INPLASY

# Effects of Exercise on Walking Balance , Muscle Strength, and Quality of Life among Adults with diabetic Neuropathy: A Systematic Review

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**Corresponding author:**
Maranatha Ngesojisos Iwundu Anudu

maranudu@gmail.com

**Author Affiliation:**
University of Nigeria.

Anudu, MN: Ibeneme, SC: Omeje, C:.

**ADMINISTRATIVE INFORMATION**

**Support -** Self.

**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 15 June 2025 and was last updated on 15 June 2025.

## INTRODUCTION

**Review question / Objective** What is the Effects of Physical Exercises on Walking Balance, Muscle Strength and Quality of Life among Adults with Diabetic Neuropathy?
To answer the review question, specific review objectives were included to define the effects in physical exercises on 1) Walking balance and 2). Muscle strength 3). Quality of life on diabetic neuropathy.

**Rationale** To answer the review question, specific review objectives were included to define the effects in physical exercises on 1) Walking balance and 2). Muscle strength 3). Quality of life on diabetic neuropathy.

**Condition being studied** This review is limited to Randomized Control Trials (RCTs) that evaluated the effect of physical exercises (aerobic exercises or resistance exercises) on any of these outcomes- Walking Balance, Muscle Strength and Quality of Life, among Adults with Diabetic Neuropathy. At least five electronic databases were searched.

Primary outcomes include:
1. Walking Balance
2. Muscle Strength
3. Quality of Life.

## METHODS

**Search strategy** The following databases were used: PubMed, CINAHL, EMBASE, the Cochrane Library, and AMED Trial registers and directory of open-access repository websites which included http://www.clinicaltrial. Moreover, hand search was done from the reference list of identified studies and suggested articles. Published systematic reviews of exercise interventions; reference lists of relevant articles and books; the Cochrane systematic review database; the National Institute of Health Research (NIHR) portfolio for recently completed or ongoing studies; and the current controlled trials register, were searched to identify relevant clinical trials.

**Participant or population** The search results yielded 4517 citations. 275 citations were removed after de-duplication and the remaining 4242

papers were screened for title and abstract eligibility. This screening that yielded 45 publications that passed through full text screening, with 4197 removed. After full text screening, fifteen (15) articles (Seyedizadeh et al. 2020; Win et al. 2020; Venkataraman et al. 2019; Monteiro et al. 2022; Monteiro et al. 2020; Allet et al. 2010; Song et al, 2011; Dixit et al.2013; Perrin et al. 2021; Ahmad et al. 2020; Ahmad et al. 2021; Quigley et al. 2014; Abdelbasset et al. 2020; Mueller et al. 2013; Izgu et al. 2020) met the inclusion criteria.

**Intervention** RCTs of physical exercises on adults with diabetic neuropathy were iincluded. Only studies that focused on supervised exercise programs were selected. Inclusion was not be restricted to a particular dose, form, frequency, duration and intensity of intervention or follow-up period after the intervention.

**Comparator** Studies were included if observable changes were made on Walking Balance, Muscle Strength and Quality of Life outcome measures in individuals with diabetic neuropathy. There was no ggrouping of outcomes into primary or secondary outcomes. All studies were included not regarding whether the outcome of interest was accounted for as a primary or secondary outcome in the first article so far as a clear analysis was carried out for each outcome and there was be no modification to the original description of the individual studies was done. Clinical results were analysed and graded appropriately.

**Study designs to be included** This review is limited to Randomized Control Trials (RCTs) that evaluated the effect of physical exercises (aerobic exercises or resistance exercises) on any of these outcomes- Walking Balance, Muscle Strength and Quality of Life, among Adults with Diabetic Neuropathy. At least five electronic databases were searched.Primary outcomes include:1. Walking Balance 2. Muscle Strength3. Quality of Life.

**Eligibility criteria** The eligibility criteria considered for selecting studies for the review includes:
3.1.1 Inclusion Criteria
i. Types of Studies:
Studies that have their Original research manuscripts in peer-reviewed journals and Conferences proceedings published in the English language were included in this review. THIs include randomized control trials (RCTs) studies that determined the effects of the effect of physical exercises on Walking Balance, Muscle Strength and Quality of Life among Adults with Diabetic Neuropathy. Additionally, grey literature on relate topics were sourced via hand searches and also included.
ii. Types of participants:
This review focused on studies involving adult human participants aged ≥ 18 years. There was no specific limitation considered as regards to the settings of the study.
iii. Intervention
RCTs of physical exercises on adults with diabetic neuropathy were iincluded. Only studies that focused on supervised exercise programs were selected. Inclusion was not be restricted to a particular dose, form, frequency, duration and intensity of intervention or follow-up period after the intervention.
iv. Types of control:
RCTs of diabetes patients with complications of diabetic neuropathy that were placed on other interventions such as nutrition, lifestyle modification, wwith/without counselling would be used.

