ORIGINAL ARTICLE

# Evaluation of Gastroesophageal Reflux Disease After Bariatric Surgery

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Abstract

*Background:* ***Obesity is a global health challenge. Bariatric surgery is the most effective long-term solution for treating morbid obesity, addressing it through gastric volume restriction, malabsorption, and associated hormonal changes. Obese individuals are more likely to suffer from upper digestive diseases, including gastroesophageal reflux disease (GERD).***

*Aim:* ***This study aims to assess GERD in patients undergoing bariatric surgery.***

*Patients and methods:* ***This prospective study included 100 patients at Al-Azhar University hospitals over two years. Preoperative esophagogastroduodenoscopy (EGD) findings categorized patients into group 1 (normal EGD, n=28) and group 2 (GERD, n=72, graded using the Los Angeles classification (LA)). Postoperative EGD was performed after 12 months to assess GERD outcomes and complications.***

*Results:* ***Preoperative GERD prevalence was 72%, with 35% of patients having a hiatal hernia. Postoperatively, in group 1, 39.3% remained GERD-free, while 60.7% developed de novo GERD; all underwent Laparoscopic Sleeve Gastrectomy (LSG). In group 2, 43.1% experienced GERD resolution, while 56.9% had persistent GERD. Among 21 patients undergoing Laparoscopic Roux-en-Y Gastric Bypass (LRYGB), none experienced GERD worsening or de novo GERD. Of 79 LSG patients, 17 (21.6%) developed de novo GERD, while GERD disappeared or improved in 48 patients (60.7%).***

*Conclusions:* ***LRYGB significantly improved GERD outcomes, while LSG exhibited variable GERD results, including de novo GERD in some cases.***

*Keywords:* Sleeve Gastrectomy; Roux-en-Y Gastric Bypass; GERD

## 1. Introduction

Obesity has become a significant global health challenge due to its rising prevalence and associated complications.[1] Obesity is associated with multiple comorbidities, including type 2 diabetes mellitus (T2DM), hypertension, obstructive sleep apnea (OSA), hiatal hernia (HH), and gastroesophageal reflux disease (GERD), which are closely related.[2]

The increasing burden of obesity has necessitated effective treatment strategies, among which bariatric surgery has emerged as the most reliable long-term intervention for achieving substantial weight loss and improving obesity-related comorbidities.[3]

Bariatric procedures such as Laparoscopic Sleeve Gastrectomy (LSG) and Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) induce weight loss through different mechanisms, including gastric volume restriction, malabsorption, and hormonal modulation.[4]

While these procedures have demonstrated significant benefits in weight reduction and metabolic improvement, their impact on GERD remains debated. LSG has been associated with both improvement and worsening of GERD symptoms due to its effects on gastric anatomy and lower esophageal sphincter (LES) pressure [5], whereas LRYGB is generally regarded as a procedure that alleviates reflux symptoms by diverting bile and reducing acid exposure in the esophagus.[6]

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Given the varying effects of bariatric surgery on GERD, understanding the postoperative outcomes of these procedures is crucial for optimizing patient selection and surgical planning. This study aims to assess GERD in patients undergoing LSG and LRYGB, examining preoperative and postoperative esophagogastroduodenoscopy (EGD) findings to determine the effectiveness of these surgical interventions in managing GERD symptoms.

## 2. Patients and methods

Study design:

The study was a prospective study carried out at Al-Azhar university (Al-Hussein and Bab Al-sharia) hospitals, in the period between March 2022 and February 2024. All patients gave their informed written consent for participation and publication prior to participation. The study received approval from the ethical board of Al-Azhar University, Faculty of Medicine.

Patients:

A total of 130 patients were evaluated for eligibility, with 30 patients excluded for various reasons. The remaining 100 eligible patients, aged 18–65 years, had a BMI of more than 40 or at least 35 kg/m² with associated comorbidities and underwent bariatric surgery. The eligible 100 patients were aged from 18 to 65 years, with a BMI of more than 40 (or 35 kg/m2 with comorbidities), and had bariatric surgery. Patients excluded were aged <18 or >65 years, pregnant females, patients with active malignancy, uncontrolled medical conditions unfit for anesthesia, previous gastric surgery, or the presence of esophageal varices, or refusal for endoscopy.

