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Araştırma Makalesi ● Research Article

Cost Effectiveness of Bariatric Surgical Treatment Methods: A Systematic Review

Bariyatrik Cerrahi Tedavi Yöntemlerinin Maliyet Etkililiği: Sistematik Bir İnceleme

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Abstract: Obesity has become an epidemic today and has become one of the important public health problems. Pharmacological treatment, exercise, cognitive behavioral therapy, medical nutrition, and bariatric surgery are used in the treatment of obesity. The aim of this study is to systematically identify and evaluate the national and international literature on the cost-effectiveness of bariatric surgery methods. In this context, a systematic search of electronic databases was conducted. Screening, data extraction, and critical assessment of methodological quality were evaluated according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS). Incremental cost-effectiveness ratio (ICER) and cost per quality-adjusted life year (QALY) were interpreted using the outcome measure. A total of 448 articles were accessed and the full text of 164 articles was analyzed. Within the framework of inclusion and exclusion criteria, 20 articles were included in the study. According to the studies in the literature, bariatric surgery is a low-cost or cost-saving treatment option in the long term. There is limited evidence about the long-term clinical effects and safety of bariatric surgery. Therefore, further studies in this context will significantly contribute to the results of cost-effectiveness studies.

Keywords: Bariatric Surgery, Cost Effectiveness Analysis, Systematic Review.

Öz: Obezite günümüzde salgın haline gelerek önemli halk sağlığı sorunlarından biri olmuştur. Obezite tedavisinde farmakolojik tedavi, egzersiz, bilişsel davranışçı terapi, tıbbi beslenme ve bariyatrik cerrahi gibi yöntemler uygulanmaktadır. Bu çalışmanın amacı bariyatrik cerrahi yöntemlerinin maliyet etkililiği hakkındaki ulusal ve uluslararası literatürü sistematik olarak tanımlamak ve değerlendirmektir. Bu kapsamda elektronik veri tabanlarında sistematik bir araştırma yapılmıştır. Tarama, veri çıkarma, metodolojik kalitenin kritik değerlendirmesi Konsolide Sağlık Ekonomisi Değerlendirme Raporlama Standartları [Consolidated Health Economic Evaluation Reporting Standards (CHEERS)] göre değerlendirilmiştir. İlave maliyet-etkililik oranı (İMEO) ve kaliteye ayarlı yaşam yılı (QALY) başına maliyet sonuç ölçütü kullanılarak yorumlanmıştır. Araştırmada toplam 448 makaleye ulaşılmış ve 164 makalenin tam metni incelenmiştir. Dahil etme ve çıkarma

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kriterleri çerçevesinde 20 makale araştırma kapsamına alınmıştır. Literatürdeki çalışmalara göre bariyatrik cerrahi, uzun zaman diliminde düşük maliyetli veya maliyet tasarrufu sağlayan bir tedavi seçeneği olduğu görülmüştür. Bariyatrik cerrahinin uzun vadeli klinik etkileri ve güvenliği hakkında sınırlı kanıt bulunmaktadır. Bu nedenle konuyla ilgili daha fazla çalışmanın yapılması maliyet-etkililik çalışmalarının sonuçlarına önemli derece katkıda bulunacaktır.

Anahtar Kelimeler: Bariyatrik Cerrahi, Maliyet Etkililik Analizi, Sistematik Tarama.

Introduction

One of the biggest public health problems of our time is obesity, which is also defined as an epidemic disease (Swinburn et al., 2011). Overweight (BMI≥25 kg/m^2) and obesity (BMI≥30 kg/m^2) are when abnormal or excessive fat accumulation reaches a level that poses a risk to the health of the individual (WHO, 2022). While 15% of the adult population (764 million) in the world was obese in 2020, it is predicted that this rate will increase to 18% (1.025 million) in 2030 (Lobstein et al., 2022: 19). While 36% of individuals aged fifteen and over were overweight and 29% were obese in 2019 in Türkiye, it is estimated that this rate will be 50% in 2030 (Lobstein et al., 2022: 22; Ministry of Health, 2022: 21). Obesity causes many diseases such as diabetes, dyslipidemia, hypertension, cardiovascular disease, polycystic ovary syndrome, sleep apnea, depression, and cancer. The public health is gravely threatened by this circumstance (TEMD, 2017: 27–54). Besides the effects of obesity and obesity-related disorders such as causing disability, decreasing in life expectancy, and health-related quality of life in obese individuals (Wang et al., 2011) they also cause increase in cost (Okunogbe et al., 2021). It can be said that the treatment of obese individuals is significant from an individual and social perspective, both in terms of health and economy.

