Bariatric Surgery Versus Conventional Therapy for Type 2 Diabetes Remission and Metabolic Outcomes in Obese Children: A Systematic Review

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ABSTRACT

Background: Over the past two decades, the incidence of type 2 diabetes mellitus (T2DM) in children and adolescents has risen sharply, largely paralleling the global surge in pediatric obesity. Youth-onset T2DM is marked by greater insulin resistance, rapid β-cell decline, early complications, and poor response to conventional therapies such as lifestyle medication and pharmacotherapy. These limitations made bariatric surgery superior to conventional therapies because it shows substantial and sustained weight loss, improved glycemic control, and high remission rates in adolescents.

Methods: A systematic search of PubMed, Web of Science, and other databases was conducted to identify studies to differentiate bariatric surgery from conventional therapies in pediatric patients diagnosed with T2DM. Moreover, included studies contained randomized controlled trials and retrospective cohorts. Data were extracted based on glycemic control (HbA1c), BMI change, and diabetes remission

Results: Three studies, conducted in China and the United States, were included. Participants' mean ages ranged from 15.3 to 17.81 years, with female representation between 44% and 70%. Follow-up durations varied from short- to long-term. Pooled analysis showed that bariatric surgery resulted in greater HbA1c reduction compared with medical therapy, despite significant heterogeneity ($I^2 = 91\%$). Surgery also led to a significantly larger decrease in BMI [MD: -14.61, 95% CI: -18.67 to -10.55] and fasting glucose [MD: -57.06 mg/dL, 95% CI: -81.63 to -32.48] ($P < 0.00001$).

Conclusion: Our study shows that bariatric surgery provides better outcomes compared with conventional treatment in obese adolescents with type 2 diabetes, especially in terms of glycemic control, weight loss, and diabetes remission. However, the generalizability of these ndings is limited, highlighting the need for further high-quality, long-term studies.

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INTRODUCTION

Over the past twenty years, the number of children and teens with type 2 diabetes mellitus (T2DM) has gone up a lot. The main reason for this problem is that more and more young people around the world are overweight. Around 20,000 to 22,000 Teens in the US are diagnosed with type 2 diabetes mellitus, which starts in adolescence. Ethnic minorities, such as Native Americans, African Americans, and Hispanics exhibit significantly elevated rates (1). Adolescent-onset type 2 diabetes mellitus exhibits a more severe pathophysiology, marked by heightened insulin resistance and expedited β-cell degeneration, resulting in premature repercussions and diminished treatment efficacy (1). Pharmacotherapy and lifestyle modifications are acknowledged treatment strategies that have demonstrated restricted long-term efficacy. Research, such as the TODAY study, indicates that children often have difficulty sustaining stable blood glucose levels. A limited percentage of adolescents can sustain normal HbA1c levels over time (2). By the fourth year, the significant adjustments in lifestyle had a much less effect (3). People are more likely to look for different types of therapy that could change their lives, such as metabolic or bariatric surgery. Bariatric surgery has shown substantial and enduring weight reduction, improved glycemic regulation, and increased remission rates of Type 2 Diabetes Mellitus (T2DM) in both adult and adolescent populations (4,5). After surgery, like sleeve gastrectomy (SG) or Roux-en-Y gastric bypass (RYGB), 65% to 95% of teens go into remission, and their other health problems, including high blood pressure and dyslipidemia, become better (5, 6). In light of these findings, esteemed organizations like the American Society for Metabolic and Bariatric Surgery (ASMBS) now endorses bariatric surgery as a conventional intervention for adolescents suffering from severe obesity and associated health complications (7). Even while the results so far have been good, there are still worries about how well bariatric surgery works compared to other therapies in kids and teens. This is especially important for the safety of surgery, metabolic outcomes (including blood pressure, insulin sensitivity, and lipid profile), and keeping type 2 diabetes in remission. There is a lot of information available for adults, but a detailed analysis is very important for children. This is why a tailored synthesis is needed. This large study is meant to find out how well bariatric surgery works compared to regular (non-surgical) treatment for getting obese kids and teens with type 2 diabetes mellitus (T2DM) into remission. The secondary objectives encompass the comparison of metabolic outcomes, the evaluation of remission durability, and the assessment of safety and complication rates associated with surgical intervention.

Inclusion and exclusion criteria

The inclusion criteria were articles published in English and
peer-reviewed, patients who are children or adolescents, between the ages of 10 and 19 years with T2DM and obesity, articles reporting outcomes like T2DM remission, HbA1c, or BMI, articles comparing bariatric surgery vs conventional treatment, articles with a study type: RCTs, cohort studies, or comparative observational studies. The exclusion criteria were non-comparative studies or animal studies, studies on adults only or mixed age without subgroup analysis, articles that focus on type 1 diabetes or secondary causes of obesity, studies not reporting T2DM-related outcomes, and articles written with a study type: case report, reviews, abstract, or editorials.

