

REVIEW

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Evidence mapping the role of acupuncture in diabetes-related obesity: A systematic review and quality assessment

Xi Zhang¹, Yaling Chen¹, Shengtao Shan², Yan Zheng¹, Mukun Li¹, Yifei Fang¹, Rui Hu¹, Yanpei Liu¹ and Chao Ke^{2*}

Abstract

Background Acupuncture and moxibustion have played a greater role in the treatment of diabetes-related obesity. We used evidence map to analyze the current status of clinical research on acupuncture intervention for diabetes-related obesity and reveal the characteristics of evidence distribution and research problems in this field.

Methods We searched seven databases from the establishment of the library to December 2024. The clinical literature, including randomized controlled trials (RCTs) and non-RCTs, on acupuncture for the treatment of diabetes-related obesity was included, and the basic information and characteristics of the clinical research were extracted. A descriptive analysis was made of the frequency of the information included, while the quality of the articles was evaluated.

Results 104 papers were included, 100 in Chinese and 4 in English. The overall trend of the number of publications was upward, reaching a peak in 2014. The patients were predominantly type 2 diabetes mellitus combined with overweight or obesity. The most commonly used intervention was manual acupuncture, and the high-frequency acupoints included Zhongwan (RN12) (n = 69), Tianshu (ST25) (n = 54), Zusanli (ST36) (n = 64). Outcome indicators focused on fasting blood glucose (FBG) (n = 86), Body Mass Index (BMI) (n = 71), Triglycerides (TG) (n = 58). The methodology of the included literature and the overall results of the report evaluation are low due to the lack of blinding and the incomplete content of the detailed report.

Conclusions Acupuncture may demonstrate potential in the treatment of diabetes-related obesity; however, the existing clinical evidence is mainly from China and is limited by low methodological and reporting quality. There is an urgent need to conduct more high-quality, large-sample randomized controlled trials (RCTs) in the future and to strictly follow the clinical trial reporting norms in order to provide more reliable basis for evidence-based medicine.

Keywords Acupuncture, Diabetes, Obesity, Clinical Trial, Evidence map

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Introduction

Diabetes is a metabolic syndrome in which diabetes and obesity coexist [1]. According to the International Diabetes Federation (IDF) [2], the global number of adults aged 20–79 with diabetes has already reached 589 million in 2024; it is projected to climb to 853 million by 2050. The total number of diabetes patients in China is 148 million, and there are 274 million people in pre-diabetes. Among them, Type 2 Diabetes Mellitus (T2DM) patients account for the main body, accounting for about 90%, and mainly in the middle-aged and elderly population [3, 4]. Of all the risk factors for T2DM, obesity is one of the most dangerous, critical, yet intervenable causative factors in the development of T2DM [5–7]. The number of people who are overweight ($\text{BMI} \geq 25 \text{ kg/m}^2$) or obese ($\text{BMI} \geq 30 \text{ kg/m}^2$) globally will be around 2.548 billion in 2022. Notably, obesity is growing extremely rapidly, and is projected to increase from 524 million in 2010 to 1.13 billion in 2030, an increase of more than 11.5% [8]. Obesity contributes to the development and progression of T2DM by inducing chronic systemic inflammation, Insulin Resistance (IR), and β -cell dysfunction [9–11].

However, current mainstream interventions for obesity-related T2DM, such as pharmacotherapy and lifestyle interventions, often have unsatisfactory results. Drug therapy carries the risk of potentially serious adverse effects, such as liver and kidney damage, while diabetes mellitus is characterized by excessive food intake, making dietary control particularly difficult [12]. In recent years, a growing number of clinical studies have investigated the use of acupuncture for obesity-related T2DM, reporting potential benefits in correcting glycolipid metabolism. Acupuncture can improve islet function by enhancing the expression of glucose transporters, improving the function of islet β cells and inhibiting their apoptosis, promoting the browning of white fat, and regulating the expression of leptin [13], thereby correcting the glycolipid state, regulating fasting blood glucose (FBG), triglyceride (TG), postprandial blood glucose (2h-PG) and other biochemical indicators, and improving islet function. It has the advantages of simplicity and few side effects [14].

While numerous clinical trials exist, there is a lack of integrated visual mapping and systematic appraisal of the evidence structure, distribution, and gaps. Evidence mapping was selected over meta-analysis to systematically catalogue and visually summarize the existing evidence, identify evidence gaps, and characterize the methodological quality and reporting patterns of studies in this field. Therefore, the aim of this study is to systematically search relevant databases at home and abroad, and use the evidence map to visually present the evidence distribution of clinical studies on acupuncture for diabetes-related obesity, and analyze the current status

and limitations of the current studies, with a view to providing a more valuable reference for future high-quality research design and clinical practice in this field.

Materials and methods

Search strategy

We searched seven databases which are, WanFang, VIP, CBM, PubMed, Cochrane library, and Embase, with the language restriction of Chinese and English, and with the time limit of searching from the Databases' establishment to December 17, 2024. The search was conducted by combining subject terms with free words, using “or” “and” to connect the search terms. The English search terms included Acupuncture, Moxibustion, point injection, obesity, overweight, Diabetes Mellitus, Prediabetic State, etc. And the specific search terms are listed in Supplementary material 1.

Inclusion criteria

The type of study was a clinical study; the participants of the study were patients with a clear diagnosis of diabetes-related obesity; there were no limitations on the gender, age, disease duration, or country of the patients; The intervention for the treatment group consisted of various types of acupuncture therapies (e.g., manual acupuncture, electro-acupuncture, acupoint embedding, moxibustion) either as a standalone treatment or in combination with other treatment (e.g., diet, exercise, Chinese medicine); the aim of the control was the efficacy of the acupuncture therapeutic effect; and there were no limitations on the outcome indicators.

Exclusion criteria

(i) duplicate literature (1 article with more complete basic information was retained); (ii) animal experiments reviews, case studies, data mining, conferences, case reports, experiences of famous and old experts, etc.; (iii) the participants of the study were not obese patients with diabetes mellitus; (iv) the treatment/observation group interventions were not acupuncture; (v) the full text was not available even after contacting the authors.

Study selection and data extraction

Initial screening was performed by two authors (the literature search and screening were conducted by researchers fluent in Chinese and English, ensuring no language barriers for the included databases.) by reading the title and abstract on The King of Medical Literature in strict accordance with the literature inclusion and exclusion criteria, followed by further reading of the full text for data extraction and cross-checking, and any disagreements were resolved by discussion or consultation with a third author for negotiation. Two reviewers independently screened the titles and abstracts of 1664 records.

A random sample of 100 records was selected for inter-rater reliability assessment. The Cohen's kappa coefficient was 0.76, indicating substantial agreement between reviewers. The data were extracted by using Excel 2021, and the extraction included (1) basic information of the literature (title, author, year of publication, journal, region of publication, fund support, clinical trial registration, and type of clinical study); (2) characteristics of the clinical study (type of diabetes, type of obesity, diagnostic criteria, underlying treatment, sample size, group design, intervention, control, treatment period, outcome indicators, effective rate, whether follow-up); (3) evaluation of literature quality (literature bias status, RCT report of acupuncture).

Risk of bias assessment

The quality evaluation of RCTs was assessed according to the Cochrane Collaboration Network Risk of Bias Assessment Tool (RoB2.0) [15]. The evaluation included seven aspects: generation of randomized sequences, allocation concealment, blinding of implementers and participants, blinding in outcome assessment, completeness of outcome data, selective reporting, and other biases (potential bias related to specific study design, sample size estimation, baseline imbalance, and claims of deception), and the included literature was evaluated by making the following statements “low risk of bias”, “unclear risk of bias” and “high risk of bias”.

The quality evaluation of non-RCTs utilized the MINORS [16] evaluation entries, with a total of 12 evaluation indicators, each of which was scored from 0 to 2 (0 for not reported, 1 for reported but insufficient information, and 2 for reported and sufficient information provided). The first 8 items are suitable for the study without control group, the highest score is 16 points; 1–12 are suitable for studies with a control group, with a maximum of 24 points.

The quality of acupuncture clinical research literature was evaluated using the Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) [17]. The evaluation consisted of 6 entries and 17 sub-entries, which were evaluated by “yes” or “no”, with ‘yes’ indicating that the content of the entry was reported, and “no” indicating that it was not reported. “No” indicates that the content of the entry was not reported. The more entries were reported, the higher the quality of the literature.

Statistical analysis

Extract the required literature information into an Excel table, use Excel 2021, IBM SPSS Modeler18 (In the association rule analysis of acupoint prescriptions, the Apriori algorithm was used. The support value was set to more than 30.0% and the confidence score to more

than 80% based on the previous research experience in the field of acupuncture acupoint combination analysis and the actual number of included studies. This setting can ensure that the screened acupoint combinations have certain clinical application frequency and reliability.), Review Manager 5.4 and Origin pro 2025 to analyze the frequency and association rules of the input information, and finally Presented as a table or picture.

Results

Results of study selection

We systematically searched the database and obtained 2391 related articles, and the remaining 1664 articles after removing duplicate articles. After initial screening by reading the titles and abstracts, 1469 articles were excluded based on the inclusion and exclusion criteria. The remaining 195 articles were re-screened by full-text intensive reading, and 91 articles were further excluded, and 104 clinical studies that met the criteria were finally included. The specific process of literature screening is detailed in Fig. 1. For details of the search strategy, please refer to Supplementary material 1-search strategy.