In the treatment of obesity, there are different methods such as medical nutrition, exercise, and cognitive behavioral therapy, including pharmacological and surgical treatment (TEMD, 2017: 53–104). Surgical treatment accelerates the healing process by providing faster weight loss compared to other treatment methods (Chang et al., 2014; Picot et al., 2009). These surgical methods can be named as adjustable gastric band (AGB), sleeve gastrectomy (SG), roux-en-Y gastric bypass (RYGB), gastric bypass (GB), biliopancreatic diversion ± duodenal switch (BPD-DS), and mini gastric bypass (MGB). These methods can be performed as closed (laparoscopic (L)) or open (O), and differ in terms of mechanism of action, weight loss, advantages, and disadvantages (O'Brien et al., 2019; TEMD, 2018). Economic evaluation studies are used to compare the costs and outcomes of these methods used in the treatment of obesity (Picot et al., 2009). Although there are different types of economic evaluation, generally four of these techniques named are applied in the studies cost-minimization analysis (CMA), cost-benefit analysis (CBA), cost-utility analysis (CUA), and cost-effectiveness analysis (CEA) (Briggs and O'brien, 2001: 179; Çelik, 2016). CEA and CUA are the most widely used economic evaluation techniques (Drummond et al., 2015). One of the common techniques used to measure health outcomes in economic evaluations is quality-adjusted life years (QALY) (Ara and Braizer, 2014: 130; Kobelt, 2010: 45). The measure of health in the QALY ranges from "1" (perfect health) to "0" (death). "1" QALY represents a year spent in perfect health (Fox-Rushby and Cairns, 2005: 8). The cost per effectiveness is measured by the incremental cost-effectiveness ratio (ICER). In other words, ICER measures the cost per QALY and enables the selection of the most suitable alternative among all alternatives (Gafni and Birch, 2006: 2091). Economic evaluations are vital studies that compare the costs and results of two alternative treatment methods. Additionally, economic evaluation studies are paramount for the optimization of resource allocation, informing decision-makers, enhancing patient outcomes, and ensuring the sustainability of healthcare services (Rudmik & Drummond, 2013, p. 1341). Specifically, these studies may assume even greater significance when addressing conditions with elevated costs for both the healthcare system and public health, such as obesity (Tremmel et al., 2017, pp. 440–442). Bariatric surgery, identified as an efficacious intervention in obesity treatment, is acknowledged to incur higher costs compared to alternative therapeutic modalities (Jacobsen et al., 2022), and the global prevalence of individuals opting for this surgical approach continues to rise steadily (Welbourn et al., 2019, p. 788). Within this context,

economic evaluation studies pertaining to bariatric surgery are being conducted to optimize resource allocation and provide guidance for decision-makers. The aim of this study is to systematically examine these studies on the cost-effectiveness of bariatric surgery methods in the treatment of obesity. In this context, the study is important in terms of providing up-to-date evidence-based information to decision makers, academics and other relevant stakeholders by evaluating the existing literature.

Method

A literature screening was conducted using Pubmed, Web of Science, Science Direct, and EBSCHO databases between 2000 and 2022. The search words were determined as obesity, obesity treatment, bariatric surgery, cost-effectiveness analysis, and cost-utility analysis. The search criteria in the study are as follows: (1) written in English, (2) published between 2000 and 2022, (3) patients having obesity-related surgeries, (4) comparing the bariatric surgery and non-surgical interventions, (5) comparing the costs and effectiveness of the methods (6) full-text availability (7) being conducted with cost-effectiveness analysis or cost-utility analysis. The PICOS cycle for the study is given in Table 1 below.

Table 1. PICOS Research Question Setting Tool

PICO (S)	Inclusion Criteria
P (Patient/Problem/Population)	Patients diagnosed with obesity
I (Intervention)	Bariatric Surgery (SG, GB, RYGB, AGB)
C (Comparison)	Non-surgical treatment methods
O (Outcomes)	Health Outcomes (QALYs, DALYs, LYG, ICER)
S (Study design)	Cost-Effectiveness Analysis (CEA), Cost-Utility Analysis (CUA)

By using the determined search words, the articles meeting the criteria in the relevant databases were initially classified separately, subsequently merged, and duplicates were removed. After the duplicates were removed, the abstracts of the articles were examined. And 20 articles were included in the scope of the study. The study was prepared according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). The flow chart of the study prepared according to the PRISMA directives is shown in Figure 1.

