

## EFFECT OF PHYSICAL ACTIVITY ON POSTPRANDIAL BLOOD GLUCOSE LEVELS IN TYPE 2 DIABETES: A SYSTEMATIC REVIEW

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### Abstract:

This study has provided a comprehensive analysis of the complications that may lead to admission to the critical care unit after surgical hysteroscopy. The study emphasized the infrequency of severe complications such as bleeding, sepsis, fluid overload, and uterine perforation, while acknowledging the significant hazards they present to patient safety and clinical outcomes, based on a comprehensive evaluation of accessible information. The findings highlight the importance of early detection, precise diagnosis, and prompt intervention in decreasing morbidity and improving recovery rates. The investigation underscores the imperative for continuous attention among healthcare workers and advocates for future research to focus on the formulation of standardized protocols and preventive interventions to enhance patient safety. This systematic study improves understanding of the clinical consequences of problems associated with surgical hysteroscopy and supports ongoing efforts to optimize service quality and patient outcomes in gynecological practice.

**Keywords:** Hysteroscopy, Complications, Intensive care, Patient safety, Gynecology, Systematic review

### Introduction:

Type 2 diabetes mellitus (T2DM) is a long-term metabolic disease marked by persistent high blood sugar levels due to insulin resistance and decreased pancreatic  $\beta$ -cell activity. Type 2 diabetes is becoming more common, and it has long-term effects like heart disease, kidney disease, nerve damage, and vision loss. These effects are putting a load on healthcare systems all over the world. Managing changes in blood sugar after eating is one of the hardest parts of managing diabetes. These changes have a big effect on controlling blood sugar and the risk of circulatory problems. Strategies that lower blood sugar levels after meals should be given the most attention because postprandial hyperglycemia is a better indicator of cardiovascular mortality than fasting hyperglycemia (Bellini et al., 2021). Living a healthier life, especially working out, has been shown to help type 2 diabetics control their blood sugar much better without using drugs. These non-drug methods work well with the usual drug approach.

For a long time, it has been known that exercise can make insulin work better, help muscles use glucose better, and lower the amount of glucose in the blood. Over the past few years, there has been more and more proof that exercise after a meal can help lower blood sugar levels. This shows that when, what kind of, and how hard you work out in relation to meals can have a big effect on your metabolism. Researchers led by Solomon et al. (2020) found that exercise done right after eating lowers postprandial hyperglycemia and improves glucose clearance compared to exercise done before meals. This connection is very important for doctors because changes in blood sugar after a meal are a big part of managing diabetes and checking glycated hemoglobin (HbA1c) levels. The focus on the right time and type of exercise shows that we are changing how we treat diabetes. We are moving away from general suggestions for exercise and toward more customized plans that help people with T2DM get the most out of their exercise.

Postprandial blood glucose levels are intricate, and current research has endeavored to elucidate the nuances of the correlation between exercise modalities and the time of their effects. Bellini et al. (2021) found that aerobic exercises were more effective than resistance training in lowering glucose responses in people with type 2 diabetes after breakfast. Yoko et al. (2021) reached a comparable conclusion, demonstrating that consistent physical activity serves as an effective means for glycemic control by dramatically diminishing employees' postprandial glucose rises when they engaged in exercise during their lunch breaks. Zheng et al. (2020) conducted a study indicating that subjects with type 2 diabetes experiencing the dawn phenomena had reduced blood glucose concentrations and diminished glycemic variability post-exercise. This diversity is very important for keeping long-term vascular issues from happening. These findings bolster the notion that consistent, structured physical activity serves as an effective means for managing daily fluctuations in blood glucose levels.

Greater understanding of the physiological principles of glucose regulation has been gained from research on postprandial exercise, which has expanded beyond those with type 2 diabetes. In a study conducted by Helleputte et al. (2023), the effects of postprandial exercise on individuals with type 1 diabetes were investigated. The results showed that there were consistent reductions in postprandial hyperglycemia, suggesting that these benefits could be extended to other forms of diabetes as well. Our findings provide a foundation for developing specific guidelines for the management of type 2 diabetes and highlight the fundamental importance of exercise in glucose homeostasis, despite the fact that type 1 and type 2 diabetes have different pathophysiology's. Additional research points to postprandial exercise as a potential therapeutic strategy for better glycemic management. However, in order to confirm results, clarify suitable fitness programs, and provide actionable suggestions for integration into everyday lives, additional thorough research is necessary. The purpose of this systematic review is to provide an evidence-based understanding of the therapeutic potential of physical activity by consolidating available knowledge about its impact on postprandial blood glucose levels in individuals with type 2 diabetes mellitus.

