Jurnal Aisyah: Jurnal Ilmu Kesehatan

Volume 9, Issue 1, 03 2023, p. 165–176
ISSN 2502-4825 (print), ISSN 2502-9495 (online)

SARCOPENIA IN TYPE 2 DIABETES MELLITUS: A SYSTEMATIC REVIEW OF PREVALENCE AND IMPACT IN ASIAN POPULATIONS

Authors:

***Nurul Afifah*[1], *Siti Fatimah Muis*[2], *Adriyan Pramono*[3]**

[1]*Universitas Diponegoro; Jl. Prof Sudarto SH. Tembalang, Semarang 50271.(024)76402881*
[2]*Universitas Diponegoro; Jl. Prof Sudarto SH. Tembalang, Semarang 50271.(024)76402881*
[3]*Universitas Diponegoro; Jl. Prof Sudarto SH. Tembalang, Semarang 50271.(024)76402881*
*Corresponding Email: *adiva.baiza@gmail.com*

About the Author

1. 1st Author : dr. Nurul Afifah
   Affiliation : Magister Ilmu Gizi, Fakultas Kedokteran, Universitas Diponegoro.
   Mailing address : Jl. Prof Sudarto SH. Tembalang, Semarang 50271, Indonesia
   Email of author : adiva.baiza@gmai.com
   Orcid ID : https://orcid.org=0009-0002-7736-9335
   Google Scholar URL :
   https://scholar.google.com/citations?hl=en&user=U0mDcAgAAAAJ&view_op=list_works&authuser=1&gmla=AH70aAUdTOykoFyBytcu4dGi3FC8UTKzExx8G4Sg2huPiZblFAY7L_LQxMr4sw3MCWrM3Yv0uznUgRZZS_6aAVZhOF6GVjLcuMWzvuHMOHgKMyr8pjl69AWTGlFpAdSOy1Z2EQLwhsBj28zZLxCUrK
   Phone number : 085329966110

   2nd Author : Prof. Dr. dr Siti Fatimah Muis, M.Sc., Sp.GK
   Affiliation : Magister Ilmu Gizi, Fakultas kedokteran Universitas Diponegoro.
   Mailing address : Jl. Prof Sudarto SH. Tembalang, Semarang 50271, Indonesia
   Email of author : -
   Orcid ID :
   Google Scholar URL :
   Phone number : 08122867895

   3nd Author : Adriyan Pramono, S.Gz.,M.Si.,Ph.D
   Affiliation : Magister Ilmu Gizi, Fakultas kedokteran Universitas Diponegoro.
   Mailing address : Jl. Prof Sudarto SH. Tembalang, Semarang 50271, Indonesia.
   Email of author : adriyanpramono@lecturer.undip.ac.id
   Orcid ID : https://orcid.org/0000-0003-2159-4576
   Google Scholar URL : https://scholar.google.co.id/citations?user=5K7_LZgAAAAJ&hl=en
   Phone number : -

ABSTRACT

Sarcopenia and Type 2 Diabetes Mellitus (T2DM) present a significant health burden, particularly within Asian populations. This systematic review aims to explore the prevalence and impact of sarcopenia in Asian individuals with T2DM. Employing a comprehensive literature search in databases like PubMed and Scopus from 2013 to 2023, studies were selected based on strict inclusion and exclusion criteria. The review focuses on the relationship between sarcopenia and T2DM, considering factors such as chronic inflammation, hormonal imbalances, and lifestyle choices. Results from 11 high-quality studies indicate a higher prevalence and risk of sarcopenia in T2DM patients, with a pooled odds ratio of 1.49, suggesting a 49% increased risk in the diabetic population. The findings highlight the need for integrated management strategies and suggest further research into long-term interventions. The study emphasizes the importance of routine sarcopenia screening and a holistic approach to diabetes care that includes diet, exercise, and medication to improve patient outcomes.

Keywords: Sarcopenia, Type 2 Diabetes Mellitus (T2DM), Asian Population, Risk

ABSTRAK

Sarkopenia dan Diabetes Melitus Tipe 2 (T2DM) memberikan beban kesehatan yang signifikan, terutama dalam populasi Asia. Tinjauan sistematis ini bertujuan untuk mengeksplorasi prevalensi dan dampak sarkopenia pada individu Asia dengan T2DM. Melalui pencarian literatur yang komprehensif di basis data seperti PubMed dan Scopus dari tahun 2013 hingga 2023, studi dipilih berdasarkan kriteria inklusi dan eksklusi yang ketat. Tinjauan ini berfokus pada hubungan antara sarkopenia dan T2DM, mempertimbangkan faktor seperti inflamasi kronis, ketidakseimbangan hormonal, dan pilihan gaya hidup. Hasil dari 11 studi berkualitas tinggi menunjukkan prevalensi dan risiko sarkopenia yang lebih tinggi pada pasien T2DM, dengan rasio peluang gabungan sebesar 1,49, yang menunjukkan risiko meningkat 49% pada populasi diabetes. Temuan ini menekankan perlunya strategi manajemen terintegrasi dan menyarankan penelitian lebih lanjut tentang intervensi jangka panjang. Studi ini menekankan pentingnya skrining sarkopenia rutin dan pendekatan holistik dalam perawatan diabetes yang mencakup diet, olahraga, dan medikasi untuk meningkatkan hasil pasien.