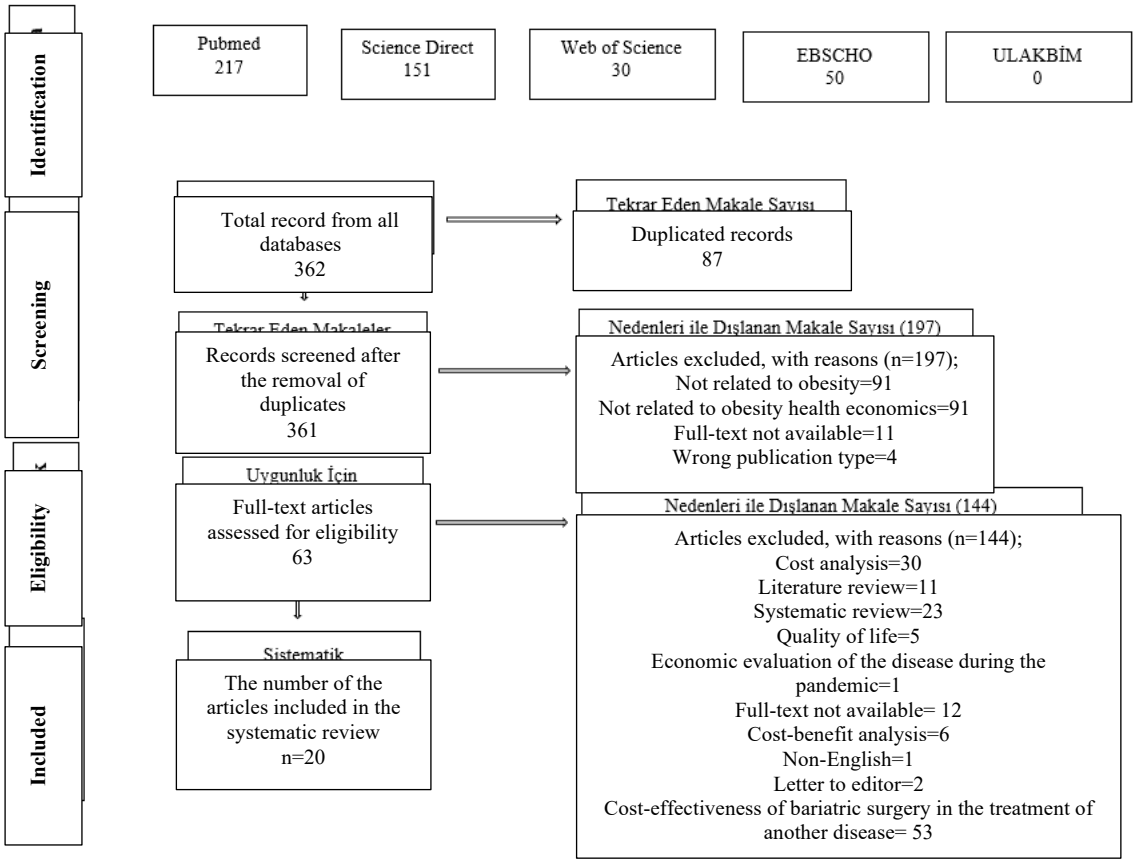

Figure 1. PRISMA flow chart

In the study, Pubmed, Science Direct, Web of Science, EBSCHO, and ULAKBİM databases were searched, and 448 articles were reached. Duplicate articles were removed, and a title review was conducted. Finally, within the framework of inclusion criteria, the full text of 164 articles were examined and 20 articles were examined within the scope of the study.

In addition, the CHEERS score (the risk of bias and the quality of the study) was evaluated by the researchers. The CHEERS (Consolidated Health Economic Reporting Standards) checklist is used in systematic review studies examining economic evaluation studies (Gerkens et al., 2008). In this study, the critical assessment of screening, data extraction, and methodological quality was evaluated according to the Consolidated Health Economic Reporting Standards (CHEERS) published in Turkish (Saygin Avsar et al., 2023). CHEERS checklist evaluates the quality of economic evaluation studies. In this list, which is used for full economic evaluations and consists of 24 items, each item is formed with a score. Full economic evaluation studies with 20-24 score (80% and above) are considered high quality, those with 15-19 score (60%-80%) are considered medium quality, and studies with less than 14 score (60% and below) are calculated as low quality (Husereau et al., 2013). When the methodological quality of the studies was evaluated according to the CHEERS checklist, all were found to be high quality, except for one study which was found to be medium quality (Faria et al., 2013).

Results

As a result of the systematic reviewing process, 20 articles meeting the inclusion criteria were examined in detail. It was seen that 50% of the published articles were published between 2013-2017 and most of them in 2017 and 2018 (5 articles for both). As for the country, more than half of the studies were conducted in developed European countries such as England (2), Spain (2), Belgium (1), Italy (1), Finland (1), Denmark (1), Germany (1), and Sweden (1).

Table 2. Characteristics of the Articles Examined in the Systematic Review

Characteristics	**N**	**%**
Publication Year		
2008-2012	3	15
2013-2017	10	50
2018-2022	7	35
Intervention Type		
LSG, LAGB, LRYGB	11	55
LAGB-LRYGB	3	15
LGB	1	5
LAGB- LRYGB	1	5
LRYGB and LSG	3	15
LRYGB, ORYGB, and LAGB	1	5
Perspective of the Study		
Public	2	-
Reimbursement	19	-
Sensitivity Analysis		
Used	20	100
Not-used	-	-
Country		
European Countries	10	50
Countries in the Americas	6	30
Asian Countries	2	10
Australia	1	5
Non-specified	1	5
Discount Ratio		
1.5%	-	-
3%	13	65
3.5%	2	10
5%	4	20
No discount	1	5
Time period		
10 years	2	10
10 years and lifetime	7	35
Lifetime	9	45
Other	2	10
Cost-effectiveness Ratio Report		
ICER reported	20	100
Non-reported	-	-