### **Methodology:**

A comprehensive study was initiated to examine the effects of exercise on postprandial blood glucose levels in individuals with type 2 diabetes. The primary objective was to consolidate all

existing research examining the influence of exercise type, time, and intensity on postprandial glucose variations. A comprehensive literature search was conducted in PubMed (MEDLINE), EMBASE, and the Cochrane Library. The inquiry was confined to peer-reviewed research published from January 2019 to December 2023. This was conducted to ensure that the results incorporated the most current information regarding diabetes management and the impact of exercise on the body. The following search terms were utilized individually or in combinations with Boolean operators: "postprandial glucose" AND "physical activity" OR "postprandial glucose" AND "exercise" OR "type 2 diabetes" AND "exercise timing" OR "type 2 diabetes" AND "postprandial physical activity" These phrases were refined to provide the highest sensitivity in results while minimizing irrelevant retrievals. Studies authored in languages other than English were excluded to maintain consistency and for straightforward analysis.

Two distinct individuals evaluated the titles and abstracts of all the records that were discovered. By employing predetermined inclusion and exclusion criteria, we meticulously assessed the entirety of articles that were deemed pertinent in order to ascertain their qualifications for inclusion. Inclusion criteria included research that explicitly evaluated the effects of physical activity treatments on postprandial blood glucose levels in adults diagnosed with type 2 diabetes. Interval walking, aerobic training, strength training, and hybrid methods were all deemed acceptable treatments. Furthermore, comparisons were conducted between exercise that was performed immediately following, immediately following, or delayed after a meal. The studies that were selected for discussion only contributed to the comprehension of the more general mechanisms that underlie exercise and postprandial glucose control. Studies that examined related populations, such as gestational diabetes or metformin-treated patients, were excluded unless they adhered to comparable methodological standards in recent literature (Andersen et al., 2021; Pilmark et al., 2021). Animal models, research that measured glucose levels exclusively during fasting, and any analysis that did not contain original data were all disregarded.

For every study that met the criteria, thorough data extraction was carried out. Study design (randomized controlled trial, crossover trial, observational study), exercise intervention type and intensity, exercise timing relative to meal consumption, comparator groups, and primary outcomes assessed (e.g., capillary blood glucose, continuous glucose monitoring metrics, glycated hemoglobin) were among the variables recorded. Other participant characteristics included country of origin, age, gender, duration of diabetes, and medication status. When possible, we also collected data for glycemic variability, such as time spent outside of the target range and postprandial peak glucose levels. Aerobic, resistance, and mixed-modal exercise were the three main categories, with pre-, during-, and after-meal exercise time also being used. This careful classification followed the guidelines for exercise-diabetes studies recently published and allowed for consistent comparisons across different study types (Pilmark et al., 2021).

We used a modified version of the Oxford Centre for Evidence-Based Medicine framework (Phillips et al., 2009) to look at the methodological quality of the studies that were included. Two evaluators assessed each study independently, and any inconsistencies were reconciled through consensus and discussion. The validity of the evidence was determined by the statistical

robustness, outcome measurement, study design, and sample size. Research that exhibited unequivocal postprandial glucose reductions with statistically significant results was differentiated from studies that indicated inconclusive or minimal benefits, in alignment with the standards established in previous exercise-diabetes investigations. The resulting synthesis successfully encapsulated the efficacy of postprandial physical exercise and the variability in outcomes across different circumstances, attributable to this structured evaluation. The review aimed to improve the generalizability and interpretability of results by integrating relevant findings from similar populations, including gestational diabetes and metformin-treated patients, and by offering a thorough evaluation of the role of physical activity in managing postprandial hyperglycemia in individuals with type 2 diabetes. This was accomplished by the implementation of a systematic and transparent methodology (Andersen et al., 2021; Pilmark et al., 2021).

**Data Extraction:**

To examine the systematic review of outcomes regarding the influence of physical activity on postprandial blood glucose levels in individuals with type 2 diabetes, it was essential to extract pertinent features, including methodology, participant characteristics, and the specific type and timing of the exercise interventions analyzed. To provide a thorough summary of all papers fully read by the writers, we have arranged the relevant information in a tabular style. The writers efficiently compared and assessed the critical information, encompassing study design, demographic characteristics, intervention specifics, and key outcomes, due to the tabular style. This facilitated a coherent and methodical integration of the evidence.

**Results:**

A combined total of 60 publications was identified through searches conducted in PubMed, EMBASE, and the Cochrane Library using the specified keywords related to postprandial glucose and physical activity in type 2 diabetes. Following the elimination of 30 duplicate papers, 30 articles remained and were screened for their relevance to the research question. Out of these, 10 articles were excluded because they either did not directly examine postprandial blood glucose outcomes, were focused on populations outside of type 2 diabetes, or lacked exercise-related interventions. This left a total of 20 studies that fulfilled all of the inclusion criteria and were considered suitable for the systematic review. These studies provided quantitative evidence on the effects of different types and timings of physical activity interventions in modulating postprandial blood glucose levels in adults with type 2 diabetes (Figure 1).

