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ORIGINAL CONTRIBUTIONS

Estimated Costs of Clinical and Surgical Treatment of Severe Obesity in the Brazilian Public Health System

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Abstract

Background Obesity is a major global epidemic and a burden to society and health systems. This study aimed to estimate and compare the anual costs of clinical and surgical treatment of severe obesity from the perspective of the Brazilian Public Health System.

Methods An observational and cross-sectional study was performed in three reference centers. Data collection on health resources utilization and productivity loss was carried out through an online questionnaire. Participants were divided in clinical (waiting list for a bariatric surgery) and surgical groups (open Roux-en-Y gastric bypass), and then allocated by the time of surgery (up to 1 year; 1–2 years; 2–3 years; and >3 years). Costs of visits, medications, exams, and surgeries were obtained from government sources. Data on non-medical costs, such as transportation, special diets, and caregivers, were also colleted. Productivity loss was estimated using self-reported income. Costs in local currency (Real) were converted to international dollars (Int$ 2015).

Results Two hundred and seventy-four patients, 140 in surgical group and 134 in clinical group were included. In first postoperative year, the surgical group had higher costs than clinical group (Int$6005.47 [5000.18–8262.36] versus 2148.14 [1412.2–3506.8]; $p = 0.0002$); however, from the second year, the costs decreased progressively. In the same way, indirect costs decreased significantly after surgery (259.08 [163.63–662.72] versus 368.17 [163.62–687.27]; $p = 0.06$).

Conclusion Total costs were higher in the surgical group in the first 2 years after surgery. However, from the third year on, the costs were lower than in the clinical group.

Keywords Obesity · Bariatric surgery · Healthcare costs · Costs and cost analysis

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Introduction

The prevalence of obesity has tripled in the world in the last four decades, increasing from 4.8% in 1975 to 12.8% in 2014. It is expected in 2025 that rate might reach 18% in men and

over 21% in women [1]. In Brazil, the prevalence of self-reported adult obesity is 17.9% [2], with a 6.3% increase in the prevalence of obesity between 2006 and 2014 [3].

The global epidemic of obesity has become a serious public health problem. Bahia et al. estimated the direct costs related to the diseases most commonly associated with overweight and obesity (diabetes, cardiovascular disease, cancer, and osteoarthritis) in the context of the Brazilian Public Health System (SUS) and showed an annual cost of US$2.1 billion with outpatient procedures and hospitalizations. Ten percent of these costs were attributed to the presence of obesity as a risk factor [4].

The medical treatment of obesity is based on dietary interventions and encouragement of physical activity. However, its results are unsatisfactory even when combined with drug therapy [5, 6]. A recent systematic review assessing weight loss associated with the use of several drugs showed that the mean weight loss was only 5% in 52 weeks [7]. Given the difficulties faced during the clinical treatment of obesity, bariatric surgery (BS) has become a more effective treatment option for individuals with severe obesity when compared to non-surgical interventions [8]. Surgical treatment provides greater weight loss, better control of dyslipidemia and hypertension, control or remission of diabetes mellitus type 2 [9, 10], and reduced deaths from cardiovascular disease in the long term [11, 12]. In addition, some studies have shown that surgical treatment is able to reduce the costs of treatment of obesity-related diseases, being a cost-effective intervention in certain contexts [13].

Due to the significant increase in obesity prevalence and its major economic impact, it is important to analyze the costs of the current treatment options for severe obesity in Brazil. The aim of this study was to estimate and compare the costs of clinical and surgical treatment of severe obesity at reference centers for the treatment of obesity funded by the Brazilian Public Health System.

Material and Methods

An observational, cross-sectional and multicenter study was conducted to estimate healthcare costs and loss of productivity during 12 months in obese patients treated at public reference centers. The patients who underwent surgical treatment were selected at Hospital São Lucas (HSL) of the Pontifícia Universidade Católica do Rio Grande do Sul (PUCRS). The patients undergoing clinical treatment were selected at Policlínica Piquet Carneiro of the Universidade do Estado do Rio de Janeiro (PPC/UERJ) and at the Instituto Estadual de Diabetes e Endocrinologia (IEDE) in Rio de Janeiro. They were placed on a waiting list for surgery according to national guidelines of eligibility [14].