It was determined that the studies examined within the scope of the systematic review were mostly conducted in the USA (5 of the studies). Half of the articles (55%) aimed to examine the cost-effectiveness of bariatric surgery methods, SG, AGB, and RYGB, compared to standard care. In other studies, the treatment of the examined method was compared with the standard care by considering fewer methods instead of 3. Nineteen of the studies were conducted from a reimbursement institution and one from a public perspective. In addition, a study was conducted from both a reimbursement institution and a public perspective. Afterward, studies were examined in terms of whether sensitivity analysis was carried out or not. It is seen that, in all of the studies, sensitivity analysis was conducted. Also, 65% of the studies set the discount ratio to 3%, while the time period in 45% of the studies was lifetime. Other studies determined the time periods as 3-4-5 years, 30 years, and 80 years. Included studies consist of cost-effectiveness analysis (65%) and cost-utility analysis (35%) (Table 2). Detailed information about the research parameters of the studies examined is given in Table 3 below.

Table 3. Research Parameters on the Cost-Effectiveness of Bariatric Surgery Methods

No	Author(s)	CHEERS score	Type of Intervention(s)	Perspective of the	Country	Time Period	Study Design	Discount Ratio (%)	ICER
1	Borisenkon et al., 2018;	23 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution	Belgium	10 years and lifetime	Markov	3	BC, compared to traditional medical treatment, in 10 years ICER: 2.809 € BC is dominant for lifetime, compared to traditional medical treatment
2	Lucchese et al., 2017	23 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution	Italy	10 years and lifetime	Markov	3	BC, compared to traditional medical treatment, in 10 years ICER:2.412 € BC is dominant for lifetime, compared to traditional medical treatment
3	Borisenko, Lukyanov, and Ahmed, 2018	21 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution	England	10 years and lifetime	Markov	3-5	BC, compared to traditional medical treatment, in 10 years ICER:3.294 € BC is dominant for lifetime, compared to traditional medical treatment
4	Borisenko, Lukyanov, et al., 2017	23 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution.	Denmark	10 years and lifetime	Markov	3	BC, compared to traditional medical treatment, in 10 years ICER: 17.818 DKK BC is dominant for lifetime, compared to traditional medical treatment
5	Borisenko, Mann, and Dupree, 2017	23 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution.	Germany	10 years and lifetime	Markov	3	BC, compared to traditional medical treatment, in 10 years ICER: 2.457 € BC is dominant for lifetime, compared to traditional medical treatment
6	Borisenko et al., 2015	21 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution.	Sweden	Lifetime	Markov	3	BC is dominant for lifetime, compared to traditional medical treatment
7	Sanchez-Santos et al., 2018	24 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution	Spain	10 years and lifetime	Markov	3	BC, compared to traditional medical treatment, in 10 years ICER: 5.966 € BC is dominant for lifetime, compared to traditional medical treatment
8	Mäklin et al., 2011	22 High quality	BC (GB, SG, AGB) and traditional medical treatment	Reimbursement institution.	Finland	10 years	Markov	3	BC is dominant in 10 years, compared to traditional medical treatment
9	Alsumali et al., 2018	23 High quality	SG, GB, AGB, and traditional	Reimburse	USA	Lifetime	Markov	3	GB, compared to traditional medical treatment, for lifetime ICER = 5.446 $

			medical treatment					SG, compared to traditional medical treatment, for lifetime ICER = 7.655 $ AGB, compared to traditional medical treatment, for lifetime ICER = 8.214 $
10	Castilla et al., 2014	22 High quality	GB and not getting treated	Reimbursement institution	Spain	Lifetime	Markov	3	GB, is dominant for lifetime, compared to not getting treated
11	Campbell et al., 2010	22 High quality	AGB, GB, and not getting treated	Reimbursement institution	USA	Lifetime	Markov	3	AGB, compared to not getting treated, for lifetime ICER: 5.400 $ GB, compared to not getting treated, for lifetime ICER: 5.600 $
12	Klebanoff et al., 2017	23 High quality	BC (GB, SG) and not getting treated	Reimbursement institution	USA	5 years	Markov	-	BC, compared to not getting treated, in 5 years ICER: Dominant
13	Song et al., 2013	21 High quality	BC (AGB, GB, SG) and traditional medical treatment	Reimbursement institution	South Korea	Lifetime	Markov	5	BC, compared to traditional medical treatment, for lifetime ICER: 1.771 $
14	Faria et al., 2013	14 Medium Quality	AGB, GB, and traditional medical treatment	Public	Non-specified	Lifetime	Markov	3	GB, compared to traditional medical treatment, for lifetime ICER: Dominant
15	Lester et al., 2021).	22 High quality	BC (AGB, GB, SG), traditional medical treatment, and not getting treated	Reimbursement institution and public	Canada	10 years and lifetime	Markov	5	BC, compared to not getting treated in 10 years, from the reimbursement institution perspective ICER: 19.990 $ BC, compared to not getting treated in 10 years, from the public perspective ICER: Dominant BC compared to not getting treated for lifetime, from the reimbursement institution perspective ICER: 14.080 $ BC, compared to not getting treated for lifetime, from the public perspective ICER: Dominant
16	James et al., 2017	24 High quality	AGB, SG, GB, and traditional medical treatment	Reimbursement institution	Australia	Lifetime	Markov	5	AGB, compared to traditional medical treatment, for lifetime ICER: 24.454 $ GB, compared to traditional medical treatment, for lifetime ICER: 22.645 $ SG, compared to traditional medical treatment, for lifetime ICER: 27.523 $