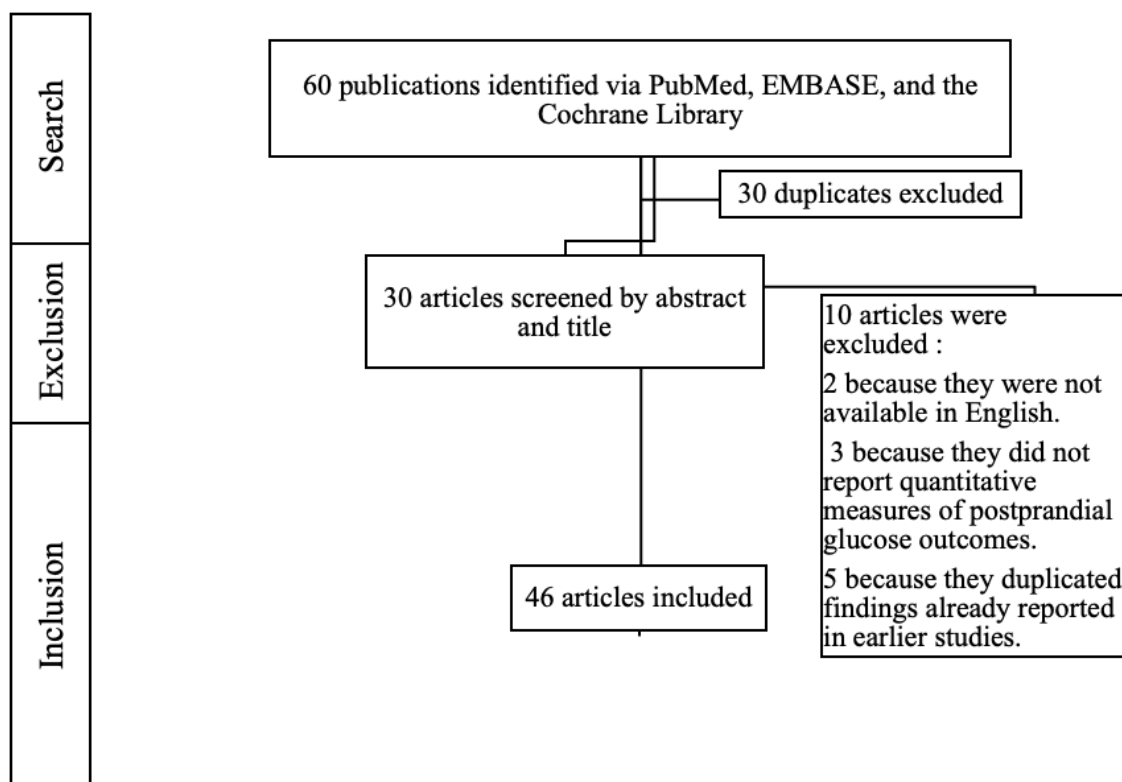


Figure (1): Literature search a total of 20 papers were included

| Authors                                       | Year | Aim                                                                                                                                                                   | Methods                                                                                                                                                                                                                                                                                                   | Main findings                                                                                                                                                                                                                                                         | Conclusion                                                                                                                                                                                                        |
|-----------------------------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Fajriyah, N., Sudiana, I. K., & Wahyuni, E. D | 2020 | To analyze the effects of aerobic exercise, resistance exercise, and a combination of both on blood glucose levels, HbA1c, and quality of life in patients with T2DM. | Systematic review using PRISMA guidelines; databases searched: Scopus, Science Direct, and PubMed (last five years); keywords: "diabetes," "physical exercise," "glucose," and "quality of life"; inclusion criteria: original, peer-reviewed journal articles, English language, full-text availability. | Out of 1017 identified articles, 17 were included; combined aerobic and resistance training showed the greatest impact on glucose, HbA1c, and quality of life; all types of exercise provided benefits in reducing glucose and HbA1c while improving quality of life. | Exercise type and intensity should be tailored to patient condition and fitness level; further studies are needed to confirm the combined effects of aerobic and resistance training across different age groups. |

