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The impact of bariatric surgery on health outcomes, wellbeing and employment rates: analysis from a prospective cohort study

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Parole chiave: Chirurgia bariatrica, Obesità patologica, Bypass gastrico, Idoneità lavorativa

Abstract

Purpose. *Morbid obesity is associated with several comorbidities that often impair patients' ability to obtain and keep a job and that, eventually, could hinder their fitness to work. This study aimed at determining whether the employment status of morbidly obese patients may be positively affected by bariatric surgery.*
Methods. *A total of 30 morbidly obese patients who underwent Roux-en-Y gastric bypass (RYGB) from March 2014 to March 2015 were prospectively evaluated. All patients underwent a pre-operative assessment including the collection of personal and occupational data and the evaluation of musculoskeletal system. All evaluations were repeated at the end of a 24-month follow up.*
Results. *After RYGB, employment rates increased from 15/30 (50.0%) to 25/30 (83.3%, $p = 0.012$). Patients who were working at the end of follow-up referred lower rates of comorbidities, in particular of musculoskeletal complaints (4/25 vs. 4/5, $p < 0.001$), and presented significantly increased scores of energy/vitality at SF-36 assessment.*
Conclusions. *Our study suggests that RYGB can increase employment rates, increasing tolerance to effort and reducing prevalence and severity of obesity-related symptoms and complaints.*

Introduction

The prevalence of overweight (body mass index, BMI ≥ 25 kg/m^2) and obesity (BMI ≥ 30 kg/m^2) has globally risen in the past five decades, becoming an international public health concern (1-3). In particular, obesity has been associated with increased risk of type 2 diabetes mellitus, coronary heart disease, stroke, hypertension, gallbladder disease, some forms of cancer, sleep apnoea and musculoskeletal disorders (MSD), collectively causing a considerable increase in direct and indirect costs (1-8). Among the latter, the substantial impact of obesity on occupational fitness to work has been repeatedly reported (4). For instance, available evidences suggest that obese employees would have around 80% of the productivity of normal-weight workers (5, 6), and more frequently get negative job evaluations and wage penalties,

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due to a higher average number of sick leaves, medical claims and workplace injuries (4-7), ultimately explaining the lower rates of employment (9, 10). Two-thirds of the direct and indirect costs of obesity at workplaces (11) have been associated with the increased prevalence of MSD, especially low back pain (LBP) and neck pain (NP), particularly in female workers (12), with a lifetime prevalence for LBP exceeding 80% and ranging between 40 and 70% for NP (13, 14).

Bariatric surgery (BS) has been described as an effective treatment for morbid obesity, with significant effects on weight- and obesity-related comorbidities, improving overall physical activity and consequent work capacity (15-17). Relatively few studies have investigated the links between occupation and BS (4), but available data suggest that BS may significantly increase employment rate in morbidly obese patients. For instance, according to a previous study by Wagner et al, 37% of 38 patients treated with Roux-en-Y gastric bypass (RYGB) returned to work after surgery, compared to 6% of 16 non-surgically treated controls (18), and, similarly, a retrospective survey on 59 patients, who had been treated either with RYGB or laparoscopic adjustable gastric band (LAGB), found a 32% increase in the employment rate (19). More recently, a retrospective study on 193 severely obese unemployed subjects reported that, over a two-year period, up to 24% of patients treated with BS were employed, compared with 9% of untreated subjects (20), whereas a larger retrospective study including 803 patients from a French Regional Reference Centre for Obesity identified steady employment rates within the sample (i.e. 64.4% before and 64.7% after surgery), probably because of the high prevalence of retired subjects (4). Data regarding productivity are scanty and more controversial (21-25) and collectively suggest that BS would increase occupational wellbeing not only because of better physical functioning, but also through significant improvement of obesity-related psychiatric conditions (6, 8, 26), in particular in patients with major psychopathology and work impairment prior to surgery (6).

The purpose of this study was to determine the impact of BS on employment rates by evaluating its beneficial and possibly adverse health effects (i.e. post-prandial weakness, chronic diarrhoea, requirement of repetitive small daily meals) on maintaining paid jobs and occupational wellbeing in a cohort of severe obese individuals treated at our institution.

Patients and methods

1. Study Sample. Study participants were prospectively enrolled among the patients that underwent laparoscopic RYGB for morbid obesity between March 2014 and March 2015 at the Deparment of Surgical Sciences, University of Parma. All the patients met the international criteria for bariatric surgery (27): age at surgery 18 to 60, BMI $\geq$ 40 kg/m^2 or BMI 35-40 kg/m^2 with comorbidities in which surgically-induced weight loss is expected to improve the disorder (i.e. metabolic disorders, cardio-respiratory disease, severe joint disease, obesity-related severe psychological problems, etc.). All patients underwent an interdisciplinary assessment at the time of initial evaluation for RYGB (T^0), and during the follow ups ($T^{+24\ months}$): this specific protocol has been described in previous studies (26,28,29,30), and included the periodic collection of anthropometric, functional and psychological data.

2. Instruments. Employment status was assessed through a specifically designed structured questionnaire based on the available literature (4,6,18-20). The questionnaire was submitted to patients preoperatively and at 24-months follow-up. The investigated domains concerned the patients' occupational status at one month before surgery and at the time of their follow-up, any difficulties encountered maintaining six small meals a day, managing 30 minutes of daily physical activity and the repercussion of post-prandial weakness and

diarrhoea at work. Patients were also asked about clinical symptoms usually associated with severe obesity (i.e. *headache, back pain, muscle cramps of the lower limbs, dyspnoea, palpitations, nausea, tachycardia, dizziness, abdominal pain, shoulders' and upper limbs' pain*). Self-assessment of pre- and post-operatory conditions was performed using a 5-point Likert scale (i.e. *strongly agree, agree, neither agree nor disagree, disagree, strongly disagree*).

The test-retest reliability of questionnaire items was preventively assessed by having 5 BS patients not included in the present study complete the questionnaire at two different points in time. A correlation coefficient was calculated to compare the two sets of responses: items having a coefficient >0.80 were interpreted as consistent and, therefore, were included in the questionnaire used in this survey. All questions were self-reported and not externally validated.