Data collection

At the initial clinic visit, participants underwent a comprehensive assessment including history taking (name, age, sex, special habits as smoking and alcohol, residential area, and occupational history). A comprehensive evaluation includes both general and localized abdominal examinations. Routine laboratory tests consist of a complete blood count (CBC) and liver function tests—specifically alanine transaminase (ALT), aspartate transaminase (AST), prothrombin time (PT) with its concentration, total and direct bilirubin, and serum albumin. Additionally, a lipid profile (serum cholesterol and triglycerides) along with HbA1C is performed, and renal function is assessed via measurements of blood urea, uric acid, and serum creatinine. Pelviabdominal ultrasound with specific concern for fatty liver & its grades and presence of gall bladder stones.[7] Also, patients were asked to fill out a GERD Questionnaire, and a score was established (scale from 0 to 18), with a cut-off point of≥ 8, which was related to the likelihood of the presence of esophageal erosions.[8]

Study Procedures

Studied persons underwent diagnostic EGD at the endoscopy units of Hepatology, Gastroenterology, and Infectious Diseases departments of Al-Azhar University Hospitals of Cairo. Assessment of GERD and grading were done using the LA classification.[9]

Outcome measures

Patients were assessed at baseline and 1 year after bariatric surgery. Pre-operative diagnostic EGD: according to findings, selected patients were categorized into two main groups: Group 1: with normal EGD study (n=28). Group 2: with GERD by its different grades according to the LA classification (n=72). A postoperative diagnostic EGD is performed to assess post-bariatric symptoms, identify and manage complications, and evaluate potential causes of weight loss failure.

Statistical Analysis

The sample size was estimated to be a total of 100 morbidly obese patients undergoing bariatric surgery using the EPI Info statistical calculator according to the Fleiss w/ cc formula. Data analysis was conducted using the Statistical Package for Social Sciences (SPSS) version 26.0. Quantitative data will be presented as mean ± standard deviation (SD), while qualitative data will be displayed as frequency and percentage.

## 3. Results

At baseline, the socio-demographic characteristics of study participants revealed that the total number of study subjects enrolled was 100, females were 57% with urban residence 61%, mean age was 43.79 ± 12 years, and the mean BMI was 37.47 ± 3.65 kg/m2. 8% were smokers. Most of our patients had co-morbidities, including 26% with T2DM, 37% in a prediabetic state, 31% with hypertension (HTN), and 16% with ischemic heart disease (IHD) (see table 1).

Regarding laboratory results (table 2), 11% were anemic, with no abnormalities in white blood cells, platelets, or INR; 71% had elevated liver enzymes likely due to nonalcoholic steatohepatitis (NASH), 68% had hypercholesterolemia, 71% had hypertriglyceridemia, 56% had hyperuricemia, and 43% had renal impairment (elevated serum creatinine). As regards the U/S findings: fatty liver (NAFLD) was found in 90%. Gall bladder stones were found in 79% of the people studied (table 3). Patients were asked to fill in a GERD questionnaire (table 4) according to symptoms frequency, association and seeking medical treatment. GERD questionnaire score range was 4-15 with a Mean 10.24 ± 2.93 SD. Prevalence of

pre-operative GERD in our study was 72% (group 2) as following; 19% grade A, 48% grade B, 4% grade C and 1% grade D (according to LA classification), with 28 patients had no baseline GERD (group 1). Also, 35% of patients had HH.

As regard post-operative endoscopic findings (table 4), in group 1 who had no pre-operative GERD (n=28) there were 11 patients (39.3%) continued with no GERD, while 17 patients (60.7%) revealed de novo post-operative GERD (10 patients for GERD-A & 7 patients for GERD-B) and all seventeen patients underwent LSG. While in group 2 who had pre-operative GERD (n=72); there were 31 patients (43.1%) with GERD disappearance, plus 41 patients (56.9%) with GERD persistence as following (30 patients=41.6% for GERD-A, 8 patients=11.1% for GERD-B & 3 patients=4.2% for GERD-C). According to the type of bariatric surgery, there were 21 patients who underwent LRYGB: 4 patients (19%) in group 1 and all of them continue with no GERD. In addition to 17 patients (81%) in group 2 as follows; 5 patients (23.8%) with GERD disappearance, 11 patients (52.5%) with GERD grade improvement and one patient (4.7%) with GERD grade persistence with no GERD worsening or de novo GERD at all. In contrast, 79 patients underwent LSG as follows; 24 patients (30.4%) in group 1 where 7 patients (8.8%) continued with no GERD, while 17 patients (21.6%) developed de novo GERD (10 for GERD-A & 7 for GERD-B as mentioned before). In addition to 55 patients (69.6%) in group 2 as follows; 26 patients (32.9%) with GERD disappearance, 22 patients (27.8%) with GERD grade improvement, 4 patients (5.1%) with GERD grade persistence and 3 patients (3.8%) with GERD grade worsening.