17	Salem et al., 2008	21 High quality	AGB, GB, and traditional medical treatment	Reimbursement institution	USA	Lifetime	Decision-Analytic Model	3	AGB, compared to traditional medical treatment, for lifetime ICER: in men11.604 $ in women 8.878 $ GB, compared to traditional medical treatment, for lifetime ICER: in men 18.543 $; in women 14.680 $
18	An et al., 2020	21 High quality	BC (GB, SG) and traditional medical treatment	Reimbursement institution	South Korea	Lifetime	Markov	5	BC, compared to traditional medical treatment, for lifetime ICER: 674 $
19	Panca et al., 2018	23 High quality	SG, GB, and not getting treated	Reimbursement institution	England	Lifetime	Markov	3-5	GB, compared to not getting treated, for lifetime ICER: in men 2.018 £; in women 2.005 £ SG, compared not getting treated, for lifetime ICER: in men 1.978 £; in women 1.941 £
20	Wang et al., 2014	21 High quality	LGB, OGB, LAGB, and traditional medical treatment	Reimbursement institution.	USA	Lifetime	Decision-Analytic Model	3	LGB, compared to traditional medical treatment, for lifetime ICER: 6.600 $ LAGB compared to traditional medical treatment, for lifetime ICER: 6.200 $ OGB compared to traditional medical treatment, for lifetime ICER:17.300 $

Examining the research parameters of the studies included, it was seen that different BS methods were compared with traditional medical treatment with not getting treated. In cases where BS methods are not considered separately and evaluated as a whole, it has been determined that the percentages of the usage of the methods differ in studies. In addition, it was observed that BS methods were applied laparoscopically in all of the studies, except for one (Wang et al., 2014). The Markov model was used in 90% of the studies (18 of them) and the decision analytical model was conducted in 10% (Table 4). Detailed information about the articles obtained as a result of the systematic screening is given below.

In the study conducted by Borisenko et al. in Belgium, it was found that 75% of BS patients were treated with GB, 20% with SG, and 5% with AGB. It was assumed that the patients treated with the traditional medical treatment method were treated by going to the general practitioner twice a year. In the study, BS and traditional medical treatment were compared over 10 years and a lifetime period. Compared to traditional medical treatment over a 10-year time period, BS treatment has been found to provide 1.3 QALYs and a lifetime QALYs was 5. In addition, the ICER of BS treatment over 10 years compared to traditional medical treatment and was determined as €2,809 per QALY. In the lifetime period, BS has been found to be a cost-effective strategy compared to traditional medical treatment (Borisenko et al., 2018).

Lucchese and the rest of the research team compared BS with traditional medical treatment over a 10-year and lifetime period. 37.2% of BS patients were treated with IGB, 34.6% with SG and 28.2% with GB. Cases in which there is no lifestyle intervention, behavior change, or any treatment were discussed under the scope of traditional medical treatment. Compared to traditional medical treatment over a 10-year time period, BS treatment was found to provide of 1.1 QALYs and a lifetime of 3.2 QALYs. Over a 10-year time period, BS treatment had an ICER of € 2,412, compared to the traditional

medical treatment. BS treatment has also been found to be a cost-effective method in a lifetime period (Lucchese et al., 2017).

Borisenko, Lukyanov, and Ahmed found in their study conducted in England that, 56% of BS patients were treated with GB, 22% with SG, and 22% with AGB. The patients who were treated with the traditional medical treatment were given medication and put on diet and physical exercises. The study compared BS with traditional medical treatment over a 10-year and lifetime period. Compared to traditional medical treatment over a 10-year time period, BS treatment was found to provide of 1.7 QALYs and a lifetime of 4 QALYs. By comparing with traditional medical treatment, BS was also found to provide ICER of €3,294 per QALY. In the lifetime period, the BS treatment method was found to be a cost-effective method (Borisenko, Lukyanov, and Ahmed, 2018).