Search strategy

A literature search was conducted on 87 articles in PubMed and Web of Science using the following keywords ("Bariatric Surgery" OR "Metabolic Surgery" OR "Weight Loss Surgery") AND ("Type 2 Diabetes Mellitus" OR "T2DM") AND ("Children" OR "Adolescents" OR "Pediatric") AND ("Obesity" OR "Severe Obesity") AND ("Effectiveness" OR "Outcomes" OR "Diabetes Remission" OR "Glycemic Control").

Selection and Data collection process

Eighty-seven studies were identified from databases. Eighty-seven started the screening, with one group handling the screening by title and abstract, and the other group by full text. Eighty-four studies did not meet the inclusion criteria, and three studies were included. This was done through an Excel sheet. Disagreements are resolved between members through discussion. Data collection and extraction processes were done through Excel sheets by dividing reviewers into teams to work on one section, whereas the others handled another. A team of four did the data extraction independently; the data were collected then. Any disagreement between members was resolved through discussion.

Risk of bias assessment

The risk of bias (ROB) was evaluated based on the study design. The ROBNS-I was used to assess three cohort Studies to evaluate seven domains: confounding, selection of participants, classification of the interventions, deviations from the interventions, missing data, measurement of outcomes, and selection of the reported results. Studies were categorised as low, moderate, or high-risk based on the ROBNS-I scores.

Each study was evaluated by two reviewers independently. Any disagreements were solved after discussion and consensus.

Characteristics of Included Studies.

Three articles comparing the efficacy of surgical intervention versus medical therapy in obese patients with type 2 diabetes were included in our study. The eligible studies consist of randomized controlled trials and retrospective cohorts. The included studies were originally from the USA and China. Follow-up durations varied from short-term assessments to extended periods. The ages of the participants ranged from 15.3 to 17.81 years. Moreover, females represent a significant portion of each group, with female percentages ranging from 44% to 70%. The summary characteristics of the included studies are reported in Table 1. The baseline features of the included studies are outlined in Table 2.

METHODS

Cochrane Review Manager 5.3 was used to perform a meta-analysis of the selected studies. The mean difference (MD) was used for continuous outcomes. Random mode was used to reduce heterogeneity. The heterogeneity assumption was checked using the I2 test. A leave-one-out sensitivity test was applied to solve any resulting heterogeneity. In terms of values, we interpreted the I-square as follows: not significant for 0-40 %, moderate heterogeneity for 30-60 %, and substantial heterogeneity for 50-90 %, following the Cochrane Handbook chapter nine.

RESULTS

Primary Outcomes.

1- HbA1c percentage change.

The pooled mean difference indicated that the surgical group had a lower HbA1c percentage change compared to the medical therapy group [MD: -1.75 (-03.02, -0.47) with 95% CI], which was statistically significant (P 0.007) (Figure 1). Subsequently, the sensitivity analysis revealed substantial heterogenicity among our included studies (I2=91%, P< 0.0001) that resolved after omitting Inge et. al2018 by leave one out test (I2=0%, P= 0.81) (Figure 2). The funnel plot of HbA1c percentage change is shown in (Figure 3).

