Cost Effectiveness of Bariatric Surgery as a Treatment for Morbid Obesity: A Literature Review

Muhammad Ali Karim¹, Sumiya Altaf², W Gordon Mackay³ and AbdulMajid Ali⁴

1 Department of Surgery, University Hospital Ayr, UK
2 King AbdulAziz Medical City, UK
3 Institute of Healthcare Associated Infection, University of the West of Scotland, UK
4 Consultant General and Upper GI Surgeon, University Hospital Ayr, University of the West of Scotland, UK

1 Background

Obesity is no less than an epidemic with current reports forecasting a substantial strain on health economies if appropriate intervention is not actively instituted. It is estimated that there are 1.1 billion adults worldwide that are classified as being overweight or obese (Haslam & James, 2005). The rising prevalence of obesity is a major public health concern as excess body weight has significant health implications, in particular cardiovascular disease, diabetes mellitus, musculoskeletal problems and cancer (Clinical Guidelines on the Identification, 1998).

According to the Public Health England report 2014, 24.7% of adults aged 16 years and above are obese (body mass index ≥ 30kg/m²) and the prevalence of obesity in England has significantly increased since 1993 (National Obesity Observatory, 2014). By 2015, the Foresight Report estimates that 36% of males and 28% of females aged between 21 and 60 years of age will become obese. By 2050, it is predicted that obesity will affect up to 60% of adult men, 50% of adult women and 25% of children (Butland et al., 2007).
At present, obesity costs the UK economy £7 billion and the National Health Service (NHS) £2 billion per year. The projected future costs to the economy may increase to a staggering £45 billion with costs to the NHS £6.5 billion by the year 2050 (Butland et al., 2007).

The escalation of obesity has resulted in bariatric surgery becoming more readily available and gaining popularity. The estimated number of bariatric operations performed in the United States alone in 2008 was thirteen-fold higher than the number performed in 1992 (Dumon & Murayam, 2011).

Types of bariatric operations may be classified as either restrictive, malabsorptive or a combination of both. Restrictive procedures include adjustable gastric band (AGB), vertical banded gastroplasty (VGB), sleeve gastrectomy and intragastric balloon insertion (Elder & Wolfe, 2007; Stanczyk et al., 2007). Malabsorptive procedures include biliopancreatic diversion/ duodenal switch and jejunoileal bypass (Shabbir et al., 2009). Roux-en-Y gastric bypass (RYGB) is a commonly performed procedure that is both restrictive and malabsorptive (Maggard et al., 2005). Since the advent of laparoscopic approach and further development of techniques in bariatric surgery, there has been a reduction in post-operative complications and overall improved favourable outcomes after surgery (Abell & Minocha, 2006; Hutter et al., 2006; Reoch et al., 2011).

There is ongoing research investigating the outcomes of bariatric surgery, both at regional and national levels. There are already several published studies that explore the health benefits of bariatric surgery with focus on patients’ quality of life and obesity-related health conditions (Ashrafian et al., 2008; Buchwald et al., 2004; Sjöström et al., 2004; 2012).

Cost saving is a term applicable to preventative care that decreases future costs. When the outcomes of an intervention are significant then this is considered to be cost effective (Goodell et al., 2009).

A number of published economic evaluation studies have demonstrated the impact of bariatric surgery on health services and economics. With the advent of weight loss surgery being relatively new, long term outcomes remain largely unclear. The purpose of this review is to address the early cost effectiveness of bariatric surgery and speculate on long term health and financial benefits.