The participants were selected consecutively from the medical visit schedule at their treatment centers. Adult patients who had been followed up for longer than 6 months were included in the study. Only patients who underwent the technique of Roux-en-Y gastric bypass by laparotomy were included in the surgical group because the laparoscopic approach is not performed at public centers. They were grouped according to the time since surgery (up to 1 year, 1–2 years, 2–3 years, and >3 years).

Demographic, clinical, and economic data were collected through an interview conducted during medical visits. Subsequently, the medical records were checked to quantify the health resource utilization in the previous 12 months. The research team involved in data collection was previously trained to fill out the electronic form and directly enter data into the online platform. Data were collected from January 2015 to July 2016. All patients signed an informed consent form.

Cost Estimates

Micro-costing approach was used to include a detailed description of the health resources utilization in the previous 12 months. Health resources reported by the patients were multiplied by the cost of each service. Costs were calculated in local currency (Real) and converted to international dollars (Int$) using the purchasing parity power (R$ 1 = Int$ 0.6, year 2015) [15]. Direct medical costs included visits with physicians and other healthcare professionals, laboratory and imaging tests, procedures, surgeries, and medications. Direct non-medical costs included transportation, special and dietetic foods (dietary supplements and diet, light and fat-free food), and home caregivers.

Indirect costs were estimated based on the work hours/days missed (absenteeism), sick leaves, and early retirement due to obesity or its complications. Human capital approach was used, considering that the productivity loss was based on the multiplication of work time missed (hours/days) by its cost (self-reported income). To calculate the probability of each event (absenteeism and sick leave), we divided the number of patients who reported absenteeism and sick leave by the total number of patients in each group.

To calculate the cost of medications and vitamin supplements, we used the Maximum Prices of Medication per Active Ingredient (CMED) of the Brazilian National Health Surveillance Agency (ANVISA) [16], including value-added tax of 18% on the maximum consumer price. The amount paid for health professional visits, diagnostic tests, procedures, surgeries, and hospitalizations was based on the Table of Procedures (SIGTAP) of the Brazilian Public Health System [17]. To calculate the cost of transportation, we considered the average prices of bus and train tickets at the metropolitan areas of Porto Alegre [18, 19] and Rio de Janeiro [20, 21].

Table 1 Demographic and clinical characteristics of the participants

	Surgical group $n = 140$	Medical group $n = 134$	P value
Gender (female, *n*/%)	112 (80%)	114 (84%)	0.42
BMI (mean)	34.9 (±6.99)	46.0 (±8.17)	<0.001
Age (years, mean ± SD)	43.93 ± 9.93	44.21 ± 12.07	0.70
Diabetes (*n*/%)	59 (42%)	57 (42%)	1
Hypertension (*n*/%)	107 (76%)	99 (73%)	0.50
Acute myocardial infarction (*n*/%)	15 (11%)	11 (8%)	0.60
Heart failure (*n*/%)	13 (9%)	17 (13%)	0.50
Stroke (*n*/%)	3 (2%)	7 (5%)	0.21
Sleep apnea (*n*/%)	100 (71%)	51 (38%)	<0.001
Polycystic ovary syndrome (*n*/%)	26 (19%)	25 (19%)	1
Gallstones (*n*/%)	68 (49%)	15 (11.2)	<0.001
Gastroesophageal reflux disease (*n*/%)	37 (26%)	32 (24%)	0.70
Steatosis (*n*/%)	76 (54%)	37 (27%)	<0.001
Varicose ulcers (*n*/%)	37 (26%)	13 (10%)	<0,001
Asthma (*n*/%)	26 (19%)	14 (10%)	0.007
Depression (*n*/%)	73 (52%)	66 (49%)	0.67
Cancer (*n*/%)	2 (1%)	4 (3%)	0.44

Statistical Analysis

Descriptive statistics was performed to investigate the behavior of the variables and the characteristics of the sample. Some analyses of subgroups were carried out to check for possible significant differences. Chi-square and Fisher's exact tests were used for categorical variables, whereas Mann-Whitney U and Student's t test were used for numerical variables using the R software.