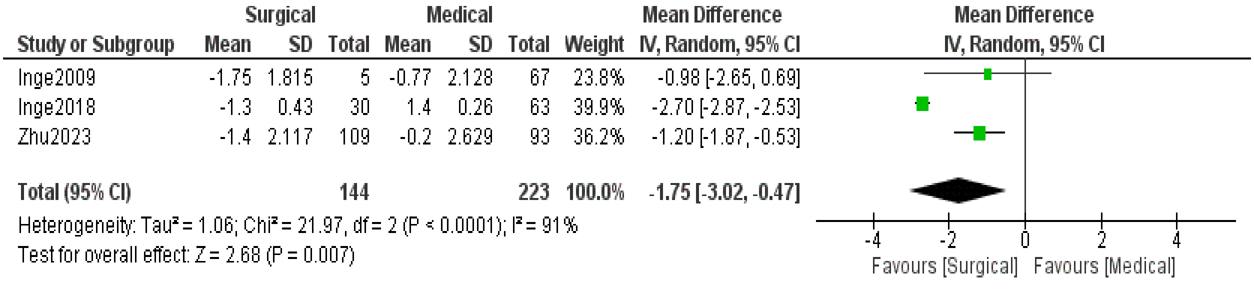
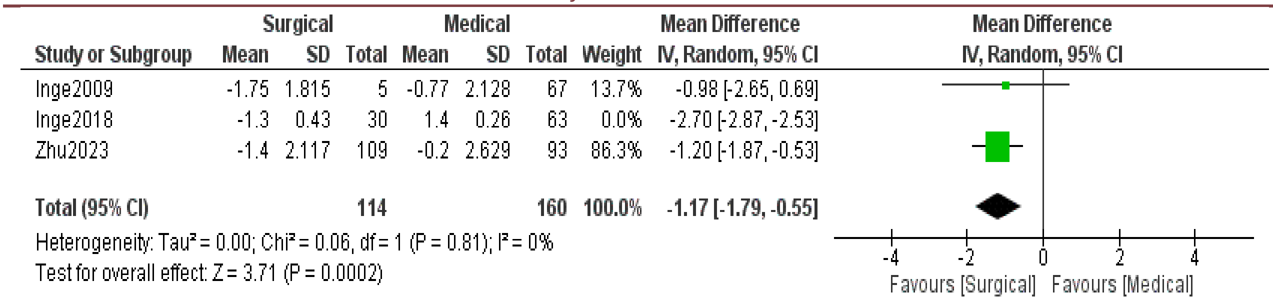


Figure1: Forest plot of HbA1c percentage change.



Study or Subgroup	Surgical Mean	Surgical SD	Surgical Total	Medical Mean	Medical SD	Medical Total	Weight	Mean Difference IV, Random, 95% CI
Inge2009	-1.75	1.815	5	-0.77	2.128	67	13.7%	-0.98 [-2.65, 0.69]
Inge2018	-1.3	0.43	30	1.4	0.26	63	0.0%	-2.70 [-2.87, -2.53]
Zhu2023	-1.4	2.117	109	-0.2	2.629	93	86.3%	-1.20 [-1.87, -0.53]
Total (95% CI)			**114**			**160**	**100.0%**	**-1.17 [-1.79, -0.55]**

Figure2: Sensitivity test of HbA1c percentage change.

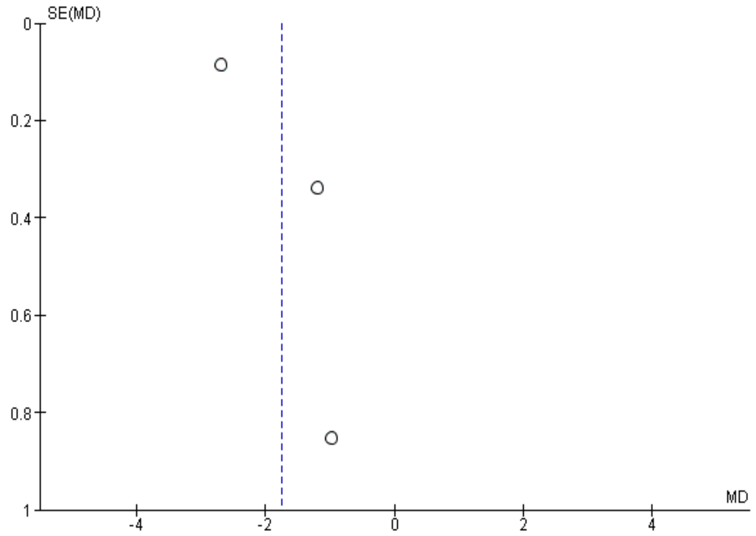
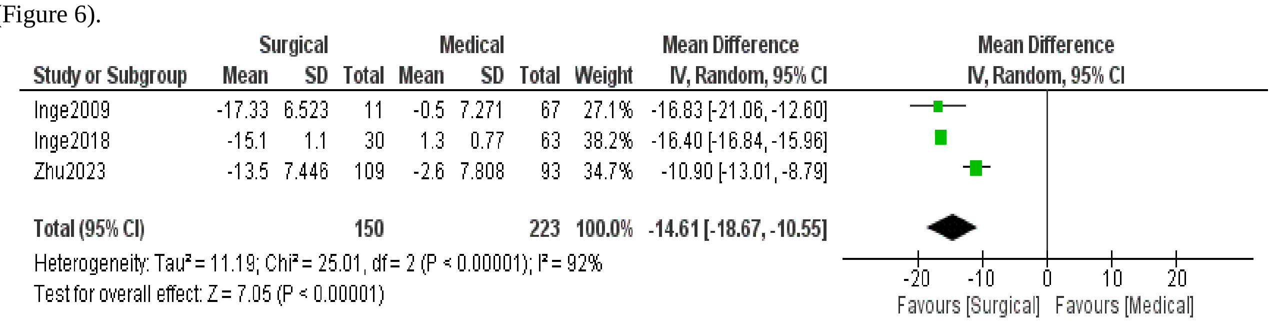


Figure3: Funnel plot of HbA1c percentage change.