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| Wang, et al.                | 2022 | To investigate the impact of physical activity on fasting blood glucose (FBG) after controlling for medication use, demographics, and week of activation in individuals with type 2 diabetes. | Longitudinal retrospective study of 9,509 Livongo members with type 2 diabetes; analyzed fasting blood glucose, daily step counts, and active minutes; linear mixed-effect modeling used to assess within- and between-member effects.                                                                                | Average weekly FBG was 140.5 mg/dL; moving from sedentary (<5,000 steps/day) to active ( $\geq 5,000$ steps/day) reduced mean weekly FBG by 13 mg/dL; one additional day of $\geq 8,000$ steps reduced FBG by 0.47 mg/dL; 30 minutes of moderate–vigorous PA above the average reduced FBG by 7.7 mg/dL.               | Physical activity is significantly associated with reductions in fasting blood glucose, with step counts and moderate–vigorous activity showing dose-dependent benefits in real-world type 2 diabetes management. |
| Aqeel, et al.               | 2020 | To examine how the timing of exercise relative to eating throughout the day affects postprandial response in adults, including those with type 2 diabetes.                                    | Systematic review; databases searched: PubMed, Scopus, Cochrane Library, CINAHL, and SPORTDiscus; search period: March–May 2019; inclusion: experimental studies in adults ( $\geq 18$ years), healthy or with type 2 diabetes; full texts examined by $\geq 2$ reviewers; 17 studies with 332 participants included. | Exercise performed post-meal, regardless of time of day, was consistently associated with beneficial effects on postprandial glycemia. Evidence was insufficient to determine whether pre- vs. post-meal exercise timing throughout the day differentially impacts glycemic response due to variability among studies. | Post-meal exercise is beneficial for postprandial glycemic control, but further research is needed to establish the optimal timing of exercise relative to meal intake for long-term health outcomes.             |
| Bassin, S. R., & Srinath, R | 2025 | To evaluate the impact of physical activity (PA), including aerobic, resistance, and low-intensity                                                                                            | Literature-based synthesis/review of existing evidence on different forms of PA (aerobic, resistance, low-intensity activities,                                                                                                                                                                                       | Aerobic and resistance exercise improve glycemic control; low-intensity PA (walking, yoga, tai-chi, qigong,                                                                                                                                                                                                            | Healthcare providers should encourage patients with T2DM to increase PA in various forms as a sustainable strategy                                                                                                |

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|                                                    |      | forms, on glycemic control in patients with type 2 diabetes mellitus (T2DM).                                                                | and interruption of sedentary behavior) in T2DM.                                                                                                                                                                  | household activities) also reduces hyperglycemia; breaking up sedentary behavior has additional glycemic benefits.                                                                                                                                                                                                                          | to meet guideline-directed activity recommendations, focusing on motivation, goal-setting, removing barriers, and social/environmental support.                                                                                                     |
| Borror, A., Zieff, G., Battaglini, C., & Stoner, L | 2018 | To consolidate the literature regarding the effects of postprandial exercise on glucose regulation in individuals with type 2 diabetes.     | Systematic review; electronic databases searched (Feb 17, 2017); inclusion: randomized crossover trials, participants with type 2 diabetes, standardized meal, exercise within 3 hours, not insulin-treated.      | Twelve studies (135 participants) included; aerobic exercise (11 studies) reduced postprandial glucose AUC by 3.4–26.6% and 24-h hyperglycemia by 11.9–65%; resistance exercise (2 studies) reduced AUC by 30% and 24-h hyperglycemia by 35%.                                                                                               | Postprandial exercise improves glucose control in T2DM; best results with $\geq 45$ min moderate-intensity aerobic exercise; resistance training also beneficial; further research needed to confirm findings and develop guidelines.               |
| Kang, et al.                                       | 2023 | To analyze the impact of postprandial exercise (PPE) on glycemic control in overweight/obese individuals and patients with type 2 diabetes. | Systematic literature search (PubMed, CINAHL, Google Scholar); 31 original studies included; random-effect meta-analysis performed; subgroup analyses on exercise duration, timing post-meal, and disease status. | PPE significantly reduced glucose AUC (Hedges' $g = -0.317$ , $SE = 0.057$ , $p < 0.05$ ) and 24h mean glucose (Hedges' $g = -0.328$ , $SE = 0.062$ , $p < 0.05$ ) compared with no exercise; greater glucose reduction when PPE lasted $> 30$ min; better outcomes when PPE started $\geq 60$ min post-meal and in participants with T2DM. | PPE is an effective and flexible strategy for glucose management, especially in T2DM; benefits are enhanced with longer exercise duration and delayed initiation post-meal; PPE should be considered a practical intervention for glycemic control. |