Results

We selected 286 patients, 11 patients refused to participate in the study and one patient was excluded because he did not meet the inclusion criteria. Therefore, 274 patients were included, 140 patients in the surgical group, and 134 patients in the clinical group. Table 1 shows the demographic and clinical characteristics of the participants. There was a female predominance in both groups. The surgical group had a higher frequency of comorbidities associated with obesity (sleep apnea, gallstones, hepatic steatosis, asthma, and varicose ulcers); however, no significant difference was found in terms of frequency of diabetes mellitus and cardiovascular diseases; however, there was no significant difference between the groups in terms of total direct costs, but hospitalization costs (bariatric surgery), tests, and transportation resulted in higher costs for the surgical group, possibly due to increased presence of comorbidities.

Table 2 shows the direct medical and non-medical costs of clinical and surgical groups. The surgical group included all patients in the surgical sample, regardless of the time since surgery.

Considering the surgical period, Table 3 shows the comparison of direct medical and non-medical costs between the clinical and surgical groups. In the first year after the surgery, the surgical cost was higher than the clinical treatment, due to hospitalization for bariatric surgery and the need for frequent postoperative monitoring. In the second year after surgery, the total direct surgical costs were already lower than the clinical treatment and it keeps decreasing in the following years. After surgery, a significant decrease in expenses with medication, health professionals visits, dietetic foods, and supplements was observed. However, the costs with exams and procedures remained slightly higher in the surgical group compared to the clinical group.

Table 4 shows the indirect costs according to the postoperative time and in the clinical group. Although the indirect

Table 2 Annual direct costs in the surgical and clinical groups (SUS—2015)

Cost category	SURGICAL ($n = 140$) Int$	CLINICAL ($n = 134$) Int$	P value
Medical costs			
Medications	577.08 (499.2–782.82)	909.72 (406.88–1714.37)	<0.0001
Tests and procedures	201.22 (128.47–317.04)	87.96 (51.30–132.96)	<0.0001
Health professional visits	56.46 (31.56–111)	64.92 (39.12–132.48)	0.03
Hospitalizations[a]	2610.00 (517.41–2610.00)	229.62 (127.68–293.40)	<0.0001
Non-medical costs			
Transportation**	193.32 (84.84–391.38)	179.16 (77.82–358.38)	0.0001
Dietetic foods and supplements	244.8 (129.60–460.80)	504 (144–1188)	0.002
Total direct costs	1671.38 (1138.92–4431.70)	1763.72 (1114.62–2727.65)	0.27

Calculation of costs in international dollar—2015 (Int$). Data expressed as median [interquartile range 25–75]

** transport for visits and tests

[a] Including hospitalization for bariatric surgery in the group up to 1 year

costs decreased significantly after the first year of surgery (40%), they remained higher than in the clinical group. There was an increase in indirect costs between 2 and 3 years, possibly for hospitalizations related to reconstructive plastic surgery and hernia repair.

Table 5 shows the total costs in the surgical groups, according to the time since surgery, and in the clinical group. After the second postoperative year, the cost of the surgical group was lower than the clinical group, and after 3 years, the difference was higher than Int$600.00 per patient in 1 year.

The direct costs are shown in the Graph 1; comparisons between the surgical and clinical groups were made using Mann-Whitney *U* test, surgical <1 year versus clinical $p < 0.001$, surgical 1–2 years versus clinical $p = 1$, surgical 2–3 years versus clinical $p = 0.02$, and surgical >3 years versus clinical $p = 0.001$. The indirect costs are shown in the Graph 2, comparisons between the surgical and clinical groups were made using Mann-Whitney *U* test, surgical <1 year versus clinical $p < 0.001$, surgical 1–2 years versus clinical $p = 1$, surgical 2–3 years versus clinical $p = 0.53$, and surgical >3 years versus clinical $p = 1$.