*Table 1. Comparison between group 1 & 2 patients (with and without GERD before surgery) regarding demographic & clinical data*

| | | GERD BEFORE SURGERY | | | TEST | P-VALUE |
|---|---|---|---|---|---|---|
| | | Total | No (Group 1) | Yes (Group 2) | | |
| | | No. =100 | No. = 28 | No. = 72 | | |
| AGE | Mean ± SD | 43.79±12.11 | 45.5 ± 11.71 | 43.31 ± 12.69 | 0.793• | 0.430 |
| | Range | 18-65 | 18 – 64 | 19 – 65 | | |
| SEX | Female | 57 (57%) | 17 (60.7%) | 40 (55.6%) | 0.219* | 0.640 |
| | Male | 43 (43%) | 11 (39.3%) | 32 (44.4%) | | |
| RESIDENCE | Urban | 61 (61%) | 20 (71.4%) | 41 (56.9%) | 0.931* | 0.334 |
| | Rural | 39 (39%) | 8 (28.6%) | 31 (43.1%) | | |
| SMOKING | No | 92 (92%) | 27 (96.4%) | 65 (90.3%) | 1.036* | 0.309 |
| | Yes | 8 (8%) | 1 (3.6%) | 7 (9.7%) | | |
| DM | No | 74 (74%) | 23 (82.1%) | 51 (70.8%) | 1.340* | 0.247 |
| | Yes | 26 (26%) | 5 (17.9%) | 21 (29.2%) | | |
| HTN | No | 69 (69%) | 20 (71.4%) | 49 (68.1%) | 0.107* | 0.743 |
| | Yes | 31(31%) | 8 (28.6%) | 23 (31.9%) | | |
| IHD | No | 84 (84%) | 22 (78.6%) | 62 (86.1%) | 0.853* | 0.356 |
| | Yes | 16 (16%) | 6 (21.4%) | 10 (13.9%) | | |
| BMI | Mean ± SD | 37.47±3.65 | 37.53 ± 2.71 | 37.45 ± 3.97 | 0.093• | 0.926 |
| | Range | 31.2 –56.5 | 35.1 – 45.6 | 31.2 – 56.5 | | |
| BMI GRADES (KG/M2) | <35 | 12 (12%) | 0 (0%) | 12 (16.6%) | 7.738* | 0.171 |
| | 35 – 40 | 72 (72%) | 24 (85.8%) | 48 (66.7%) | | |
| | 40 – 45 | 10 (10%) | 2 (7.1%) | 8 (11.1%) | | |
| | 45 – 50 | 4 (4%) | 2 (7.1%) | 2 (2.8%) | | |
| | 50 – 55 | 1 (1%) | 0 (0%) | 1 (1.4%) | | |
| | 55 – 60 | 1 (1%) | 0 (0%) | 1 (1.4%) | | |

P-value > 0.05: Non-significant; P-value < 0.05: Significant *: Chi-square test; •: Independent t-test
DM: Diabetes Mellitus, HTN: Hypertension, IHD: Ischemic Heart Disease, BMI: Body Mass Index