Kata kunci Sarkopenia, Diabetes Melitus Tipe 2 (DM 2), Populasi Asia, Faktor Risiko

INTRODUCTION

Sarcopenia, a syndrome characterized by the progressive and generalized loss of skeletal muscle mass and strength, is increasingly recognized as a critical component of the aging process. This condition not only compromises physical function and independence but also contributes significantly to the risk of disability, poor quality of life, and mortality among the elderly (Santilli et al., 2014). Meanwhile, Type 2 Diabetes Mellitus (T2DM), a chronic metabolic disorder characterized by insulin resistance and hyperglycemia, represents a global health burden (Riddle et al., 2022). The intricate relationship between sarcopenia and T2DM, involving shared pathophysiological pathways, including chronic low-grade inflammation, hormonal imbalances, and lifestyle factors, is of particular interest to the medical community (Marcotte-Chénard et al., 2023). This interplay is believed to exacerbate the progression of both conditions, potentially leading to a synergistic decline in muscle function and metabolic control. Furthermore, the intersection of these conditions presents a complex therapeutic challenge, as the management of one can inadvertently impact the other (Chen et al., 2023).

In Asia, home to more than half of the world's population, the prevalence of both T2DM and sarcopenia is notably high and continues to rise, driven by aging populations, urbanization, and lifestyle changes (Fung et al., 2019; Narayan & Kanaya, 2020) This trend is concerning, as Asian populations exhibit unique characteristics in the context of these diseases. For instance, compared to Western populations, Asians tend to develop T2DM at a lower body mass index (BMI), and the manifestation of sarcopenia in Asians occurs differently, often at lower levels of obesity and muscle mass (Ke et al., 2022). This divergence underscores the need for a targeted understanding of these conditions within Asian demographics. Moreover, the genetic, dietary, and cultural diversity across Asian countries further complicates the epidemiological landscape of sarcopenia and T2DM, posing challenges in developing universally applicable clinical guidelines and interventions.

The biological mechanisms linking sarcopenia and T2DM are complex and interwoven (Izzo et al., 2021). Insulin resistance, a central feature of T2DM, has been implicated in the development of muscle wasting, as it disrupts the normal anabolic processes essential for muscle maintenance (Duan et al., 2021). Additionally, the chronic inflammatory state associated with T2DM may contribute to muscle catabolism (Purnamasari et al., 2022). Conversely, the reduction in muscle mass and quality inherent to sarcopenia can exacerbate insulin resistance, creating a vicious cycle that accelerates the decline in both muscle function and glycemic control. This bidirectional relationship suggests that effective management of one condition could positively influence the other. However, the extent and nature of this interaction in Asian populations, who may have distinct physiological responses due to genetic and lifestyle factors, remain underexplored (Purnamasari et al., 2022).

The co-occurrence of sarcopenia and T2DM has profound implications for individual health outcomes and healthcare systems. Patients with both conditions are at a higher risk of falls, fractures, physical disability, and hospitalizations, which drastically affects their quality of life and independence. From a healthcare perspective, this dual burden significantly strains resources, particularly in Asian countries where healthcare systems may already be grappling with challenges like limited funding, workforce shortages, and increasing demands from aging populations (Giha et al., 2022; Mesinovic et al., 2019) The economic implications are substantial, with increased healthcare utilization, higher costs of care, and the need for long-term management strategies (Izzo et al., 2021). Addressing this dual burden effectively requires not only medical interventions but also policy-level changes, including public health initiatives focused on prevention, early detection, and integrated care models that holistically address the complexities of managing sarcopenia and T2DM together.

Despite the growing recognition of the interplay between sarcopenia and T2DM, there is a notable gap in the comprehensive synthesis of research specifically focusing on Asian populations. Current literature is fragmented, with studies varying significantly in terms of methodology, population demographics, and outcomes measured. This heterogeneity hinders the development of a cohesive understanding and effective management strategies tailored to Asian populations. The proposed systematic review aims to bridge this gap by methodically collating, analyzing, and synthesizing existing research. By focusing on prevalence rates, pathophysiological mechanisms, clinical impacts, and management approaches specific to Asian populations with T2DM and sarcopenia, this review aspires to elucidate patterns and trends that are critical for guiding future research, informing clinical practice, and shaping health policy in this rapidly evolving field.

