

## Postprint of a Meta-Analysis on the Prevalence of Sarcopenia-Osteoporosis in Chinese Patients with Type 2 Diabetes Mellitus

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### Abstract

**Background:** Type 2 diabetes mellitus (T2DM), as a chronic metabolic disease that poses a serious threat to the health of middle-aged and elderly individuals in China, is a key risk factor for osteosarcopenia (OS). OS can significantly affect the health status and quality of life of T2DM patients. In-depth investigation of the epidemiological characteristics of OS is of great significance for the prevention and management of OS in Chinese T2DM patients.

**Objective:** To systematically evaluate the prevalence of OS in Chinese patients with type 2 diabetes mellitus.

**Methods:** Databases including CNKI, Wanfang Data Knowledge Service Platform, VIP Chinese Journal Full-text Database, Chinese Biomedical Literature Service System, Cochrane Library, PubMed, Web of Science, EBSCO, and Embase were searched for studies on the prevalence of OS in Chinese T2DM patients from inception to June 2024. Two researchers independently screened the literature and extracted information including first author, publication year, survey time, region; OS prevalence; diagnostic criteria, assessment tools; literature quality assessment information; and used the AHRQ tool to assess article quality. Data were analyzed using Stata 15.0 software.

**Results:** A total of 18 cross-sectional studies were included, comprising 3,724 T2DM patients, of whom 623 were OS patients. Meta-analysis showed: the prevalence of OS in Chinese T2DM patients was 21% (95% CI = 15%-26%). Subgroup analysis showed: the prevalence after 2020 (25%) was higher than before 2020 (19%); the prevalence in the elderly group (27%) was higher than in the middle-aged and elderly group (13%); the prevalence using AWGS as diagnostic criteria (23%) was higher than AWGS2 (14%); the detection rate by BIA (22%) was higher than DXA (17%); the prevalence in males (38%) was higher than in females (36%); the prevalence with average T2DM duration

\$10 years (25%) was higher than duration >10 years (20%); the prevalence in western regions (27%) was higher than in central (18%) and eastern regions (16%) ( $P < 0.05$ ). Meta-regression showed no statistically significant results ( $P > 0.05$ ), and no source of heterogeneity was identified.

**Conclusion:** Current evidence shows that the prevalence of OS in Chinese T2DM patients is relatively high, and there are significant differences among different survey times, age groups, diagnostic criteria, assessment tools, gender, T2DM duration, and regions. Therefore, early screening and intervention management of high-risk populations should be strengthened to effectively prevent and delay disease progression.

## Full Text

### Evidence-Based Medicine: Meta-Analysis of the Prevalence of Osteosarcopenia in Chinese Patients with Type 2 Diabetes Mellitus

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## Abstract

**Background:** Type 2 diabetes mellitus (T2DM), as a chronic metabolic disorder, represents a significant health threat to middle-aged and elderly populations in China and is a major risk factor for osteosarcopenia. The presence of osteosarcopenia can markedly impact the health status and quality of life of individuals with T2DM. A comprehensive examination of the epidemiological characteristics of osteosarcopenia holds substantial significance in guiding the prevention and management of osteosarcopenia among T2DM patients in China.

**Objective:** To conduct a systematic evaluation of the prevalence of osteosarcopenia in patients with T2DM in China.

**Methods:** A comprehensive search was conducted for studies on the prevalence of osteosarcopenia in Chinese patients with T2DM across multiple databases, including CNKI, Wanfang, VIP, SinoMed, Cochrane Library, PubMed, Web of Science, EBSCO, and Embase. The search period extended from the establishment of these databases to June 2024. Two researchers independently screened the literature, extracting relevant information such as the first author, publication year, survey period, geographical region, osteosarcopenia prevalence, diagnostic criteria, assessment tools, and quality evaluation information. The methodological quality of the included studies was assessed using the AHRQ tool. Data were analyzed using Stata 15.0.