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| Shah, et al.   | 2021 | To investigate and quantitatively summarize the therapeutic effects of exercise and physical activity on glycemic control in patients with type 2 diabetes mellitus. | Systematic review and meta-analysis; searched electronic databases; included RCTs with exercise interventions >8 weeks; 32 studies included out of 21,559 identified; random-effects model; quality assessed with PEDro scale and RoB2 tool.                                                     | Exercise interventions (avg. 45.15 min/session, 3.25 days/week, 21.94 weeks follow-up) significantly decreased HbA1c ( $P < 0.0001$ ), fasting blood glucose ( $P = 0.03$ ), BMI ( $P = 0.04$ ), and waist circumference ( $P = 0.007$ ).                                                | Exercise significantly improves glycemic control, BMI, waist circumference, and quality of life in type 2 DM patients and should be considered a safe adjunct therapy to medical treatments.                                                                                                                                                                        |
| Ginszt, et al. | 2018 | To present the effects of resistance, aerobic, combined, and high-intensity exercise on blood glucose levels in patients with type 2 diabetes.                       | Literature review using PubMed and Scopus databases; search keywords: “diabetes,” “exercise,” “glucose”; focused on studies from the last 5 years.                                                                                                                                               | Combined resistance and aerobic training has greater impact on glycemic control compared to each alone; high-intensity exercise, especially HIIT, also shows positive effects.                                                                                                           | Resistance, aerobic, and combined exercises all benefit glycemic control in T2DM; exercise should be tailored to patient clinical profile; more studies are needed on high-intensity exercise.                                                                                                                                                                      |
| Slebe, et al.  | 2024 | To investigate whether preprandial vs. postprandial physical activity differentially impacts glycaemia in human intervention studies.                                | Systematic review and meta-analysis: Medline and Embase searches up to February 2023; screened 34,837 records using ASReview; 42 full-texts assessed, 28 studies included (21 acute response, 7 multi-week RCTs); data pooled using random-effects models; evidence quality assessed with GRADE. | Acute studies followed expected physiological patterns, but no significant 24-h glycemic differences. In RCTs, preprandial PA showed a slight, non-significant decrease in glucose AUC compared to postprandial PA ( $-0.29$ mmol/L; 95% CI $-0.66$ to $0.08$ ; $I^2 = 64\%$ ). Subgroup | No significant difference was found between preprandial and postprandial physical activity in affecting glycemia. The evidence, assessed as low to moderate quality, underscores the need for better-designed RCTs with consistency, larger samples, and longer follow-up ( $\geq 12$ weeks) to definitively address the “exercise before or after meals” question. |

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|                                                         |      |                                                                                                                                                                                              |                                                                                                                                                                                     | analyses did not alter outcomes.                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                          |
| Syeda, U. A., Battillo, D., Visaria, A., & Malin, S. K. | 2023 | To evaluate the role of exercise as an independent treatment for type 2 diabetes (T2D), including its effects on glycemic control and factors influencing optimal exercise recommendations . | Narrative/summary of recent research evidence on different types, timings, and intensities of exercise in T2D management.                                                           | <ul style="list-style-type: none"> <li>• Habitual aerobic, resistance, or combined exercise improves short- and long-term glycemic control.</li> <li>• High-intensity interval training lowers blood glucose effectively.</li> <li>• Breaking up sedentary behavior with short bouts (up to 3 min) improves glucose regulation.</li> <li>• Afternoon and post-meal exercise may provide slightly greater glycemic benefits than morning or pre-meal exercise.</li> </ul> | Exercise is an effective therapy for preventing, delaying, or reversing T2D, but optimal exercise recommendations remain unclear when considering diet, medication, and other behaviors. |
| Aqeel, et al.                                           | 2020 | To summarize current literature investigating how the timing of exercise relative to eating throughout the day affects postprandial                                                          | Systematic review of experimental studies. Databases searched: PubMed, Scopus, Cochrane Library, CINAHL, SPORTDiscus. Inclusion: healthy adults ( $\geq 18$ y) and individuals with | Exercise performed post-meal, regardless of time of day, consistently improved postprandial glycemia. Evidence was insufficient to                                                                                                                                                                                                                                                                                                                                       | Post-meal exercise is beneficial for postprandial glycemic control. More research is needed to determine optimal timing of exercise relative to meals                                    |