2 Search Structure and Methodology

2.1 Data Sources and Study Selection

A comprehensive electronic search of Ovid database was performed. Ovid, MEDLINE, EMBASE, EBM Reviews: Cochrane Database of Systematic Reviews and EBM Reviews: Cochrane Central Register of Clinical Trials, NHS Economic Evaluations Database and Health Technology Assessments Database were searched for all relevant articles written in the English language that described cost effectiveness of bariatric procedures in adult populations (age > 18 years). All clinical trials and economic evaluation studies published from 1996–2012 were searched for relevant articles.
Data was searched for articles comparing either:

- Cost effectiveness of bariatric surgery versus medical treatment (diet and exercise) / pharmacological treatments) for obesity
- Pre- and post-operative cost implications of different bariatric procedures
- Direct and indirect economic impact of bariatric surgery on health care systems
- Impact of bariatric surgery on quality of life, morbidity related to obesity, cost effectiveness in QALY

Full articles were retrieved applying the selection criteria to the abstracts and titles. Randomised controlled trials (RCT), perspective cohort studies, retrospective cohort studies and articles describing laparoscopic or open bariatric procedures were included. All included articles were obtained and read by two reviewers. The findings were discussed and tabulated (see Table 1). Literature reviews and studies on animals, childhood obesity or those without clear outcomes on the cost effectiveness of bariatric surgery and any publication not in the English language were excluded.

2.2 Primary Economic Evaluation

In this review, all three types of economic evaluations were included (cost benefit analysis, cost effectiveness analysis and cost utility analysis) in order to obtain a detailed representation of economic evaluations carried out in the field of bariatric surgery. The direct impact on health care services can be measured by assessing the outcomes of bariatric surgery patients compared to non-surgical groups in terms of excess weight loss, gained QALY, improved or resolved comorbid conditions like diabetes, reduction in medications, decreased hospital visits or in-hospital stays and incremental cost and cost effectiveness ratios (ICER). Below the terms used in economic evaluations are briefly explained.

Cost benefit analysis: Cost benefit analysis shows the overall costs and benefits of an intervention. It evaluates the excess of monetary benefits over the costs (Palmer et al., 1999).

Cost utility analysis: Cost utility analysis measures the effect of an intervention on both the quantitative and qualitative aspects of health using measures such as Quality Adjusted Life Years (QALY’s) gained (Waxman, 2013).

Cost effectiveness analysis (CEA): Cost effectiveness analysis shows what it costs to achieve a certain effect. In cost effectiveness analysis, costs and benefits are measured in non-comparable units e.g., life years gained, improvement in physical health status etc.

The incremental cost-effectiveness ratio (ICER): ICER of an intervention is defined “as the ratio of the change in costs of a therapeutic intervention (compared to the alternative, such as doing nothing or using the best available alternative treatment) to the change in effects of the intervention” (Waxman, 2013).

Direct costs of obesity consist of expenditure on disease prevention, diagnosis and treatment. Indirect costs of obesity include reduced economic output mortality, decreased productivity at work, unemployment and decreased time at work.
2.3 Methodology of Cost Effectiveness Studies

The economic evaluation studies included in our research are RCTs, observational case control studies and prospective studies based on an economic model or a decision tree. Cost effectiveness analysis of bariatric surgery is usually performed using decision trees or Markov models to estimate the effects prospectively over a long time frame. For this review, data was extracted from previously published studies, health databases and payer-sourced cost data. This selection also comprises of sensitivity testing used for each model. This can aid policy makers and health economists to evaluate the benefits of bariatric services provision in a given population.

3 Search Results

A total of 949 articles were obtained at the first stage of the search. Seventy five articles met the inclusion criteria in the second stage. Further exclusion resulted in 36 articles in the third stage. Full articles were then extracted and a fourth stage manual search was carried out that yielded 26 relevant articles with clear methodology and outcomes.

![Flow chart of search methodology and structure.](image)
4 Descriptive and Tabular Analysis of Relevant Studies

At the end of the structured search strategy, 26 relevant articles were to be included in this literature review. There were seven RCTs, ten model-based observational studies, six retrospective cohort studies and three case-control observational studies. To achieve comprehensive and organized data results, these 26 studies are categorised by their primary objectives.

4.1 Bariatric surgery versus No Treatment/Standard Treatment

This group included studies comparing costs of either bariatric surgery versus no treatment for obese patients, bariatric surgery versus standard medical treatment for obese patients or specific bariatric procedure versus no treatment or standard care.