**Results:** A total of 18 cross-sectional studies were included, involving 3,724 T2DM patients, of whom 623 were diagnosed with osteosarcopenia. The meta-analysis revealed that the overall prevalence of osteosarcopenia in Chinese T2DM patients was 21% (95%CI=15%~26%). Subgroup analysis showed that the prevalence after 2020 (25%) was higher than that before 2020 (19%); the prevalence in the elderly group (27%) was higher than in the middle-aged group (13%); the prevalence using the AWGS diagnostic criteria (23%) was higher than with the AWGS2 criteria (14%); the detection rate by BIA (22%) was higher than by DXA (17%); males (38%) had a higher prevalence than females (36%); the prevalence in patients with a T2DM duration of  $\leq 10$  years (25%) was higher than in those with a duration  $>10$  years (20%); and the prevalence in the western region (27%) was higher than in the central (18%) and eastern regions (16%) ( $P < 0.05$ ). Meta-regression analysis revealed no statistically significant results ( $P > 0.05$ ), and no significant sources of heterogeneity were identified.

**Conclusion:** Existing evidence suggests a relatively high prevalence of osteosarcopenia among patients with T2DM in China, with significant disparities observed across factors such as survey period, age groups, diagnostic criteria, assessment tools, gender, duration of T2DM, and regional differences. Consequently, it is imperative to enhance early screening and intervention strategies for high-risk populations in order to effectively prevent and mitigate the progression of the disease.

**Key words:** Osteosarcopenia; Osteoporosis; Diabetes mellitus, type 2; Prevalence; China; Systematic review

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## Introduction

Osteosarcopenia (OS) is a novel musculoskeletal syndrome characterized by the concurrent presence of decreased bone mass and/or osteoporosis (OP) with sarcopenia (SP) [1-2]. Research reports indicate that the prevalence of OS in aging populations can reach up to 40% [3]. A meta-analysis [4] demonstrated that OS significantly increases the risk of falls, fractures, and mortality, severely impacting physical function and quality of life. Statistics show that the annual medical costs associated with fragility fractures in China amount to approximately \$9.45 billion, with projections indicating a doubling by 2035 [5]. Patients with type 2 diabetes mellitus (T2DM) experience significant declines in muscle and bone mass due to insulin resistance and secretion defects [6-7], with a fivefold higher risk of being diagnosed with OS compared to non-diabetic populations [8]. Currently, the prevalence of OS among T2DM patients in China remains unclear [9-10]. This study employs meta-analysis to further elucidate the epidemiological characteristics of OS in T2DM patients, providing an evidence-based reference for prevention and treatment strategies.

### 1.1 Inclusion and Exclusion Criteria

**Inclusion criteria:** (1) Study design: cross-sectional studies; (2) Study population: Chinese patients with T2DM; (3) Outcome measure: prevalence of OS among Chinese T2DM patients.

**Exclusion criteria:** (1) Studies where full text was unavailable or information could not be extracted; (2) Duplicate publications based on the same sample; (3) Conference abstracts, patents, and review articles; (4) Studies not published in Chinese or English.

### 1.2 Literature Search Strategy

A systematic search was conducted across CNKI, Wanfang Data Knowledge Service Platform, VIP Chinese Journal Full-text Database, China Biology Medicine disc, Cochrane Library, PubMed, Web of Science, EBSCO, and Embase for studies on the prevalence of OS in Chinese T2DM patients. The search timeframe spanned from database inception to June 2024, with language restrictions limited to Chinese and English. Chinese search terms included: osteoporosis/bone mass/bone density/bone metabolism; type 2 diabetes mellitus; muscle mass/sarcopenia. English search terms included: bone mass/bone density/bone metabolism/osteoporosis; osteosarcopenia; Type 2 diabetes mellitus/T2DM; muscle mass/sarcopenia. The PubMed search strategy is detailed in Table 1 .

### 1.3 Literature Screening and Quality Assessment

All retrieved literature was imported into Zotero software. Two evidence-based researchers independently reviewed titles and abstracts to identify potentially eligible studies, followed by full-text assessment for final inclusion. Disagreements were resolved by a third expert. The quality of included studies was evaluated using the AHRQ criteria [11], with total scores interpreted as: 3 points indicating high risk of bias, 4-7 points indicating moderate risk, and 8 points indicating low risk [12].