METHOD

Search Strategy

A comprehensive literature search will be performed in PubMed, Scopus, Web of Science (WoS), and Google Scholar, focusing on studies published between 2013 and 2023. This search will use a combination of keywords and Boolean operators to identify research pertinent to sarcopenia and Type 2 Diabetes Mellitus (T2DM) within Asian populations. The keywords will encompass terms associated with sarcopenia, T2DM, prevalence, management, and risk factors, with a specific emphasis on Asian demographic contexts. To ensure relevance and language accessibility, the search will be limited to articles published in English or those accompanied by English translations.

Study Selection

The study selection process will involve two phases: initial screening based on titles and abstracts, followed by a full-text review following the PRISMA (Preferred Reporting Items for Systematic

Review and Meta Analysis) guideline (Moher et al., 2010). Inclusion criteria will focus on studies with a population of patients with T2DM, addressing sarcopenia, conducted in Asian countries, and encompassing peer-reviewed articles, clinical trials, and cohort studies. Exclusion criteria will include studies on non-diabetic populations, research outside Asia, non-peer-reviewed literature, irrelevant study designs like case reports, studies with non-specific sarcopenia outcomes, non-English articles without translations, and duplicated data. This approach ensures a targeted selection of relevant and high-quality studies for analysis.

Data Extraction

Data extraction will be systematic, extracting relevant information from each selected study. Key information will include study design, participant demographics, methods of sarcopenia and diabetes diagnosis, prevalence rates, outcomes related to sarcopenia in diabetic patients, and any noted risk factors or management strategies. Data will be compiled in a standardized form to facilitate comparison and synthesis. This process will be performed independently by multiple reviewers to ensure accuracy and completeness, with discrepancies resolved through discussion or consulting a third reviewer if necessary.

Quality Assessment

The quality of each included study will be assessed using the Newcastle-Ottawa Scale (NOS). Studies will be graded as low (0–3), moderate (4–6), or high quality (7–9) based on selection, comparability, and outcome. This comprehensive assessment will help in identifying potential biases and the overall strength of the evidence provided by the studies . Discrepancies in quality assessment will be resolved through consensus among reviewers, ensuring a balanced and fair evaluation of each study.

Qualitative Analysis

Qualitative analysis will synthesize findings from the selected studies to provide insights into the prevalence, impact, and management of sarcopenia in Asian populations with T2DM. This narrative synthesis will focus on variations in study design, population characteristics, and outcomes, highlighting common trends, differences, and potential reasons for these variations. The synthesis will also consider the cultural, genetic, and healthcare context of the Asian populations studied, providing a comprehensive understanding of the issue at hand.

Quantitative Analysis

Quantitative data will be analyzed using Cochrane Review Manager 5.4. The heterogeneity of studies will be evaluated using the I2 statistic, with $I2 \geq 50\%$ indicating substantial heterogeneity, warranting a random-effects model, and $I2 < 50\%$ suggesting homogeneity, suitable for a fixed-effects model. This analysis will calculate pooled prevalence and 95% confidence intervals (CI) for sarcopenia in T2DM patients. Odds ratios (OR) and 95% CIs will be derived to compare sarcopenia risk in diabetic versus non-diabetic groups. Statistical significance will be set at $P < 0.05$, ensuring rigorous evaluation of the data.

RESULTS AND DISCUSSION

In the systematic review titled "Sarcopenia in Type 2 Diabetes Mellitus: A Systematic Review of Prevalence and Impact in Asian Populations," the study selection began with the identification of 378

records from databases including PubMed, Scopus, Web of Science, and Google Scholar, as well as additional sources. After the removal of duplicates and records not meeting the initial relevance criteria, 301 records remained. These were subjected to a screening process where 107 were excluded due to irrelevancy to the review's focus. The subsequent detailed evaluation of abstracts resulted in 194 records, of which 77 reports were not retrieved, leaving 117 full-text articles to be assessed for eligibility (Figure 1).

This meticulous full-text assessment led to the exclusion of articles due to poor quality and methodology, irrelevance to the defined PICO criteria, or being off-topic, leaving 11 studies that were included in the final review. These studies represented a diverse set of Asian countries: China, Taiwan, Korea, Iraq, Malaysia, Japan, and Singapore, reflecting the geographic spread and varied demographics of the region.