In this group were 16 articles. A comprehensive description of methodology, results and conclusions of these studies is shown in Table 1. Of all studies comparing bariatric surgery with no treatment or standard care, 11 studies reported cost effectiveness results of bariatric surgery as costs / QALYs gained. Five studies have estimated direct economic impact of bariatric procedures on health services. From the payers’ perspective, the long term cost utility of surgery compared to non-surgical management is convincing with ICUR ranging from $1,000–$40,000 per QALY.

A study by Craig et al. estimated cost effectiveness of gastric bypass surgery compared to no treatment and reported that gastric bypass surgery is dominantly cost effective with ICER = $5,000–$16,100 / QALY for women and $10,000–$35,600 / QALY for men over lifetime (Craig & Tseng, 2002).

The cost effectiveness of laparoscopic adjustable gastric band (AGB) and laparoscopic Roux-en-Y gastric bypass (RYGB) as treatment for morbid obesity was compared to no treatment. This study by Campbell et al. showed 100% probability that AGB and RYGB are cost effective over lifetime at willingness to pay of $50,000 (Campbell et al., 2010).

Studies by Anselmino et al and Ackroyd et al. were based on health economic models and compared cost effectiveness of bariatric surgery to the standard care treatment of obese patients in six European countries. The results showed that both adjustable gastric band and Roux-en-Y gastric bypass are cost effective over a period of 5 years in diabetic patients in Spain and United Kingdom, and cost saving in Germany, Austria, Italy and France (Anselmino et al., 2009; Ackroyd et al., 2006).

Three studies (Makary et al., 2010; Maciejewski et al., 2010; Crémieux et al., 2008) have estimated the overall pre-operative, operative and post-operative economic impact of bariatric surgery. They have shown similar results with immediate post-operative costs being higher as compared to the pre-operative period but these costs adopt a downward trend at 6 months post-operatively. Fifteen months after surgery, monthly savings are estimated to be around $400–$600 for open bariatric procedures ($p < 0.01$) and $> $900 for laparoscopic bariatric surgery in as early as 13 months following surgery ($p < 0.01$). This decline in the cost post-operatively is attributed to the decrease in medication use, number of outpatient clinics and laboratory investigations especially in
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<tr>
<td>Makary et al., 2010</td>
<td>Retrospective time series; 2,235 obese type 2 DM patients 2002 – 2005</td>
<td>To study medication utilisation and annual health care costs in patients with type 2 DM before and after bariatric surgery</td>
<td>Mean age 48.4 years, type 2 DM</td>
<td>Bariatric surgery (pre- and post-op), pharmacological treatment</td>
<td>Pre-procedure health care cost = $6376 Mean procedure cost = $29,959 Post-procedure cost: Year 1 = 10% more than pre-op Year 2 = 34% less Year 3 = 70% less</td>