v. Timing
Studies were included only if outcome measures were evaluated at the completion of the intervention and/or at ≤ 6 months post-intervention.
vi. Types of outcomes:
Studies were included if observable changes were made on Walking Balance, Muscle Strength and Quality of Life outcome measures in individuals with diabetic neuropathy. There was no ggrouping of outcomes into primary or secondary outcomes. All studies were included not regarding whether the outcome of interest was accounted for as a primary or secondary outcome in the first article so far as a clear analysis was carried out for each outcome and there was be no modification to the original description of the individual studies was done. Clinical results were analysed and graded appropriately.

**Information sources** An extensive search strategy was conducted to select studies that were used for this review, and this iinvolved searching the bibliographic database, grey literature as well as hand searches of the reference list of eligible publications using snowballing approach. This procedure was in accordance with the rules of the Cochrane Handbook of Systematic Reviews of Interventions (Higgins & Green, 2014) and advice for Health Care Review by the Centre for Reviews and Dissemination (Akers 2009).

3.2.1 Search Strategy:
An extensive study strategy was formulated after consulting a research specialist, using combinations of search terms from Medical

Subject Heading (MeSH) and keywords in the titles, abstract and text for the population, intervention, control and major outcomes. The search strategy was pilot-tested to determine the sensitivity and specificity of the search strategy. A host of commands was employed which included using the Boolean operators and search truncations for the searches. A search strategy for the PubMed search is shown in Appendix I and II. There was modification of the strategy to suit the syntax and subject heading of the other databases. The following databases were used: PubMed, CINAHL, EMBASE, the Cochrane Library, and AMED Trial registers and directory of open-access repository websites which included http://www.clinicaltrial. Moreover, hand search was done from the reference list of identified studies and suggested articles. Published systematic reviews of exercise interventions; reference lists of relevant articles and books; the Cochrane systematic review database; the National Institute of Health Research (NIHR) portfolio for recently completed or ongoing studies; and the current controlled trials register, were searched to identify relevant clinical trials.

3.3 Study Record and Data Management

Search results were exported to RefWorksTM manager to check for studies that were duplicated. Bibliographic records will be exported from RefWorksTM manager into Microsoft Excel (Microsoft 2010) to facilitate the organization and sorting of the articles according to the specific inclusion and exclusion criteria for this review. Review questions were well-structured and refined (if required) to aid the sorting of articles by considering the inclusion and exclusion criteria.

Table 3.1: Search terms

Concept Search terms

Population MeSH terms: diabetic neuropathy

Free text terms: peripheral neuropathy, diabetic polyneuropathy .

Intervention MeSH terms: Physical exercises

Free text terms: physical activity, aerobic exercise, walking, strength training, resistance exercises.

Comparator MeSH terms: Randomized clinical trials

Free text terms: RCTs, Random allocation, randomly, randomized, trial

Outcomes MeSH terms: walking balance, muscle strength, quality of life.

Free text terms: Balance, Gait balance, Postural balance, Muscles, musculature, strength, HRQOL, well-being, life quality, Health-related quality of life.

NOTE: A more detailed search strategy is included in Appendix I, II and III.

3.4 Selection Process

Screening was done using the inclusion criteria to identify eligible studies. Initial screening was conducted using the title and abstract by M.U (reviewer 1) to identify studies while C.O (reviewer 2) check through the initial screening results independently. The two reviewers then read through the full text of identified studies for further screening using the eligibility criteria. Differences in opinions at any stage for the.

**Main outcome(s)** The methodological rigor of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) quality appraisal tool (de Morton et al. 2009). This tool was chosen over the Cochrane Risk of Bias (CROB) tool, because although neither of them are considered the gold standard for risk assessment, the arduousness in blinding subjects and therapists has the possibility of making the application of the CROB tool more challenging (Moseley et al. 2019).

The PEDro is an 11-item scale in which the first item is focused on external validity and the other ten items assess the internal validity of a clinical trial. One point is given for each satisfied criterion (except for the first item) which gives rise to a maximum score of 10. The higher the score, the better the quality of the study and the following point scale is used: 9-10 (excellent); 6-8 (good); 4-5 (fair); <4 (poor). A particular criterion was awarded a point only if the article stated that the criterion was met. A score of one was given for each yes answer and zero for no, unclear and not applicable (N/A) answers. The overall score was reported as a tally of all yes answers out of 11 based on the answers for each study. Scores of individual items from the critical appraisal tool will be added to give the total score. The included studies were appraised independently by the Reviewer 1 and reviewer 2. Resolving of areas of differences was done by discussion and reflection, or in consultation with the reviewer 3. Appraisal of the qualities of the included studies will be carried out upon completion of study selection. And the level of evidence was assigned to each study based on the PEDro assessment and sample size used. High-quality random controlled trials (RCTs).