Patients' quality of life in physical and mental domains was measured using The Medical Outcomes Study Short-Form 36 Health Status Survey (SF-36) (31), which was submitted to the patients prior to BS and at 2 years follow-up. The SF-36 measures eight domains of functioning and yields a physical component score (SF36-PCS) and a mental component score (SF36-MCS). Scores range from 0 (lowest or worst possible level of functioning) to 100 (highest or best possible level of functioning). The SF-36 has been previously used in BS and has good construct validity, high internal consistency and high test-retest reliability (6, 32-34). Moreover, an official Italian translation was previously validated (33, 35).

The EPM (Ergonomics of Posture and Movement) research unit medical questionnaire was completed before surgery and at follow-up, collecting information on pain, aches or discomfort in the back, neck and shoulders. The questionnaire, previously validated, has been found appropriate for use in Italian working population, and is commonly used by occupational physician in Italy as a musculoskeletal anamnestic utility (36). All patients received a physical examination with specific attention to musculoskeletal signs and symptoms (37).

Results were recorded and classified in accordance with the EPM method, which has been endorsed since 2004 by the Italian Society for Occupational Medicine and Industrial Hygiene (SIMLII) in its guidelines on prevention of Work-Related Musculoskeletal Disorders (36, 38, 39) (Table 1).

3. Statistical analysis. Descriptive analyses were performed for all variables being examined. Univariate analysis of continuous variables was performed through Student's t test for paired or unpaired data, when appropriate, whereas association between discrete variables was analysed using Fisher's exact test. For each subject included in the study, the response variables were considered as binary: variables expressed through a Likert scale were therefore conveniently collapsed as dichotomous ones (i.e. presence of the event and absence of the event). All tests were two-tailed and statistical significance was set at $p < 0.05$. All statistical analyses were performed using IBM SPSS Statistics 24.0 for Macintosh (IBM Corp. Armonk, NY).

Ethical considerations. This study was carried out in accordance with the principles of the Declaration of Helsinki. All participants gave their written consent prior to the surgical procedures, and subjects refusing their consent were excluded from the study population.

Results

Among 38 patients scheduled for RYGB at our institution during the study period, 36 (94.7%) signed their consent to the study and underwent the preoperative assessment. Six patients were excluded for complications unrelated to BS during the follow-up (n = 1), because we were unable to successfully determine employment status (n =1), or because they were lost to follow-up (n = 4). A total of 30 RYGB patients attended the 24-

Table 1 - Working definition and classification of work-related musculoskeletal disease of back, neck and upper limb following SIMLII 2004 guidelines (36, 38, 39).

Back/neck pain grade 1	Discomfort in the back or in the neck with or without radiation into the leg to below to knee for at least 1 day during the preceding 12 months. Physical examination negative.
Back/neck pain grade 2	grade 1 + pain elicited by palpation of paravertebral muscle and/or spinal apophysis
Back/neck pain grade 3	grade 2 + positivity of direct and/or indirect Lasegue sign, with/without pain at mobilization (active/passive)
Upper limb involvement	Persistent pain in at least one district (shoulder, elbow, whist/hand) of the upper limb
OR	Pain in at least one district (shoulder, elbow, whist/hand) of the upper limb, lasting at least 1 week during the preceding 12 months
OR	Pain in at least one district (shoulder, elbow, whist/hand) of the upper limb, lasting at least 1 day/month during the preceding 12 months

month post-surgery appointment and were included in the final analyses (83.3% of the original sample) (Figure 1).

The characteristics of the study population are shown in Table 2. The sample consisted mostly of females (n = 25, 83.3%), was of Italian origin (n = 28, 93.3%), with a mean preoperative BMI of 46.9 kg/m^2. Mean total weight loss was 34.8%±6.8 at $T^{+24\ months}$ follow-up.

Table 3 shows the general characteristics of the study population at baseline and after BS. Employment rate at T^0 was 50.0%, as 15/30 of the patients referred either a part-time (5/30, 16.7%) or full-time (10/30, 33.3%) employment, whereas, among the unemployed, 6/15 were either retired (n = 2; 6.7%) or received a disability pension (n = 4; 13.3%). At $T^{+24\ months}$, all 15 patients employed before surgery kept a job and the employment rate globally rose to 83.3%% (25/30; p = 0.012), with 13 full-time contracts (43.3%, p = 0.596). Moreover, 1 of the disability pensions was terminated because of the health improvements of the BS patient.

Prevalence of medically assessed comorbidities was 28/30 (93.3%) preoperatively and 8/30 (26.7%) postoperatively (p < 0.001).

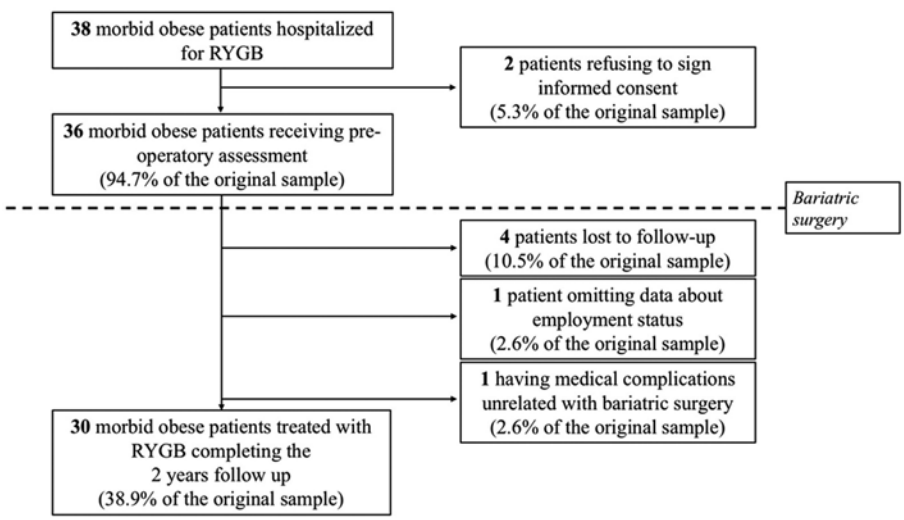

Figure 1 - Flow-chart explaining the selection of the study sample.