<td>After surgery, the proportion using at least one diabetic medication decreased to 25.3% at 6 months, 19.4% at 12 months, and 15.5% at 24 months</td>
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<td>Hoerger et al., 2010</td>
<td>CDC-RTI (Centre for Disease Control and Prevention - RTI Diabetes cost effectiveness model)</td>
<td>Cost effectiveness of bariatric surgery in patients with type 2 DM (newly diagnosed and obese patients with established DM)</td>
<td>BMI ≥ 30, age 35-74 years, DM</td>
<td>AGB, RYGB, standard care</td>
<td>RYGB = $7000/QALY, 2.21 QALYs gained (incident DM); $12,000/QALY, 1.70 QALY’s gained (prevalent DM); AGB = $11,000/QALY, 1.57 QALYs gained (incident DM); $13,000/QALY, 1.34 QALYs gained (prevalent DM)</td>
<td>95% probability that RYGB cost effective for 45 – 54 years ranged from $2,300 – $27,000; 95% probability that AGB cost effective for 45 – 54 years ranged from $0 – $35,000</td>
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<td>Keating <em>et al.</em>, 2009</td>
<td>2 year randomized control trial, 60 obese patients in Australia</td>
<td>To determine the within trial cost efficacy of surgical therapy relative to conventional therapy for achieving remission of DM in class I and II obese patients</td>
<td>BMI 30 – 40, recently diagnosed type 2 DM</td>
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<tr>
<td>Maciejewski <em>et al.</em>, 2010</td>
<td>Retrospective longitudinal cohort study of health care use and expenditures from 2000 – 2006; 846 obese veteran patients</td>
<td>To examine health care utilization and expenditures of severely obese individuals before and after bariatric surgery within the veterans health administration</td>
<td>Mean BMI = 48.5, mean age 51 years, 73% males</td>
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</table>
| Keating et al., 2009 | Randomized control trial, 60 obese patients in Australia | To determine the within trial cost efficacy of surgical therapy relative to conventional therapy for achieving DM remission in class I and II obese patients (modeled life time analysis) | BMI 30 – 40, recently diagnosed type 2 DM | Laparoscopic AGB, standard care | Health care savings = 2,400AUD
QALYs gained = 1.2/patient
Time horizon = life time | Probability of surgical therapy being dominant is 57% with DM remission in ≥2 years and for being cost effective is 98% with DM remission in ≥10 years |
| Crémieux et al., 2008 | Case control observational study, 3651 cases and 3651 controls, multivariate study 1999 – 2005 | A study on the economic impact of bariatric surgery | BMI ≥ 40, mean age = 44 years, 86% females, 10 common comorbid conditions in both groups | Bariatric surgery; standard care | 15 months after surgery monthly savings > $500 for the whole sample, $400 – $600 for open bariatric procedure (p < 0.01), laparoscopic bariatric surgery > $900 at 13 months following surgery (p < 0.01) | Costs associated with open surgery are recovered within 49 months (95% CI, 35 – 63 months)
Costs associated with laparoscopic surgery are recovered within 25 months (95% CI, 16 – 34 months) |