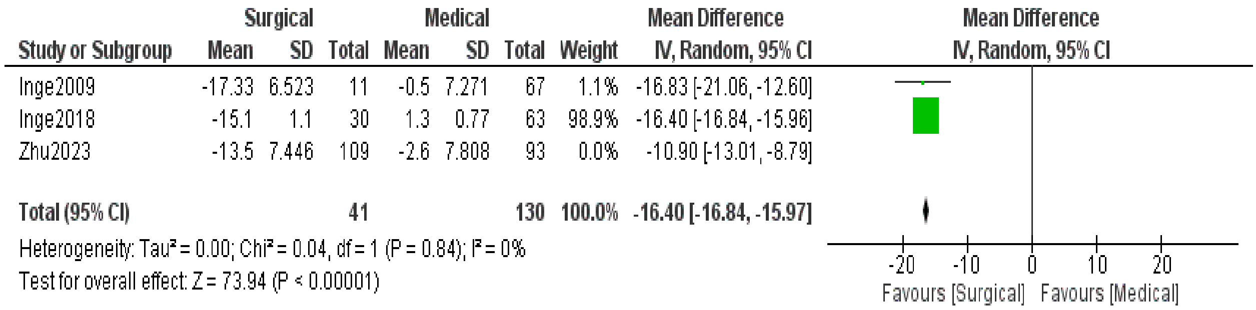
2- BMI change.

The pooled mean difference indicated that the surgical group had a lower BMI change compared to the medical therapy group [MD: -14.61 (-18.67, -10.55) with 95% CI], which was statistically significant (P< 0.00001) (Figure 4). Subsequently, the sensitivity analysis revealed substantial heterogeneity among our included studies (I2=92%, P< 0.00001) that was not resolved after omitting Zhu et. al 2023 by leave one out test (I2=0%, P< 0.00001) (Figure 5). The funnel plot of BMI change is shown in (Figure 6).



Study or Subgroup	Surgical Mean	Surgical SD	Surgical Total	Medical Mean	Medical SD	Medical Total	Weight	Mean Difference IV, Random, 95% CI
Inge2009	-17.33	6.523	11	-0.5	7.271	67	27.1%	-16.83 [-21.06, -12.60]
Inge2018	-15.1	1.1	30	1.3	0.77	63	38.2%	-16.40 [-16.84, -15.96]
Zhu2023	-13.5	7.446	109	-2.6	7.808	93	34.7%	-10.90 [-13.01, -8.79]
Total (95% CI)			**150**			**223**	**100.0%**	**-14.61 [-18.67, -10.55]**

Figure4: Forest plot of BMI change.



Study or Subgroup	Surgical Mean	Surgical SD	Surgical Total	Medical Mean	Medical SD	Medical Total	Weight	Mean Difference IV, Random, 95% CI
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Inge2018	-15.1	1.1	30	1.3	0.77	63	98.9%	-16.40 [-16.84, -15.96]
Zhu2023	-13.5	7.446	109	-2.6	7.808	93	0.0%	-10.90 [-13.01, -8.79]
Total (95% CI)			**41**			**130**	**100.0%**	**-16.40 [-16.84, -15.97]**

Figure5: Sensitivity test of BMI change.

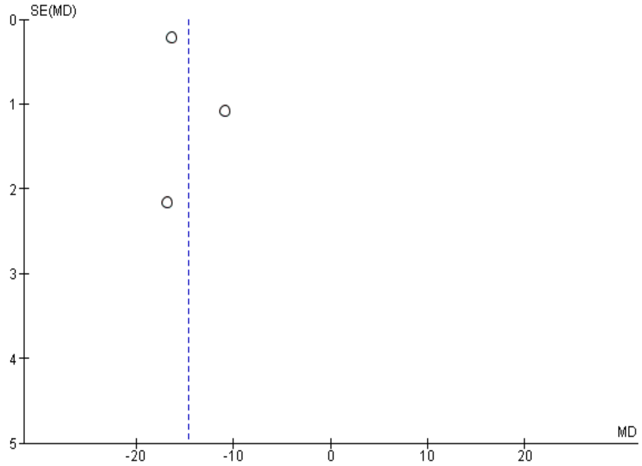


Figure6: Funnel plot of BMI change.

3- Fasting glucose level change.

