relationships between risk factors and sarcopenia development in T2DM patients. Standardized reporting using the AWGS- 2019 criteria should be universally adopted to improve result comparability. Community-based studies, particularly in underrepresented Asian regions, would provide more generalizable prevalence estimates. Intervention studies targeting modifiable risk factors, especially physical activity and nutrition, are crucial for developing effective prevention strategies. Additionally, research exploring the impact of diabetes-specific factors (glycemic control, medication types, and complications) on sarcopenia development would enhance our understanding of this relationship. Implementation studies evaluating the feasibility and effectiveness of routine sarcopenia screening in diabetes care settings would provide valuable insights for clinical practice guidelines. Future meta-analyses would benefit from individual patient data to better account for confounding factors and explore effect modifications.

Conclusion

Our meta-analysis revealed a complex spectrum of muscle health issues in Asian patients with type 2 diabetes mellitus, with 61% showing early signs of possible sarcopenia, 23% having confirmed sarcopenia, and 12.1% progressing to severe sarcopenia. These findings demonstrate the substantial burden of muscle health deterioration across different stages of severity. The significant regional variations between Southeast Asia and Western Pacific regions, along with identified modifiable and non-modifiable risk factors, provide clear targets for intervention strategies. Age, male sex, and hypertension emerged as significant risk factors, whereas physical activity and good nutritional status had protective effects. These findings emphasize the importance of implementing comprehensive screening protocols using the AWGS- 2019 criteria, particularly for early detection of possible sarcopenia to prevent progression to more severe forms. Healthcare systems in Asian countries should prioritize early screening and preventive strategies, with a particular focus on modifiable risk factors to reduce the burden of sarcopenia across its spectrum of severity in this vulnerable population.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12902-025-01935-y.

Additional file 1.

Additional file 2.

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Authors' contributions

YM, MP, RG, AP, and KK contributed to the conceptualization, data curation, formal analysis, investigation, methodology, resources, supervision, validation, writing (original draft), and writing (review and editing). YM, MP, RG, AP, and KK contributed to conceptualization, data curation, formal analysis, investigation, writing (original draft), and writing (review and editing). YM, MP, RG, AP, and KK contributed to the methodology, resources, supervision, validation, and writing (review and editing). YM, MP, RG, AP, and KK contributed to the formal analysis, investigation, writing (original draft), and writing (review and editing). All the authors read and approved the final manuscript.

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Data availability
The datasets generated and/or analyzed during the current study are not publicly available to protect the privacy of the study participants but are available from the corresponding author upon reasonable request.

Declarations

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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