INPLASY

Effects of acupuncture and electrical stimulation on continuous glucose monitoring parameters in type 2 diabetes: a systematic review and meta-analysis of randomised controlled trials

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ADMINISTRATIVE INFORMATION

Support - Not applicable.

Review Stage at time of this submission - Completed but not published.

Conflicts of interest - None declared.

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Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 20 April 2026 and was last updated on 20 April 2026.

INTRODUCTION

Review question / Objective To systematically evaluate the effects of acupuncture and electrical stimulation therapies on continuous glucose monitoring (CGM)-derived glycaemic variability indices in patients with type 2 diabetes mellitus (T2DM).

Condition being studied Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterised by persistent hyperglycaemia resulting from impaired insulin secretion, insulin resistance or both. Despite intensive pharmacologic strategies, a substantial proportion of patients remain exposed to glycaemic variability (GV) – fluctuations in blood glucose beyond average levels – that are strongly associated with oxidative stress, endothelial dysfunction and diabetic complications.

METHODS

Participant or population Patients with type 2 diabetes mellitus (T2DM).

Intervention Acupuncture or electrical stimulation modalities, including NMES, TENS, PES, tVNS and electroacupuncture; treatment alone or on top of standard care.

Comparator Sham/placebo stimulation, attention control or standard/usual care.

Study designs to be included Parallel-group RCTs.

Eligibility criteria Adults (≥18 years) diagnosed with T2DM by author-reported criteria.

Information sources We searched PubMed (1966–31 May, 2025), Embase (1974–31 May,

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2025), Web of Science (1900–31 May, 2025), Scopus (1960–31 May, 2025) and CENTRAL (1993–31 May, 2025) from inception to 31 May, 2025, without language restriction.

Main outcome(s) At least one CGM outcome measurable as a continuous variable:
Primary: MAGE (mg/dL)
Key secondary: Mean glucose (mg/dL), SD (24h) (mg/dL), CV (%).

Quality assessment / Risk of bias analysis We applied a seven-domain risk of bias (RoB)(16) framework aligned with Cochrane RoB 1 (D1–D7) and mapped to overall risk with explicit thresholds; outcome-level bias assessment was performed for all CGM outcomes (objective measures), with no differential bias detected across outcomes. At least one CGM outcome measurable as a continuous variable:
Primary: MAGE (mg/dL)
Key secondary: Mean glucose (mg/dL), SD (24h) (mg/dL), CV (%).

Strategy of data synthesis All statistical analyses were performed using the inverse-variance method under a common- or random-effects model, depending on between-study heterogeneity.
A fixed-effects (common-effects) model was applied when heterogeneity was low ($I^2 < 50\%$ and Q-test $p \geq 0.10$).
When heterogeneity reached $I^2 \geq 50\%$ or Q-test $p < 0.10$, a random-effects model was adopted using the restricted maximum-likelihood estimator.
The DerSimonian–Laird estimator was applied for sensitivity comparison.
Statistical significance was determined at a two-sided $\alpha = 0.05$.

Subgroup analysis The main pooled meta-analysis was conducted for each CGM outcome, summarising the mean difference (MD) and 95% CI across studies. Post hoc subgroup analyses by stimulation modality (acupuncture vs electrical stimulation; peripheral stimulation [NMES/TENS/PES] vs vagal stimulation [tVNS]) and intervention duration (short-term: ≤8 weeks vs long-term: >8 weeks) were performed for the primary outcome (MAGE) to address clinical heterogeneity; these analyses are reported in the results section.

Sensitivity analysis A leave-one-out analysis was conducted to evaluate the influence of individual studies on the pooled estimate; stability was inferred if pooled MDs remained within ±20% of the overall effect after exclusion of any single study. Additional sensitivity analyses were performed for MAGE: (1) exclusion of high RoB studies; (2) exclusion of crossover trials; (3) exclusion of studies with comorbid T2DM populations, with results reported in the supplementary materials.

Country(ies) involved China.

Keywords diabetes mellitus, type 2; acupuncture therapy; electric stimulation therapy; continuous glucose monitoring.

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