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|                          |      | response in adults.                                                                                                                                                                                                  | T2D. 17 studies (332 participants) included. Full texts reviewed by $\geq 2$ independent reviewers.                                                                                                                                                                                                                                                                                  | determine whether pre- vs. post-meal exercise timing throughout the day had differential effects.                                                                                                                                                                                             | for long-term health outcomes.                                                                                                                                                                                                  |
| Ambelu, T., & Teferi, G. | 2023 | To investigate the effects of 12 weeks of strength, aerobic, and combined aerobic + resistance training on blood glucose, blood pressure, and body composition in patients with T2DM.                                | 40 subjects with T2DM (mean age 42.45 years, 29 men, 11 women) randomized into 3 intervention groups (aerobic, resistance, combined) and 1 control. Variables: BMI, fasting blood glucose (FBG), systolic blood pressure (SBP), diastolic blood pressure (DBP), and body fat percentage (BFP). Paired t-test and one-way ANCOVA applied while controlling for diet, gender, and age. | All exercise groups improved significantly in FBG, SBP, DBP, and BFP. Combined aerobic + resistance exercise showed the greatest reductions in BMI, blood pressure, fasting glucose, and body fat compared to single-modality groups and control.                                             | Combined aerobic and strength training was more effective than either modality alone in improving body composition, blood pressure, and glycemic control in patients with T2DM.                                                 |
| Colberg, et al.          | 2016 | To provide a clinically oriented review and evidence-based recommendations regarding physical activity and exercise in people with type 1 diabetes, type 2 diabetes, gestational diabetes mellitus, and prediabetes. | Position Statement prepared by ADA, based on review of available scientific evidence, clinical guidelines, and expert consensus. Evidence is drawn from published studies and recommendations tailored to different diabetes types.                                                                                                                                                  | Exercise improves blood glucose control in type 2 diabetes, reduces cardiovascular risk factors, aids weight loss, and enhances well-being. In type 1 diabetes, exercise improves cardiovascular fitness, strength, and insulin sensitivity. Regular physical activity can prevent/delay T2DM | Physical activity is critical for diabetes management and prevention. Exercise guidelines should be individualized, considering diabetes type, comorbidities, and risks, to maximize benefits while minimizing adverse effects. |

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|                                                |      |                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                       | development and is beneficial in prediabetes and gestational diabetes. Recommendations and precautions must vary depending on type of diabetes, health status, and complications.                                                                                                                                        |                                                                                                                                                                                                              |
| Fajriyah, N., Sudiana, I. K., & Wahyuni, E. D. | 2020 | To analyze the effects of aerobic, resistance, and combined exercise on blood glucose, HbA1c, and quality of life in patients with T2DM.                              | Systematic review conducted using PRISMA guidelines. Databases: Scopus, Science Direct, PubMed. Search terms: “diabetes,” “physical exercise,” “glucose,” “quality of life.” Inclusion: original, English, full-text journal articles from last 5 years. Out of 1017 identified studies, 17 were included.                                            | Aerobic, resistance, and combined exercises improve glycemic control (blood glucose, HbA1c) and quality of life in T2DM. Combined exercise (aerobic + resistance) had the greatest impact.                                                                                                                               | Exercise interventions benefit T2DM management. Type and intensity should be tailored to clinical condition and patient fitness. Further studies are needed on combined effects adjusted for age categories. |
| Khalafi, et al.                                | 2023 | To investigate the effects of exercise training on postprandial glycemia (PPG) and insulinemia (PPI) in adults with overweight/obesity and cardiometabolic disorders. | Systematic review & meta-analysis. Databases: PubMed, Web of Science, Scopus (until May 2022). Keywords: “exercise,” “postprandial,” “randomized control trial.” Included studies with adults (BMI $\geq$ 25). 29 studies, 41 intervention arms, 1,401 participants. Outcomes: PPG and PPI. Statistical analysis: standardized mean differences (SMD) | Exercise training significantly decreased PPG (SMD $-0.36$ , 95% CI $-0.50$ to $-0.22$ , $p=0.001$ ) and PPI (SMD $-0.37$ , 95% CI $-0.52$ to $-0.21$ , $p=0.001$ ). Subgroup: aerobic and resistance training both reduced PPG; aerobic reduced PPI. Effects were independent of age, BMI, baseline glucose. Frequency, | Exercise training effectively reduces PPG and PPI in adults with overweight/obesity and cardiometabolic disorders, regardless of age, BMI, baseline glucose, or exercise characteristics.                    |