Characteristics of included studies

According to the basic information of the included literature (Fig. 2), between 1999 and December 2024, a total of 104 clinical papers were published on acupuncture for the treatment of diabetes-related obesity. In terms of geographical distribution (Fig. 2a), all research focuses on domestic. And in terms of provincial administrative regions, Jiangsu Province ranked first with 20 articles, followed by Beijing (12 articles) and Guangdong Province (10 articles), while all other regions had less than 10 publications. Literature publications showed a staged growth trend (Fig. 2b), with fewer publications before 2013, more publications after 2013, and an overall significant upward trend over the last decade (2015–2024), peaking in 2014 (14 publications/year). Notably, only four publications (3.8%) were labeled with a clinical trial registration number. In terms of fund support (Fig. 2c), the total number of literature supported by funds was 48 (46.2%), with the highest proportion of national funds (35%), followed by provincial and ministerial level (15%) and university and college level (13%). The distribution of journal types showed (Fig. 2d) that the included literature was mainly published in journals of different levels. The China Science Citation Database (CSCD) accounts for 20% of the publications, the Peking University Core Journals/China Science and Technology Paper Citation Database PKU/CSTPCD) account for 18%, and the SCI journals account for the lowest proportion (4%).

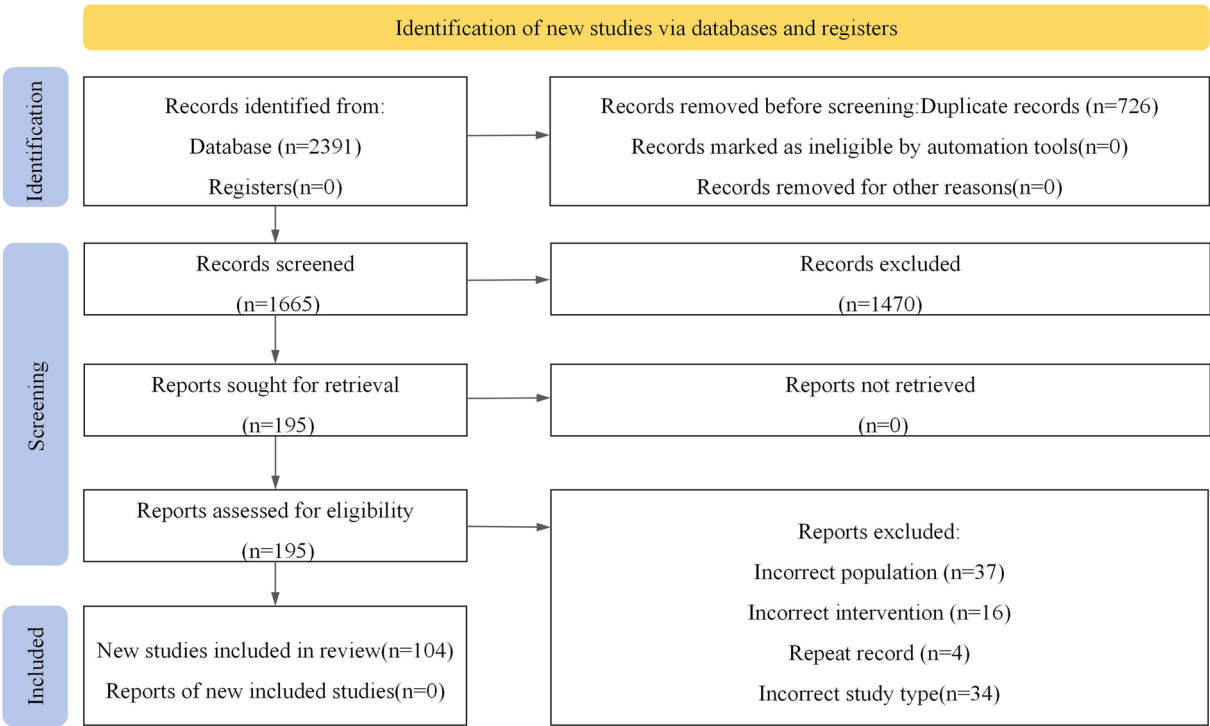


Fig. 1 Process of literature screening

Methodological characteristics of included studies

Participants characteristics

Based on the classification criteria of the *Chinese Guidelines for the Prevention and Treatment of Diabetes (2024 Edition)* [3] the diabetes types reported in the included literature was categorized into three groups: T2DM-related publications predominated with 73 articles, followed by 19 articles on prediabetes, and 12 articles that did not specify a diabetes subtype. According to the typing basis of the *Chinese Resident Obesity Prevention and Control Expert Consensus (2022)* [18], the participants of the included literature were categorized into overweight, obese, and overweight combined with obesity. The results showed that there were only 2 articles reporting on the overweight participants, 10 articles reporting on the obese participants, and 52 articles reporting on both obesity and overweight, in addition to 40 articles that did not specifically report on the type of obesity. T2DM combined with overweight or obesity was the most prevalent types in the included studies (Fig. 3a).

The top three diabetes diagnostic criteria used in the 104 publications were: *the ADA Standards for the Medical Treatment of Diabetes*, *the Chinese Guidelines for the Prevention and Control of Type 2 Diabetes*, and the World Health Organization (WHO) Diabetes Diagnostic Criteria. The top three obesity diagnostic criteria are: *Chinese Guidelines for the Prevention and Control of Overweight and Obesity in Adults*, *Asia-Pacific Regional Diagnostic Criteria*, and *Chinese Obesity Working Group Criteria*.

Part of the literature for Western medicine diagnosis, but also the use of traditional Chinese medicine typing standards for diabetes obesity disease typing, the use of the top three frequency is *Chinese medicine new drug clinical research guidelines*, *acupuncture treatment of obesity*, *Chinese herbal medicine disease diagnosis efficacy standards* (Fig. 3b). See Supplementary material 2 for details.

Intervention characteristic

The 104 included studies were predominantly single-center, moderate-sample-size investigations. Among them, Randomized Controlled Trials (RCTs) had the smallest sample size of 39 cases and the largest sample size of 320 cases. The minimum sample size of non-randomized controlled trials (non-RCT) were 25 cases and the maximum were 640 cases. From the distribution of intervals (Fig. 4a), the sample size was mainly concentrated in 51–100 cases with 66 articles, accounting for 63.5%, followed by 101–150 cases with 18 articles, accounting for 17.3%.

In terms of the application of basic treatment (Fig. 4b, c), a total of 67 articles adopted basic treatment, covering four aspects: reasonable diet, maintaining exercise, health promotion, and blood sugar control.

The period of acupuncture treatment (Fig. 4d) was concentrated in 9–12 weeks, accounting for 39%. Followed by 5–8 weeks, accounting for 24%. The proportion of 0–4 weeks also reached 19%. The rest of the treatment cycle accounted for a small proportion. It can be deduced that

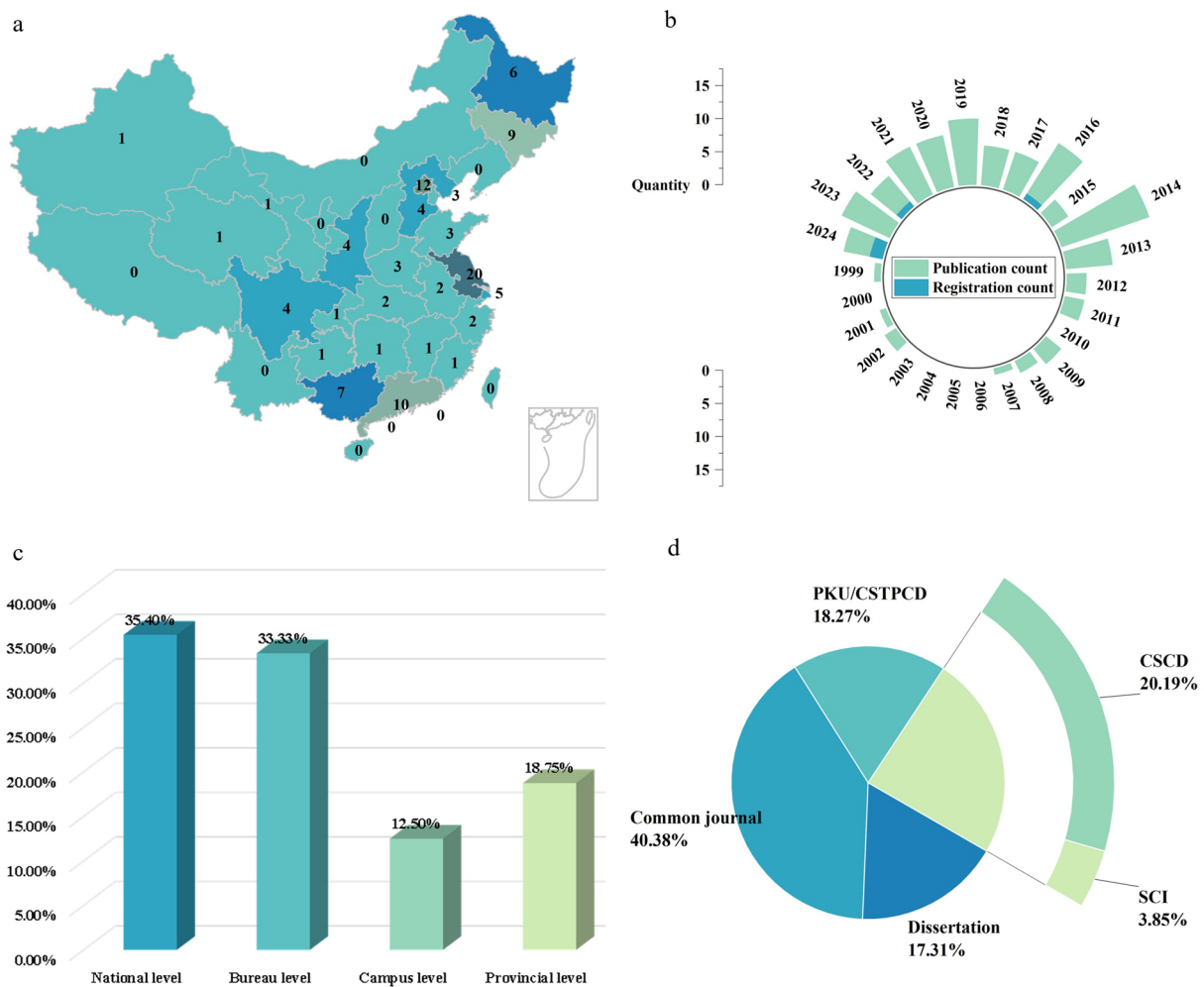


Fig. 2 Characteristics of included studies. **a** Shows the map of publication regions of the included literature, **b** shows the yearly distribution of the volume of clinical trial registrations and publications, **c** shows the bar chart of the level of foundation support, and **d** shows the pie chart of the weight of the literature level. Abbreviations: SCI: Science Citation Index database, CSCD: Chinese Science Citation Database, PKU/CSTPCD: Peking University Core Journals/China Science and Technology Paper Citation Database

9–12 weeks is the current mainstream treatment cycle for acupuncture treatment of diabetes-related obesity.