When comparing patients with and without diabetes mellitus, diabetics were older (47.27 ± 10.53 versus 41.78 ± 10.81 years; $p < 0.001$) and had higher frequency of acute myocardial infarction (17 ± 14.7 versus 9 ± 5.7; $p < 0.02$), heart failure (21 ± 18.3 versus 9 ± 5.7; $p < 0.001$), and hepatic steatosis (57 ± 49.1 versus 56 ± 35.4; $p < 0.02$). Comparing the diabetic and non-diabetic patients in the surgical group up to 1 year after the surgery, there was a higher cost with medications in the diabetic group (Int$763.16 [503.5–1568.47] versus Int$620.97 [406.89–942.24]; $p = 0.003$), with no differences in other comparisons.

Discussion

This study estimated the direct and indirect costs of surgical and clinical treatment of severe obesity based on a primary data collection at reference centers for obesity treatment funded by the Brazilian Public Health System. This study aims to estimate the costs in the perspective of the Brazilian Public Health System, and laparoscopic surgery is only performed in the private health system and not reimbursed in public bariatric centers yet.

The total costs were higher in the surgical group in the first 2 years after surgery; however, from the third year on, there was a significant decrease, reaching lower costs than in the clinical group. Depending on the cost of bariatric surgery, there was no significant difference in total direct costs between the groups, but the surgical group showed lower costs related to medications, health professional visits, and dietetic foods from the second year on. Indirect costs were higher in the surgical group in the first year after surgery compared to the

Table 3 Annual direct costs in the surgical group, according to the time since surgery, and in the clinical group (SUS—2015)

	Surgical Int$				Clinical Int$
Cost category	<1 year ($n = 41$)	1–2 years ($n = 29$)	2–3 years ($n = 24$)	>3 years ($n = 46$)	($n = 134$)
Medical costs					
Medications	561.34 [499.71–792.87]	663.28 [522.10–831.11]	542.76 [424.26–685.96]	555.96 [402.66–774.82]	909.72 [410.59–1699.08]
Tests and procedures	416.58 [337.80–480.96]	231.90 [182.64–255.48]	134.94 [97.02–176.76]	116.04 [102.90–172.32]	87.96 [51.30–132.96]
Health professional visits	90.24 [58.68–153.84]	56.46 [31.56–94.47]	44.46 [29.46–109.05]	36.00 [24–69.36]	64.92 [39.12–129.60]
Hospitalizations[a]	2610.00 [2610.00–2610.00]	415.80 [332.97–415.80]	399.07 [390.69–407.40]	466.62 [415.80–810]	167.74 [74.82–291.48]
Non-medical costs					
Transportation[b]	254.64 [113.21–509.28]	240.48 [129.66–452.70]	169.62 [75.42–370.20]	146.16 [74.47–261.72]	179.16 [77.82–358.38]
Dietetic foods and supplements	360 [198–676.80]	345.60 [230.40–489.60]	180.00 [129.60–252]	136.80 [50.40–288]	504.00 [144–1188.00]
Total direct costs	4661.34 [4431.70–5412.28]	1676.39 [1364.24–2291.45]	1241.31 [854.50–1571.35]	1144.56 [782.92–1446.10]	1763.82 [1114.62–2727.65]

Calculation of costs in international dollar—2015 (Int$). Data expressed as median [interquartile range 25–75]

[a] Including hospitalization for bariatric surgery

[b] Transport for visits and tests

Table 4 Indirect costs in the surgical group according to the time since surgery and in the clinical group in 1 year (SUS—2015)

	Surgical Int$				Clinical Int$
Cost category	<1 year	1–2 years	2–3 years	>3 years	
Patient's absences from work					
N/probability of occurrence	33/80%	23/79%	21/87%	40/86%	85/65%
Cost	1767.95 [526.50–2018.17]	465.33 [283.60–1104.03]	559.08 [190.86–1236.72]	248.82 [165.6–437.7]	348.0 [163.63–683.70]
Patient's sick leaves[a]					
N	6	0	2	3	4
Cost	127.44 [80.24–179.82]	0	162 [135.0–189.0]	170.20 [124.25–193.10]	135.55 [91.53–241.05]
Caregiver's absence from work[b]					
N/probability of occurrence	14/34%	5/17%	2/8.3%	5/10%	23/17%
Cost	507.06 [180–1015.56]	196.32 [118.02–613.24]	247.68 [167.04–328.38]	80.79 [45.51–120.16]	204.54 [76.32–512.72]
Total indirect costs	1171.53 [522.75–3623.01]	459.54 [218.17–1227.27]	673.42 [214.77–2140.90]	259.08 [163.63–662.72]	368.17 [163.62–687.27]

Calculation of costs in international dollar - —2015 (Int$). Data expressed as median [interquartile range 25–-75]. *hours and days of work missed due to health professionals visits, tests, hospitalizations. **hours and days of work missed to take care of the patient.