The pooled mean difference indicated that the surgical group had a lower Fasting glucose level change compared to the medical therapy group [MD: -57.06 (-81.63, -32.48) with 95% CI], which was statistically significant (P< 0.00001) (Figure 7). Subsequently, the sensitivity analysis revealed substantial heterogenicity among our included studies (I2=89%, P= 0.003). The funnel plot of fasting glucose level change is shown in Figure 8.

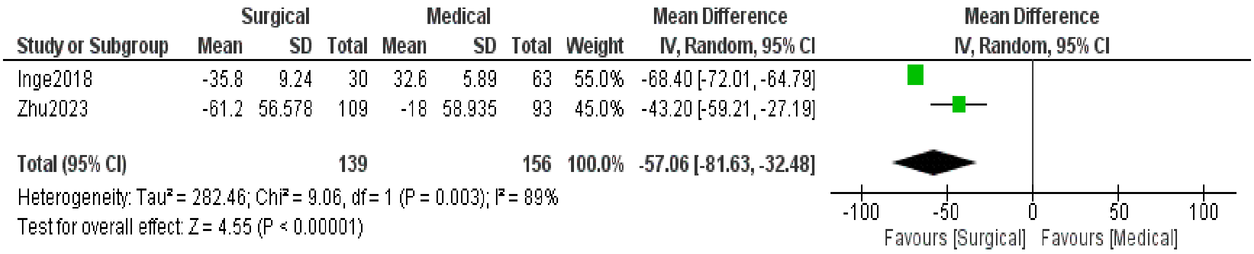


Figure7: Forest plot of Fasting glucose level change.

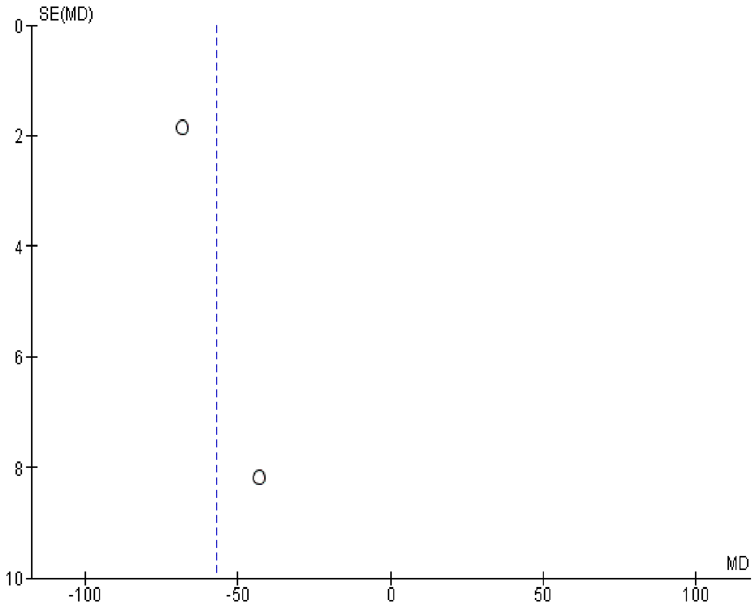
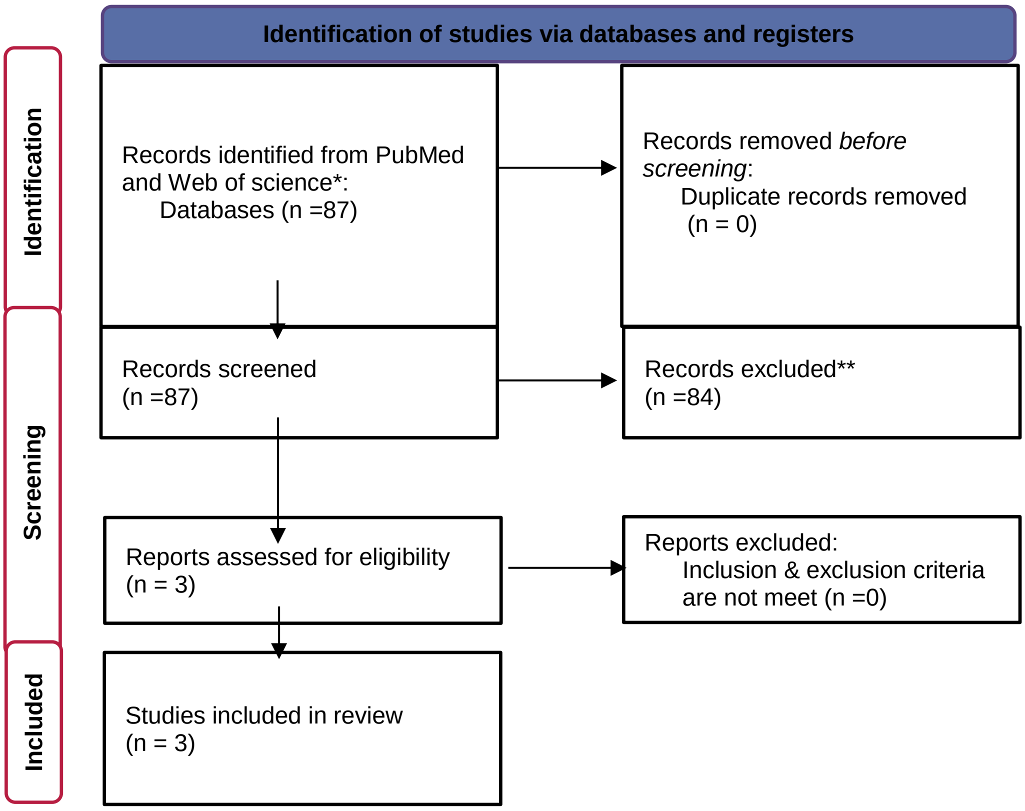