### 1.4 Data Extraction

Extracted information included: first author, publication year, survey period, geographical region; OS prevalence; diagnostic criteria and assessment tools; and literature quality evaluation information.

### 1.5 Statistical Analysis

Data analysis was performed using Stata 15.0 statistical software. A single-group rate meta-analysis was applied to pool the prevalence of OS, expressed with 95% confidence intervals (CI). Heterogeneity across studies was assessed using the  $\hat{I}^2$  test combined with the  $I^2$  statistic. When  $I^2 \leq 50\%$  and  $P > 0.1$ , indicating homogeneity, a fixed-effects model was applied; otherwise, a

random-effects model was used. Sensitivity analysis was conducted to evaluate result robustness, while subgroup analysis and meta-regression were employed to explore sources of heterogeneity. The significance level was set at 0.05. Publication bias was assessed using Egger's and Begg's tests, with the trim-and-fill method applied if bias was detected.

## Results

### 2.1 Literature Search Results

The initial database search yielded 1,188 articles, with 18 studies ultimately included [9-10,13-28]. Among these, 17 were in Chinese [9-10,13-18,20-28] and one in English [19]. The literature screening process is illustrated in Figure 1 [Figure 1: see original paper].

### 2.2 Basic Characteristics and Quality Assessment of Included Studies

This study included 18 cross-sectional studies comprising 3,724 T2DM patients, among whom 623 had OS. The average AHRQ quality score of included studies was 6 points, indicating overall good methodological quality (detailed in Table 2).

#### 2.3.1 Prevalence of OS in Chinese T2DM Patients

The meta-analysis included 18 studies with substantial heterogeneity ( $I^2=96.5\%$ ,  $P<0.001$ ), warranting use of a random-effects model. The pooled prevalence of OS among Chinese T2DM patients was 21% (95%CI=15%~26%), as shown in Figure 2 [Figure 2: see original paper].

#### 2.3.2 Subgroup Analysis and Meta-Regression

To explore sources of heterogeneity, subgroup analysis and meta-regression were performed based on survey period, patient age, diagnostic criteria, measurement tools, gender, average T2DM duration, and geographical region. Results showed that prevalence after 2020 (25%) was higher than before 2020 (19%); the elderly group (27%) had higher prevalence than the middle-aged group (13%); prevalence using AWGS diagnostic criteria (23%) was higher than with AWGS2 (14%); detection rates by BIA (22%) were higher than by DXA (17%); males (38%) had slightly higher prevalence than females (36%); prevalence in patients with T2DM duration  $\leq 10$  years (25%) was higher than in those with duration  $>10$  years (20%); and the western region (27%) had higher prevalence than central (18%) and eastern regions (16%) ( $P<0.05$ ) (Table 3).

Meta-regression revealed no statistically significant results ( $P>0.05$ ), and no significant sources of heterogeneity were identified (Table 4).

## 2.4 Sensitivity Analysis

Sensitivity analysis using the one-study-removed approach demonstrated that the pooled prevalence of OS in Chinese T2DM patients ranged from 17% to 22%, indicating robust results.

## 2.5 Publication Bias

Egger' s test ( $t=5.15$ ,  $P<0.001$ ) and Begg' s test ( $Z=3.6$ ,  $P<0.001$ ) suggested potential publication bias. After applying the trim-and-fill method, the funnel plot appeared symmetrical, and the pooled result remained stable (Figure 3 [Figure 3: see original paper]).

## Discussion

With changing lifestyles and dietary patterns, the incidence of T2DM among older adults is rising annually, posing a serious chronic metabolic threat to public health. Reports indicate that by 2021, China had 141 million people with diabetes, with numbers continuing to grow [29]. Studies have confirmed that deterioration of pancreatic  $\beta$ -cell function in T2DM patients increases OS risk [19]. This meta-analysis revealed a 21% prevalence of OS among Chinese T2DM patients (95%CI=15%~26%), which is higher than rates reported in Brazil (4.5%) [30], Chile (16.4%) [31], and globally (18.5%) [32]. Chronic hyperglycemia increases oxidative stress, disrupts endocrine function in muscle fibers and bone cells, and exacerbates musculoskeletal metabolic imbalance [33-34]. The crosstalk between bone and muscle reduces normal mechanical stimulation to bones, decreasing bone density and strength while diminishing muscle mass and function [35].