Table 2 - Demographics of the study population

Parameters	Total		Women	Men	P value
	N (%)	30 (100.0%)	25 (83.3%)	5 (16.7%)	-
Age at baseline (yrs)	Mean±SD	42.4 ± 11.4	43.1 ± 11.7	38.8 ± 10.0	0.449
BMI at baseline (kg/m^2)	Mean±SD	46.9 ± 7.5	45.5 ± 5.2	54.2 ± 12.9	0.204
BMI at T$^{+24\ months}$ (kg/m^2)	Mean±SD	30.9 ± 4.8	30.1 ± 4.2	36.6 ± 6.5	0.198
Weight loss at T$^{+24\ months}$ (%)	Mean±SD	34.8 ± 6.8	34.7 ± 5.7	35.3 ± 11.9	0.913
Migration background	N (%)	2 (6.7%)	1 (4.0%)	1 (20.0%)	0.310
Smoking history	N (%)	8 (26.7%)	6 (24.0%)	2 (40.0%)	0.589
Education level					
Primary and/or middle school	N (%)	17 (56.7%)	14 (56.0%)	3 (60.0%)	1.000
High school or higher education	N (%)	13 (43.3%)	11 (44.0%)	2 (40.0%)	

More specifically, whereas prevalence of fasting hyperglycaemia (4/30 vs. 2/30, 13.3% and 6.7% respectively) and hypertension (9/30 vs. 4/30, 30.0% and 13.3%) was statistically similar (p = 0.671 and p = 0.209), MSD were identified in 26 out of 30 participants (86.7%) at T^0, and in 6/30 at T$^{+24\ months}$ (20.0%, p < 0.001). In particular, all patients unemployed at T^0 had MSD, compared with the cumulative prevalence of 73.3% in employed subjects (p = 0.100). Focusing on the affected districts, low back involvement was identified in 26/30 BS patients at T^0 (86.7%), and decreased to 5/30 (16.7%) at T$^{+24\ months}$ (p < 0.001). Moreover, whereas Grade 3 prevalence at T^0 was 13 out of 26 positive cases (50.0%), at the follow up no Grade 3 case was identified. The prevalence of neck complaints also decreased from 16/30 at T^0, and most cases were either Grade 2 (12/16, 75.0%) or Grade 3 (12.5%), decreasing to 5/30 (16.7%) at T$^{+24\ months}$, with no Grade 3 cases and n=2 Grade 2 cases.

Self-assessed musculoskeletal complaints decreased from T^0 to T$^{+24\ months}$. The decrease was greater for LBP (23/30, 76.7% vs. 4/30, 13.3%; p < 0.001) and muscle cramps in the lower limbs (13/30, 43.3% vs. 2/30, 6.7%; p = 0.002), whereas the rates of musculoskeletal complaints for NP (10/30, 33.3% vs. 5/30, 16.7%) and upper limbs (6/30, 20.0% vs. 4/30, 13.3%) also decreased after BS, but the difference was not statistically significant (p = 0.233 and p = 0.731, respectively). Cardiorespiratory symptoms, such as dyspnoea (n = 14, 46.7% vs. no cases) and palpitations (n = 13, 43.3% vs. n = 4, 13.3%) significantly decreased during follow up (p < 0.001, and p = 0.020, respectively), whereas no significant difference was found regarding gastrointestinal symptoms, having nausea (n = 3, 10.0% vs. n = 2, 6.7%) and abdominal pain (n = 4, 13.3% vs. n = 5, 16.7%) similar prevalence before and after BS (p = 1.000 in both cases).

After BS, 72.0% of the employed patients referred some difficulties in maintaining daily physical activity compared to 40.0% of unemployed, but the difference was not statistically significant (p = 0.300). However, employed patients referred less frequently difficulties in performing at least 30' of physical activity a day (44.0% vs. 60.0%), and also in maintaining 6 meals a day (6/25, 24.0%) compared to non-workers (2/5, 40%): again the difference was not statistically significant (p = 0.589 and p = 1.000, respectively).

Self-assessed complaints are shown in Table 4 broken down by occupational status at T$^{+24\ months}$. In particular, symptoms associated with BS, such as post-prandial weakness (3/25 vs. 5/5, p < 0.001) and diarrhoea (3/25 vs. 3/5, p = 0.031), but also prevalence of headache (6/25 vs. 4/5, p = 0.031), palpitations (3/25 vs. 3/5, p = 0.041), nausea (2/25 vs. 4/5, p =

Table 3 - General characteristics of the study population at baseline and after bariatric surgery (BS).