In the study carried out by Borisenko and Lukyanov in Denmark, BS and traditional medical treatment methods were compared and analyzed over a 10-year and lifetime period. 68.8% of BS patients were treated with GB, 31% with SG and 0.2% with AGB. In this study, traditional medical treatment methods consisted of medication, diet, and physical exercise. Compared to traditional medical treatment over a 10-year time period, BS treatment was found to provide of 1.1 QALYs and a lifetime of 2.9 QALYs. Over a 10-year time period, BS treatment had an ICER of 17,818 Danish krone (DKK). In the lifetime period, the BS treatment method has been found to be cost-effective compared to traditional medical treatment (Borisenko, Lukyanov et al., 2017).

A study, carried out by Borisenko, Mann, and Dupree in Germany, has declared that 52% of the BS patients were treated with GB, 33% with AGB and 17% with SG. It is assumed that traditional medical treatment patients' treatments were carried out by going to the general practitioner and dietitian. BS and traditional medical treatment were compared over a 10-year and a lifetime period. By comparing the traditional medical treatment over a 10-year time period, BS treatment was found to provide of 1.2 QALYs and a lifetime of 3.2 QALYs. The BS treatment methods were dominant over the lifetime period and had an ICER of €2,457 per QALY in 10 years (Borisenko, Mann, and Dupree, 2017).

In Sweden, a study was carried out by Borisenko et al. in which 98% of the BS patients were treated with GB, 1.6% with SG and 0.4% with the AGB method. Medication, diet, and exercise were considered as traditional medical treatment procedures. Then, traditional medical treatment and BS treatments were compared in a lifetime period. As a result, BS was found to be a cost-effective treatment strategy, with of 4.1 QALYs, compared with traditional medical treatment (Borisenko et al., 2015).

A study to compare BS and traditional medical treatment over a 10-year and lifetime period was made in Spain. 76% of BS patients were treated with GB, 22% with SG, and 2% with AGB. Diet, exercise, and behavior modifications were assumed to be traditional medical treatment procedures. According to the results of the analysis, BS provides 1.6 QALYs and ICER of €5,966 over traditional medical treatment in 10 years and 4.4 QALYs in lifetime. In the lifetime period, BS is found to be the dominant method (Sanchez-Santos et al., 2018).

In the study conducted in Finland, 68 of the BS patients were treated with GB, 30% with SG, and 2% with AGB. In traditional medical treatment, it was assumed that the patients were treated with medication, exercise, and diet. Traditional medical treatment and BS over a 10-year time period were compared. BS has been found to provide 0.58 QALYs over 10 years compared to traditional medical treatment and is also a cost-effective treatment method (Mäklin et al., 2011).

Alsumali et al. carried out a study in the USA to compare SW, SG and AGB bariatric surgery methods with traditional medical treatment methods. Traditional medical treatment methods consisted of diet, exercise, and medication. GB provided 1.9, SG 1.37, and AGB 0.93 QALYs over traditional medical treatment over a lifetime period. Compared to traditional medical treatment over a lifetime period, GB's ICER was found to be $5,446, SG's ICER $7,655 and AGB's ICER $8,215 per QALY. Among BS methods, GB was detected to be the dominant choice in the lifetime period compared to traditional medical treatment (Alsumali et al., 2018).

Castilla et al. conducted a study in Spain to compare GB and not getting treated. In a lifetime period, GB has been identified as a cost-effective treatment strategy, with of 5.63 QALYs compared to no treatment (Castilla et al., 2014).

The purpose of the study by Campbell et al. was to compare the costs and consequences of GB, AGB and no treatment options in the USA. It was determined that GB provided 2.9 QALYs and AGB provided 2.04 QALYs, compared to not getting treated for lifetime. And also, by comparing with not getting treated, GB has been found to provide ICER of $5,600 per QALY AGB $5,400. GB and AGB are cost-effective strategies compared to not getting treated (Campbell et al., 2010).

In the study conducted in the USA by Klebanoff et al., BS versus not getting treated was compared. 70.6% of BS patients were treated with GB and 29.4% with SG method. Over a 5-year time period, BS was found to be a cost-effective method, yielding 0.35 QALYs compared to no treatment (Klebanoff et al., 2017).

A study by Song et al., in South Korea has compared BS with traditional medical treatment. Diet, exercise, and medication are considered to be traditional medical treatment procedures. Of the patients with BS, 76.4% were treated with AGB, 18% with GB and 0.056% with SG. Compared to no treatment, BS was found to provide 0.86 QALYs for a lifetime period. In addition, it was stated that the BS treatment method is a cost-effective option with an ICER of $1,771 per QALY (Song et al., 2013).

In the study conducted by considering the global patient population, GB and AGB were compared with traditional medical treatment (diet, exercise, and medication). In a lifetime period, GB has been found to be a cost-effective BS method, with of 1.9 QALYs compared to traditional medical treatment (Faria et al., 2013).

Lester et al. conducted a study in Canada to compare BS and traditional medical treatment (diet, exercise, and medication) and not getting treated. In the study, it is seen that equal numbers of BS patients were treated with GB, SG, and AGB methods. Compared to no treatment, BS methods have been found to provide 1.33 QALYs in a 10-year time period from the public perspective, and 1.35 QALYs for the reimbursement institution perspective. In a lifetime period, it provided 4.22 QALYs in both perspectives. Compared to no treatment for the reimbursement institution perspective, BS's ICER was found to be $19,900 per QALY for 10-year and $14,080 for a lifetime period (Lester et al, 2021).