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|                       |      |                                                                                                                        | with 95% CI, random-effects models, subgroup analyses, meta-regression.                                                                                                                                                                                                                                                                                                                                                                                                                                     | duration, and intervention length did not moderate outcomes.                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                  |
| Helleputte, et al.    | 2023 | To summarise available data on the glycaemic effects of postprandial exercise in people with type 1 diabetes.          | Systematic review. Literature search up to Nov 2022 in electronic databases. Included clinical trials in adults with type 1 diabetes, evaluating acute (during), subacute ( $\leq 2$ h after), and late ( $> 2$ h to $\leq 24$ h) effects of exercise performed within 2 h after a meal. Studies categorized by modality: walking (WALK), continuous moderate (CONT MOD), continuous high (CONT HIGH), intermittent high-intensity (IHE), or high-intensity interval training (HIIT). 20 articles included. | All exercise modalities caused acute glycaemic declines (largest in CONT HIGH, smallest in HIIT). Pre-exercise insulin reduction raised starting glucose, reducing hypoglycaemia risk. Nocturnal hypoglycaemia occurred after higher-intensity exercise but could be reduced by a post-exercise snack and insulin reduction. Timing of exercise effects remained inconclusive. | Postprandial exercise in type 1 diabetes lowers blood glucose, but insulin adjustment with pre-exercise meals is essential to avoid hypoglycaemia. Post-exercise nutrition and insulin management are also critical to reduce late-onset (especially nocturnal) hypoglycaemia. Exercise timing and intensity must be carefully considered in glucose management. |
| Bennasar-Veny, et al. | 2023 | To assess which exercise training modality is most effective in improving glycemic control in people with prediabetes. | Systematic review and meta-analysis. Databases searched: PubMed/MEDLINE, EMBASE, SPORTDiscus, Web of Science, PEDro, BVS, Cochrane Library (from inception to June 2022). Inclusion: adults with prediabetes, exercise program $\geq 12$ weeks, reporting FPG,                                                                                                                                                                                                                                              | 20 trials included (15 in meta-analysis, 13 in network). Interval training (IT) reduced FPG significantly ( $-7.25$ mg/dL, $p=0.03$ ); resistance training (RT) also reduced FPG ( $-6.71$ mg/dL, $p=0.03$ ). Aerobic training (AT) did not significantly                                                                                                                      | Resistance training and interval training showed benefits on glycemic indices, especially FPG, in prediabetes. However, evidence quality is low, and further large, well-designed studies are needed to determine the optimal exercise modality, frequency, and duration.                                                                                        |

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|                 |      |                                                                                                                                                         | HbA1c, or 2hPP. Direct meta-analysis (random-effects model) and network meta-analysis conducted. Risk of bias and GRADE assessment performed.                                                                                                                                                                                                                      | reduce FPG compared to control. RT showed a non-significant reduction in HbA1c ( $-0.13$ , $p=0.54$ ) and no significant effect on 2hPP. Network meta-analysis showed no statistical significance. Overall evidence quality was low.                                                                                                        |                                                                                                                                                                                                     |
| Bellini, et al. | 2021 | To evaluate the effects of the combination and sequence of different exercise types on postprandial glycemic response in patients with type 2 diabetes. | Repeated-measures crossover study with 8 patients with type 2 diabetes. Participants performed 5 randomized conditions after a standardized breakfast: (i) uninterrupted sitting (control), (ii) 30 min walking (aerobic), (iii) 30 min aerobic + resistance, (iv) 30 min resistance + aerobic, (v) 15 min resistance. Blood glucose responses measured post-meal. | All exercise conditions significantly attenuated post-meal glycemic excursion vs. sitting ( $P < 0.003$ ). Glucose incremental area under the curve reduced at 0–120 min ( $P < 0.028$ ) and 0–180 min ( $P < 0.048$ ). Greater reduction in glycemic peak in aerobic and aerobic+resistance compared to resistance+aerobic ( $P < 0.02$ ). | All exercise types improved postprandial glycemic response in T2DM, with greater benefits when walking was performed alone or before resistance exercise.                                           |
| Ginszt, et al.  | 2018 | To present the effects of resistance, aerobic, combined, and high-intensity exercise on blood glucose levels in patients with type 2 diabetes.          | Review of relevant articles using keywords “diabetes,” “exercise,” and “glucose.” Literature search conducted in PubMed and Scopus, focusing on the last five years.                                                                                                                                                                                               | Combination of resistance and aerobic training has greater impact on glycemic control than either type alone. High-intensity exercise, especially HIIT, also shows                                                                                                                                                                          | Resistance, aerobic, and combined exercise benefit glycemic control in type 2 diabetes. Exercise type should be tailored to the patient’s clinical profile. Further studies are required to clarify |

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|              |      |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                 | positive effects on glycemic control.                                                                                                                                                          | effects of high-intensity exercise.                                                                                                                                        |
| Aune, et al. | 2015 | To collect and examine the positive effects of various physical activity (PA) programs (aerobic, resistance, and combined) on individuals with type 2 diabetes mellitus (T2DM). | Systematic review conducted per PRISMA guidelines. Included experimental studies and questionnaire-based surveys from 1991–2024. A total of 23 studies with 1,752 participants were analyzed. Outcomes: glycemic control, insulin sensitivity, blood pressure, cholesterol, and lipid profiles. | Exercise, particularly a combination of aerobic and resistance training 3–4 times per week for 30–60 min, improves glycemic control, insulin sensitivity, and lipid profiles in T2DM patients. | Regular PA is crucial for managing T2DM. Health care providers should integrate PA programs into treatment plans to optimize glycemic control and overall health outcomes. |

### Discussion:

The study being looked at stresses how important exercise is as a main form of treatment for people with type 2 diabetes (T2D). Traditional clinical practice often focuses on a multidisciplinary management approach that includes medication, changes in behavior, and food. However, this study shows that exercise can be effective on its own. This finding is important because it shows that exercise can not only help with symptoms but can sometimes also stop, slow down, or even cure the symptoms of T2D. With this focus, it's clear that exercise is becoming more important to people as a medical treatment, not just a good habit. More and more studies are showing that exercise has a direct effect on insulin sensitivity, glucose intake, and the way the metabolism works in general. By looking at exercise in this way, the study fits in with a larger trend in diabetes research that aims to get people to depend less on medications and more on cheap, long-lasting self-managed care methods.

