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Bariatric surgery effects on glycemic control and diabetes mellitus remission: A meta-analysis

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ABSTRACT

Introduction: There is an increasing awareness of morbidity-based indications for bariatric surgery, literature on bariatric surgery and diabetes is scarce. *Aim:* We aimed to assess the bariatric surgery role in diabetes remission and HbA1c reduction. *Methods:* We systematically searched three databases Pub Med, Cochrane Library and Google Scholar from the first published article up to September 2022. Two reviewers searched the databases using the following keywords: Diabetes remission, HbA1c level, glycated hemoglobin, glycemic control, Bariatric surgery, sleeve gastrectomy and Roux-en-Y gastric bypass. The retrieved data were entered in a datasheet detailing the author's name, year and country of publication, the methodology and HbA1c levels before and after surgery and diabetes remission. The data were analyzed using the most recent RevMan. *Results:* Out of the 12 studies included in the final meta-analysis**,** five studies on bariatric surgery effect on the glycated hemoglobin (5257 events) showed a reduction of the glycated hemoglobin (odd ratio, -1.05, 95% *CI*, -1.15-0.96). A substantial heterogeneity was observed, (I^2=79%, P-value=0.0007) the P-value for the overall effect<0.001. Regarding the complete resolution of diabetes mellitus, we pooled seven studies and found a complete resolution of diabetes mellitus following bariatric surgery (odd ratio, 29.25, 95% *CI*, 10.92-78.43). No heterogeneity was observed, (I^2=0%, P-value=0.63). The P-value for overall effect<0.001 and the chi-square=4.32 with a mean difference of 6. *Conclusion:* Bariatric surgery was effective in diabetes remission and improving HbA1c. Further studies comparing different types of bariatric surgery regarding the same are needed.

Keywords: Bariatric surgery, glycemic control, diabetes remission.

1. INTRODUCTION

Under half a billion people are living with diabetes mellitus globally. In addition, the same number is suffering from the disease without awareness of

the diagnosis. The projection is to increase by 25% and 51% by the years 2030 and 2045 respectively (Saeedi et al., 2019). Although dietary management, exercise and antidiabetic medications are the best methods for improving glycemic control however, lifestyle intervention is difficult to follow and antidiabetic medication is not without side effects (Garcia-Molina et al., 2020; Salehi et al., 2019). Furthermore, most patients with diabetes mellitus are not reaching glycemic targets with increasing complications, morbidity and mortality (Phillips and Shikora, 2018).

Bariatric surgery and since 1950 and over the decades showed a meaningful weight reduction and substantial improvement in diabetes control, hypertension and cholesterol as major cardiovascular risk factors. Furthermore, an improvement in the procedure substantially decreased surgical complications despite the high-risk patients undergoing the operation. The evolution from high mortality and morbidity to a laudable safety and the benefits observed on metabolic disorders and independent of weight loss indicated that metabolic surgery may be targeted for various metabolic disorders (Basto-Abreu et al., 2020). There is an increasing awareness about metabolic oriented bariatric surgery regardless of weight management. The neurohormonal modulation inside and outside the gut will be targeted. Duodenal stimulation and terminal ileum bypass showed promising effects (Buchwald et al., 2020). The current meta-analysis aimed to assess the effects of bariatric surgery on diabetes remission and glycated hemoglobin.

2. MATERIALS AND METHODS

Eligibility criteria according to PICOS

Studies were eligible if they were randomized controlled studies, cross-sectional studies, case control and case series were excluded. The trials must be published in English and report the effects of bariatric surgery on diabetes remission or glycated hemoglobin. Animal studies and experimental studies were not included.

Outcome measures

The outcome measures were the diabetes remission and the effects on HbA1c after bariatric surgery.

Literature search and data extraction

A systematic literature search was conducted in PubMed Medline, Cochrane Library and Google Scholar from the date of the first inception up to September 2022. Two reviewers searched the databases for relevant articles. The diabetes remission, HbA1c improvement, glycated hemoglobin, glycemic control, Bariatric surgery, gastric bypass, sleeve gastrectomy and Roux-en-Y gastric bypass were used. The titles, abstracts and references of the included studies were screened. Any discrepancy was solved by a consensus. We identified 1435 studies and 240 stands after the removal of duplication from them, 66 full texts were screened and only 12 studies were included in the final meta-analysis. A datasheet was used to extract the author's name year and country of publication, the study type, HbA1c improvement and diabetes remission. A modified Cochrane risk of bias assessed the quality of the included studies (Higgins et al., 2016) (Tables 1, 2, 3 and Figure 1).