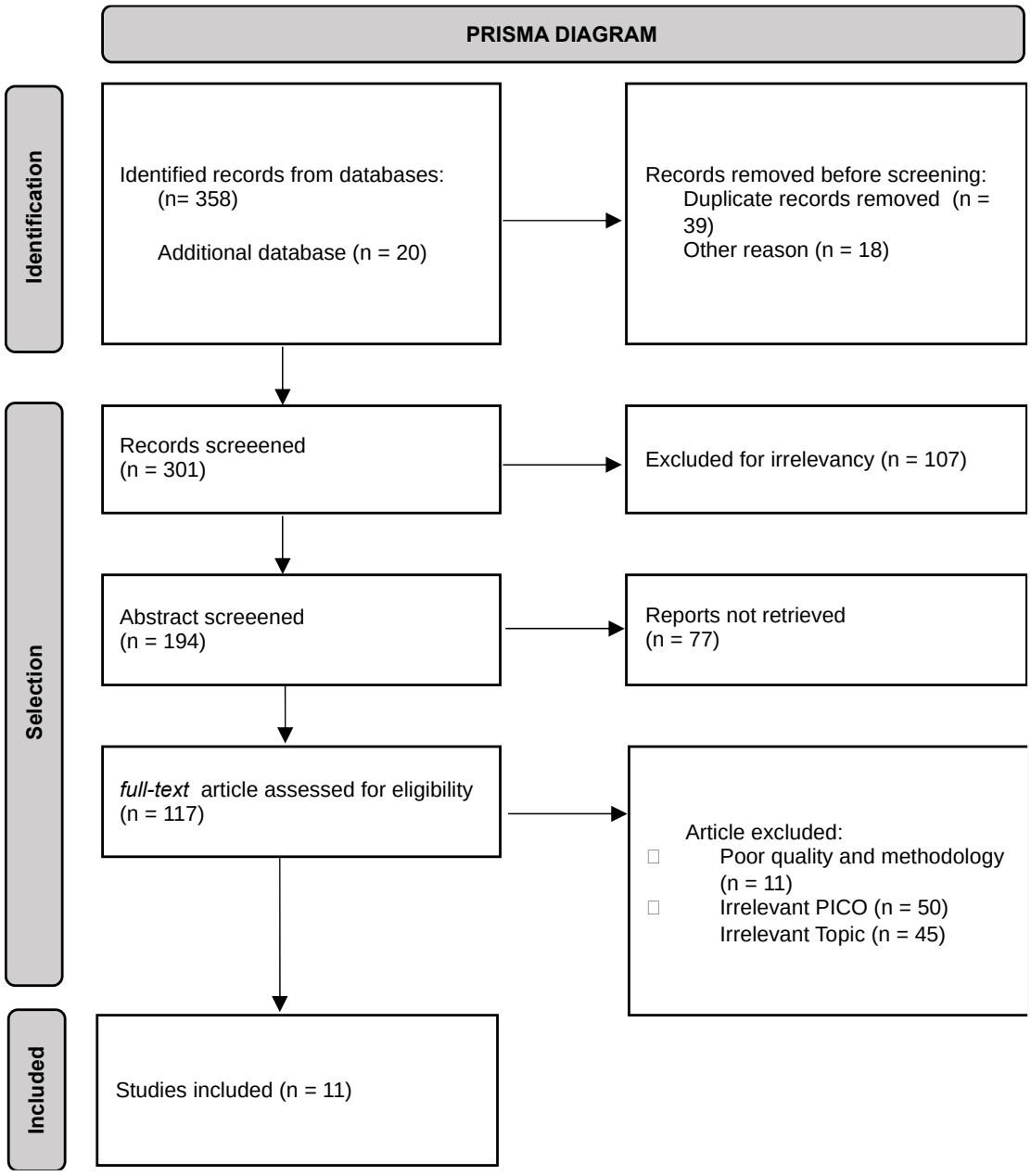

Figure 1. PRISMA flow-chart of extracted articles.

Four studies, in particular, were distinguished by their high methodological quality and were included in the meta-analysis. These were conducted by Han et al. (2016) and Wang T et al. (2016) from China, Kang et al. (2021) from Korea, and Keng BMH (2019) from Singapore. The selected studies provided robust data on the prevalence of sarcopenia in T2DM patients across different Asian populations and contributed valuable insights into the association between muscle mass, strength, BMI, and other clinical outcomes. The meta-analysis of these studies aimed to synthesize quantitative data to better understand the risk and prevalence of sarcopenia among individuals with T2DM in Asia.

First Author (Year)	Country	N	Assessments	Outcome	Score
(Wang et al., 2016)	China	1090	Association of type 2 diabetes with the risk of sarcopenia and pre-sarcopenia	Higher prevalence of sarcopenia and pre-sarcopenia in T2DM patients	High (7/9)
(Mu et al., 2021)	China	582	Association between biochemical indicators (like homocysteine) and sarcopenia	Increased concentrations of homocysteine were independent predictors of sarcopenia	Moderate (6/9)
(Hsu et al., 2023)	Taiwan	110	Estimation of the prevalence and association between sarcopenia and blood biochemical parameters, nutritional intake, anthropometric measurements, physical performance, and physical activity in patients with T2DM	Significant differences in age, serum vitamin D3 levels, nutritional intake, anthropometric measurements, and physical performance among the three groups (Non-sarcopenia, Possible Sarcopenia, and Sarcopenia). Low serum vitamin D3 is a significant risk factor for possible sarcopenia.	Moderate (5/9)
(Kim et al., 2014)	Korea	414	Association between type 2 diabetes and low muscle mass in older adults	Higher prevalence of low muscle mass in older men with diabetes than those without.	High (7/9)
(Cui et al., 2020)	China	132	Associations between sarcopenia and clinical characteristics in T2DM patients	Sarcopenia associated with increased age, trunk fat mass, and free thyroxine levels; regular exercise and certain medications found protective	Low (3/9)
(Gorial et al., 2020)	Iraq	130	Prevalence of sarcopenia in Iraqi patients with type 2 diabetes mellitus	Higher prevalence of sarcopenia in diabetic patients	Low (3/9)
(Sazlina et al., 2020)	Malaysia	506	Prevalence and factors associated with sarcopenia among elderly with T2DM in public primary care clinics in Malaysia	28.5% of elderly with T2DM had sarcopenia, associated with advanced age, male gender, duration of diabetes, and physical activity levels	Moderate (6/9)
(Nakamura et al., 2018)	Japan	826	Association of handgrip strength with cortical porosity and trabecular bone mineral density in T2DM patients	Reduced muscle strength in T2DM patients associated with thinner cortical thickness but not trabecular bone mineral density	High (7/9)
(Kang et al., 2021)	Korea	2403	Prevalence of sarcopenia and frailty in older adults with diabetes	Lower muscle mass index and muscle strength in older adults with diabetes, with higher prevalence of sarcopenia and frailty, particularly in women	High (7/9)