*Table 2. Comparison between group 1 & 2 patients regarding laboratory parameters*

| VARIABLES | GERD BEFORE SURGERY | | | T- TEST | P-VALUE |
|---|---|---|---|---|---|
| | Total | No (Group 1) | Yes (Group 2) | | |
| | No.= 100 Mean± SD Range | No. = 28 Mean± SD Range | No. = 72 Mean ± SD Range | | |
| HEMOGLOBIN (G/DL) | 12.18 ± 1.24 8.8 – 15.1 | 11.93 ± 1.1 8.8 – 13.5 | 12.28 ± 1.32 9.1 – 15.1 | 1.278• | 0.204 |
| WHITE BLOOD CELLS ($X10^3$/UL) | 7.23 ± 2.1 4.2 –11.1 | 7.14 ± 2.09 4.3 – 10.7 | 7.26 ± 1.98 4.1 – 11.1 | 0.255• | 0.799 |
| PLATELETS ($X10^3$/UL) | 296.54 ± 95.86 150 –463 | 313.68 ± 96.04 153 – 450 | 289.88± 95.63 150 – 463 | 1.116• | 0.267 |
| INR | 1.06 ± 0.16 0.8 –1.3 | 1.05 ± 0.16 0.8 – 1.3 | 1.07 ± 0.16 0.8 – 1.3 | 0.695• | 0.489 |
| AST (IU/L) | 44.63 ± 14.67 13– 93 | 45.21 ± 10.66 25 – 62 | 44.4 ± 16.02 13 – 93 | 0.247• | 0.805 |
| ALT (IU/L) | 53.28 ± 17.42 20 –125 | 52.43 ± 11.6 30 – 77 | 53.61 ± 19.28 20 – 125 | 0.303• | 0.762 |
| TOTAL BILIRUBIN (MG/DL) | 1.01 ± 0.21 0.6 –1.3 | 1.03 ± 0.22 0.6 – 1.4 | 1.01 ± 0.2 0.5 – 1.3 | 0.363• | 0.717 |
| SERUM ALBUMIN (G/DL) | 4.57 ± 0.63 3.4 –5.6 | 4.51 ± 0.69 3.6 – 5.5 | 4.6 ± 0.61 3.4 – 5.6 | 0.616• | 0.539 |
| HBA1C (%) | 6.62 ± 1.92 4.1 –11.4 | 6.21 ± 1.75 4.5 – 11.4 | 6.78 ± 1.97 4.1 – 11.2 | 1.333• | 0.186 |
| SERUM CHOLESTEROL (MG/DL) | 223.1±55.74 122 –361 | 218.21 ± 51.74 131 – 285 | 224.92± 57.47 122 – 361 | 0.538• | 0.592 |

| | | | | | | |
|---|---|---|---|---|---|---|
| TRIGLYCERIDES (MG/DL) | 182.1±54.94 | 176.64 ± 49.34 | 184.17± 57.16 | 0.613• | 0.541 |
| | 94 –376 | 94 – 255 | 95 – 376 | | |
| UREA (MG/DL) | 48.86 21.91 | 48.32 ± 22.05 | 49.07 ± 22.01 | 0.153• | 0.879 |
| | 20 –107 | 22 – 91 | 20 – 107 | | |
| SERUM CREATININE (MG/DL) | 1.46 ± 0.65 | 1.42 ± 0.6 | 1.47 ± 0.67 | 0.331• | 0.741 |
| | 0.5 –3.8 | 0.5 – 2.8 | 0.5 – 3.8 | | |
| URIC ACID (MG/DL) | 6.76 ± 1.87 | 6.27 ± 1.96 | 6.95 ± 1.82 | 1.646• | 0.103 |
| | 2.4 –10.4 | 2.7 – 9.1 | 2.4 – 10.4 | | |

P-value > 0.05: Non-significant; P-value < 0.05: Significant; •: Independent t-test

*Table 3. Comparison between the patients studied regarding U/S findings*

| | | GERD BEFORE SURGERY | | | TEST VALUE | P-VALUE |
|---|---|---|---|---|---|---|
| | | Total | No (Group 1) | Yes (Group 2) | | |
| | | No. = 100 | No. = 28 | No. = 72 | | |
| FATTY LIVER GRADES | Grade (0) | 10 (10%) | 1 (3.6%) | 9 (12.5%) | 4.588* | 0.205 |
| | Grade (1) | 21 (21%) | 9 (32.1%) | 12 (16.7%) | | |
| | Grade (2) | 53 (53%) | 15 (53.6%) | 38 (52.8%) | | |
| | Grade (3) | 16 (16%) | 3 (10.7%) | 13 (18.1%) | | |
| GALLBLADDER STONES | No | 21 (21%) | 6 (21.4%) | 15 (20.8%) | 1.004* | 0.948 |
| | Yes | 79 (79%) | 22 (78.6%) | 57 (79.2%) | | |