Figure8: Funnel plot of Fasting glucose level change



ID	Country	Study design	Intervention	Duration	Results	Conclusion
IZhu2023	China	Retrospective, nonrandomized, multicenter study	202 obese adolescents with type 2 diabetes who received surgery or medical treatment in three hospitals from 2017 to 2019.	2 years	Among the 202 adolescents, 109 adolescents underwent surgery, and the remaining 93 adolescents received nonsurgical treatment. Both in the entire cohort and in the propensity-score matching cohort, the mean body mass index (BMI) and total weight in the surgery group notably decreased. Similarly, the effect of surgery on glycemic control (with respect to HBG, HbA1c, HOMA-IR) was superior to that of medical treatment. In the surgery group, the remission rate of diabetes was 76.1% in the entire cohort and 80.5% in the matched group, which was significantly higher than that in the control group (6.5% and 5.7%, respectively). In addition, LRYGB had better effects on weight loss and glycemic control than LSG.	Bariatric surgery is more effective in the control of weight loss and type 2 diabetes than medical treatment. The effects between different types of bariatric surgeries remain to be further investigated, and longer follow-up times are needed.

Inge2018	USA	RCT	Teen-LABS participants underwent a primary bariatric surgical procedure; TODAY participants were randomized to receive metform in therapy alone or incombination with rosiglitazone or an intensive lifestyle intervention	2 years	Data from 30 participants from Teen-LABS(mean[SD]age at baseline,16.9[1.3] years; 21 [70%]female; 18[66%]white) and 63 from TODAY (mean[SD]age at baseline, 15.3 [1.3] years; 28 [44%] female; 45 [71%]white) were analyzed. During 2 years,mean hemoglobin A1 cconcentration decreased from 6.8%(95%CI,6.4%-7.3%)to 5.5%(95%CI, 4.7%-6.3%)in Teen-LABS and increased from 6.4%(95%CI,6.1%-6.7%) to 7.8%(95%CI, 7.2%-8.3%)in TODAY. Compared with baseline, the body mass index decreased by29% (95%CI,24%-34%) in Teen-LABS and increased by 3.7%(95%CI,0.8%-6.7%) in TODAY. Twenty-three percent of Teen-LABS participants required a subsequent operation during the 2-year follow-up.	Compared with medical therapy, surgical treatment of severely obese adolescents with type 2 diabetes was associated with better glycemic control, reduced weight, and improvement of other comorbidities.These data support the need for a well-designed, prospective controlled study to define the role of surgery for adolescents with type 2diabetes, including health and surgical outcomes.
Inge2009	USA	Retrospective study	Anthropometric, hemodynamic, and biochemical measures and surgical complications were analyzed. Similar measures from 67 adolescents with type 2 diabetes mellitus who were treated medically for 1 year were also analyzed.	1 year	After surgery there was evidence of remission of type 2 diabetes mellitus in all but 1 patient. Significant improvements in BMI (-34%), fasting blood glucose (-41%), fasting insulin concentrations (-81%), hemoglobin A1c levels (7.3%-5.6%), and insulin sensitivity were also seen. There were significant improvements in serum lipid levels and blood pressure. In comparison, adolescents with type 2 diabetes mellitus who were followed during 1 year of medical treatment demonstrated stable body weight (baseline BMI: 35 +/- 7.3 kg/m(2); 1-year BMI: 34.9 +/- 7.2 kg/m(2)) and no significant change in blood pressure or in diabetic medication use. Medically managed patients had significantly improved hemoglobin A1c levels over 1 year	Extremely obese diabetic adolescents experience significant weight loss and remission of type 2 diabetes mellitus after Roux-en-Y gastric bypass. Improvements in insulin resistance, beta-cell function, and cardiovascular risk factors support Roux-en-Y gastric bypass as an intervention that improves the health of these adolescents. Although the long-term efficacy of Roux-en-Y gastric bypass is not known, these findings suggest that Roux-en-Y gastric bypass is an effective option for the treatment of extremely obese adolescents with type 2 diabetes mellitus.