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<td>McEwen et al., 2010</td>
<td>Randomized control trial, 221 patients 2001 - 2005</td>
<td>To assess cost, quality of life impact and the cost utility of bariatric surgery</td>
<td>Mean BMI = 52, mean age = 42 years, 88% females, 36% DM, managed care population</td>
<td>97% RYGB; standard care</td>
<td>Incremental cost/QALY = $48,662 (2 years), $1,425 (lifetime)</td>
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<td>Maklin et al., 2011</td>
<td>Prospective study based on Markov model and decision tree</td>
<td>To evaluate the cost-utility of bariatric surgery compared to ordinary treatment in Finnish health care system</td>
<td>Mean BMI = 47, mean age = 43 years, 35% males, DM</td>
<td>AGB, RYGB, SG, standard care</td>
<td>Incremental cost of bariatric vs. standard care = –23,375€, AGB = –7,476€, RYGB = –17,288€, SG = –15,733€ Time horizon = 10 years</td>
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<td>Hayashi et al., 2011</td>
<td>Retrospective cohort study, n = 176, 94 bariatric population (group I), 34 clinical (group II), 48 surgical controls (group III)</td>
<td>Four year hospital resource utilization after bariatric surgery: comparison with clinical and surgical controls</td>
<td>Group I BMI = 52.2 ± 10; Group II BMI = 33.8 ± 5; Group III BMI = 23.8 ± 4; age = 18 - 59 years, all females, DM</td>
<td>RYGB; standard care, colorectal surgery</td>
<td>Outpatient visits: Group I = 5.7 ± 0.2/year, Group II = 10.5 ± 0.9/year, Group III = 3.5 ± 0.8/year Time horizon = 5 years</td>
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All bariatric procedures show strong dominance over standard care (1.5x more expensive over 10 years)
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<td>Salem et al., 2008</td>
<td>Based on payer-perspective decision analytic model of 3 year operative and non-operative interventions for morbid obesity</td>
<td>To evaluate the incremental cost effectiveness of bariatric procedures compared with non-operative weight loss interventions and with each other</td>
<td>BMI = 40 – 60, Age = 35 – 55 years, 0% DM</td>
<td>Laparoscopic AGB, laparoscopic RYGB, standard care</td>
<td>ICER in males = $11,604/QALY for AGB compared with $18,543/QALY for RYGB; ICER in females = $8878/QALY for AGB compared with $14,680/QALY for RYGB (lifetime)</td>
<td>Both operations were cost effective at &lt; $25,000/QALY</td>
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<td>Sampalis et al., 2004</td>
<td>Observational two cohort study between 1986 – 2002, bariatric group n = 1,035, control group n = 5,746</td>
<td>To assess the impact of weight reduction surgery on health related costs</td>
<td>BMI = 38 – 69, mean age = 45 years, 0% DM</td>
<td>RYGB, VBG, standard care</td>
<td>5 years absolute difference of cumulative costs = CDN $6,000,000 per 1,000 patients in both groups</td>
<td>Initial costs of surgery can be amortized over 3.5 years; RYGB alone reduces 29% of total direct health care costs</td>
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<td>Craig et al., 2002</td>
<td>Observational study, n = 608 14 years</td>
<td>To estimate the cost effectiveness of RYGB in the treatment of severe obesity</td>
<td>BMI = 40 – 50, age = 35 – 55 years, 0% DM</td>
<td>RYGB, no treatment</td>
<td>ICER = $5000 – $16,100/QALY for women, $10,000 – $35,600/QALY for men (lifetime)</td>
<td>RYGB is cost effective sensitive to excess weight loss</td>
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<th>Ikramuddin et al., 2009</th>
<th>Prospective observational study based on CORE diabetes model, ( n = 204 ), 2 years</th>
<th>To assess the cost effectiveness of RYGB compared to medical management for treating type 2 DM</th>
<th>Mean BMI = 48.4, mean age = 50 years, 78% females, 100% DM</th>
<th>RYGB; standard care</th>
<th>ICER = $23,510/QALY gained Time horizon = 35 years</th>
<th>84% probability that RYGB cost effective over 35 years at a willingness to pay of $50,000</th>
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<tr>
<td>Anselmino et al., 2009</td>
<td>Perspective observational study based on health economics model in Austria, Italy and Spain</td>
<td>To assess cost effectiveness and budget impact of obesity surgery in type 2 DM in three European countries</td>
<td>BMI ( \geq 35 ), 100% DM</td>
<td>AGB, RYGB, standard care</td>
<td>AGB and RYGB are cost effective over 5 years time in DM patients in Spain and are cost saving in Austria and Italy</td>
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<tr>
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<th>Intervention/Control</th>
<th>Country</th>
<th>Results</th>
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</table>
| Ackroyd et al., 2006 | Perspective observational study based on health economics model in Germany, UK and France | To assess cost effectiveness and budget impact of obesity surgery in type 2 DM in three European countries | BMI ≥ 35, 100% DM | AGB, RYGB, standard care | Germany | AGB = -3488€/QALY RYGB = -3754€/QALY 
France | AGB = -4357€/QALY RYGB = -4385€/QALY 
UK | AGB = 1929€/QALY RYGB = 1517€/QALY 
Time horizon = 5 years | AGB and RYGB are effective at 5 year follow up and cost saving in Germany and France; cost effective in the UK |
| Campbell et al., 2010 | RCT, n = 43 5 years | To assess cost effectiveness of laparoscopic AGB and RYGB as treatment for morbid obesity | BMI > 35, mean age = 40 years, 82% females, 2% DM | Laparoscopic AGB; laparoscopic RYGB; no treatment | Incremental costs/QALY gained $6,033 (lifetime) 
$6,256 (lifetime) | 100% probability that laparoscopic AGB and RYGB are cost effective over lifetime at willingness to pay of $50,000 |