P-value > 0.05: Non-significant; P-value < 0.05: Significant; *: Chi-square test

*Table 4. Comparison between group 1 & 2 patients regarding GERD questionnaire, Hiatal Hernia, GERD grades before & after in addition to type of surgery*

| | | GERD GRADES BEFORE SURGERY | | | TEST VALUE | P-VALUE |
|---|---|---|---|---|---|---|
| | | Total | No (Group 1) | Yes (Group 2) | | |
| | | No. = 100 | No. = 28 | No. = 72 | | |
| QUESTIONNAIRE | Mean ± SD | 10.24 ±2.93 | 6.36 ± 0.83 | 11.75 ± 1.87 | 14.699• | 0.000 |
| | Range | 4 –15 | 4 – 7 | 8 – 15 | | |
| HIATAL HERNIA | No | 65 (65%) | 28 (100%) | 37 (51.4%) | 20.940* | 0.000 |
| | Yes | 35 (35%) | 0 (0%) | 35 (48.6%) | | |
| GERD GRADES BEFORE SURGERY | No | 28 (28%) | 28 (100%) | 0 (0%) | 23.936* | 0.000 |
| | Yes | 72 (72%) | 0 (0%) | 72 (100%) | | |
| | A | 19 (19%) | 0 (0%) | 19 (26.3%) | | |
| | B | 48 (48%) | 0 (0%) | 48 (66.7%) | | |
| | C | 4 (4%) | 0 (0%) | 4 (5.6%) | | |
| | D | 1 (1%) | 0 (0%) | 1 (1.4%) | | |
| GERD GRADES AFTER SURGERY | No | 42 (42%) | 11(39.2%) | 31 (43.1%) | 0.118* | 0.732 |
| | Yes | 58 (58%) | 17(60.8%) | 41 (56.9%) | | |
| | A | 40 (40%) | 10 (35.7%) | 30 (41.6%) | | |
| | B | 15 (15%) | 7 (25.1%) | 8 (11.1%) | | |
| | C | 3 (3%) | 0 (0%) | 3 (4.2%) | | |
| | D | 0 (0%) | 0 (0%) | 0 (0%) | | |
| SURGERY | LRYGB | 21(21%) | 4 (14.3%) | 17 (23.6%) | 1.057* | 0.304 |
| | LSG | 79(79%) | 24 (85.7%) | 55 (76.4%) | | |

P-value > 0.05: Non-significant; P-value < 0.05: Significant. *: Chi-square test; •: Independent t-test
(LRYGB= Laparoscopic Roux-en-Y Gastric Bypass, LSG=Laparoscopic Sleeve Gastrectomy)

## 4. Discussion

Obesity is a global health concern with increasing prevalence and is associated with many comorbidities, including T2DM, HTN, and GERD.1,10 Bariatric surgery remains the most effective strategy for the management of morbid obesity, primarily through weight loss mechanisms such as gastric volume restriction, malabsorption, and metabolic changes.[3] However, the impact of bariatric procedures on GERD remains debatable, with conflicting findings in the literature.[5]

Our aim in the current study was to assess GERD by EGD in patients who had undergone bariatric surgery. This study evaluated GERD outcomes in 100 patients undergoing bariatric surgery. Preoperatively, GERD was diagnosed in 72% of cases, with 35% presenting with hiatal hernia (HH). Postoperative follow-up after one year revealed that GERD symptoms were resolved in 43.1% of affected patients, while 56.9% experienced persistent symptoms. Additionally, 60.7% of previously GERD-free individuals developed de novo GERD following Laparoscopic Sleeve Gastrectomy (LSG), whereas no cases of GERD worsening or new onset were recorded in the Laparoscopic Roux-en-Y Gastric Bypass (LRYGB) group. These findings align with prior studies, indicating a higher likelihood of GERD persistence and development post-LSG compared to RYGB. [11,12]

The pathophysiology behind GERD post-LSG includes altered gastric anatomy, reduced lower esophageal sphincter pressure, and increased intragastric pressure. The disruption of his angle and the reduction of gastric compliance further exacerbate reflux symptoms. Burgerhart et al. [13] and Gorodner et al.[14] reported that LES dysfunction and changes in the gastric anatomy contribute significantly to reflux exacerbation. A systematic review by So et al.[15] found a 19% increase in GERD symptoms and a 23% incidence of de novo GERD post-LSG. Barrett's

esophagus, a severe GERD complication, was observed in 6% of post-LSG cases, emphasizing the need for vigilant follow-up.[15] Moreover, increased intra-abdominal pressure following LSG can elevate transient lower esophageal sphincter relaxations, further contributing to GERD progression.