Subgroup analysis revealed higher OS prevalence after 2020 compared to before 2020, and higher rates in the elderly versus middle-aged groups. China' s elderly population proportion increased from 18.7% in 2020 to 21.1% in 2023 [36-37], with diabetic individuals comprising approximately 30% of this group and T2DM accounting for over 95% of diabetes cases [38]. Aging accelerates intramuscular and bone marrow fat accumulation, promoting increased secretion of adipokines that induce apoptosis of muscle and bone cells [39]. Recent research [32] found OS prevalence rates of 24.8%, 19.1%, and 17.1% in individuals aged  $\geq 80$ , 65, and  $<65$  years respectively, confirming a positive correlation between age and OS prevalence, as aging leads to age-related declines in muscle and bone mass [40].

The AWGS2 criteria [41] increased the grip strength cutoff to 28 kg for men and gait speed to 1.0 m/s, primarily due to the close relationship between sarcopenia and cognitive impairment/frailty [42]. Our subgroup analysis showed higher OS prevalence using AWGS versus AWGS2 criteria. To ensure comparability across studies, standardized diagnostic criteria should be adopted for future investigations.

DXA represents the gold standard for body composition analysis, with studies confirming consistency between BIA and DXA in assessing muscle mass among hospitalized Chinese older adults [43]. Our findings showed higher OS detection rates with BIA compared to DXA. Recent research indicates that BIA demonstrates high sensitivity and specificity for diagnosing low muscle mass in adults, though it may underestimate muscle mass, and its consistency with DXA varies across age and body mass categories [44]. While DXA offers high precision and accuracy for bone density assessment, BIA provides advantages of being non-invasive and cost-effective. Combined use may improve OS diagnostic accuracy but requires further validation [45].

Regarding gender, our study found slightly higher OS prevalence in males with T2DM compared to females. Testosterone is the primary hormone maintaining muscle mass, function, and bone health in men, declining at approximately 3% annually after age 70, which increases OS risk [46]. While prolonged T2DM duration can exacerbate  $\beta$ -cell damage [47] and inhibit myogenic differentiation factors and osteocalcin expression, leading to progressive muscle and bone mass decline [48], our findings regarding disease duration were inconsistent. This discrepancy may be attributed to our analysis of average T2DM duration rather than more granular categorization, potentially affecting result validity. Future research should refine T2DM duration classifications and employ high-quality, large-scale prospective cohort studies to clarify the relationship between disease duration and OS.

Geographically, our study revealed higher OS prevalence in western versus central and eastern China. The eastern coastal regions have abundant seafood rich in high-quality protein and calcium that strengthens bone development. In contrast, western China has higher altitudes, and studies show that hypoxic conditions impair osteoblast differentiation while increasing osteoclast activity, accelerating bone loss [49]; hypoxia exposure can also affect appetite, reducing energy intake [50]. Malnutrition is considered a risk factor for OS [32], with protein intake closely correlated with whole-body and spinal bone density. Older adults require daily calcium intake exceeding 950 mg and serum 25(OH)D levels above 50 nmol/L to maintain normal bone health [51]. Therefore, nutritional issues in elderly T2DM patients warrant serious attention.

## Limitations

This study has several limitations. Only published cross-sectional studies were included. Subgroup analysis and meta-regression failed to reduce heterogeneity. Additionally, the number and quality of included studies limited the scope of further subgroup analyses.

## Conclusion

In summary, the prevalence of OS among Chinese T2DM patients is relatively high. Future efforts should focus on systematic screening of T2DM patients

for OS, early identification of risk factors in high-risk populations, and comprehensive management of glycemic control and nutritional intake in aging T2DM groups. Research on prevention strategies should be conducted to effectively prevent and delay disease progression.

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*Author contributions: SUN Qing was responsible for conceptualization, design, data collection and analysis, and manuscript writing and revision; WU Yuzhao conducted literature searches and data collection and organization; CUI Limin supervised quality control and review of the manuscript and takes overall responsibility for the paper.*

*This article has no conflicts of interest.*

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