Risk of bias assessment

A modified Cochrane tool was used (Higgins et al., 2016).

Statistical analysis

The most recent version of the RevMan system was used. We pooled 12 cohorts from ten studies (five on HbA1c and seven on diabetes remission). The dichotomous data were entered manually and the random effect was applied for HbA1c outcome due to the significant heterogeneity. No heterogeneity was observed regarding diabetes remission. Thus, the fixed effect was applied. A P-value of <0.05 was considered significant.

Table 1 Bariatric surgery and diabetes remission

Author	Year	Country	Duration	Method	Bariatric	Drugs	P-value
Courcoulas et al., (2014)	2014	USA	1 year	RCT	9/46	0/23	0.0092
Courcoulas et al., (2015)	2015	Spain	3 years	RCT	14/38	0/14	0.04
Courcoulas et al., (2020)	2020	USA	3 years	RCT	20/41	0/20	0.01
Cummings et al., (2016)	2016	USA	1year	RCT	9/15	1/17	0.002
Mingrone et al., (2021)	2021	Italy	10 years	RCT	15/40	1/17	0.04
Parkh et al., (2014)	2014	USA	0.5 years	RCT	13/20	0/24	<0.001

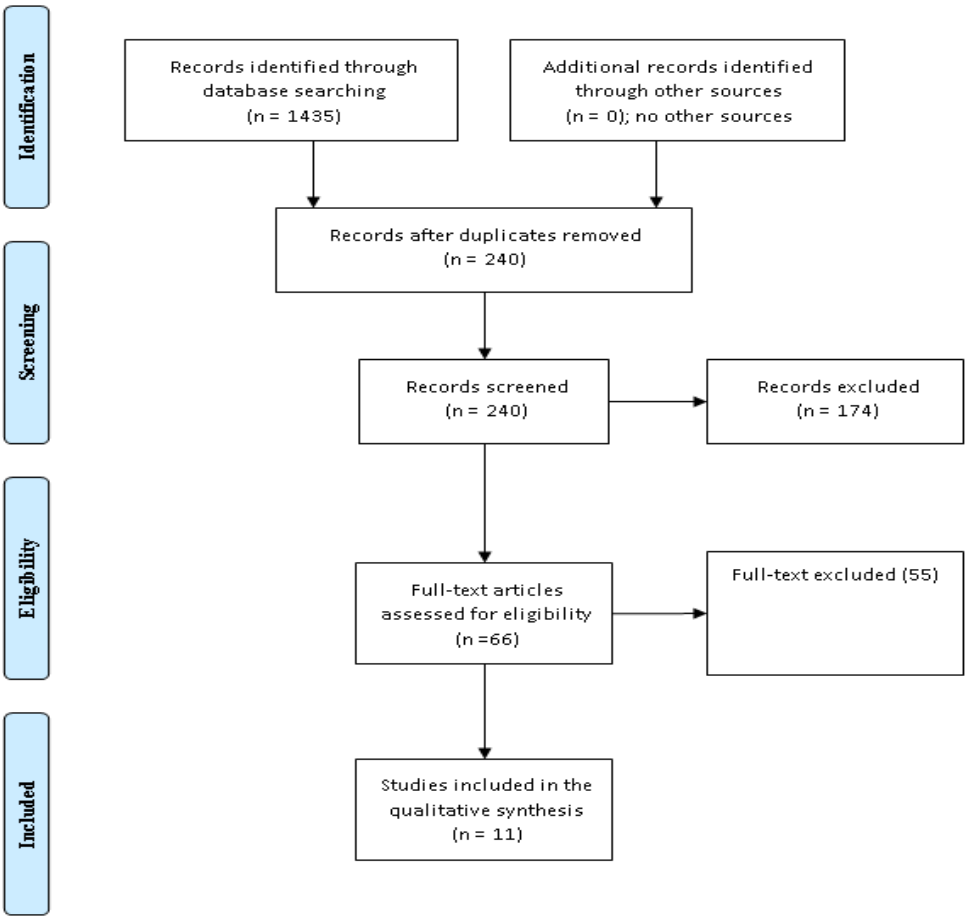

Figure 1 Effects of bariatric surgery on diabetes mellitus (The PRISMA Chart)