		Before BS	After BS	P value
Employment status	N (%)	15 (50.0%)	25 (83.3%)	0.012
Full time	N (%)	10 (33.3%)	13 (43.3%)	0.596
Fixed time	N (%)	5 (16.7%)	5 (16.7%)	1.000
Retired	N (%)	2 (6.7%)	2 (6.7%)	1.000
Disability pension	N (%)	4 (13.3%)	4 (13.3%)	1.000
Medically assessed morbidities	N (%)	28 (93.3%)	8 (26.7%)	< 0.001
Fasting hyperglycaemia	N (%)	4 (13.3%)	2 (6.7%)	0.671
Hypertension	N (%)	9 (30.0%)	4 (13.3%)	0.209
Osteoarticular complaints (any)	N (%)	26 (86.7%)	8 (26.7%)	< 0.001
Lumbosacral MSC (any)	N (%)	26 (86.7%)	4 (13.3%)	< 0.001
Grade 1	N (%)	7 (23.3%)	4 (13.3%)	
Grade 2	N (%)	6 (20.0%)	1 (3.3%)	
Grade 3	N (%)	13 (43.3%)	0 (-%)	
Cervical MSC (any)	N (%)	16 (53.3%)	5 (16.7%)	0.006
Grade 1	N (%)	2 (6.7%)	3 (10.0%)	
Grade 2	N (%)	12 (40.0%)	2 (6.7%)	
Grade 3	N (%)	2 (6.7%)	0 (-%)	
Self-assessed Complaints				
Headache	N (%)	14 (46.7%)	10 (33.3%)	0.430
Low back pain	N (%)	23 (76.7%)	4 (13.3%)	< 0.001
Muscle cramps of the lower limbs	N (%)	13 (43.3%)	2 (6.7%)	0.002
Dyspnoea	N (%)	14 (46.7%)	0 (-%)	< 0.001
Palpitations	N (%)	13 (43.3%)	4 (13.3%)	0.020
Nausea	N (%)	3 (10.0%)	2 (6.7%)	1.000
Tachycardia	N (%)	16 (53.3%)	10 (33.3%)	0.192
Dizziness	N (%)	6 (20.0%)	3 (10.0%)	0.472
Abdominal pain	N (%)	4 (13.3%)	5 (16.7%)	1.000
Neck Pain	N (%)	10 (33.3%)	5 (16.7%)	0.233
Pain of the upper limb	N (%)	6 (20.0%)	4 (13.3%)	0.731
SF-36 components				
Physical functioning	Mean ± SD	49.3 ± 30.4	90.2 ± 17.6	< 0.001
Role limitation PH	Mean ± SD	60.2 ± 38.7	94.2 ± 16.6	< 0.001
Role limitation EP	Mean ± SD	62.2 ± 38.9	89.5 ± 23.3	< 0.001
Energy / Fatigue	Mean ± SD	50.7 ± 20.7	76.3 ± 15.2	< 0.001
Emotional wellbeing	Mean ± SD	64.0 ± 23.2	81.0 ± 15.1	< 0.001
Social functioning	Mean ± SD	64.2 ± 28.4	90.0 ± 13.5	< 0.001
Pain	Mean ± SD	55.0 ± 30.1	89.2 ± 18.7	< 0.001
General health	Mean ± SD	50.2 ± 19.1	80.5 ± 14.3	< 0.001

0.003) and dizziness (3/25 vs. 4/5, p = 0.006) were significantly lower in employed patients than in unemployed ones. Even though no significant difference about self-reported LBP between employed and unemployed patients was ultimately referred (3/25 vs. 1/5, p = 0.538), medical assessment of MSD identified significantly higher prevalence in

Table 4 - General characteristics of the study population after bariatric surgery (BS) broken down by employment status.

		Employed (n = 25, 83.3%)	Not employed (n = 5, 16.7%)	
Medically assessed morbidities				
Osteoarticular complaints (any)	N (%)	4 (8.0%)	4 (80.0%)	0.001
Lumbosacral MSC (any)	N (%)	1 (4.0%)	3 (60.0%)	0.009
Cervical MSC (any)	N (%)	1 (4.0%)	4 (80.0%)	0.001
Fasting hyperglycaemia	N (%)	1 (4.0%)	1 (20.0%)	0.310
Hypertension	N (%)	1 (4.0%)	3 (60.0%)	0.009
Self-assessed complaints				
Post-prandial weakness	N (%)	3 (12.0%)	5 (100.0%)	< 0.001
Diarrhoea	N (%)	3 (12.0%)	3 (60.0%)	0.031
Headache	N (%)	6 (24.0%)	4 (80.0%)	0.031
Back pain	N (%)	3 (12.0%)	1 (20.0%)	0.538
Muscle cramps of the lower limbs	N (%)	1 (4.0%)	1 (20.0%)	0.355
Palpitations	N (%)	3 (12.0%)	3 (60.0%)	0.041
Nausea	N (%)	2 (8.0%)	4 (80.0%)	0.003
Tachycardia	N (%)	7 (28.0%)	3 (60.0%)	0.300
Dizziness	N (%)	3 (12.0%)	4 (80.0%)	0.006
Abdominal pain	N (%)	4 (16.0%)	1 (20.0%)	1.000
Pain of the shoulders	N (%)	2 (8.0%)	3 (60.0%)	0.022
Pain of the upper limb	N (%)	1 (4.0%)	3 (60.0%)	0.609
Abiding by post-operative advice				
Difficulty in maintaining 6 meals by day	N (%)	6 (24.0%)	2 (40.0%)	0.589
Difficulty in performing at least 30 min of daily physical activity	N (%)	11 (44.0%)	3 (60.0%)	1.000
Difficulty in maintaining regular physical activity	N (%)	18 (72.0%)	2 (40.0%)	0.300

unemployed patients than in employed ones, both in general (4/25 vs. 4/5, p = 0.001) and in specific anatomical districts (1/25 vs. 3/5 for lumbosacral region, p = 0.009; 1/25 vs. 3/5 for cervical region, p = 0.001). In general, referred complaints were identified as compromising daily life by 3 out of 25 employed patients and by all unemployed participants. Eventually, 4 out 25 employed patients (16.0%) stated that, in previous months, the referred complaints had caused some sporadic work problems, including sick leave or cessation of daily task, but the frequency was in all cases lesser than 1 time every month.

As shown in Table 3 and in Figure 2a, preoperative values in all 8 SF-36 domains were relatively low. The 8 examined categories were physical functioning (mean: 49.3 ± 30.4 points), physical role limitation (PH) (60.2 ± 38.7), emotional role limitation (EP) (62.2 ± 38.9), energy/fatigue (i.e. vitality) (50.7 ± 20.7), emotional wellbeing (64.0 ± 23.2), social