Study groups and interventions

Included literature includes 1–4 arm studies, as shown on the right side of Fig. 5, the group design is divided into self-control before and after and inter-group control. And the control design of inter-group control can be divided into five types: comparison of different acupuncture treatments, synergy between acupuncture and other therapies, comparison between acupuncture and other therapies, curative effect of acupuncture itself, and different syndrome types of the participants. Among them, the synergy between acupuncture and other therapies is the most, with 51 articles. In the intervention design, acupuncture + basic treatment VS basic treatment, acupuncture + drugs + basic treatment VS drugs + basic treatment were used more frequently.

The left side of Fig. 5 shows the number of groups, intervention measures in the control group, and the use of acupuncture and moxibustion measures. The amount of literature in the 2-arm study is the largest. Among the interventions, single-needle therapy is the most frequently used, followed by single-needle combined with basic treatment and multiple needles. Manual acupuncture, electro-acupuncture, auricular acupuncture/auricular point pressing pills and acupoint embedding are the four specific acupuncture therapies most frequently used included in the literature.

Acupoint characteristics

The acupoint frequency analysis of the included literature shows that the high-frequency acupoints used are Zhongwan (RN12), Zusanli (ST36), Tianshu (ST25), Sanyinjiao (SP6), Guanyuan (RN4), Pishu (BL20), etc. And they are concentrated in the chest, abdomen, back,

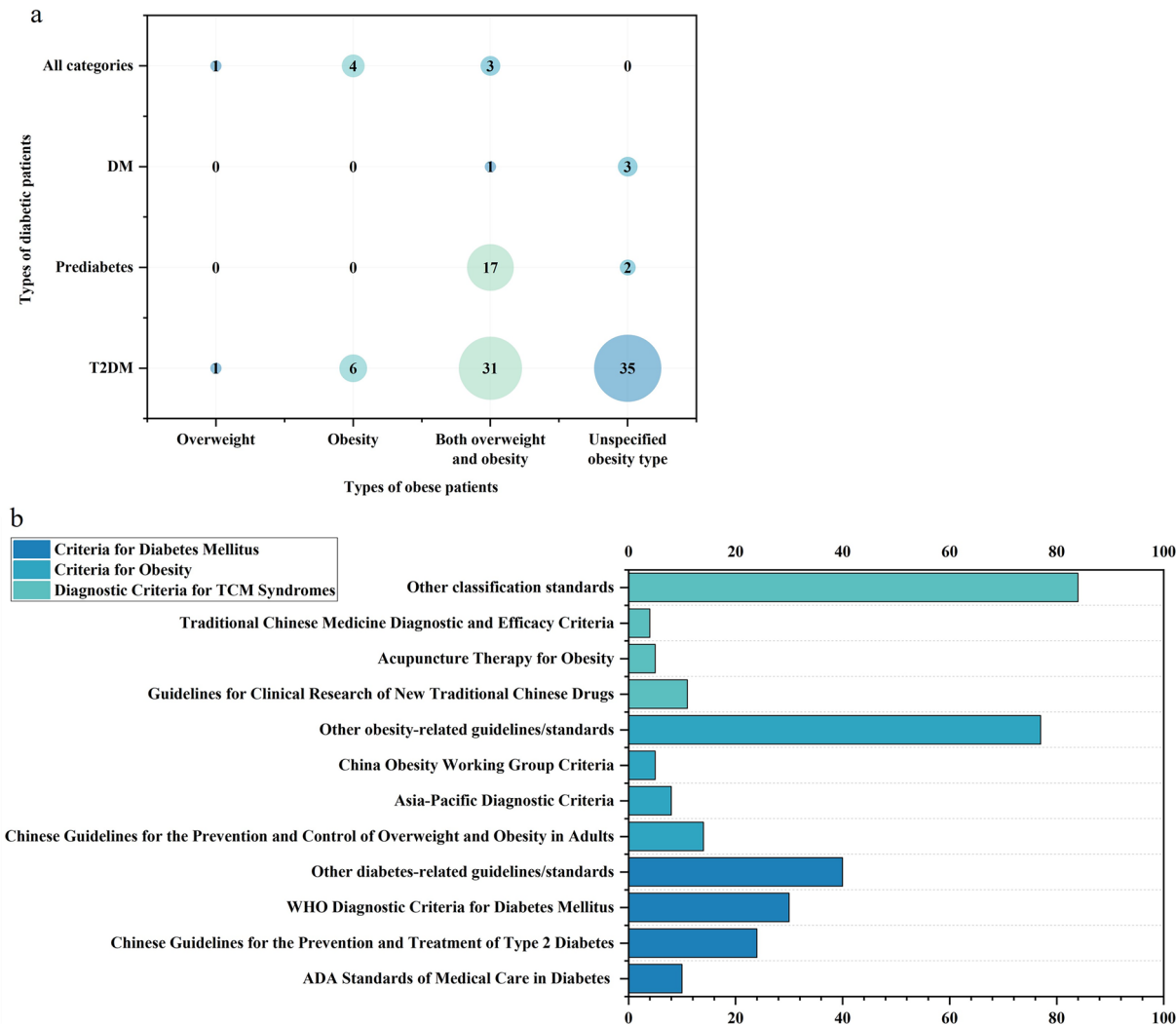


Fig. 3 Baseline characteristics of study participants. **a** Shows the bubble chart of disease types of included subjects, and **b** shows the frequency chart of diagnostic criteria for diabetes mellitus, obesity, and diabetes-related obesity TCM evidence Abbreviations: DM: diabetes mellitus, T2DM: Type 2 Diabetes mellitus

waist, and lower limbs (Fig. 6). See Supplementary material 3 for details.

The association rules were analyzed for the included acupoint prescriptions, and the support value was more than 30.0%, the confidence score was more than 80%. And the two, three acupoint combinations that met the above conditions were screened. A total of 51 groups of associated acupoint combinations were obtained. The top five most frequently used acupoint pairs were: ST36 (Zusanli)-SP6 (Sanyinjiao), ST25 (Tianshu)-CV12 (Zhongwan), SP6 (Sanyinjiao)-ST36 (Zusanli), CV4 (Guanyuan)-CV12 (Zhongwan), BL20 (Pishu)-SP6 (Sanyinjiao) (Table 1). In this study, support represents the proportion of a certain combination of acupoints in all prescriptions, and confidence represents the frequency of a prescription containing acupoint A containing acupoint B at the same time. Under the same support and confidence conditions, a total of 59 groups of acupoint meridian attribution were obtained. The top five meridian combinations in support were Foot Yangming Stomach Meridian-Foot Taiyin Spleen Meridian; Foot Taiyin Spleen Meridian-Ren Pulse; Foot Taiyin Spleen Meridian-Foot Yangming Stomach Meridian; Ren pulse-foot Taiyin spleen meridian; Ren Pulse-Foot Yangming Stomach Meridian. Analysis of the acupoint parts to obtain 19 groups of associated parts. The top five parts of support for the combination are leg-abdomen area; dorsal-ventral region; dorsal region-leg region; dorsal region, leg-ventral region; dorsal region, ventral-leg region. Analyzing the association rules of specific points, 173 combinations were obtained, and the top five supporting points were Crossing Point-Front Mu Point; Crossing Point-Eight Influential Point; Eight Influential Point-Front Mu