Table 2 Bariatric surgery and HbA1c

Author	Year	Country	Duration	Study type	Medical therapy	Bariatric surgery	P-value
Cummings et al., (2016)	2016	USA	1year	RCT	6.9 ± 1.3	6.4 ± 1.6	0.04
Imtaz et al., (2021)	2021	Canada	2 years	RCT	7.8 ± 1.8	6.3 ± 1.2	<0.001
Mingrone et al., (2021)	2012	Italy	2 years	RCT	7.69±0.57	5.65±0.95	<0.001
Parikh et al., (2014)	2014	USA	0.5 years	RCT	7.8 ±1.7	6.2 ±0.9	0.0027
Schauer et al., (2012)	2012	USA	1 year	RCT	7.5±1.8	6.5±0.95	0.007

Table 3 Risk of bias of the included randomized controlled trials

Study	Year	Selection	Performance	Attrition	Reporting	Other
Courcoulas et al., (2014)	2014	low	Unclear	Low	Low	Low
Courcoulas et al., (2015)	2015	low	Unclear	Low	Low	Low
Courcoulas et al., (2020)	2020	low	Unclear	Low	Low	Low
Cummings et al., (2016)	2016	Low	unclear	low	Low	Unclear
Mingrone et al., (2021)	2021	Low	Unclear	High	Low	Low
Parkh et al., (2014)	2014	Low	Unclear	High	Low	Low
Imtaz et al., (2021)	2021	low	Unclear	Low	Low	Low
Mingrone et al., (2012)	2012	Low	Unclear	High	Low	Low
Schauer et al., (2012)	2012	Low	Unclear	High	Low	Low

3. RESULTS

Regarding the complete resolution of diabetes mellitus, we pooled six studies (Courcoulas et al., 2014; Courcoulas et al., 2015; Courcoulas et al., 2020; Cummings et al., 2016; Mingrone et al., 2021; Parikh et al., 2014) and found a complete resolution of diabetes mellitus following bariatric surgery (odd ratio, 21.63, 95% CI, 7.47-62.57). No heterogeneity was observed (I^2=0%, P-value=0.88). The P-value for overall effect<0.001 and the chi-square=1.80 with a mean difference of 5 (Figure 2). There were five studies (Cummings et al., 2016; Parikh et al., 2014; Imtiaz et al., 2021; Mingrone et al., 2012; Schauer et al., 2012) on bariatric surgery's effect on the glycated hemoglobin (5257 events); the studies showed a reduction of the glycated hemoglobin indicating improvement of glycemic control (odd ratio, -1.05, 95% CI, -1.15-0.96). A substantial heterogeneity was observed (I^2=79%, P-value=0.0007). The P-value for overall effect<0.001 and the chi-square=19.27 with a mean difference of 4 (Figure 3).