The study by James et al. in Australia was conducted to compare GB, SG, and AGB which are bariatric surgery methods and diet, exercise, and medication which are traditional medical treatment methods. AGB has been found to provide 0.5, GB 0.71, and SG 0.77 QALYs over traditional medical treatment for a lifetime period. By comparing it with traditional medical treatment, the ICER of the IGB was found to be $24,454, GB's $22,645, and SG's $27,523. As a result, bariatric surgery methods have been identified as cost-effective alternatives (James et al., 2017).

In a study by Salem et al., conducted in the USA, some of the BS methods which are GB, AGB, and traditional medical treatment which consists of diet, exercise, and medication, were compared in men and women separately. Compared to traditional medical treatment for a lifetime period, the ICER of AGB was found to be $8,878 per QALY in women and $11,604 in men. Additionally, the ICER of GB per QALY in women was detected as $14,680 and $18,543 in men. GB and AGB were found to be the dominant treatment methods (Salem et al., 2008).

A study was conducted by An et al. to compare BS with traditional medical treatment (diet, exercise, and medication) in South Korea. 50% of the BS patients were treated with GB and 50% with SG method. BS has been found to provide 0.348 QALYs and $674 ICER per QALY for a lifetime period, compared to traditional medical treatment. As a result, BS was determined as the dominant method (An et al., 2020).

SG and GB methods and not getting treated were evaluated in England by Panca et al. It has been determined that GB provides 5.57 QALYs in men and 5.66 QALYs in women, compared to no treatment for a lifetime period. The ICER per QALY was found to be £2,018 in men and £2,005 in women. It has

been determined that SG provides 5.50 QALYs in men and 5.64 QALYs in women compared to no treatment. The ICER per QALY was found to be £1,978 in men and £1,941 in women. GB and SG were found to be the dominant treatment methods compared to no treatment for a lifetime period (Panca et al., 2018).

Wang et al. compared LGB, OGB, LAGB, and traditional medical treatment (diet and exercise) options in the USA. Comparing it with traditional medical treatment, LGB is found to provide 2.8 QALYs, OGB 2.2 QALYs, and LAGB 2.6 QALYs. Compared to traditional medical treatment for lifetime, LGB treatment was detected to provide $6,600 ICER per QALY, LAGB $6,200 and OGB $17,300. LGB, OGB, and LAGB have been found to be cost-effective treatment methods compared to traditional medical treatment (Wang et al., 2014).

Table 4. Conclusion of the Studies on Cost-Effectiveness of Bariatric Surgery Methods

No	Author(s) and Year	Result(s)
1	Borisenko, Lukyanov, Debergh, et al., 2018;	Bariatric surgery has become cost-effective 10 years after surgery in Belgium. It has been proven to provide lifetime cost savings.
2	Lucchese et al., 2017	Bariatric surgery methods are cost-effective over 10 years and lifetime cost-saving treatments, in Italy.
3	Borisenko, Lukyanov, and Ahmed, 2018	It has been found that lifetime bariatric surgery methods provide cost savings in England.
4	Borisenko, Lukyanov, et al., 2017	In Denmark, Bariatric surgery methods which are found to be cost-effective in 10 years, can provide lifetime savings in healthcare costs for individuals with severe obesity.
5	Borisenko, Mann, and Dupree, 2017	Bariatric surgery is found to be cost-effective 10 years after surgery in Germany. It has also been found that it can reduce the financial burden on the health system for lifetime.
6	Borisenko et al., 2015	Treating patients with bariatric surgery can lead to cost savings in the health system in Sweden.
7	Sanchez-Santos et al., 2018	Bariatric surgery for individuals with morbid obesity is less costly and more effective treatment in Spain compared to traditional medical treatment.
8	Mäklin et al., 2011	Bariatric surgery increases individuals' health-related quality of life and reduces health-related costs. In Finland, bariatric surgery is cost-effective 5 years after surgery.
9	Alsumali et al., 2018	GB is the most cost-effective bariatric surgery method in the USA, compared with SG and AG.
10	Castilla et al., 2014	In Spain, GB is a cost-effective treatment compared to no treatment, lifetime.
11	Campbell et al., 2010	In the USA, GB and AGB provide significant weight loss in patients compared to no treatment and are cost-effective treatment methods.
12	Klebanoff et al., 2017	Bariatric surgery is a cost-effective treatment method for morbidly obese adolescents in the USA, compared to no treatments, in 5 years.
13	Song et al., 2013	For patients with morbid obesity in South Korea, bariatric surgery is a cost-effective method with significant benefits to traditional medical treatments.
14	Faria et al., 2013	Being treated with the GB method is found to be cost-effective compared to traditional medical treatment. It also provides significant savings in healthcare systems by reducing lifetime costs.
15	Lester et al., 2021	Compared to traditional medical treatment in Canada, bariatric surgery is a cost-effective treatment method from a reimbursement institution perspective, while it is the dominant alternative with cost savings from the public perspective.
16	James et al., 2017	In Australia, GB, SG, and AGB are cost-effective treatments over traditional medical treatment, lifetime.
17	Salem et al., 2008	In the USA, GB, and AGB have been identified as cost-effective options over traditional medical treatment, lifetime.
18	An et al., 2020	Bariatric surgery is found to be a cost-effective treatment method compared to traditional medical treatment, lifetime, in South Korea.
19	Panca et al., 2018	In England, GB and SG are cost-effective compared to no treatment for lifetime. GB and SG also significantly improve patient's quality of life.
20	Wang et al., 2014	LGB, OGB and LAGB have been found to be cost-effective treatment methods compared to traditional medical treatment in the USA.