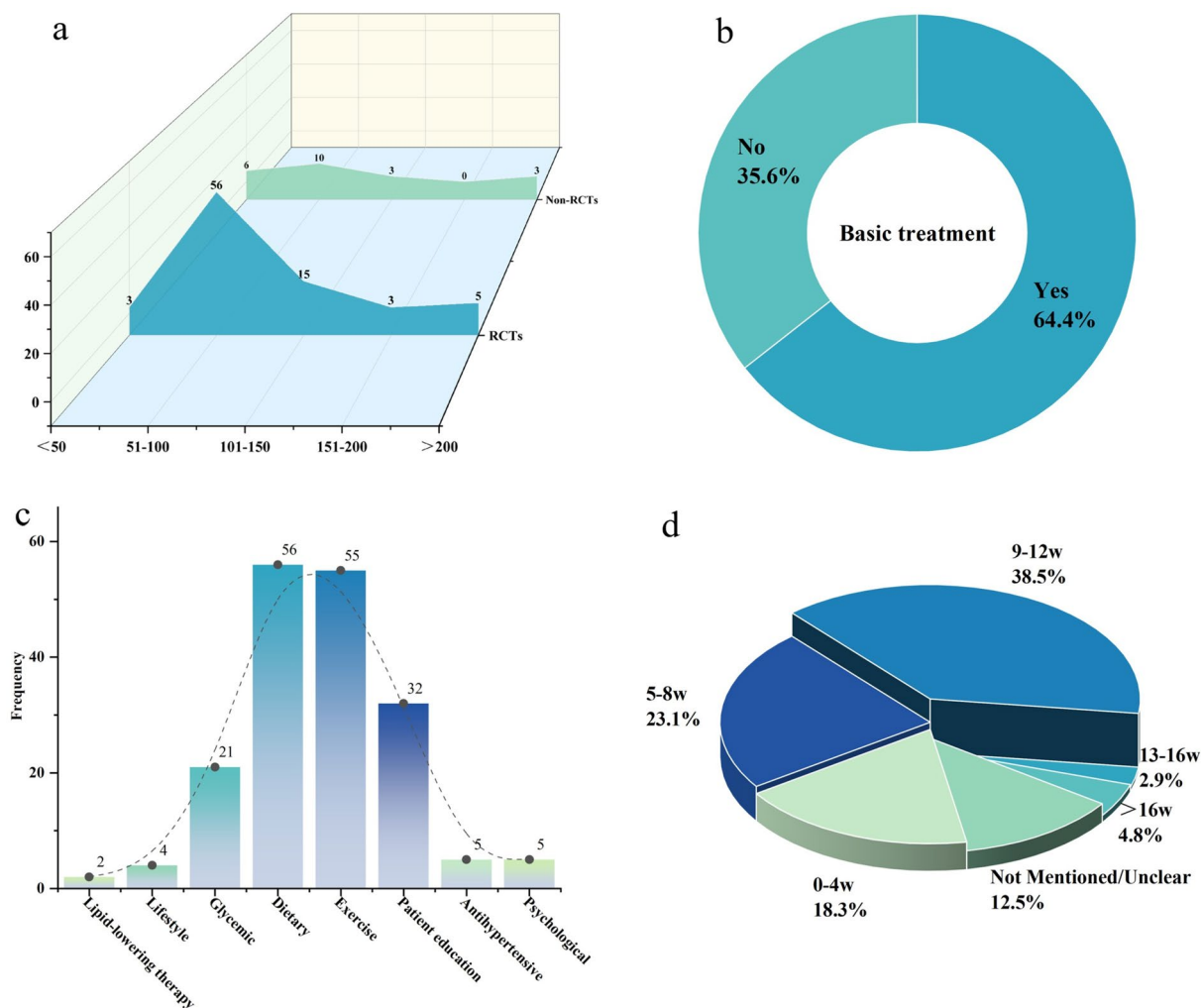


Fig. 4 Details of the intervention protocol. **a** Shows a peak-to-peak plot of sample size versus type of literature, **b** shows a circular percentage plot of whether or not foundation therapy was used, **c** shows a bar chart of the frequency of specific interventions for foundation therapy components, and **d** shows a pie chart of intervention cycle intervals

Point; Eight Influential Point-Crossing Point; Front Mu Point- Crossing Point. Details are shown in Table.

In the network correlation diagram of Fig. 7, the thickness of the line indicates the strength of the correlation degree. Figure 7(a) shows that Zhongwan (RN12), Zusanli (ST36), Sanyinjiao (SP6) and other acupuncture points are highly correlated, indicating that they are often used synergistically in the acupuncture treatment of diabetes-related obesity. In Fig. 7(b), the Stomach Meridian of foot-yangmin (ST), Spleen Meridian of foot-taiyin (SP), Conception Vessel (CV), and Bladder Meridian of foot-taiyang (BL) are strongly related. Figure 7(c) shows that the acupuncture points for the treatment of diabetes-related obesity are concentrated in the back, abdomen, and leg areas. Figure 7(d) shows that five special points are often used in conjunction with each other, namely Wushu point, Front Mu point, Eight influential points (EIP), Crossing points (CP), and Lower he-sea points (LHSP).

Outcome characteristics

Figure 6(a) shows the top tenth outcomes among the 104 articles included, followed by fasting blood glucose (FBG), body mass index (BMI), triglycerides (TG), total cholesterol (TC), body weight (BW), fasting insulin level (FINS), low-density lipoprotein cholesterol (LDL-C), two-hour postprandial blood glucose (2h-PPG), HemoglobinA1c (HbA1c), and high-density lipoprotein cholesterol (HDL-C). It can be deduced that these outcome indicators are commonly used detection indicators for clinical diabetes-related obesity. The cumulative peak of the use frequency of outcome indicators also appeared in 2014, which was significantly related to the number of published literature in that year.

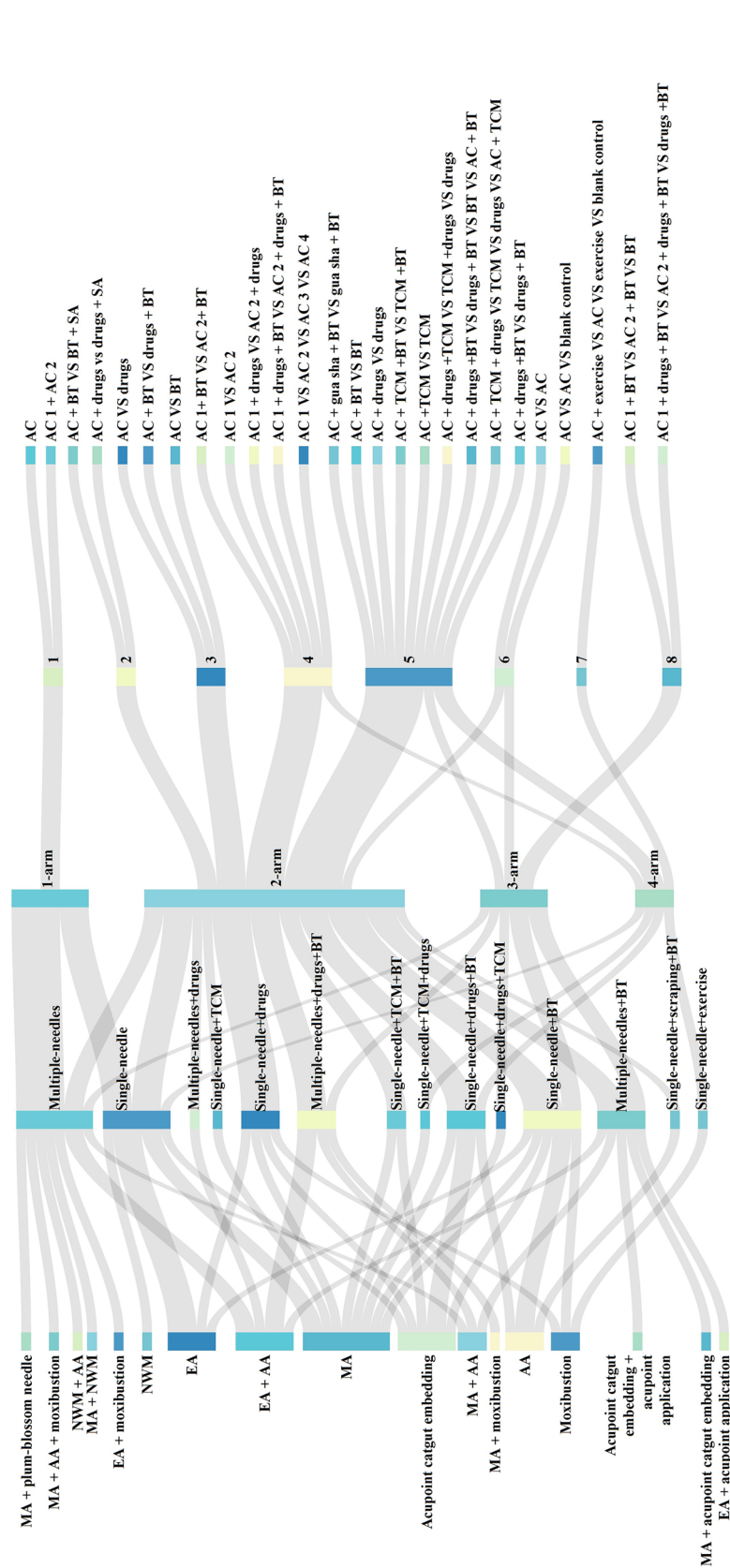


Fig. 5 Sankey diagram of intervention measures. Abbreviations: 1: controlled before-after studies; 2: Acupuncture efficacy; 3: acupuncture compared with other therapy; 4: compare the different acupuncture therapies; 5: Synergy Opportunities for acupuncture and other therapy; 6: patients with different syndromes; 7: Synergy Opportunities for acupuncture and other therapy+ acupuncture compared with other therapy; 8: Acupuncture efficacy+ Synergy Opportunities for acupuncture and other therapy; MA: manual acupuncture; AA: auricular acupuncture; NWM: needle warming moxibustion; EA: electric acupuncture; TCM: traditional Chinese medicine; BT: basic treatment; AC: acupuncture; SA: shame acupuncture