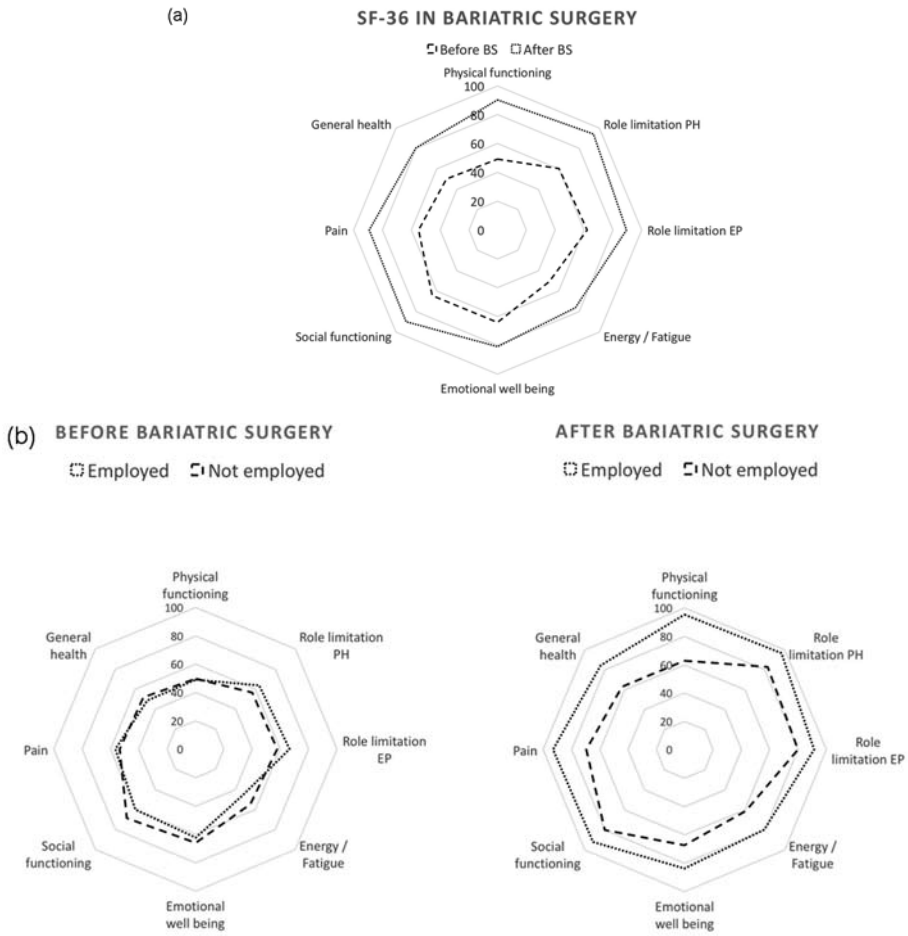

Figure 2 - Results of Medical Outcomes Study Short-Form 36 Health Status Survey (SF-36) before (T^0) and after ($T^{+24\ months}$), in general (a) and broken down by employment status (b).

functioning (64.2 ± 28.4), pain (55.0 ± 30.1) and general health (50.2 ± 19.1). After BS, there were significant improvements in all 8 domains: the greatest improvements occurred in the domains of physical functioning (mean difference: 40.8 ± 28.1 points), pain (34.1 ± 30.0), and physical role limitation (34.0 ± 39.3), whereas emotional wellbeing was associated with lesser improvements (17.0 ± 25.3). Even though employed participants at $T^{+24\ months}$ had better mean scores in all the SF-36 domains (Figure 2b), only for the category "Energy/Fatigue" the difference was statistically significant (79.4 ± 13.7 vs. 61.0 ± 13.9; p = 0.011) (Table 5).

Discussion and Conclusions

BS has been repeatedly associated with remission of physical comorbidities and improvements in mental health: overall, these factors may positively contribute to the patient's outcome, including the achievement of better employment rates (4, 6, 7, 10, 16, 18-22, 25, 27, 32).

Despite two recent European-based surveys (4, 25) suggesting that BS may be associated with health improvements, but with no significant increase in occupational rates, most of the few available studies support the

Table 5 - Medical Outcomes Study Short-Form 36 Health Status Survey before (T^0) and after ($T^{+24\ months}$) broken down by employment status.

T^0		Employed (n = 15, 50.0%)	Not employed (n = 15, 50.0%)	
Physical functioning	Mean ± SD	49.0 ± 27.1	49.7 ± 34.4	0.953
Role limitation PH	Mean ± SD	63.7 ± 36.6	56.7 ± 41.7	0.629
Role limitation EP	Mean ± SD	66.6 ± 33.4	57.8 ± 44.5	0.542
Energy / Fatigue	Mean ± SD	46.5 ± 20.7	55.0 ± 20.4	0.267
Emotional well being	Mean ± SD	62.1 ± 20.0	65.9 ± 26.7	0.662
Social functioning	Mean ± SD	60.0 ± 26.0	68.4 ± 30.9	0.429
Pain	Mean ± SD	56.6 ± 27.1	53.5 ± 33.7	0.786
General health	Mean ± SD	48.3 ± 19.0	52.0 ± 19.6	0.607
$T^{+24\ months}$		Employed (n = 25, 83.3%)	Not employed (n = 5, 16.7%)	
Physical functioning	Mean ± SD	95.6 ± 7.3	63.0 ± 28.6	0.063
Role limitation PH	Mean ± SD	96.4 ± 11.1	83.0 ± 32.7	0.414
Role limitation EP	Mean ± SD	91.4 ± 17.4	80.0 ± 44.7	0.603
Energy / Fatigue	Mean ± SD	79.4 ± 13.7	61.0 ± 13.9	0.011
Emotional well being	Mean ± SD	83.7 ± 12.8	67.2 ± 19.7	0.135
Social functioning	Mean ± SD	91.9 ± 11.1	80.0 ± 20.9	0.277
Pain	Mean ± SD	93.1 ± 13.4	69.5 ± 29.9	0.153
General health	Mean ± SD	84.0 ± 10.7	63.0 ± 18.6	0.063

hypothesis that the proportion of employed patients would significantly increase after successful surgical procedures (6,18-20). Our results are consistent with these earlier reports as, in this single centre prospective study, BS was actually followed by increased employment rates at the end of follow up (15/30 vs. 25/30, p = 0.012).

These improvements can be explained in several ways.

First at all, as patients who were working at follow-up had also better rates of self-referred symptoms, we may guess that employment rates may ultimately be secondary to the improved physical functioning. Actually, the efficiency of BS in reducing BMI is widely acknowledged (16, 17, 40) and a reduced BMI is, in turn, associated with better physical functioning, including increased resistance to physical efforts, and reduced MSC, in particular at lumbosacral level (13, 16, 41). In our sample, not only was the prevalence of both self-reported and medically assessed MSC significantly reduced, but also their severity benefited from BS, as no Grade 3 lumbosacral or cervical MSC was identified at follow-up.