Evaluating the systematic screening findings, bariatric surgery methods were compared with traditional medical treatment and no treatment in 5 years, 10 years, and lifetime. When the outcome findings are examined, bariatric surgery is a treatment method that is more cost-effective and increases the patients' quality of life compared to alternative treatment methods (Table 4).

Discussion and Conclusion

There are systematic review studies conducted on the cost-effectiveness of bariatric surgery in the literature. Although these systematic reviews were carried out for different purposes with different inclusion and exclusion criteria, some of the articles examined in these were also examined in this systematic review.

Studies on bariatric surgery from 1995 to September 2015 were systematically reviewed by Campbel et al. Pubmed, MEDLINE, EMBASE, Scopus, and other databases (American Economic Association, IDEAS, the Cost-Effectiveness Analysis Registry, and the Centre for Reviews and Dissemination) were scanned. As a result, in the study in which 77 economic evaluation studies were examined, 53% of the articles were full and 47% were partial economic evaluation studies. In this systematic review, 8 articles, which were also examined in the study of Campbel et al., were reviewed (Borisenko et al., 2015; J. Campbell et al., 2010; Castilla et al., 2014; Faria et al., 2013.; Mäklin et al., 2011; Salem et al., 2008; Song et al., 2013; Wang et al., 2011). When the results of the relevant research are evaluated, it is seen that the majority (56%) of the articles examined conducted in the USA, held from a reimbursement institution perspective and the direct costs were calculated. Compared to other treatment methods, bariatric surgery has been found to be cost-effective and cost-saving in individuals with high obesity and T2DM (Campbell et al., 2016).

A systematic review was conducted by Xia et al. to meta-analyse surgical and non-surgical methods in the treatment of obesity between 1995 and 2018. The systematic review was updated to cover the September 2015-2018 date range of the study of Campbell et al., and the systematic review was expanded by adding 24 studies, 63% of which were full economic evaluations. All of the full economic evaluation studies were cost-effectiveness analysis (CEA). It was observed that 83% of the studies were conducted from the perspective of the health system/third-party payer and considered the direct costs. Between 1995-2018, 101 economic evaluation studies were found, but a meta-analysis was conducted using 61 of these studies. According to the results of the study, even in the case of excluding indirect costs, bariatric surgery was found to be cost-effective and cost-saving, compared to non-surgical methods. In addition, bariatric surgery was found to be a cost-effective option when the meta-analysis was done from a public perspective. When the costs before and after bariatric surgery were compared, it was seen that BS provides cost savings (Xia et al., 2020). Unlike the research conducted by Xia et al., this study included 2 more studies conducted after 2018 (Lester et al., 2021; An et al., 2020).

In the STD report of 2015-2018 by Louwagie et al., economic evaluation studies on bariatric surgery were systematically reviewed by scanning the EMBASE and MEDLINE databases, and 13 studies were examined. (Louwagie et al., 2019). Unlike the research by Louwagie et al., 2 more articles (Lester et al., 2021; An et al., 2020) were included in this study.

The studies in which the economic evaluation studies on bariatric surgery were systematically examined in the literature have evaluated the articles published between 1995-2018. When the results of the studies were examined, it was determined that bariatric surgery was cost-effective compared to alternative interventions. Unlike other studies, this study included articles published between 2018-2022. In addition, the results of this study support the results of other systematic review studies in the literature. Unlike other systematic review studies, the ULAKBİM database was planned to be scanned, and include studies conducted in Turkey in the review process. However, as a result of the scanning, no study on this particular subject was detected in the ULAKBİM database.

Studies in the literature show that bariatric surgery is a low-cost or cost-saving treatment option for a long period of time. However, there is limited evidence about the long-term clinical effects and safety of bariatric surgery. For this reason, conducting more studies in this context will contribute

significantly to the results of cost-effectiveness studies. It is recommended to conduct economic evaluation studies on bariatric surgery and alternative treatment methods in the treatment of obesity, which is a significant, vital health problem in Turkey.

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