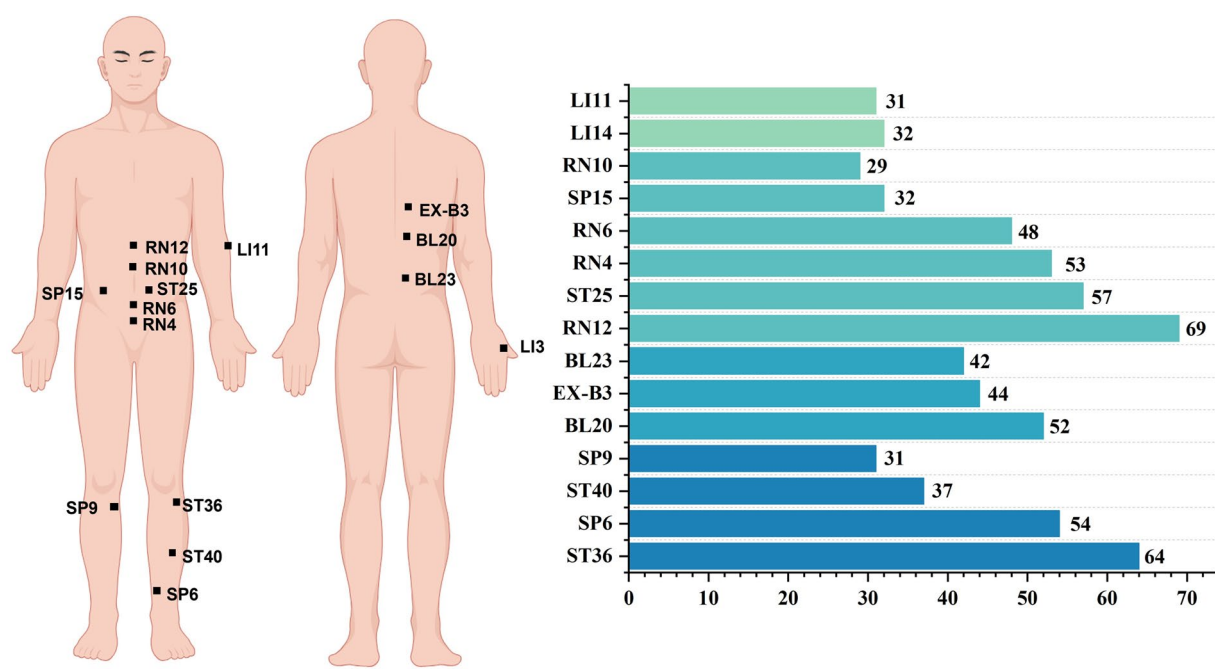


Fig. 6 Topographically mapped high-frequency acupuncture points

Table 1 Acupoint attribute association rules analysis

Acupoints	Support (%)	Confidence (%)	Meridian	Support (%)	Confidence (%)	Parts	Support (%)	Confidence (%)	Special points	Support (%)	Confidence (%)
ST25→RN12	56.863	93.103	SP→CV	73.077	84.211	Back→ stomach	56.731	88.136	CP→EIP	82.692	87.209
RN4→RN12	50.98	88.462	CV→SP	72.115	85.333	Back and leg→ stomach	53.846	87.5	EIP→CP	75.962	94.937
BL20→SP6	50	80.392	CV→ST	72.115	96	Back and stomach →leg	50	94.231	FMP→EIP	75	93.59
BL20→S36	50	86.275	SP and ST→CV	71.154	83.784	Wrist→ stomach	34.625	83.333	FMP→CP	75	93.59
RN6→RN4	45.098	80.435	CV and ST→SP	69.231	86.111	Wrist→leg	34.625	100	EIP and CP→FMP	72.115	92
RN6→ST25	45.098	80.435	CV and SP→ST	61.538	96.857	Ankle→back	34.625	91.667	FMP and EIP→CP	70.192	94.521
RN6→ST25	45.098	95.652	BL→SP	57.692	83.333	Ankle→ stomach	34.625	91.667	FMP and CP→EIP	70.192	94.521
RN4 and RN12→ST25	45.908	82.609	BL→ST	57.692	98.333	Ankle→leg	34.625	97.222	FSP→LHSP	69.231	84.722

CP: Crossing points; EIP: Eight influential points; FMP: Front-mu points; LHSP: Lower he-sea points; FSP: Five-shu points; SP: Spleen Meridian of foot taiyin; Conception Vessel; ST: Stomach Meridian of foot yangmin; BL: Bladder Meridian of foot taiyang

The outcome indicators involved in the literature can be divided into six categories: symptoms/signs, basic health status, TCM syndrome types, physical and chemical examination, efficacy evaluation, and safety evaluation. Figure 6(b) shows that symptoms and signs, physical and chemical examination, and curative effect evaluation are the three most frequently used outcome indicators, and their numbers all reached their peak in 2014. Although it has declined since then, it has remained at a relatively high level. Basic health status, TCM syndrome type, safety evaluation related to the frequency

of outcome indicators in most years maintained at a low level, and did not fluctuate much. Regarding the evaluation time of outcome indicators, 104 articles all carried out a global evaluation after the end of treatment, but only 9 mentioned the evaluation during treatment. It can be seen from Fig. 8c that the time span for evaluating outcome indicators ranges from 1 to 96 weeks, and the 4th, 8th, and 12th weeks after treatment are the high-frequency time nodes for evaluating outcome indicators. The outcome indexes of 92 out of 104 articles were related to diabetes mellitus and obesity for evaluation, while the indexes of the remaining 12

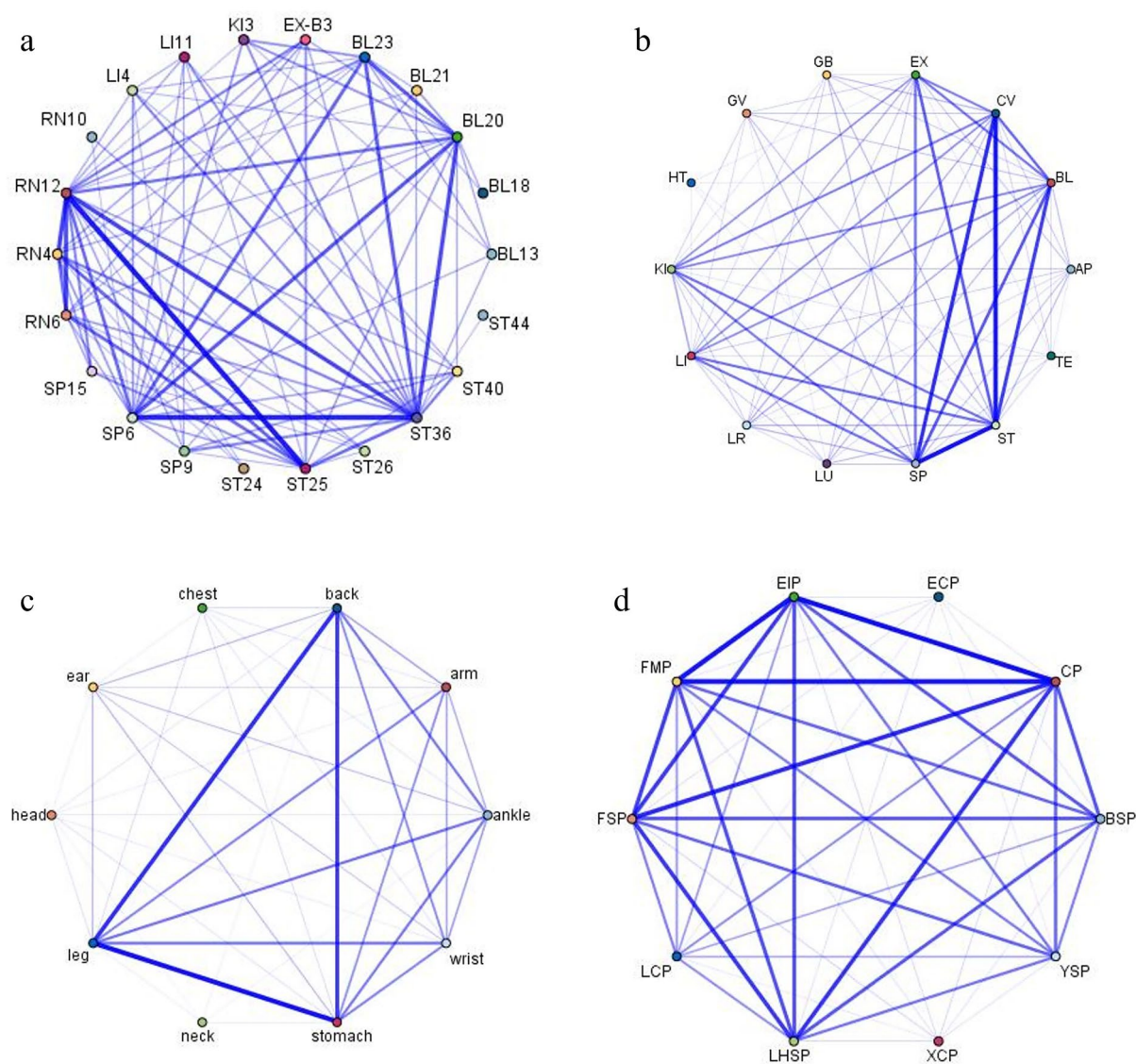


Fig. 7 Correlation diagram of acupoint, meridian, location, and special acupoints network. **a** The high-frequency acupoint network correlation diagram, **b** the acupoint meridian network correlation diagram, **c** the acupoint network correlation diagram in the human body, **d** the specific acupoint network correlation diagram. Abbreviations: LU: Lung meridian of hand-taiyin; HT: Heart meridian of hand-shaoyin; SI: Small intestine meridian of hand-taiyang; KI: Kidney meridian of foot-shaoyin; GB: Gallbladder meridian of foot-shaoyang; PC: Pericardium meridian of hand-jueyin; TE: Triple energizer meridian of hand-shaoyang; LR: Liver meridian of foot-jueyin; GV: Governor vessel; LI: Large intestine meridian of hand-yangming; EX: Extraordinary Points; AP: auricular acupoints; CP: Crossing points; LHSP: Lower he-sea points; XCP: Xi-cleft points; EIP: Eight influential points; ECP: Eight confluence points; FMP: Front-mu points; YSP: Yuan-source points; LCP: Luo-connecting points; BSP: Back-shu points; FSP: Five-shu points

articles were related to diabetes mellitus only, not obesity. See Supplementary material 4 for details.