In contrast to our findings, some studies suggest that LSG does not affect GERD. Rebecchi et al. (2018) followed patients who underwent LSG for up to two years, dividing them into two groups: those with preoperative esophageal acid exposure (Group A) and those with normal preoperative pH monitoring (Group B). Their results indicated symptom improvement in Group A, while only 5.4% of Group B developed de novo GERD. The authors attributed these findings to precise surgical techniques, including avoiding mid-gastric stenosis and performing a careful dissection of the His angle to maintain a safe distance from the gastroesophageal junction.[16] However, Patti et al. raised concerns regarding the study's conclusions due to the loss-to-follow-up rate, and some patients with abnormal pH results were excluded.[17] Similarly, Daes et al. (2020) reported a notable reduction in GERD symptoms after LSG. Among 66 patients with preoperative GERD, only two (1.5%) experienced persistent symptoms within one year post-surgery. The study highlighted specific technical factors that may influence GERD outcomes, including fundus dilation, persistent hiatal hernia, and narrowing at the incisura angularis. The authors emphasized that performing a complete fundus resection, routinely correcting hiatal hernias, and preventing sleeve narrowing or torsion significantly reduced the need for postoperative endoscopy for GERD symptoms.[18] However, the study's reliability is limited due to a 50% loss to follow-up, which may impact the generalizability of its findings. While these studies suggest that GERD may improve post-LSG, the variability in patient outcomes underscores the importance of careful surgical planning and individualized patient assessment to minimize reflux-related complications.

Conversely, RYGB significantly improves GERD outcomes by altering the gastrointestinal anatomy, diverting bile acids, reducing gastric acid exposure, and lowering intra-abdominal pressure.[19] Several studies, including a Swedish nationwide cohort study [20], demonstrated GERD resolution rates of up to 95.4% post-RYGB. Additionally, LES pressure increased postoperatively, and esophageal acid exposure decreased, further supporting RYGB as the preferred option for GERD management in obese individuals. The anatomical modification involved in RYGB allows for effective acid clearance and reduced esophageal exposure to reflux, contributing to symptom resolution. A systematic review and meta-analysis by Adil et al. (2019) evaluated the effect of RYGB on GERD and found significant symptom improvement in 93% of cases, with histological regression of Barrett's esophagus in 54.7% of patients.[19]

Preoperative esophagogastroduodenoscopy (EGD) is crucial for detecting GERD and HH, guiding surgical decision-making.[21] Identification of hiatal hernia preoperatively can influence the choice of procedure, as concurrent hiatal hernia repair during LSG may help mitigate GERD risk.[22] Postoperative EGD remains valuable for identifying complications, including Barrett's esophagus and persistent GERD.[23] Future research should incorporate advanced diagnostic modalities, such as pH monitoring, to better classify GERD severity post-bariatric surgery. Additionally, prospective studies with extended follow-up durations are necessary to clarify the long-term impact of bariatric procedures on esophageal function and GERD progression.

### *4. Conclusion*

LRYGB showed greater improvement in reflux symptoms, while GERD outcomes after LSG remained variable. The impact of bariatric surgery on GERD remains inconsistent in the literature. Pre-operative EGD is recommended to assess GERD or hiatal hernia, which may influence surgical decisions, while postoperative EGD is valuable for detecting complications. Larger, long-term controlled studies using objective diagnostic techniques, such as EGD, HRM (High Resolution Manometry), and pH-MII (Multi-channel Intra-luminal Impedance), are needed to enhance understanding and guide clinical practice.

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The authors have no financial interest to declare in relation to the content of this article.

## Authorship

All authors have a substantial contribution to the article

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## Conflicts of interest

There are no conflicts of interest.

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