(Keng et al., 2016)	Singapore	378	Bio-impedance body composition analysis, echocardiography	23.3% had sarcopenia. Smaller left ventricular sizes and lower left ventricular mass in sarcopenic participants.Positive correlation between skeletal muscle mass and various cardiac dimensions and functions.	High (7/9)
(Han et al., 2016)	China	1069	Direct segmental multifrequency bioelectrical impedance analysis, grip strength, 4-meter walking test	9.3% overall prevalence of sarcopenia: 6.4% in men, 11.5% in women.Sarcopenia presence inversely associated with BMI. Prevalence increased with age, higher in those with low gait speed or poor grip strength	High (7/9)

Notes. All studies are scored with The New Castle-Ottawa Score
Table 1. Characteristics of included studies.

Table 1 stated that all studies collectively indicated a notable prevalence of sarcopenia among Asian populations with Type 2 Diabetes Mellitus (T2DM), with variance across countries and demographic groups. Wang T et al. (2016) from China reported a higher prevalence of sarcopenia and pre-sarcopenia in T2DM patients (Wang et al., 2016). Similarly, Mu ZJ (2021) found increased homocysteine levels as independent predictors of sarcopenia, suggesting a biochemical link (Mu et al., 2021). In Taiwan, Hsu YT (2023) highlighted significant differences in nutritional and physical profiles between sarcopenic and non-sarcopenic T2DM patients, identifying low serum vitamin D3 as a significant risk factor (Hsu et al., 2023).

In Korea, Kim KS (2014) observed a higher prevalence of low muscle mass in older men with T2DM compared to those without the condition (Kim et al., 2014). Cui M (2020) from China found sarcopenia to be associated with increased age and body fat, while regular exercise and certain medications offered a protective effect (Cui et al., 2020). A study from Iraq by Gorial (2020) similarly reported a higher prevalence of sarcopenia in diabetic patients (Gorial et al., 2020).

Sazlina (2020) in Malaysia noted that 28.5% of the elderly with T2DM had sarcopenia, with associations found with advanced age, male gender, duration of diabetes, and physical activity levels (Sazlina et al., 2020). In Japan, Nakamura (2018) reported reduced muscle strength in T2DM patients, correlated with thinner cortical bone thickness but not with trabecular bone mineral density (Nakamura et al., 2018).

Kang (2021) in Korea highlighted a lower muscle mass index and strength in older adults with diabetes, with a higher prevalence noted among women. Keng BMH (2019) from Singapore found that 23.3% of participants had sarcopenia, with a positive correlation between muscle mass and cardiac dimensions. Finally, Han P (2016) in China reported a 9.3% overall prevalence of sarcopenia, with a higher incidence in those with lower BMI, gait speed, or grip strength, again emphasizing the impact of physical capability on sarcopenia prevalence.

These studies underscore the multifactorial nature of sarcopenia in T2DM patients in Asia, influenced by biochemical, nutritional, physical, and possibly genetic factors, as well as the impact of lifestyle and clinical management strategies.

Meta Analysis Result

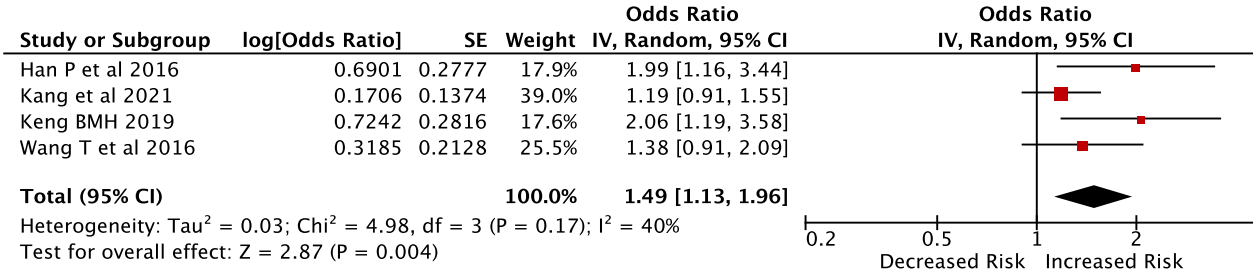

Figure 2. Outcomes of the meta-analytic comparison regarding the incidence of sarcopenia between diabetic and non-diabetic patients.