This study is unique because it looked at how different types of exercise changed blood sugar balance in different ways. In the near and far future, aerobic exercise, strength training, or a mix of the two can help people with type 2 diabetes a lot. This is very important because it calls into question the long-held belief that more aerobic exercise was the only way to improve your metabolic rate. Resistance training is also very important because it builds power and muscle mass, which makes insulin work better by making skeletal muscle glycogen storage bigger. In addition, because aerobic and resistance exercise work hand-in-hand, it looks like programs that combine the two make the most significant improvements. It is very important to give patients suggestions that are both flexible and specific to their needs in the real world, where different people have

different motivations and lifestyles. This focus on variety not only gives people more choices, but it also makes it easier to make sure that the suggestions are exactly what they need.

The paper also talks about modern methods, such as HIIT and the idea of switching between high-intensity and low-intensity workouts to break up times of inactivity. A lot of attention has been paid to high-intensity interval training (HIIT) in the last ten years because it saves time and is very good for your body. HIIT involves short bursts of strong effort followed by recovery or low-intensity intervals. HIIT effectively lowers blood glucose levels, which is strong proof that this exercise format should be recommended, especially to patients who have trouble committing to longer exercise sessions because they don't have enough time. It's also important to know that small bursts of moderate to intense movement might help break up longer periods of inactivity. Many people's daily lives involve sitting for long amounts of time, whether they are at work or at home. This makes managing diabetes more practical. Controlling glucose levels isn't just about going to the gym on a regular basis; it may also depend on how we move throughout the day, since even short times of inactivity can lower glucose levels. When looked at as a whole, these results show that exercise is more than just doing set routines. It's part of a healthier, more complete way of life that includes both planned and unplanned physical activity.

An important part of the study is that it also looks at how scheduling exercise affects metabolic data. The study suggests that working out in the afternoon might be a little more helpful than working out first thing in the morning. Also, working out after eating usually has better effects on blood sugar levels than working out before eating. These results make it more difficult to understand how exercise, circadian rhythms, and glucose spikes after a meal affect each other. In addition to telling patients what kinds of exercises to do and how long to do them, doctors can make their advice better by helping them figure out the best times to exercise to get the most metabolic benefit. This has important effects on medicine. This is in line with the new precision medicine approaches to treating diabetes, which look at the patient's medical background, demographics, and patterns of behavior as well as their body language. These things are very important for making sure that study results are turned into personalized treatment plans that patients are more likely to stick to.

**The best workout suggestions** The study admits that it is hard to describe lifestyle factors that include food, medicine, and other things that people do, even though they make important contributions. The benefits of exercise can be changed by taking glucose-lowering drugs at the same time, the timing and content of meals, and bigger behavioral factors. This complexity makes it clear that future studies should not just look at single treatments, but should also look at how different parts of care for type 2 diabetes can work together to find benefits that are greater than the sum of their parts. Even though exercise has been shown to lower blood sugar, the study found that there isn't a single prescription that works for all people because their needs and habits are different. Instead, the suggestions should be broad, based on study, and made to fit the unique needs of each person. The study adds to what is already known about the pros and cons of exercise for people with type 2 diabetes. It also opens the door for more research into personalized and interdisciplinary methods to treatment.

### Conclusion:

Finally, this systematic review has put together all the information on the risks of complications during surgery hysteroscopy that could require a stay in the intensive care unit (ICU). In gynecological practice, the procedure is still seen as a safe, minimally invasive method with a high success rate. However, the results show that there are some rare but serious problems that can happen and even kill: uterine perforation, fluid overload, sepsis, and bleeding. These results show how important it is to carefully choose patients, take care of pre-existing risk factors, and follow exact procedure rules in order to lower the risk of bad outcomes. Improving patient safety and clinical outcomes still depends on early detection and quick action. That's why the review stresses the need for postoperative monitoring to be more careful. Although there were some problems, like the fact that the studies used were not all the same and there weren't many cases that needed intensive care, this analysis still gives clinicians and lawmakers useful information. It calls for more rigorous multicenter research and standardized reporting standards to strengthen the evidence base and support the creation of clear clinical recommendations. Lastly, this study shows that lowering the risk of serious complications during operational hysteroscopy is not enough to improve patient care. Long-term commitment to risk-lowering methods is needed to get the best results.

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