Quality evaluation

Cochrane risk of bias assessment for RCTs

We assessed the risk of cochrane bias for 82 included RCTs. Among the random sequence generation methods: 47 articles clearly reported that the random sequence generation method was low-bias risk, 8 articles were high-bias risk, and 27 articles were uncertain bias risk. However, most of the literature cannot judge bias due

to the lack of reports on assignment hiding, blinding outcome evaluators, selective outcome reports, and other sources of bias. Given the characteristics of acupuncture interventions, there are inherent difficulties in implementing blinding. Only 1 article reported that the "three separations" principle was adopted for patients, experimenters, and outcome evaluators to avoid the risk of bias as much as possible. There are also 5 articles that implement the single-blind method. Due to the lack of literature information, it is impossible to judge whether the single-blind method alone will bias the experimental

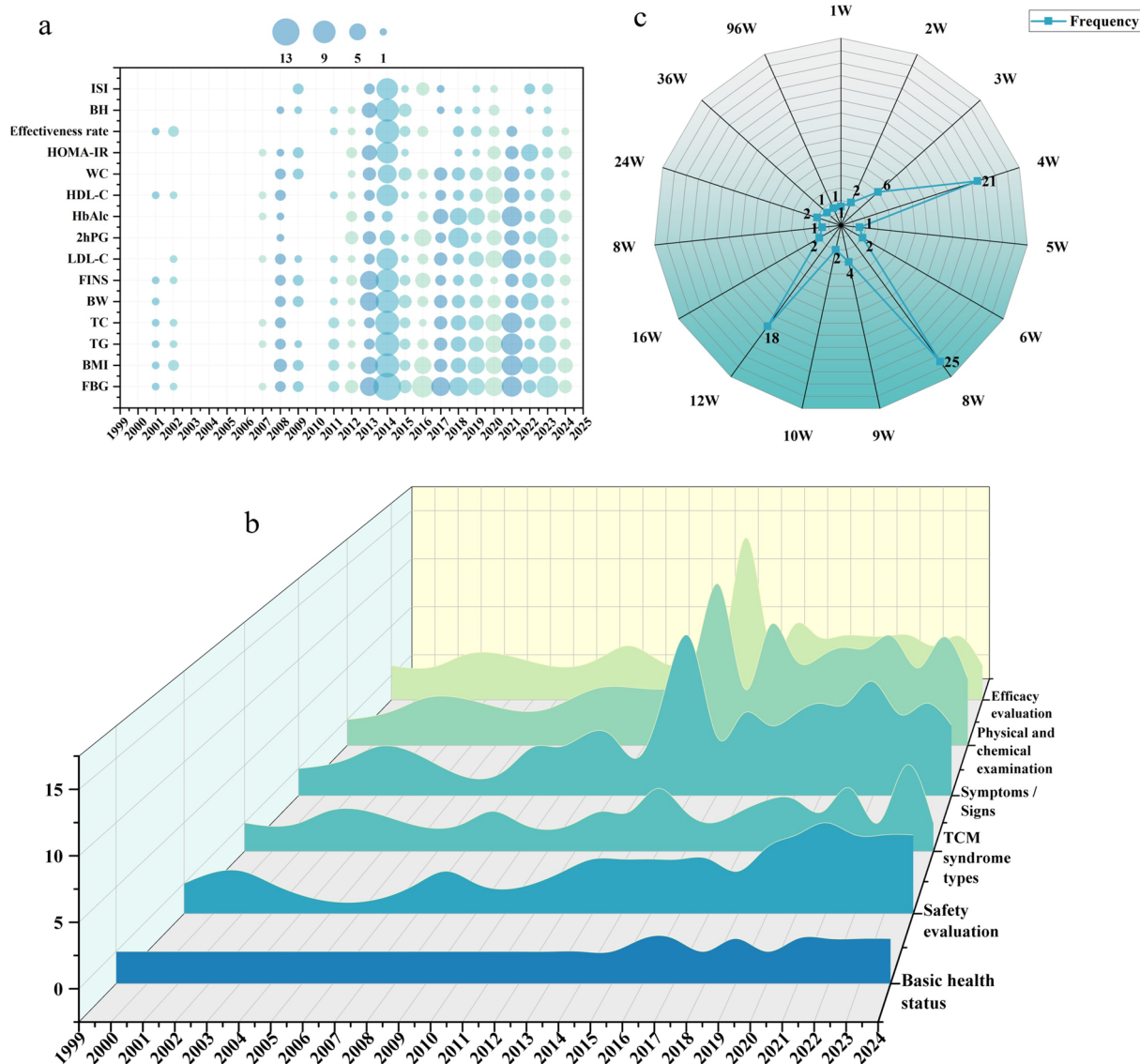


Fig. 8 Comprehensive analysis of outcome indicators in diabetes clinical trials. **a** The bubble chart of the top 15 outcome indicators used frequently, **b** the peak chart of the outcome indicators and year trends, and **c** the radar chart of the outcome index evaluation time node. Abbreviations: FBG: fasting blood glucose, BMI: body mass index, TG: triglycerides, TC: total cholesterol, BW: body weight, FINS: fasting insulin, LDL-C: low-density lipoprotein cholesterol, 2h-PG: 2-hour postprandial blood glucose, HbA1c: Hemoglobin A1c, HDL-C: high-density lipoprotein cholesterol

results, and the risk of bias is not clear. Sample size was reported in all articles, 72 reports had no subject drop-out throughout the course, and data integrity was rated as low risk. In 10 articles, there were samples falling off, and there was a high risk of data integrity (Fig. 9).

In general, there are many problems in the literature. In key links such as randomization, assignment concealment, and blinding, most studies are in an unknown or high-risk state, and clinical research results may be affected by factors such as patients' psychological hints, researchers' psychological differences, and differences between groups.

Methodological index for non-randomized studies

The MINORS scale was used to evaluate the quality of 22 Non-RCT articles, and the study purpose, the consistency of included patients, the collection of expected data, and the appropriate reflection of the study purpose by the endpoint indicators were reported and reflected. However, only 1 literature reported half-year follow-up time, and none reported the estimation of sample size. Among them, 6 articles set up a control group, the control group was carried out synchronously, the baseline was comparable between groups, and the statistical analysis was selected appropriately, but the rationality of the

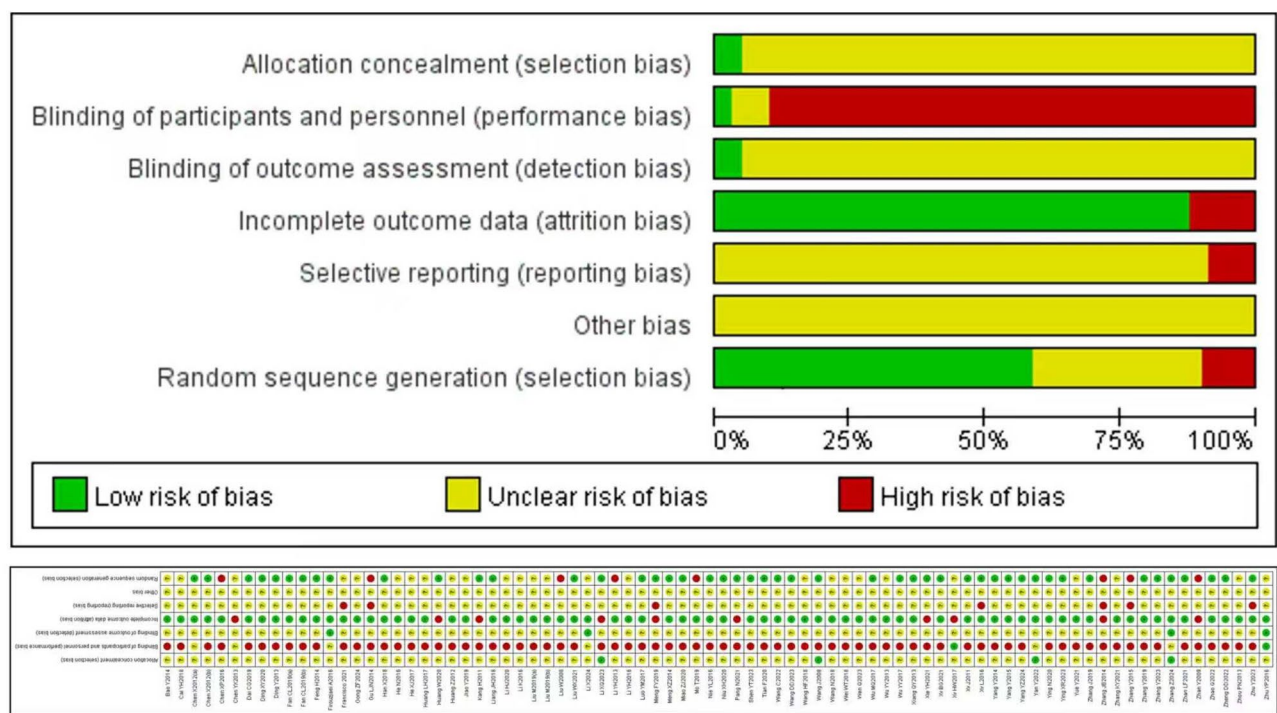


Fig. 9 Cochrane risk of bias assessment

selection of the control group was not reported. Details of the scoring are shown in Fig. 10.