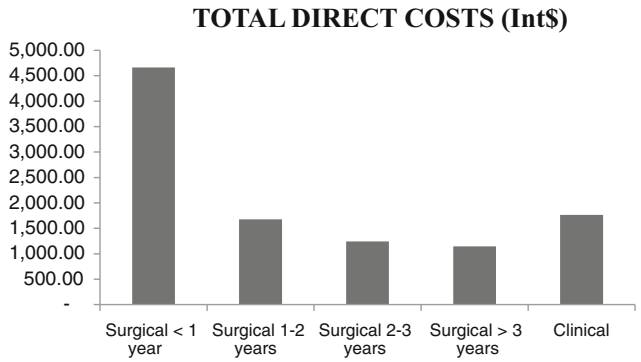
[a] Hours and days of work missed due to health professionals visits, tests, and hospitalizations

[b] Hours and days of work missed to take care of the patient

Table 5 Total costs in the surgical group according to the time since surgery and in the clinical group in 1 year (SUS—2015)

	Surgical				Clinical
Cost category	<1 year (*n* = 41)	1–2 years (*n* = 29)	2–3 years (*n* = 24)	>3 years (*n* = 46)	(*n* = 134)
Direct medical costs	3758.71 [3629.36–4117.44]	1064.83 [775.81–1517.10]	783.45 [662.31–979.57]	760.58 [597.53–1169.84]	1165.11 [667.20–1931.58]
Direct non-medical costs	736.34 [513.36–1193.18]	620.35 [303.86–891.72]	448.06 [209.21–544.42]	276.26 [132.55–510.33]	448.70 [137.83–1000.58]
Indirect costs	1171.53 [522.75–3623.01]	447.44 [238.63–1293.23]	673.43 [214.77–2140.90]	248.86 [159.54–572.21]	368.18 [163.62–687.27]
Total costs	6005.47 [5000.18–8262.36]	2357.02 [1773.34–2948.61]	1999.57 [1112.05–3586.4]	1388.05 [1076.6–2250.2]	2148.14 [1412.2–3506.8]

Calculation of costs in international dollar—2015 (Int$). Data expressed as median [interquartile range 25–75]



Graph 1 Total direct costs (Int$)

clinical group, and despite these costs have decreased progressively after surgery, they remain similar to the clinical group. Even with a worse profile of comorbidities associated with obesity, the surgical group presented a lower cost from the second postoperative year in relation to the clinical treatment, showing a clear economic benefit.

Some international studies corroborate these findings. Cremieux et al. analyzed the economic impact of BS in the USA and showed that the surgical treatment begins to have a lower cost for healthcare facilities 25 months after the surgery, although all its costs take around 6 years to be fully paid for [22]. The Swedish Obese Subjects intervention study demonstrated that until the sixth year after surgery, the cost of the surgical group was higher than the clinical treatment group. However, from the 7th to the 20th year, the cost of surgical group was lower [23].