					(baseline: 7.85% +/- 2.3%; 1 year: 7.1% +/- 2%).	

Table 1: The summary characteristics of the included studies

ID	Groups	Age	Females	Height	Bodyweight	BMI
Zhu2023	Surgical	17.6(1.4)	78(71.6%)	172.2(9.7)	138.7(20.3)	46.8(7.9)
	Medical	16.8(1.2)	62(66.7%)	174.7(8.4)	133.6(22.5)	43.7(9.5)
Inge2018	Surgical	16.9(1.3)	21(70%)	168.6(9.3)	145.2(31.41)	54.4(9.5)
	Medical	15.3(1.3)	28(44%)	170.3(7.8)	116.3(13.85)	40.5(4.9)
Inge2009	Surgical	17.81(2.17)	7(63.6%)	171.70(8.55)	149.13(23.79)	50.40(5.89)
	Medical	15.45(1.83)	NA	168.53(10.75)	101.94(28.59)	35.40(7.32)

Table 2: The baseline characteristics of the included studies.

Risk of bias assessment

Based on the ROBINS-I score for cohort studies, the majority of included studies (Inge2009, Inge2018) had a serious ROB. However, one study (Zhu, 2023) had moderate ROB. In addition, the included RCT (Inge2009, Inge2018) show high ROB while (Zhu2023) show moderate to high ROB [table5] using the RoBII tool.

DISCUSSION

Our research comprised three studies that compared the effectiveness of medical therapy and surgical intervention in obese patients with type 2 diabetes. Retrospective cohorts and randomized controlled trials are among the listed studies. The study' origins include China and the United States. The lengths of follow-up ranged from brief evaluations to protracted intervals. The age range of the participants was 15.3 to 17.81 years. With female percentages ranging from 44% to 70%, women make up a sizable fraction of each group. Table 1 presents a summary of the features of the included studies. Table 2 lists the baseline characteristics of the included studies.

According to the pooled mean difference, the percentage of HbA1c had a lower percentage change in the surgical group than in the medical therapy group.

According to these results, surgery may be a more successful glycemic control method than medication management. Great heterogeneity (I2 = 91%, P < 0.0001) emphasizes the great diversity in HbA1c responses across trials, indicating that study designs and patient characteristics may significantly affect outcomes.

The review provides evidence about the effectiveness of the surgical therapy compared to the medical therapy, despite the fact that there are several limitations that should be noted. The variability between studies indicates inconsistencies that could affect overall conclusions. In addition, the number of studies was limited, which may lead to bias or an incomplete picture of the available evidence, especially for those not included.

The significance of these findings is for clinical practice. These findings may suggest that the surgical intervention could be a priority for some specific patient population, especially for those who are not achieving adequate glycemic control while using medical therapy alone. Therefore, when developing the guidelines for diabetes management, policymakers should consider these results. Also, future research should focus on conducting more randomized controlled trials with diverse populations to gain a better understanding of the effects and safety of surgical interventions compared to medical therapy across various settings.

Therefore, when developing the guidelines for diabetes management, the policymakers should consider these results. Also, future research should focus on making more randomized controlled trials with diverse populations to gain a better understanding of the effects and the safety of the surgical interventions compared to medical therapy across various settings.

Our study shows that surgical interventions lead to significantly greater BMI reduction in obese type 2 diabetes patients when compared with those patients who take medical therapy [MD: -14.61 (-18.67, -10.55) with 95% CI], in which the results were statistically significant (P< 0.00001). Subsequently, the sensitivity analysis showed high heterogeneity among our included studies (I2 =92%, P< 0.00001) that was not resolved after omitting Zhu et. al 2023 by leave one out test (I2=0%, P< 0.00001). All studies preferred surgery because of its strong effect on weight loss, most likely due to hormonal changes and improved metabolic regulation. However, the small number of studies that focus on adolescents makes it difficult to generalize these findings. Therefore, more studies in larger populations are needed.