Standards for reporting interventions in clinical trials of acupuncture

Among the included literatures, 102 (98%) reported specific types of acupuncture treatment, only half of the literatures (50.0%) provided reference bases such as treatment reasons and historical background, and very few literatures (1.90%) reported the adjustment of treatment plans, indicating that the rationality of acupuncture treatment was not sufficient. The high reporting rate of acupoint names (97.1%), but the generally low reporting rate of key operational details, such as needling depth (31.7%) and needle type (58.6%), may affect the reproducibility and accuracy of the study. The time of needle retention (84.6%) and the way of needle stimulation (73.0%) were acceptable, but the reporting rate of body reaction (58.6%) needed to be improved. The number of treatment units (95.1%), the frequency and duration of treatment units (92.3%) were reported highly, indicating that the description of the treatment process is relatively complete. The details of additional intervention in the acupuncture group (82.6%) were also mentioned more, but the report of treatment site and relevant information (3.8%) was seriously missing, which was not conducive to a comprehensive assessment of the background of treatment implementation. More importantly, only 4.8% of the literature described the qualifications and working

hours of acupuncturists, which made it difficult to evaluate the impact of operator-related factors on the results of the study, which in turn affected the reliability of the study results. Although most of the literature (85.5%) can clearly describe the measures used by the control group, no literature has reported the rationality of the choice of control measures. This makes it difficult to judge the scientificity of control setting, and affects the accurate evaluation of acupuncture efficacy.

In general, these literatures performed well in reporting the type of acupuncture treatment, acupoint selection, and basic treatment parameters (such as frequency and duration), but in demonstrating the rationality of treatment, reporting key operation details, providing treatment background information (location, operator qualification), and justifying control measures. There are significant deficiencies (Table 2).

Discussion

Characteristics of diabetes-related obesity acupuncture research: Increasing trend, methodological limitations, and geographical clustering

This study systematically combed the relevant literature on acupuncture treatment of diabetes-related obesity, and according to the principles of PICOS, used the evidence map to integrate and analyze the evidence in this field [19], and comprehensively evaluated the acupuncture treatment of diabetes-related obesity. Judging from the basic information of the literature, relevant research

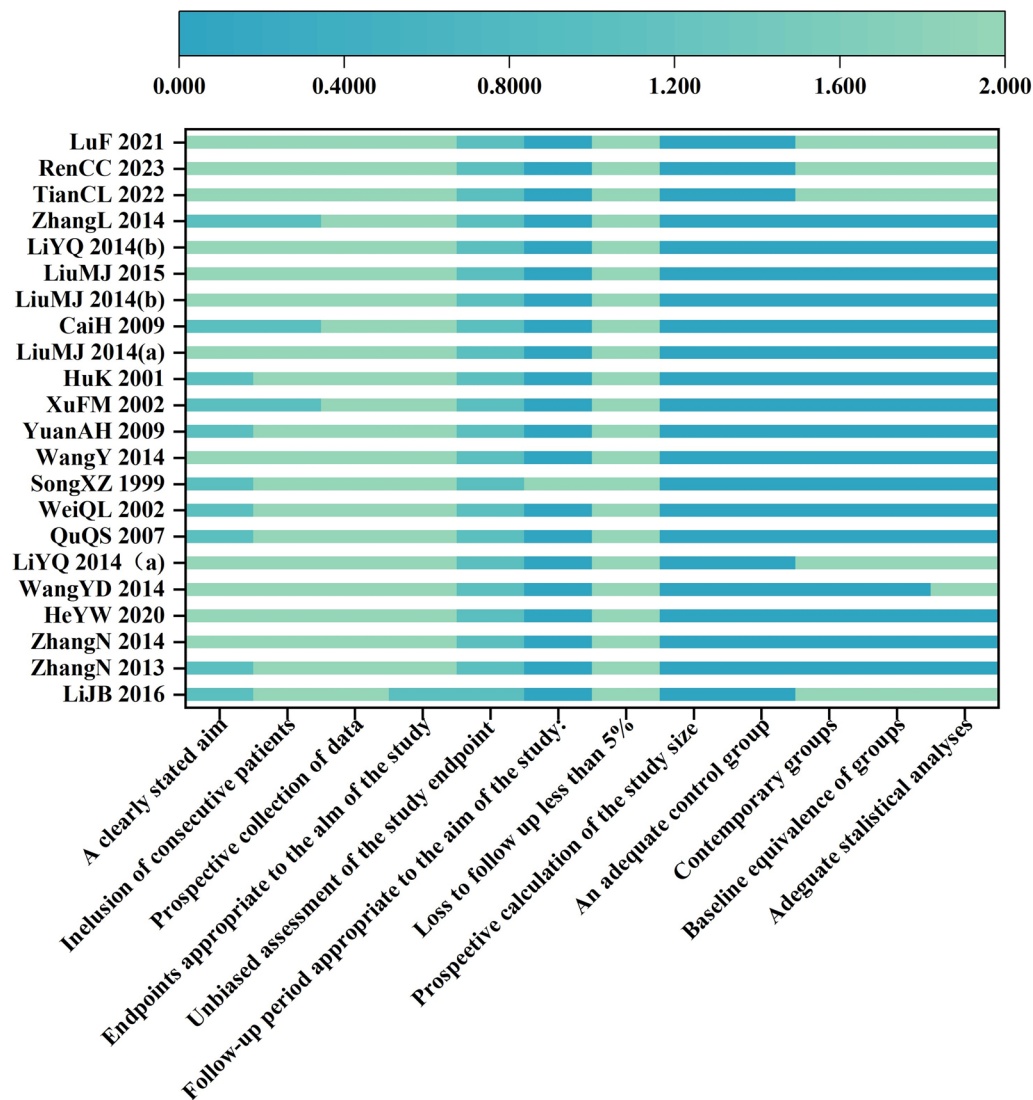


Fig. 10 Methodological index for non-randomized studies

has shown a phased growth, especially in the past ten years, reaching its peak in 2014. According to the epidemic characteristics and changing trends of diabetes in China, among the adult diabetic patients over 18 years old in the national survey in 2010 and 2013, the number of newly diagnosed diabetic patients accounted for 70% and 63% respectively, both of which were significantly higher than those in developed countries. This may be one reason for the increase in diabetes research. And the fund support has increased, reflecting the continuous increase in the attention of this field. In addition, the evidence of acupuncture treatment of diabetes-related obesity is considerable, but the quality is generally low, and the number of foreign research reports is small. This phenomenon may be related to factors such as insufficient standardization of acupuncture research and lack of reporting standardization [20, 21]. Geographically,

domestic research results are mainly concentrated in Jiangsu, Beijing, Guangdong, Heilongjiang and other areas, which may be related to the rich local medical resources, strong scientific research strength and strong acupuncture atmosphere.

Individualized early prevention and management strategies for diabetes-related obesity: Focus on patient characteristics

All included literature mainly focused on patients with T2DM-related overweight or obesity, suggesting that clinical research should attach great importance to the evaluation and management of glycolipids and weight in such patients, which has important guiding significance for disease judgment and complication prevention. It is worth mentioning that there is no limit to the course of the patient in the study, and the course of the disease

Table 2 STRICTA entry reporting status

STRICTA items		Quantity	Proportion (%)
1. Acupuncture rationale	(1a) Style of acupuncture (e.g. Traditional Chinese Medicine, Japanese, Korean, Western medial, Five Element ear acupuncture, etc	102	98.0
	(1b) Reasoning for treatment provided, based on historical context literature sources, and/or consensus methods, with references where appropriate	52	50.0
	(1c) Extent to which treatment was varied	2	1.90
2. Details of needling	(2a) Number of needle insertions per subject per session (mean and range where relevant)	0	0.0
	(2b) Names (or location if no standard name) of points used (uni/bilateral)	101	97.1
	(2c) Depth of insertion, based on a specified unit of measurement, or on a particular tissue level	33	31.7
	(2d) Response sought (e.g. de qi or muscle twitch response)	61	58.6
	(2e) Needle stimulation (e.g. manual, electrical)	76	73.0
	(2f) Needle retention time	88	84.6
3. Treatment regimen	(2g) Needle type (diameter, length, and manufacturer or material)	61	58.6
	(3a) Number of treatment sessions	99	95.1
	(3b) Frequency and duration of treatment sessions	96	92.3
4. Other components of treatment	(4a) Details of other interventions administered to the acupuncture group (e.g. moxibustion, cupping, herbs, exercises, lifestyle advice)	86	82.6
	(4b) Setting and context of treatment, including instructions to practitioners, and information and explanations to patients	4	3.8
5. Practitioner background	(5) Description of participating acupuncturists (qualification or professional affiliation, years in acupuncture practice, other relevant Practitioner background experience)	5	4.8
6. Control or comparator interventions	(6a) Rationale for the control or comparator in the context of the research question, with sources that justify this choice	0	0.0
	(6b) Precise description of the control or comparator. if sham acupuncture or any other type of acupuncture like control is used, provide details as for items 1 to 3 above	89	85.5

presents a phenomenon with a large span. The data also showed that there were few studies on prediabetes, while there were more studies on T2DM, which may reflect the insufficient diagnosis of early diabetes, causing some patients to progress to the diabetic stage. According to studies, due to the lack of obvious symptoms, people with prediabetes often underestimate their own health risks and lack internal motivation for behavior changes, resulting in insufficient perception of external prevention resources and low willingness to use them [5, 22, 23]. However, strengthening the screening of prediabetic patients and taking timely intervention measures, giving full play to the reversal effect of acupuncture in the process of prediabetic development to diabetes[24], and moving the prevention and treatment threshold forward are crucial to reducing the incidence of T2DM.