The meta-analysis results presented in the forest plot demonstrate that there is a statistically significant difference in the risk of sarcopenia between the diabetic population and the non-diabetic population. The overall pooled odds ratio is 1.49 with a 95% confidence interval (CI) of 1.13 to 1.96, which suggests that the diabetic population has a 49% higher risk of developing sarcopenia compared to the non-diabetic population. This result is statistically significant as indicated by the test for overall effect ($Z = 2.87$, $P = 0.004$).

Each study included in the meta-analysis contributes to the overall effect size with varying weights. Han P et al. (2016) and Keng BMH (2019) have relatively higher odds ratios of 1.99 and 2.06, respectively, indicating a stronger association between diabetes and increased risk of sarcopenia in their study populations. Kang et al. (2021) and Wang T et al. (2016) show a lower, but still elevated, odds ratio for sarcopenia in diabetics.

The heterogeneity amongst the studies, as indicated by the I^2 statistic, is 40%, which suggests moderate variability in the results of the included studies. The Tau^2 value is 0.03, and the Chi^2 statistic is 4.98 with a degree of freedom (df) of 3, which is not significant ($P = 0.17$), indicating that there is no substantial inconsistency among the studies included in the meta-analysis.

DISCUSSION

When we look at the recent studies, it's clear that muscle weakness, known as sarcopenia, is common in Asian adults with diabetes. Each study gives us a piece of the puzzle. For example, Wang T and colleagues in 2016 found that sarcopenia is more common in people with Type 2 Diabetes Mellitus (T2DM). This means that these patients have more health problems to deal with, making their diabetes harder to manage.

Mu ZJ's study in 2021 went deeper to show that high levels of a certain substance in the blood, called homocysteine, might predict sarcopenia. This finding is like discovering a new clue about what causes sarcopenia, which could help doctors find new ways to treat or prevent it.

Then there's the research from Taiwan by Hsu YT in 2023, which found that not getting enough of a nutrient, vitamin D3, could be linked to sarcopenia. This hints that by changing diet or adding vitamin supplements, it might be possible to lower the risk of sarcopenia. Other studies from places like Korea and China (by Kim KS in 2014 and Cui M in 2020) noticed that older adults and those with more body fat tend to have more muscle weakness. But they also found a ray of hope—regular exercise and some medicines might help protect against muscle loss.

Nakamura’s research in 2018 from Japan and Kang's study in 2021 from Korea both highlighted how sarcopenia can make it hard for people to do everyday tasks and affect their quality of life. And in Singapore, Keng BMH in 2019 linked sarcopenia to heart health, showing that muscle loss can affect more than just muscles—it can impact the whole body.

The meta-analysis of studies assessing the risk of sarcopenia among Asian populations with Type 2 Diabetes Mellitus (T2DM) reveals a significant association between diabetes and increased sarcopenia risk (Figure 2). With an odds ratio of 1.49, the diabetic group is demonstrated to have a 49% higher risk of developing sarcopenia than the non-diabetic group. This finding is critical as it underscores the need for targeted screening and preventive measures for sarcopenia within diabetic populations.

The selected studies for the meta-analysis, while varying in their individual results, collectively reinforce the notion that T2DM is a significant risk factor for sarcopenia. The studies by Han P et al. (2016) and Keng BMH (2019) report relatively higher odds ratios, which may reflect variations in study populations, measurements, and definitions of sarcopenia. It is noteworthy that the studies included in the meta-analysis are of high quality, as indicated by the Newcastle-Ottawa Score, lending credibility to the overall findings.

However, the analysis also presents with certain limitations and gaps. The moderate heterogeneity (I^2 = 40%) suggests that while the studies are generally in agreement, there may be underlying differences that could affect the magnitude of the observed association. These could stem from methodological differences, population characteristics, or varying diagnostic criteria for sarcopenia. The non-significant Tau^2 and Chi^2 values indicate that the heterogeneity is not excessive, but it still warrants consideration when interpreting the results.

LIMITATION OF THE STUDY

The studies under consideration, while informative, are not without their limitations. A primary concern is the lack of uniformity across research methodologies. Various studies employ disparate sarcopenia measurement techniques, involve diverse patient demographics, and adhere to different sarcopenia definitions. This diversity introduces a level of uncertainty, as the findings from one study may not be seamlessly applicable to the broader population—a phenomenon acknowledged in the scientific community as "moderate heterogeneity."