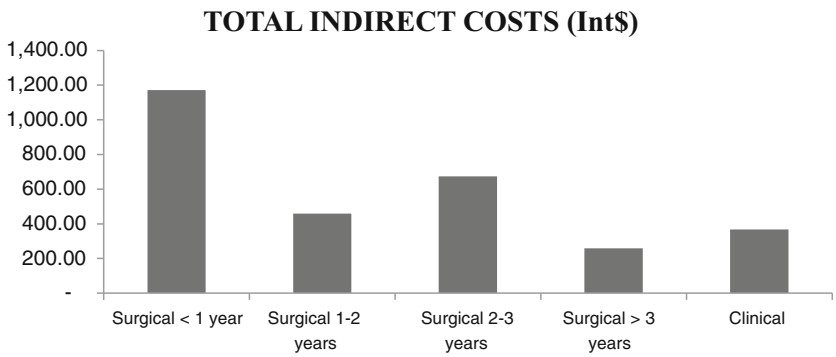
In our study, approximately 20% of total costs consisted of indirect costs, in both groups. This evidence shows the economic consequences of severe obesity to society, because it affects not only the health systems but also the income of individuals and families. This is a specific reason for concern in low- and middle-income countries, where obesity is increasing in lower social classes. A systematic review evaluating the economic costs related to overweight and obesity in adults in the Asia-Pacific region showed that only few studies presented the direct and indirect costs separately [24]. Kang et al. analyzed the cost of obesity and overweight in Korea and showed that the indirect costs accounted for 38% of total costs [25]. In New Zealand, loss of productivity was assessed using two different methods: the friction cost method (15% total costs) and the human capital method (35% total costs) [26], and in Thailand, these costs reached 54% of total costs related to obesity [27].

The costs of medications were lower in the surgical group. As previously demonstrated by our research group, 36 months after the bariatric surgery, there was a significant reduction in the monthly cost of medications (R$759.60 versus R$156.18) [28]. The authors showed that this group had an average annual cost 2.2 times higher [29]. Gesquiere et al. investigated a cohort of 143 patients in France undergoing Roux-en-Y gastroplasty and showed that medications to control diabetes and sleep apnea had an impact on the costs before the BS, and in the first month after BS, there was an increase in costs with vitamins; however, after 1 year of surgery, the costs were significantly reduced (−32%) when compared to preoperative costs [30].

Costs of exams in the surgical group were higher than in the clinical group, especially in the first postoperative year, but these costs decreased over the follow-up period. The frequency of follow-up tests during the postoperative period varies according to the routine of the healthcare facility and on the availability of resources. At our center, we use the routine recommended by the American Association of Clinical Endocrinologists (AACE), ensuring a safe and high-quality follow-up, as there is not a specific guideline determining this frequency in Brazil.

This study has some limitations. A conservative approach to estimate the costs of health resources was choosen, using only the surgical cost according to the amount reimbursed by the government (SIGTAP) and the lowest prices for medications. Probably the actual cost of the BS is higher because the amounts reimbursed by the Brazilian Public Health System are typically lower than the actual costs, as demonstrated in a Brazilian study that evaluated the evolution of the number of surgeries from 2010 to 2014 and their hospital costs. The authors considered all hospital expenses, including details of costs with all health professionals involved, medications, anesthesia, and clamps or bands [31]. The estimated surgical cost was US$2091.71 and US$2402.96 in 2010 and 2014,

Graph 2 Total indirect costs (Int$)



respectively, which are higher values than those used in our study. We chose to use this conservative approach in an attempt to standardize costs through a source of national reimbursement. It is also possible that the costs are different between the centers of excellence for BS in Brazil that sometimes have different funding sources. Our sample was small and included only three health centers, which makes national validation and extrapolation difficult.

Brazil is the second country in the world in absolute number of surgeries and official government data show that the number of surgeries performed in the public health system increased 45% from 2010 to 2013 [32]. This makes it essential to conduct economic analyses based on local cost data for discussion with managers and decision makers about financing strategies for the surgery with appropriate long-term follow-up.

Conclusion

This study showed that the total costs were higher in the surgical group in the first 2 years after surgery; however, from the third year on, there was a significant decrease in costs, reaching lower costs than the clinical group. Indirect costs, which reflect the impact of obesity on the society, accounted for around 20% of total costs. These data may help health professionals and managers take decisions related to preventive and therapeutic strategies that are more cost-effective in the treatment of severe obesity.

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Compliance with Ethical Standards

Conflicts of Interest The authors LB, MR, AP, SS, ES, and CM declare that they do not have any conflicts of interest.

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Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. This study was approved by the Research Ethics Committees of each institution being entered into and approved on the Brazil Platform for clinical trials with their related numbers: HSL/PUCRS (1.488.130), IEDE (855.012), and UERJ (731.209).

Informed Consent Informed consent was obtained from all individual participants included in the study.

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