Compared to medical therapy alone, surgical treatment significantly decreased fasting glucose levels with a mean difference of -57.06 mg/dL (95% CI: -81.63 to -32.48, P < 0.00001). Confirming a clear and considerable therapeutic benefit in terms of improved glycemic management. Significant heterogeneity was found in the included studies (I2 = 89%, P = 0.003), which may have resulted from variables, surgical techniques, or patient selection criteria. While the funnel plot found no strong indications of publication bias, the small number of studies limits the reliability of this assessment. While highlighting the need for more high-quality, standardised research to address observed heterogeneity and confirm long-term benefits, these findings do, overall, support the superiority of surgical approaches over medical therapy for lowering fasting glucose in type 2 diabetes obese patients.

CONCLUSION

Our study shows that bariatric surgery provides better outcomes compared with conventional treatment in obese adolescents with type 2 diabetes, especially in terms of glycemic control, weight loss, and diabetes remission. However, the generalizability of these findings is constrained by the small number of available studies, their heterogeneity, differences in patient populations, and varying follow-up periods. Although surgical intervention appears promising, it should be regarded as part of a comprehensive approach rather than a substitute for the vital role of pediatricians in early detection, prevention, and long-term management. Further high-quality, long-term studies are needed to validate these findings and guide evidence-based recommendations for pediatric care.

Authors contribution

Mansuor A Alanazi, Ahad Nasser J Al balawi, Jomanah Atyah S Al atawi, Rana Nafea S Al-anazi, Dareen Abdullah M Alshehri, Raghad Ibrahim H AlOmari, Renas Abdullah S Alghanami, Ghala Faisal Alghamdi, Lama Abdulrazaq M Almasoudi conducted this study. Ghala Faisal Alghamdi،Lama Abdulrazaq Almasoudi, Dareen Abdullah M Alshehri, Raghad Ibrahim H AlOmari were responsible for screening by title and abstract. Ahad Nasser J Al balawi, Jomanah Atyah S Al atawi, Rana Nafea S Al-anazi, and Renas Abdullah S Alghanami were responsible for full-text screening. Lama Abdulrazaq M Almasoudi, Dareen Abdullah M Alshehri, Raghad Ibrahim H AlOmari, Renas Abdullah S Alghanami were responsible for data extraction. Ahad Nasser J Al balawi was responsible for the flow diagram. Ghala Faisal Alghamdi, ،lama Abdulrazaq Almasoudi, Dareen Abdullah M Alshehri, Ahad Nasser J Al Balawi, and Renas Abdullah S Alghanami were responsible for ROB. Ghala Faisal Alghamdi, Jomanah Atyah S Al atawi, Ahad Nasser J Al balawi, and Rana Nafea S Al-anazi provided the study design and analyzed and interpreted the data. Ghala Faisal Alghamdi, Ahad Nasser J Al balawi, Jomanah Atyah S Al atawi, Rana Nafea S Al-anazi, Dareen Abdullah M Alshehri, Raghad Ibrahim H AlOmari, Renas Abdullah S Alghanami, Ghala Faisal Alghamdi, Lama Abdulrazaq M Almasoudi framed the manuscript. Mansuor A Alanazi reviewed and approved all the aspects of the work and the manuscript. Mansuor A Alanazi and all the authors have read and framed the manuscript and approved the final version.

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Nil.

Conflict of interest

There are no conflicts of interests.

REFERENCES

1. Shah AS, Nadeau KJ, Helmrath MA, et al. Metabolic outcomes of surgery in youth with type 2 diabetes. Semin Pediatr Surg. 2020;29(5):150893.
2. Stefater MA, Inge TH. Bariatric surgery for adolescents with type 2 diabetes: an emerging therapeutic strategy. Curr Diab Rep. 2017;17(8):62.
3. Singh AK, Singh R, Kota SK. Bariatric surgery and diabetes remission: who would have thought it?. Indian J Endocrinol Metab. 2015;19(5):563-576.
4. Tsilingiris D, Koliaki C, Kokkinos A. Remission of type 2 diabetes mellitus after bariatric surgery: fact or fiction?. Int J Environ Res Public Health. 2019;16(17):3171.
5. Thenappan A, Nadler E. Bariatric surgery in children: indications, types, and outcomes. Curr Gastroenterol Rep. 2019;21(6):24.
6. Shah AS, D’Alessio D, Ford-Adams ME, et al. Bariatric surgery: a potential treatment for type 2 diabetes in youth. Diabetes Care. 2016;39(6):934–940.
7. Pratt JSA, Browne A, Browne NT, et al. ASMBS pediatric metabolic and bariatric surgery guidelines, 2018. Surg Obes Relat Dis. 2018;14(7):882–901.