Furthermore, the geographical concentration of these studies within Asian countries, although crucial, imposes constraints on the universality of the findings. The distinct cultural, dietary, and healthcare systems of Asian countries may significantly shape the incidence and management of sarcopenia, making it uncertain whether these findings would mirror the situations in non-Asian contexts. Such regional specificity necessitates cautious application when considering the implications for international populations.

Additionally, the research design predominantly adopted in these studies is cross-sectional, offering only a glimpse into the conditions at a single point in time. This approach does not capture the progression or natural history of sarcopenia, nor does it illuminate the long-term effects of interventions. Longitudinal studies, which track individuals over extended periods, are indispensable for a more profound comprehension of sarcopenia's trajectory and for establishing causative relationships.

CONCLUSIONS AND SUGGESTIONS

Our systematic review and meta-analysis have illuminated the significant relationship between sarcopenia and Type 2 Diabetes Mellitus (T2DM) in Asian populations. The evidence suggests that individuals with T2DM have an increased prevalence of sarcopenia, presenting a 49% higher risk than those without diabetes. This enhanced risk points to a need for targeted management strategies for sarcopenia within the diabetic care framework.

Given these insights, further research should concentrate on long-term observational and interventional studies to track sarcopenia's progression in diabetic individuals. It is essential to examine the long-term efficacy of nutritional, exercise-based, and pharmacological interventions in managing sarcopenia. Investigating genetic predispositions to sarcopenia in T2DM could also lead to more tailored and effective treatments.

For practical applications, we suggest integrating routine sarcopenia screening into diabetes management protocols. Healthcare professionals should adopt a holistic approach, including diet and exercise modifications along with appropriate medication, to combat sarcopenia in T2DM patients. Awareness programs for early detection and intervention should be a priority for healthcare policymakers, given the potential for sarcopenia to exacerbate the complications associated with diabetes.

Our findings advocate for a more proactive stance in recognizing and managing sarcopenia as part of comprehensive diabetes care, which could significantly enhance patient quality of life and ease healthcare burdens. There is a clear imperative for continued research to close the knowledge gap and improve health outcomes for individuals with T2DM at risk of sarcopenia.

Acknowledgment

Not Applicable.

ETHICAL CONSIDERATIONS

Funding Statement.

No funds, grants, or other support was received.

Conflict of Interest Statement

The authors declare that they have no conflict of interest in relation to this research.

REFERENCES

Chen, H., Huang, X., Dong, M., Wen, S., Zhou, L., & Yuan, X. (2023). The Association Between Sarcopenia and Diabetes: From Pathophysiology Mechanism to Therapeutic Strategy. *Diabetes, Metabolic Syndrome and Obesity*, 1541–1554.

Cui, M., Gang, X., Wang, G., Xiao, X., Li, Z., Jiang, Z., & Wang, G. (2020). *Associations between sarcopenia and clinical characteristics patients with type 2 diabetes*. *2*(April 2019).

Duan, K., Gao, X., & Zhu, D. (2021). The clinical relevance and mechanism of skeletal muscle wasting. *Clinical Nutrition*, *40*(1), 27–37.

Fung, F. Y., Koh, Y. L. E., Malhotra, R., Ostbye, T., Lee, P. Y., Shariff Ghazali, S., & Tan, N. C. (2019). Prevalence of and factors associated with sarcopenia among multi-ethnic ambulatory