The role of improved physical functioning is also suggested by the significantly reduced prevalence of respiratory and cardiovascular symptoms after BS, and particularly in employed patients. Detrimental effects of obesity on the respiratory function have been repeatedly described in terms of increased work of breathing as a consequence of increased airways resistance, reduced respiratory system compliance, and falling lung volumes as a result of the increased abdominal volume and visceral fat (42). Consistently with previous reports (43, 44), we identified a striking improvement in respiratory function, with resting dyspnoea substantially disappearing at the end of follow-up. Regarding cardiovascular symptoms, it has been shown that changes

related to weight loss are associated with reduction in cardiovascular events, as well as with improvements in cardiac structure and function (45-47). Ultimately, BS may increase effort tolerance in treated patient, enabling them to obtain and keep also more physically demanding jobs, such as those requiring manual handling or implying occupational exposure to heat stress (48-51). In addition, even though all 8 SF-36 components posted better scores after BS, only for the "energy / fatigues" domain, the difference was statistically significant between employed and unemployed subjects, suggesting a critical role of the perceived increase in stamina of BS patients.

Moreover, morbid obesity is usually associated with metabolic comorbidities, such as fasting hyperglycaemia and hypertension (45-47, 52, 53) which could both lead to increased cardiovascular risk (45-47). In order to properly protect health and safety of severe obese patients, concurrently preventing the risk of medical malpractice claims, occupational physicians assessing the fitness to work of obese patients may, therefore, impose increasingly strict limitations, such as restriction on night shifts, which may ultimately incapacitate the worker, undermining the patient's ability to keep or find a job (6, 18-20).

Third, BS is associated with specific post-operative morbidities, as patients frequently report high prevalence of diarrhoea or post-prandial weakness (4-7, 17, 54, 55): affected patients frequently reports that such symptoms, and in particular diarrhoea, cause some work problems, as they may need to interrupt their activity in order to go the toilet or to rest for quite some time after meals (4). Not coincidentally, the overall prevalence of such symptoms was relatively low and employed subjects reported significantly lower rates than unemployed ones.

However, several limitations within our study should be addressed.

Firstly, we collected a small study population by convenience sampling (i.e. all patients referring to our centre for RYGB), which forced an univariate statistical analysis, and earlier studies on employment status after BS were severely criticized because of their small size or because of their inclusion criteria (4, 6, 18, 20, 25).

Another critical issue we share with previous reports is the self-assessment of the patient status (4, 6, 18, 20, 25), as we asked the participants not only about their occupational status, but also about their complaints, whose recalling may be not so accurate (56, 57). Eventually, the very assessment of the employment status may be affected by some uncertainties, as its dichotomous design (i.e. employed/unemployed) does not accurately describe the patients' fitness to work and work-related problems (36, 58-62). In other words, as a consequence of the obesity-related occupational stigma they previously experienced, BS patients may undermine their complaints in order to keep their job, and our study may ultimately overestimate the benefits associated with BS.

In this regard, we attempted to achieve better understanding of the patients' fitness to work and occupational wellbeing by performing a medical assessment both before and after BS. To our knowledge, previous studies lacked this specific approach, which enabled us to objectively identify a significant decrease in MSC after BS, with even better rates in employed than in unemployed patients, ultimately confirming the expected relationship between better physical functioning and improved occupational rates.

In conclusion, our study suggests that morbidly obese patients can significantly improve their occupational status and their occupational wellbeing with BS. Post-operative improvements are likely related to better physical functioning, both in terms of improved osteomuscular function and increased stamina. In other words, our findings confirm that surgical treatment of morbid obesity can be useful in the treatment of obesity-related comorbidities and

returning to work represents a cornerstone of the improved quality of life of treated patients

Riassunto

L'impatto della Chirurgia bariatrica su condizioni di salute, benessere e occupazione: analisi di uno studio di corte prospettica

Scopi. L'obesità patologica è associata con numerose comorbidità che spesso compromettono la capacità del paziente di ottenere o mantenere un lavoro retribuito e che, in ultima analisi, possono compromettere l'idoneità lavorativa. Scopo di questo studio è determinare se la chirurgia bariatrica possa influenzare positivamente lo status lavorativo di pazienti affetti da obesità patologica. **Metodi.** 30 pazienti affetti da obesità patologica sottoposti a bypass gastrico con ansa alla Roux (RYGB) fra Marzo 2014 e Marzo 2015 sono stati sottoposti ad uno studio prospettico, che ha previsto una valutazione specifica, inclusiva della raccolta di dati personali ed occupazionali, e della valutazione del sistema muscoloscheletrico, ripetuta in fase pre- e post-operatoria, a 24 mesi dall'intervento.

Risultati. La percentuale di pazienti occupati dopo l'intervento aumentava dal 50% (15/30) all'83.3% (25/30, $p = 0.012$). I pazienti occupati alla fine del follow-up riferivano una più bassa percentuale di comorbidità, in particolare di disturbi muscoloscheletrici (4/25 vs. 4/5, $p < 0.001$), e presentavano un punteggio "energia / vitalità" della valutazione con SF-36 significativamente più elevato.

Conclusioni. Il nostro studio suggerisce che la chirurgia bariatrica ed in particolare la RYGB può migliorare significativamente lo status occupazionale dei pazienti, aumentare la tolleranza allo sforzo e ridurre prevalenza e severità di sintomi e disturbi correlati all'obesità.