**Data management** 3.5.2 Data

Item: Data extraction form according to the Cochrane Handbook for Systematic Reviews of interventions, was used to extract data from the included studies and was done by the two reviewers. The following variables were considered: authors' reference, participants' characteristics, inclusion and exclusion criteria, sample of study, intervention components, the intervention setting, who delivered the intervention,

the intervention duration and follow-up (where available), attrition rate, outcome(s) assessed, the outcome measurement methods/techniques, results, conclusions and funding sources. The data extraction form consisted of descriptive characteristics and a quality appraisal
tool. 3.5.3 Data Synthesis and Assessment of Heterogeneity: The review question on the effects of physical exercise on walking balance, muscle strength and quality of life on diabetic neuropathy was answered in this review. All the quantitative outcomes used in assessing the effectiveness of the intervention were presented, evaluated and combined in a proof table. Proper statistical method was used for different variables following the standard analysis procedure in the Cochrane meta-analyses: for continuous variable, post-intervention weighted mean difference will be computed when outcomes are similar or standardised mean difference (SMD) when there were varied outcome measures/units of measurement with confidence interval (CI) of 95%, while for dichotomous variables, risk ratio was applied with CI of 95%. Interpretation of SMD was done as earlier recommended by Schünemann et al., (2019): small = 0.00–0.39, moderate = 0.40–0.70, and large = >0.70. Alpha was set at

$p<0.05$. This research also included a meta-analysis which utilised a random-effect model (I2) based on the level of heterogeneity of intervention effects, to estimate the pooled effect sizes across the involved studies. Heterogeneity assessment was done via the Cochran x2 test (10% significant level) and Higgins I2 using values of 25%, 50% and 75% to indicate low, medium and high heterogeneity respectively, as stated in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green,

2014). 3.6 Data
Analysis Study characteristics organised by year of publication and tabulated to provide information on authors' references, sample size, age, setting, data collection format, outcomes, components of the intervention, component of the control, format and provider of the intervention, intervention and follow-up periods, and results. Investigation and presentation of outcomes was done using the main outcomes. Interpretation of studies that are heterogeneous was by narrative synthesis following the guideline of the Centre for Reviews and Dissemination to investigate the relationship and findings within and between the included studies.

**Quality assessment / Risk of bias analysis** 3.5.1 Risks of Bias Assessment in Individual Studies:
The methodological rigor of the included studies was assessed using the Physiotherapy Evidence Database (PEDro) quality appraisal tool (de Morton et al. 2009). This tool was chosen over the Cochrane Risk of Bias (CROB) tool, because although neither of them are considered the gold standard for risk assessment, the arduousness in blinding subjects and therapists has the possibility of making the application of the CROB tool more challenging (Moseley et al. 2019).
The PEDro is an 11-item scale in which the first item is focused on external validity and the other ten items assess the internal validity of a clinical trial. One point is given for each satisfied criterion (except for the first item) which gives rise to a maximum score of 10. The higher the score, the better the quality of the study and the following point scale is used: 9-10 (excellent); 6-8 (good); 4-5 (fair); <4 (poor). A particular criterion was awarded a point only if the article stated that the criterion was met. A score of one was given for each yes answer and zero for no, unclear and not applicable (N/A) answers. The overall score was reported as a tally of all yes answers out of 11 based on the answers for each study. Scores of individual items from the critical appraisal tool will be added to give the total score. The included studies were appraised independently by the Reviewer 1 and reviewer 2. Resolving of areas of differences was done by discussion and reflection, or in consultation with the reviewer 3. Appraisal of the qualities of the included studies will be carried out upon completion of study selection. And the level of evidence was assigned to each study based on the PEDro assessment and sample size used. High-quality random controlled trials (RCTs) (rated as good or excellent by PEDro and sample size greater than 50) were considered as level 1 evidence, whereas lower-quality RCTs were considered level 2 evidence (rated as fair or poor by PEDro, or sample size < 50) (Warburton et al, 2011; Jamnik et al, 2011).