**Table 1:** Cost Effectiveness of Bariatric Surgery compared to No Treatment / Non-Surgical Treatment of Obesity. 
Abbreviations: AGB, adjustable gastric band; AUD, Australian dollar; BMI, body mass index; DM, diabetes mellitus; QALY, quality adjusted life year; RCT, randomised controlled trial; RYGB, Roux-en-Y gastric bypass; SG, sleeve gastrectomy; VBG, vertical banded gastroplasty
diabetic patients (Hayashi et al., 2011). Conclusively according to these studies, the overall cost of the procedure performed is recuperated by the third post-operative year.

An economic evaluation by Sampalis et al. showed the initial costs of surgery can be amortised over 3.5 years (Sampalis et al., 2004). It also showed that gastric bypass surgery alone reduces 29% of the total direct health care costs. Cost effectiveness analysis of studies shows that bariatric procedures are most effective clinically and economically in diabetic obese patients compared to non-surgical treatment. The outcomes of four studies (Makary et al., 2010; Hoerger et al., 2010; Keating et al., 2009; Keating et al., 2009) have all shown improvement or remission of diabetes mellitus after surgery with a significant decrease of up to 70% in diabetic medications by these patients in the third post-operative year and ICURs of $7,000–$10,000 over a 10 year time horizon. Mean duration of diabetes remission must be > 2 years to be cost effective and > 10 years to be cost saving.

According to Maklin et al. all types of bariatric procedures show strong dominance over conventional care which is 1.5 times more expensive over a 10 year period (Maklin et al., 2011). A previous study Salem et al. concluded that both laparoscopic RYGB and laparoscopic AGB were cost effective at $25,000 / QALY (Salem et al., 2008). Among different types of commonly performed bariatric procedures, AGB has led to an increased QALY gained and cost savings when compared to non-surgical management in the diabetic population (Maklin et al., 2011).

4.2 Comparison of Different Bariatric Procedures

This group includes studies comparing costs of either:

- One type of bariatric surgery to another
- Laparoscopic bariatric procedures versus open bariatric procedures
- Longitudinal cost-benefit analysis of one type of bariatric surgery
- Direct and indirect economic impacts of one type of bariatric surgery

A total of eight studies were included in this group. Two of the studies compared the cost of selected procedures, two studies mentioned direct and indirect cost effects of a single procedure and other studies showed the longitudinal cost analysis (cost-benefit analysis) of a single procedure. A comprehensive tabular description of these studies along with their methodology, search results and conclusions is shown in Table 2.

Three, studies have compared the costs of laparoscopic RYGB, laparoscopic AGB and laparoscopic VBG (Nguyen et al., 2001; 2009; Ojo & Valin, 2009). Their results conclude that RYGB is the most costly procedure, followed by AGB and VBG. These costs are incurred as RYGB is a lengthier and technically complex operation requiring further equipment for multiple anastomoses. AGB and VBG have comparable pre-operative and immediate post-operative costs but the intra-operative cost of instruments is greater for AGB.