References

1. Ng M, Fleming T, Robinson M, et al. Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2014; **384**: 766-81.
2. Gallus S, Odone A, Lugo A, et al. Overweight and obesity prevalence and determinants in Italy: an update to 2010. Eur J Nutr 2013; **52**: 677-85.
3. Bray GA, Frühbeck G, Ryan DH, Wilding JPH. Seminar Management of obesity. Lancet 2016; **387**: 1947-56.
4. Durand-Moreau Q, Gautier A, Bécouarn G, Topart P, Rodien P, Sallé A. Employment and Professional Outcomes in 803 Patients Undergoing Bariatric Surgery in a French Reference Center for Obesity. Int J Occup Environ Med 2015; **6**: 95-103.
5. Schmier JK, Jones ML, Halpern MT. Cost of obesity in the workplace. Scand J Work Environ Health 2006; **32**: 5-11.
6. Sockalingam S, Wnuk S, Kantarovich K, et al. Employment Outcomes One Year after Bariatric Surgery: the Role of Patient and Psychosocial Factors. Obes Surg 2014; **25**: 514-22.
7. van Duijvenbode DC, Hoozemans MJM, van Poppel MNM, Proper KI. The relationship between overweight and obesity, and sick leave: a systematic review. Int J Obes (Lond) 2009; **33**: 807-16.
8. Capodaglio P, Castelnuovo G, Brunani A, Vismara L, Villa V, Capodaglio EM. Functional limitations and occupational issues in obesity: a review. Int J Occup Saf Ergon 2010; **16**: 507-23.
9. Suhrcke M, McKee M, Arce RS, Tsolova S, Mortensen J. Investment in health could be good for Europe's economies. BMJ 2006; **333**: 1015-7.
10. Puhl RM, Heuer CA. The Stigma of Obesity: A Review and Update. Obesity 2009; **17**: 941-64.
11. Balagué F, Mannion AF, Pellisé F, Cedraschi C. Non-specific low back pain. Lancet 2012; **379**: 482-91.
12. Sangachin MG, Cavuoto LA. Obesity-related changes in prolonged repetitive lifting performance. Appl Ergon 2016; **56**: 19-26.
13. Vismara L, Menegoni F, Zaina F, Galli M, Negrini S, Capodaglio P. Effect of obesity and low back pain on spinal mobility: a cross sectional study in women. J NeuroEngineering Rehabil 2010; **7**: 3-8.
14. Mäntyselkä P, Kautiainen H, Vanhala M. Prevalence of neck pain in subjects with metabolic syndrome - a cross-sectional population-based study. BMC Musculoskelet Disord 2010; **11**: 629-6.
15. Picot J, Jones J, Colquitt JL, et al. The clinical effectiveness and cost- effectiveness of bariatric (weight loss) surgery for obesity: a systematic review and economic evaluation. Health Technol Assess 2009; **13**: 1-190.
16. Lopes EC, Heineck I, Athaydes G, Meinhardt NG, Souto KEP, Stein AT. Is Bariatric Surgery

Effective in Reducing Comorbidities and Drug Costs? A Systematic Review and Meta-Analysis. Obes Surg 2015; **25**: 1741-9.
17. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric Surgery: a systematic review and meta-analysis . JAMA 2004; **292**: 1724-37.
18. Wagner AJ, Fabry JM, Thitlby RC. Return to Work After Gastric Bypass in Medicaid-Funded Morbidly Obese Patients. Arch Surg 2007; **142**: 935-40.
19. Hawkins SC, Osborne A, Finlay IG, Alagaratnam S, Edmond JR, Welbourn R. Paid Work Increases and State Benefit Claims Decrease after Bariatric Surgery. Obes Surg 2007; **17**: 434–7.
20. Turchiano M, Saunders JK, Fernandez G, Navie L, Labrador L, Parikh M. Bariatric Surgery May Improve Employment Status in Unemployed, Underserved, Severely Obese Patients. Obes Surg 2013; **24**: 692-5.
21. Neovius K, Johansson K, Rössner S, Neovius M. Disability pension, employment and obesity status: a systematic review. Obes Rev 2008; **9**: 572-81.
22. O'Brien KS, Latner JD, Ebneter D, Hunter JA. Obesity discrimination: the role of physical appearance, personal ideology, and anti-fat prejudice. Int J Obes (Lond) 2012; **37**: 455-60.
23. Sampalis JS, Liberman M, Auger S, Christou NV. The Impact of Weight Reduction Surgery on Health-Care Costs in Morbidly Obese Patients. Obes Surg 2004; **18**: 14: 939-47.
24. van Gemert WG, Adang E, Kop M, Vos G, Greve JWM, Soeters PB. A Prospective Cost-Effectiveness Analysis of Vertical Banded Gastroplasty for the Treatment of Morbid Obesity. Obes Surg 1999; **9**: 484-91.
25. Hanvold SE, Løken EB, Paus SF, et al. Great Health Benefits But No Change in Employment or Psychopharmaceutical Drug Use 2 Years After Roux-en-Y Gastric Bypass. Obes Surg 2015; **25**: 1672-9.
26. Grieco MP, Bertozzi N, Simonacci F, et al. Quality of life in post-bariatric surgery patients undergoing aesthetic abdomi-noplasty: Our experience. Surg Chrn 2016; **21**: 5-8.
27. Fried M, Yumuk V, Oppert JM, Scopinaro N, et al. Interdisciplinary European Guidelines on Metabolic and Bariatric Surgery. Obes Surg 2013; **24**: 42-55.
28. Marchesi F, De Sario G, Reggiani V, et al. Road Running After Gastric Bypass for Morbid Obesity: Rationale and Results of a New Protocol. Obes Surg 2015; **25**: 1162-70.
29. Marchesi F, Giacosa R, Reggiani V, et al. Morphological Changes in the Carotid Artery Intima after Gastric Bypass for Morbid Obesity. Obes Surg 2017; **27**: 357-63.
30. De Panfilis C, Generali I, Dall'Aglio E, Marchesi F, Ossola P, Marchesi C. Temperament and one-year outcome of gastric bypass for severe obesity. Surg Obes Relat Dis 2014; **10**: 144-8.
31. Ware JE, Sherbourne CD. The MOS 36item shortform health survey (SF36). I. Conceptual framework and item selection. Med Care 1992; **30**: 473-83.
32. Adams TD, Pendleton RC, Strong MB, et al. Health Outcomes of Gastric Bypass Patients Compared to Nonsurgical, Nonintervened Severely Obese. Obesity 2012; **18**: 121-30.
33. Apolone G, Mosconi P. The Italian SF-36 Health Survey. J Clin Epidemiol 1998; **51**: 1025-36.
34. Brazier JE, Harper R, Jones N, et al. Validating the SF-36 health survery questionnaire: new outcome measure for primary care. BMJ 1992; **305**: 160-4.
35. Donini LM, Brunani A, Sirtori A, et al. Assessing disability in morbidly obese individuals: the Italian Society of Obesity test for obesity-related disabilities. Disabil Rehab 2011; 33: 2509-18.
36. Riccò M, Cattani S, Signorelli C. Personal risk factors for carpal tunnel syndrome in female visual display unit workers. Int J Occup Med Environ Health 2016; **29**: 927-36.
37. Buckup K. Clinical Tests for the Musculoskeletal System : examination, signs, phenomena. Stuttgart, New York: Thieme Publisher, 2004.
38. Violante FS, Bonfiglioli R, Mattioli S, et al. LINEE GUIDA per la prevenzione delle patologie correlate alla movimentazione manuale dei pazienti. Società Italiana di Medicina del Lavoro ed Igiene Industriale (SIMLII); 2008: 1-141.
39. Colombini D, Occhipinti E, Menoni O, et al. Diseases of the dorsal-lumbar spine and manual handling of loads: guidelines for fitness assessment. Med Lav 1993; **84**: 373-8.
40. Arterburn DE, Courcoulas AP. Bariatric surgery for obesity and metabolic conditions in adults. BMJ 2014; **349**: g3961.
41. Hoy D, Brooks P, Blyth F, Buchbinder R. The epidemiology of low back pain. Best Pract Res Clin Rheum 2010; **24**: 769-81.
42. Hodgson LE, Murphy PB, Hart N. Respiratory management of the obese patient undergoing surgery. J Thorac Dis 2015; **7**: 943-52.