Clinical application and acupoint combination patterns of acupuncture for diabetes-related obesity

The conclusions related to the intervention measures provide specific reference for clinical practice. The sample size of the included studies is mostly concentrated in 51–100 cases; Commonly used acupuncture therapies include manual acupuncture, electro-acupuncture and auricular acupuncture/auricular point pressing pills [25, 26], and this information helps clinical researchers to

formulate more reasonable treatment plans. At the same time, studies have found that dietary methods such as coffee extract and sesame supplements can achieve the purpose of controlling blood sugar, BMI, and blood lipid levels [27, 28]. In the future, acupuncture and moxibustion can be combined with these therapies to explore better synergistic effects and provide non-drug regulation metabolism provides a broader perspective. Obesity is a chronic metabolic disease [29, 30]. However, the short-term effect (9–12 weeks) is mainly concerned in the literature, and the long-term effect is not discussed enough, which cannot guarantee the weight loss effect of acupuncture and moxibustion.

The study of acupoint prescription reveals the important role of acupoints such as RN12, ST25, ST36, SP6, RN6 and related meridians in the treatment. ST36 is the key point for invigorating the spleen, RN12 is the key point for Front-Mu points of Stomach Meridian and SP6 is the key point for the Spleen Meridian. At the same time, the main meridians of acupoint attribution are Stomach Meridian, Conception Vessel, and Spleen Meridian, suggesting that the treatment of diabetes-related obesity can consider starting from the spleen and stomach, which provides a theoretical basis for clinical acupuncture point selection [25, 26]. Stomach Meridian channel governs qi and blood, which is related to

digestion and absorption. Spleen Meridian can transport and transform water-dampness. Conception Vessel is “Sea of Yin Meridian”. This shows that acupuncture treatment of diabetes-related obesity often through stimulating the relevant meridian acupoints, regulating the function of the spleen and stomach, harmonizing qi, blood, yin and yang, and then improving metabolism and endocrine function. In addition, there are many Front-Mu points in the abdominal area, and there are Back-Shu points in the back area, both of which are closely related to Organs and Viscera. It is suggested that acupuncture on the abdomen and back points can directly regulate the functions of viscera and help to improve the metabolic disorders of diabetic patients with obesity.

Evaluation of acupuncture efficacy for diabetic obesity: Overreliance on laboratory parameters and inadequate attention to quality of life

The high-frequency use of diet and exercise intervention reflects the accurate grasp of the importance of lifestyle intervention in the treatment of diabetes and obesity, and the inclusion of health education will help improve the treatment effect from the cognitive level of patients. Our study suggests that the existing clinical evidence tends to support the role of acupuncture in reducing fasting blood glucose (FPG), body mass index (BMI), triglycerides (TG), total cholesterol (TC) and other laboratory indicators and improving symptoms and signs [31], which reflects that current studies are more inclined to choose laboratory indicators and symptoms and signs as the main evaluation criteria when evaluating the efficacy of diabetes-related obesity. Hyperglycemia can damage blood vessels, nerves, etc., causing complications such as kidney disease, eye disease, and cardiovascular disease, thereby reducing the quality of life of patients [32]. However, there are only 4 articles that use the basic health status scale, and there are relatively few reports of adverse reactions. The low reporting of adverse events may be due to the fact that some researchers pay more attention to the positive efficacy of acupuncture and ignore the recording and reporting of adverse reactions. In addition, the lack of unified standards for reporting adverse events in acupuncture studies may also lead to incomplete reporting. For the low reporting of quality-of-life outcomes, it may be because most studies focus on objective metabolic indicators (such as blood glucose and lipid levels) and neglect the subjective feelings and quality of life of patients. The overreliance on laboratory parameters, while objective, overlooks critical patient-reported outcomes. Future trials should incorporate validated patient-centered outcome measures to ensure that interventions truly address the needs and priorities of individuals living with diabetes-related obesity. Outcome indicators take 4th, 8th, 12th weeks and other periods after treatment as

evaluation nodes, suggesting that researchers in clinical research tend to choose these periods as key nodes for observing curative effect and safety, which can provide reference for follow-up research in time design.

Critical barriers and optimization strategies for methodological quality in acupuncture clinical trials targeting diabetes-related obesity

In terms of methodological quality, most RCT literatures have deficiencies in key links such as randomization and blinding. For example, there is a high risk of bias in the random sequence generation method, the implementation of blinding methods is difficult and most of them are not explained, and the follow-up time and sample size of Non-RCT literatures there are few reports on details such as estimation, which leads to doubts about the reliability of the research results. Therefore, in the design of the study, false can be used as a control to better evaluate the specific efficacy. At the same time, explore blinding models that are more in line with acupuncture, such as blinding patients, data evaluators, and groupings, to minimize bias.

In the description of acupuncture treatment, most of the literature does not report enough on the rationality of treatment, specific operation details, and the background of therapists, and the reporting rate of key information such as needle type and needle depth is low, which seriously affects the repeatability of the study and accuracy of results. In terms of control setting, there is no literature to prove the rationality of control selection, and it is difficult to accurately evaluate the efficacy of acupuncture. These problems limit the persuasiveness and clinical application value of the research conclusions. There are only 4 articles included in the literature that set up a placebo control, but a scientific and reasonable comfort control design can provide strong evidence for the safety and effectiveness of acupuncture and moxibustion, and become an important support for promoting acupuncture research. Therefore, exploring a scientific and reasonable research control is crucial to improving the quality of clinical trials [33]. At the same time, it is necessary to improve the detailed description of acupuncture, including recording in detail the type of acupuncture, the depth of needle insertion and other operational information, fully explaining the rationality of treatment, clarifying the qualifications and background of therapists, and improving the standardization and repeatability of research [34].

The geographical bias of the included studies, mainly concentrated in China, may be due to differences in cultural backgrounds (acupuncture is more widely accepted and applied in China), differences in medical systems (traditional Chinese medicine is an important part of China's medical system, and there are more research

resources in acupuncture), and language barriers (many Chinese studies are only published in Chinese, which is not easy to be retrieved and recognized by international researchers). To address this issue, it is necessary to strengthen international academic exchanges and cooperation, encourage researchers from other countries to carry out acupuncture studies on diabetes-related obesity, and promote the translation and publication of Chinese studies in international journals.

Conclusion

The evidence map in this study clearly shows the distribution characteristics of current research evidence, such as the focus on type 2 diabetes combined with overweight or obesity, the main use of manual acupuncture, and the high-frequency use of acupoints such as Zhongwan (RN12) and Zusanli (ST36). This can guide future research to focus on understudied areas such as prediabetes and long-term efficacy of acupuncture. In clinical practice, it can provide a reference for acupoint selection and treatment cycle determination in acupuncture for diabetes-related obesity. At the same time, it is conducive to the improvement and improvement of evidence-based evidence in this field. However, it is still necessary to improve the methodology and reporting of clinical research, pay more attention to the improvement of patients' lives, pay attention to the follow-up work at the end of treatment, promote the development of multi-center clinical research at home and abroad, and provide higher evidence-based evidence for acupuncture in the treatment of diabetes and obesity. We believe, with the improvement of the methodological quality of clinical studies and the expansion of international cooperative research, more high-quality evidence on acupuncture for diabetes-related obesity will be accumulated, which will help to promote the international recognition and application of acupuncture in this field. Global collaboration in research is essential to address geographical biases and provide more comprehensive and reliable evidence.

Abbreviations

SCI	Science Citation Index database
CSCD	Chinese Science Citation Database
PKU/CSTPCD	Peking University Core Journals/China Science and Technology Paper Citation Database
DM	Diabetes mellitus
T2DM	Type 2 Diabetes mellitus
MA	Manual acupuncture
AA	Auricular acupuncture
NWM	Needle warming moxibustion
EA	Electric acupuncture
TCM	Traditional Chinese medicine
BT	Basic treatment
AC	Acupuncture
SA	Shame acupuncture
CP	Crossing points
EIP	Eight influential points
FMP	Front-mu points
LHSP	Lower he-sea points

FSP	Five-shu points
LCP	Luo-connecting points
BSP	Back-shu points
XCP	Xi-cleft points
ECF	Eight confluence points
YSP	Yuan-source points
SP	Spleen Meridian of foot-taiyin
CV	Conception Vessel
ST	Stomach Meridian of foot-yangmin
BL	Bladder Meridian of foot-taiyang
LU	Lung meridian of hand-taiyin
HT	Heart meridian of hand-shaoyin
SI	Small intestine meridian of hand-taiyang
KI	Kidney meridian of foot-shaoyin
GB	Gallbladder meridian of foot-shaoyang
PC	Pericardium meridian of hand-jueyin
TE	Triple energizer meridian of hand-shaoyang
LR	Liver meridian of foot-jueyin
GV	Governor vessel
LI	Large intestine meridian of hand-yangming
EX	Extraordinary Points
AP	Auricular acupoints
FBG	Fasting blood glucose
BMI	Body mass index
TG	Triglycerides
TC	Total cholesterol
BW	Body weight
FINS	Fasting insulin
LDL-C	Low-density lipoprotein cholesterol
2h-PG	2-Hour postprandial blood glucose
HbA1c	Hemoglobin A1c
HDL-C	High-density lipoprotein cholesterol

Supplementary Information

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Additional file1

Additional file2

Additional file3

Additional file4

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Author contributions

Chao Ke conceived and designed the study. Xi Zhang, Shengtao Shan, Yan Zheng, Yaling Chen Screening and downloading literature. Xi Zhang, Mukun Li, and Yanpei Liu extracted literature information and wrote the manuscript. Yifei Fang and Xi Zhang drew pictures of the article. Ke Chao and Zhang Xi revised the manuscript. All authors read the final manuscript and agreed to the submission of the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

The authors confirm that the work has not been published before or elsewhere.

Competing interest

The authors declare no competing interests.

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