Laparoscopic procedures are more cost effective when compared to open bariatric procedures despite their higher initial cost of surgery which is adequately offset by lower inpatient hospital costs, shorter hospital stay and post-surgical outcomes in terms of weight loss, less post-operative complications and improved quality of life (Crémieux et al., 2009; McEwen et al., 2010; Nguyen et al., 2001).
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<tr>
<td>Nguyen et al., 2009</td>
<td>Prospective randomized trial, n = 250 2002 – 2007</td>
<td>To compare the outcomes, quality of life, and costs of laparoscopic RYGB vs. laparoscopic AGB</td>
<td>BMI = 35 – 60, age = 18 – 60 years, 0% DM</td>
<td>Laparoscopic RYGB, laparoscopic AGB</td>
<td>Total costs: RYGB = $12,310 AGB = $10,766 (p &lt; 0.01)</td>
<td>RYGB costs more than AGB due to longer operative time and hospitalisation</td>
</tr>
<tr>
<td>Finkelstein et al., 2011</td>
<td>Cost benefit analysis based on medical claims data 2006 – 2008 MEPS n = 134 NHWS n = 2164</td>
<td>To estimate direct and indirect costs and potential savings of laparoscopic AGB among obese DM patients</td>
<td>BMI ≥ 35, age = 18 – 64 years, 20% DM</td>
<td>Laparoscopic AGB</td>
<td>Net savings in 5 years increase from $26,000 to $34,000 when indirect costs are included</td>
<td>Inclusion of indirect costs improves the financial outlook for laparoscopic AGB</td>
</tr>
<tr>
<td>Ojo et al., 2008</td>
<td>Prospective non-randomised study, laparoscopic VBG n = 59, laparoscopic AGB n = 83 2005 – 2006</td>
<td>To compare the cost of two gastric restrictive procedures</td>
<td>BMI = meeting criteria for surgery, age = 18 – 65 years</td>
<td>Laparoscopic VBG, laparoscopic AGB</td>
<td>Pre-op and immediate post-op cost similar in both; laparoscopic AGB instruments cost, band fills costs and post-op complications are higher</td>
<td>VBG required less expensive instruments and materials and was associated with a higher rate of weight loss and fewer complications</td>
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<td>Gemert et al., 1999</td>
<td>Prospective study, n = 21</td>
<td>To estimate the direct and indirect cost effectiveness of VBG for the treatment of morbid obesity</td>
<td>Mean BMI = 47.2, mean age = 33.1 years, 24% DM</td>
<td>VBG</td>
<td>VBG total costs = $5,865; QALY gained after VBG = 12 years; increase in paid labour from 19%-48%</td>
<td>For treatment of morbid obesity VBG saves $4,004 - $3,928/QALY</td>
</tr>
<tr>
<td>Nguyen et al., 2006</td>
<td>Retrospective study, n = 77</td>
<td>To estimate the reduction in prescription medication costs after laparoscopic RYGB</td>
<td>BMI = 38 – 65, age = 17 – 63 years, 71% females, 34% DM</td>
<td>Laparoscop-ic RYGB</td>
<td>Significant reduction in medication use after surgery, medication discontinue rate was 98% GERD, 87% HTN, 85% DM, 87% hyperlipidemia</td>
<td>Mean cost saving per patient after 1 year post- op $168/month, $2016/year</td>
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<tr>
<td>Finkelstein et al., 2011</td>
<td>Retrospective case control study, cases n = 7310, controls n = 7306</td>
<td>To quantify the costs and potential cost savings resulting from coverage for laparoscopic AGB using a claims analysis</td>
<td>BMI &gt; 35, mean age = 44 years, 12% DM</td>
<td>Laparoscop-ic AGB</td>
<td>Net cost of coverage for laparoscopic AGB was reduced to 0 by approx 4 years after band placement in non-DM and 2 years in DM patients</td>
<td>Laparoscopic AGB procedure pays for itself within a relatively short period, especially for those with DM</td>
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Table 2: Comparison of Cost Effectiveness / Longitudinal Cost Analysis of different Bariatric Procedures. Abbreviations: AGB, adjustable gastric band; BMI, body mass index; DM, diabetes mellitus; GERD, gastroesophageal reflux disease; HTN, hypertension; MEPS, Medical Expenditure Panel Survey; NHWS, National Health and Wellness Survey; QALY, quality adjusted life year; RYGB, Roux-en-Y gastric bypass; VBG, vertical banded gastroplasty

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<td>Mullen et al., 2010</td>
<td>Observational pre-post test design, n = 224 2000-2007</td>
<td>To assess the effect of RYGB surgery on the total cost of medical care for morbidly obese members</td>
<td>BMI ≥ 30, mean age = 43 years, 82% females</td>
<td>RYGB</td>
<td>Surgical costs recouped at 3.5 years post-surgery</td>
</tr>
<tr>
<td>Nguyen et al., 2001</td>
<td>Prospective randomised trial, laparoscopic RYGB n = 79, open RYGB n = 76, 1999-2001</td>
<td>To compare outcomes, quality of life and costs of laparoscopic and open RYGB</td>
<td>BMI = 40 – 60, mean age = 40 years</td>
<td>Laparoscopic RYGB, open RYGB</td>
<td>Operative costs are higher for laparoscopic RYGB but hospital costs are lower</td>
</tr>
</tbody>
</table>
Net cost savings per QALY of three commonly performed bariatric procedures are as follows:

- Vertical banded gastroplasty = $4,004–$3,928 / QALY (Nguyen et al., 2006)
- Roux-en-Y gastric bypass = $23,000 / QALY (Ikramuddin et al., 2009)
- Adjustable gastric band = $25,000 / QALY (Salem et al., 2008)

4.3 Studies Showing the Effect of Bariatric Surgery on Paid Employment

Two studies were included which addressed the subsequent indirect effect, with focus on employment potential. A case series survey undertaken in southwest England by Hawkins et al. in which 59 patients were assessed for a mean of 14 months after bariatric surgery. The proportion in paid work rose from 58% before surgery, to 76% after surgery which was comparable to the normal population average. There was also 57% increase in total time worked per week. The total number of benefits claimed had fallen by 75% (Hawkins et al., 2007).

Ewing et al. carried out a cost-benefit analysis of bariatric surgery in the southern plains of Texas from 2003–2005. Their findings showed obesity led to a loss of 1,977 jobs and decreased indirect business tax revenues by over $13 million per year. Bariatric surgery yields an economic benefit of between $1.3–$9.9 billion. The net benefit consists of the upfront costs of the surgical procedure and ongoing gains from improvements in each individual’s productivity (Ewing et al., 2001).

5 Limitations and Potential for Future Studies

Most of the studies included in our review are prospective observational studies based on economic models. The major limitation of published cost effectiveness models is that observational data and relatively short term RCT data were used to model the long term impacts. These models may overestimate the economic attractiveness of weight loss surgery despite carrying out a wide range of sensitivity analysis. Further models will be more relevant if they include population-based estimates of risk and outcomes and more accurate payer-sourced cost data.

There is a lack of long term RCTs comparing the outcomes and economic impact of each bariatric procedure. This is required in order to conclude the most appropriate and cost effective surgical procedure recommended for a defined group of obese individuals.

Most of the studies measure the cost effectiveness of surgery by calculating the direct immediate costs on health care resources. Although this is easily calculated, it is however incomplete as it does not account for post-operative indirect costs. Further studies that incorporate indirect costs would provide a more comprehensive sum of the economic impact of bariatric surgery.

Exclusion of non-English language studies and studies that did not show cost effectiveness of bariatric surgery and were not published may also be a source of bias.
6 Conclusion

Based upon published literature, bariatric surgery is cost effective in short term analysis and cost saving over a prolonged period of time compared to conventional treatment for obesity. The comparison between all types of bariatric procedures shows strong dominance over traditional care which is 1.5 times more costly over 10 years.

Both open and laparoscopic bariatric surgery is cost effective. However laparoscopic surgery appears more cost effective when compared with open surgery. Costs associated with open surgery can be recovered within 49 months and costs associated with laparoscopic surgery can be recovered as early as 25 months post-surgery.

No definitive conclusion can yet be drawn on the cost effectiveness of each bariatric operation. Roux-en-Y gastric bypass and adjustable gastric banding both are cost effective with incremental cost effectiveness ratios of $25,000 per quality adjusted life years. Adjustable gastric banding is relatively more cost effective over shorter periods of time in diabetic obese patients. However costs associated with band fills impact negatively on cost effectiveness. Dominance of any one procedure over the other also appears to depend on the region and patient selection.

After including the indirect economic impact of bariatric surgery on workers’ productivity along with the direct impact on health services, the overall economic effectiveness of bariatric surgery may become even more significant.

Abbreviations

AGB  Adjustable gastric band
AUD  Australian dollar
BMI  Body mass index
CEA  Cost effectiveness analysis
DM  Diabetes mellitus
GERD Gastroesophageal reflux disease
HSE  Health Survey for England
HTN  Hypertension
ICER Incremental cost effectiveness ratio
ICUR Incremental cost utility ratio
MEPS Medical Expenditure Panel Survey
NHWS National Health and Wellness Survey
NHS National Health Service
RCT Randomised controlled trial
RYGB Roux-en-Y gastric bypass
QALY Quality adjusted life year
VBG Vertical banded gastroplasty
References