43. Hewitt S, Humerfelt S, Søvik TT, et al. Long-Term Improvements in Pulmonary Function 5 Years After Bariatric Surgery. Obes Surg 2014; **24**: 705-11.
44. Clavellina-Gaytán D, Velázquez-Fernández D, Del-Villar E, et al. Evaluation of Spirometric Testing as a Routine Preoperative Assessment in Patients Undergoing Bariatric Surgery. Obes Surg 2014; **25**: 530-6.
45. Heneghan HM, Meron-Eldar S, Brethauer SA, Schauer PR, Young JB. Effect of Bariatric Surgery on Cardiovascular Risk Profile. Am J Cardiol 2011; **108**: 1499-507.
46. Kwok CS, Pradhan A, Khan MA, et al. Bariatric surgery and its impact on cardiovascular disease and mortality: A systematic review and meta-analysis. In J Cardiol 2014; **173**: 20-8.
47. Lee GK, Cha Y-M. Cardiovascular benefits of bariatric surgery. Trends Cardiovasc Med 2016; **26**: 280-9.
48. Vargas CB, Picolli F, Dani C, Padoin AV, Mottin CC. Functioning of Obese Individuals in Pre- and Postoperative Periods of Bariatric Surgery. Obes Surg 2013; **23**: 1590-5.
49. Xiang J, Bi P, Pisaniello D, Hansen A. The impact of heatwaves on workers' health and safety in Adelaide, South Australia. Environ Res 2014; **133**: 90-5.
50. Ibrahim JE, McInnes JA, Andrianopoulos N, Evans S. Minimising harm from heatwaves: a survey of awareness, knowledge, and practices of health professionals and care providers in Victoria, Australia. Int J Public Health 2011; **57**: 297-304.
51. Dukes-Dobos FN. Hazards of heat exposure. A review. Scand J Work Environ Health 1981; **7**: 73-83.
52. Courcoulas AP, Christian NJ, Belle SH, et al. Weight Change and Health Outcomes at 3 Years After Bariatric Surgery Among Individuals With Severe Obesity. JAMA 2013; **310**: 2416-25.
53. Purnell JQ, Selzer F, Wahed AS, et al. Type 2 Diabetes Remission Rates After Laparoscopic Gastric Bypass and Gastric Banding: Results of the Longitudinal Assessment of Bariatric Surgery Study. Diabetes Care 2016; **39**: 1101-7.
54. Harbin G, Shenoy C, Olson J. Ten-year comparison of BMI, body fat, and fitness in the workplace. Am J Ind Med 2006; **49**: 223-30.
55. Wertli MM, Held U, Campello M, Schecter Weiner S. Obesity is associated with more disability at presentation and after treatment in low back pain but not in neck pain: findings from the OIOC registry. BMC Musculoskelet Disord. BMC Musculoskelet Disord 2016; **17**: 140.
56. Shin JK, Shortridge-Baggett LM, Sachmechi I, et al. Screening for type 2 diabetes mellitus in patients with mental illness: Application of a self-assessment score for diabetes mellitus risk. Psychiatry Res 2014; **220**: 1037-42.
57. Karlsson J, Taft C, Sjöström L, Torgerson JS, Sullivan M. Psychosocial functioning in the obese before and after weight reduction: construct validity and responsiveness of the Obesity-related Problems scale. Int J Obes Relat Metab Disord 2003; **27**: 617-30.
58. Robroek SJW, van den Berg TIJ, Plat JF, Burdorf A. The role of obesity and lifestyle behaviours in a productive workforce. Occup Environ Med 2011; **68**: 134-9.
59. Alavinia SM, Molenaar D, Burdorf A. Productivity loss in the workforce: associations with health, work demands, and individual characteristics. Am J Ind Med 2009; **52**: 49-56.
60. Zhang W, Bansback N, Anis AH. Measuring and valuing productivity loss due to poor health: A critical review. Soc Sci Med 2011; **72**: 185-92.
61. Riccò M, Cattani S, Gualerzi G, Signorelli C. Use of visual display units and work-related musculoskeletal complaints: a cross-sectional study. Med Pr 2016; **67**: 707-19.
62. Manzoli L, Sotgiu G, Magnavita N, Durando P; National Working Group on Occupational Hygiene of the Italian Society of Hygiene, Preventive Medicine and Public Health (SItI). Evidence-based approach for continuous improvement of occupational health. Epidemiol Prev 2015; **39**: S81-S85.

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