older Asians with type 2 diabetes mellitus in a primary care setting. *BMC Geriatrics*, *19*, 1–10.
Giha, H. A., Alamin, O. A. O., & Sater, M. S. (2022). Diabetic sarcopenia: metabolic and molecular appraisal. *Acta Diabetologica*, *59*(8), 989–1000.
Gorial, F. I., Sayyid, O. S., & Al Obaidi, S. A. (2020). Prevalence of sarcopenia in sample of Iraqi patients with type 2 diabetes mellitus: A hospital based study. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(4), 413–416. https://doi.org/10.1016/j.dsx.2020.04.021
Han, P., Kang, L., Guo, Q., Wang, J., Zhang, W., Shen, S., Wang, X., Dong, R., Ma, Y., Shi, Y., Shi, Z., Li, H., Li, C., Ma, Y., Wang, L., & Niu, K. (2016). Prevalence and factors associated with sarcopenia in suburb-dwelling older Chinese using the asian working group for sarcopenia definition. *Journals of Gerontology - Series A Biological Sciences and Medical Sciences*, *71*(4), 529–535. https://doi.org/10.1093/gerona/glv108
Hsu, Y.-T., Lin, J.-Y., Lin, C.-J., Lee, Y.-J., & Chang, W.-H. (2023). Association of Possible Sarcopenia or Sarcopenia with Body Composition, Nutritional Intakes, Serum Vitamin D Levels, and Physical Activity among Patients with Type 2 Diabetes Mellitus in Taiwan. *Nutrients*, *15*(18), 3892. https://doi.org/10.3390/nu15183892
Izzo, A., Massimino, E., Riccardi, G., & Della Pepa, G. (2021). A narrative review on sarcopenia in type 2 diabetes mellitus: prevalence and associated factors. *Nutrients*, *13*(1), 183.
Kang, S., Oh, T. J., Cho, B. L., Park, Y. S., Roh, E., Kim, H. J., Lee, S. G., Kim, B. J., Kim, M., Won, C. W., & Jang, H. C. (2021). Sex differences in sarcopenia and frailty among community-dwelling Korean older adults with diabetes: The Korean Frailty and Aging Cohort Study. *Journal of Diabetes Investigation*, *12*(2), 155–164. https://doi.org/10.1111/jdi.13348
Ke, C., Narayan, K. M. V., Chan, J. C. N., Jha, P., & Shah, B. R. (2022). Pathophysiology, phenotypes and management of type 2 diabetes mellitus in Indian and Chinese populations. *Nature Reviews Endocrinology*, *18*(7), 413–432.
Keng, B. M., Gai, F., Teo, L. L., Lim, W. S., Tan, R. S., Ruan, W., Ewe, S. H., Koh, W.-P., & Koh, A. S. (2016). Associations Between Skeletal Muscle and Myocardium in Ageing: A Syndrome of "Cardio-Sarcopenia"? *Physiology & Behavior*, *176*(1), 139–148. https://doi.org/10.1111/jgs.16132.Associations
Kim, K. S., Park, K. S., Kim, M. J., Kim, S. K., Cho, Y. W., & Park, S. W. (2014). Type 2 diabetes is associated with low muscle mass in older adults. *Geriatrics and Gerontology International*, *14*(SUPPL.1), 115–121. https://doi.org/10.1111/ggi.12189
Marcotte-Chénard, A., Oliveira, B., Little, J. P., & Candow, D. G. (2023). Sarcopenia and type 2 diabetes: Pathophysiology and potential therapeutic lifestyle interventions. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 102835.
Mesinovic, J., Zengin, A., De Courten, B., Ebeling, P. R., & Scott, D. (2019). Sarcopenia and type 2 diabetes mellitus: a bidirectional relationship. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, 1057–1072.
Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, P. (2010). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *International Journal of Surgery*, *8*(5), 336–341.
Mu, Z. J., Fu, J. L., Sun, L. N., Chan, P., & Xiu, S. L. (2021). Associations between homocysteine, inflammatory cytokines and sarcopenia in Chinese older adults with type 2 diabetes. *BMC Geriatrics*, *21*(1), 1–9. https://doi.org/10.1186/s12877-021-02622-y
Nakamura, M., Inaba, M., Yamada, S., Ozaki, E., Maruo, S., Okuno, S., Imanishi, Y., Kuriyama, N., Watanabe, Y., Emoto, M., & Motoyama, K. (2018). Association of Decreased Handgrip Strength with Reduced Cortical Thickness in Japanese Female Patients with Type 2 Diabetes Mellitus. *Scientific Reports*, *8*(1), 1–8. https://doi.org/10.1038/s41598-018-29061-x
Narayan, K. M. V., & Kanaya, A. M. (2020). Why are South Asians prone to type 2 diabetes? A hypothesis based on underexplored pathways. *Diabetologia*, *63*(6), 1103–1109.
Purnamasari, D., Tetrasiwi, E. N., Kartiko, G. J., Astrella, C., Husam, K., & Laksmi, P. W. (2022).

Sarcopenia and chronic complications of type 2 diabetes mellitus. *Review of Diabetic Studies*, *18*(3), 157–165.

Riddle, M. C., Cefalu, W. T., Evans, P. H., Gerstein, H. C., Nauck, M. A., Oh, W. K., Rothberg, A. E., le Roux, C. W., Rubino, F., & Schauer, P. (2022). Consensus report: definition and interpretation of remission in type 2 diabetes. *The Journal of Clinical Endocrinology & Metabolism*, *107*(1), 1–9.

Santilli, V., Bernetti, A., Mangone, M., & Paoloni, M. (2014). Clinical definition of sarcopenia. *Clinical Cases in Mineral and Bone Metabolism*, *11*(3), 177.

Sazlina, S.-G., Lee, P. Y., Chan, Y. M., A. Hamid, M. S., & Tan, N. C. (2020). The prevalence and factors associated with sarcopenia among community living elderly with type 2 diabetes mellitus in primary care clinics in Malaysia. *Plos One*, *15*(5), e0233299. https://doi.org/10.1371/journal.pone.0233299

Wang, T., Feng, X., Zhou, J., Gong, H., Xia, S., Wei, Q., Hu, X., Tao, R., Li, L., Qian, F., & Yu, L. (2016). Type 2 diabetes mellitus is associated with increased risks of sarcopenia and pre-sarcopenia in Chinese elderly. *Scientific Reports*, *6*(December), 1–7. https://doi.org/10.1038/srep38937