**Strategy of data synthesis** 3.5.3 Data Synthesis and Assessment of Heterogeneity:
The review question on the effects of physical exercise on walking balance, muscle strength and quality of life on diabetic neuropathy was answered in this review. All the quantitative outcomes used in assessing the effectiveness of the intervention were presented, evaluated and combined in a proof table. Proper statistical method was used for different variables following the standard analysis procedure in the Cochrane meta-analyses: for continuous variable, post-intervention weighted mean difference will be computed when outcomes are similar or standardised mean difference (SMD) when there

were varied outcome measures/units of measurement with confidence interval (CI) of 95%, while for dichotomous variables, risk ratio was applied with CI of 95%. Interpretation of SMD was done as earlier recommended by Schünemann et al., (2019): small = 0.00–0.39, moderate = 0.40–0.70, and large = >0.70. Alpha was set at p<0.05.

This research also included a meta-analysis which utilised a random-effect model (I2) based on the level of heterogeneity of intervention effects, to estimate the pooled effect sizes across the involved studies. Heterogeneity assessment was done via the Cochran x2 test (10% significant level) and Higgins I2 using values of 25%, 50% and 75% to indicate low, medium and high heterogeneity respectively, as stated in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins & Green, 2014).

**Subgroup analysis** This study performed three meta-analyses by the comparing the result of both aerobic, strengthening and functional exercises (gait and balance training) with their control, across the three outcome measures, which include:
1. Effect of exercise on muscle strength among adults with DNP.
2. Effect of exercise on General Walking balance (TUG, Foot Up and Go, Cadence, Stride length and walking speed-10-MWT & 6-MWT) among adults with DNP.
3. Effect of exercise on general quality of life among adults with DNP.

In addition, ten subgroup comparisons were done, considering studies with most-similar outcome measures. These include:
• Three analyses under the muscle strength outcome: (i) lower extremity - ankle and toes strength (ii) Lower extremity – toe strength (III) Upper extremity strength.
• Four analyses under the General walking balance outcome: (i) TUG and Foot up & Go (ii) TUG only (iii) Stride length (iv) Cadence (v) Walking speed
• Three analyses under the General quality of life outcome: (i) General QoL (ii) QOL – EURO-QoL (iii) QoL – neuropathic-specific QoL.
4.7.1 Exclusion from meta-analysis
• Five out of eight studies were included in the meta-analysis of muscle strength, excluding three papers because they have dis-similar outcomes from the studies included in the meta-analysis. They include: Ahmad et al. 2020 – which measured maximal voluntary contraction of muscles, Mueller e t al. 2013 – which assessed foot and ankle activity measure; and Perrin et al. 2021 – which determined lower lib muscle endurance, using sit-to-stand assessment).
• In the meta-analyses of General walking balance, all of the six studies that participated in the systematic review were included.
• ON the other hand, Four out of five studies were included in the meta-analysis of Quality of life, excluding Monteiro et al. 2020 because there was no between-group analysis conducted between the interventional and control group.

4.7.2 Heterogeneity test
Significant heterogeneity (p-val < .0001) was observed in the meta-analyses of muscle strength (90.43%) and general walking balance (78.40%), while there was less heterogeneity in the meta-analysis of general quality of life (21.18%), with P-val of 0.3093 This reason for the significant heterogeneity could be as a result of variation in gender and outcome measures, combination of various form of exercises, duration of the intervention, the weight difference of the study participants and study location. Hence, a random effect model was used for the meta-analyses.

**Sensitivity analysis** Since meta-analysis was conducted, the significant of studies with a high risk of bias on the general outcomes was determined using sensitivity analysis. Subgroup analyses were performed to study the potential influence of significant heterogeneity which could be due to intervention types or comparator on the treatment effect direction. This was done only when there were more than two studies with homogeneous subsets, and was be performed only on those with very-similar outcomes.
3.7.1 Meta-Biases
Data from studies published only as abstracts were added to the meta-analysis to evaluate whether these data influenced effect size direction. Meta bias was checked using the funnel plot for asymmetry and the Egger's regression test (Egger et al. 1997).

**Language restriction** No.

**Country(ies) involved** United Kingdom, United States of America.

**Keywords** Search termsConcept Search termsPopulation MeSH terms: diabetic neuropathyFree text terms: peripheral neuropathy, diabetic polyneuropathy.

**Dissemination plans**
To inform decision-making or policy
• To influence practice or behavior
• To contribute to academic knowledge
• To engage the community or target beneficiaries

• To ensure that funders or stakeholders see the impact of the research.

### Contributions of each author

Author 1 - Maranatha Ngesojisos Iwundu Anudu - Main Systematic reviewer drafted the manuscript.
Email: maranudu@gmail.com
Author 2 - Samuel Ibeneme - second reviewer. Reviewed the work.
Author 3 - Chidimma Omeje - Third Reviewer. Reviewed the work.
Email: omejec64@gmail.com