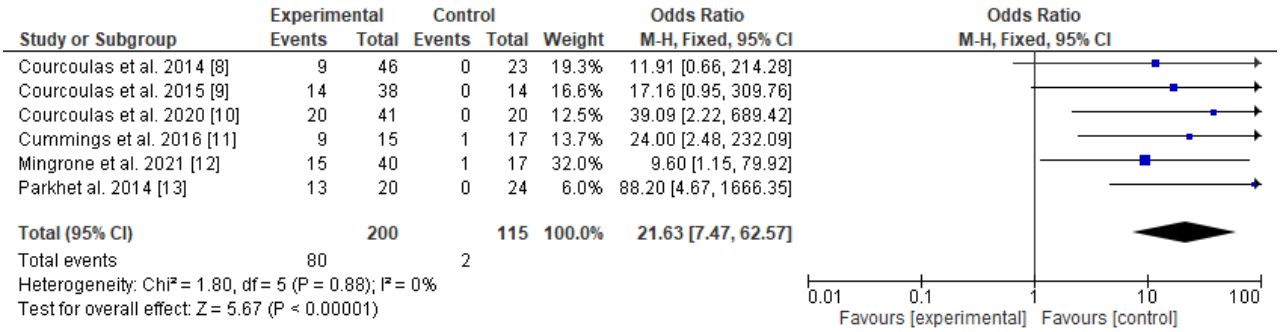

Figure 2 Bariatric surgery and diabetes remission

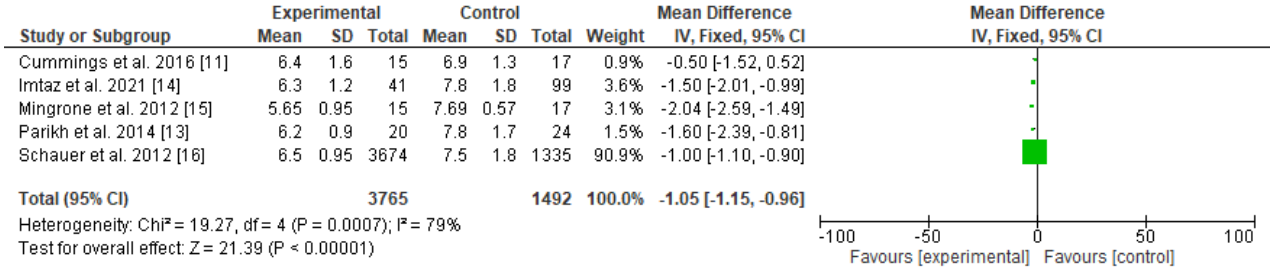

Figure 3 Bariatric surgery and HbA1c

4. DISCUSSION

In the present meta-analysis, bariatric surgery improved the glycated hemoglobin and induced remission of diabetes, a study that included ten studies (Sheng et al., 2017) found similar results. However, the study included only one trial. Another study of seven randomizedtrials found similar results (Khorgami et al., 2019). The mechanisms for the remission included a higher GLP-1 and lower GIP, Ghrelin and glucagon (Russel et al., 2020). Other proposed mechanisms are the effects on the gut microbiota diversity (Magouliotis et al., 2017). It is interesting to note that baseline glycated hemoglobin and fasting plasma glucose are associated with a lower remission rate while preoperative fasting plasma C-peptide was associated with a higher chance of remission (Yan et al., 2017). BS results on diabetes remission varied by ethnicity as Asian and Black Americans showed a higher rate of remission at five years compared to other ethnicities (Kim et al., 2020; Admiraal et al., 2012) the effects are not related to baseline body mass index (remission were observed even among patient with BMI<30) (Panunzi et al., 2015; Rubio-Almanza et al., 2019). A meta-analysis showed that the chance of diabetes remission is higher for young patients, with good diabetes control and a short duration of diabetes (Wang et al., 2015).

Roux-en-Y gastric bypass (LRYGB) achieved more diabetes remission at one year. However, no difference was found at 2 to 5 years compared to sleeve gastrectomy (Borgeraas et al., 2020; Madadi et al., 2019). Guraya and Strate, (2020) showed that Laparoscopic Roux-en-Y gastric bypass is similar to sleeve gastrectomy in inducing diabetes remission at five years an observation supported by Sha et al., (2020), Xu et al., (2020) in their meta-analysis assessed diabetes remission and found similar results in both procedures. However, a lower rate of complications and a higher rate of safety were reported for sleeve gastrectomy. Further meta-analyses reported a lower rate of gastroesophageal reflux among gastrectomy patients with no differences in diabetes remission (Sharples andMahawar, 2020).

In addition, sleep gastrectomy had a lower rate of ulcers, strictures and obstruction compared to LRYGB (Park et al., 2019). On the other hand, Gu et al., (2020) concluded the superiority of (LRYGB). The above results imply that metabolic surgery is an interesting option for diabetes management (Cresci et al., 2020).

5. CONCLUSION

Bariatric surgery improved glycemic control and induced diabetes remission. Further studies comparing laparoscopic sleeve gastrectomy and Roux-en-Y gastric bypass are needed.

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Authors' contributions

Hyder Mirghani, the concept and design and data analysis, Bandar Alamrani and Mohammad Algabri searched the literature and drafted the introduction, Meshal Alatawi and Mohammed Alasmari drafted the methods, Ali Alsharif and Fahad Alqahtani drafted the results, Mshari Albalawi, Fadi Alamrani, Asem Albalawi andAli Alalawi discussed the data. All the authors revised the manuscript critically and approved it before submission.

Ethics approval and consent to participate

Not applicable

Informed consent

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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