European Journal of Human Movement, 2014: **32**, 145-160

BARIATRIC SURGERY, WEIGHT LOSS AND THE ROLE OF PHYSICAL ACTIVITY: A SYSTEMATIC REVIEW

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ABSTRACT

Obesity has become one of the major health problems of today's society, being considered as an epidemic. For people with morbid obesity (Body Mass Index (BMI) ≥ 40 kg·m^{-2}) who don't lose weight using conventional weight reduction methods we must resort to bariatric surgery. There is controversy in the relationship between physical activity and weight loss after bariatric intervention. Therefore, the aim of this paper is to review and describe the different research existing about this topic. A literature review of Medline and Scopus databases was performed. From a total of 128 articles and after the exclusion criteria 24 full papers were read, out of which, 21 were observational research and 3 were experimental research. We found that physical activity positively correlated with weight loss; however, although there are no significant differences in the short term (six months), differences begin to be seen in the medium to long term (+ 9 months).
Key Words: excess weight loss, gastric bypass, exercise volume and intensity

RESUMEN

La obesidad se ha convertido en uno de los mayores problemas de salud en la sociedad actual, hasta tal punto de ser considerada como una epidemia. Para personas con obesidad mórbida (Índice de Masa Corporal (IMC) ≥ 40 kg·m^{-2}) que no consiguen reducción de peso por métodos convencionales se recurre a cirugía bariátrica. Existe cierta controversia entre la relación de la actividad física y la pérdida de peso posterior a la intervención bariátrica, por lo que, el objetivo de este trabajo es el de revisar y describir los distintos trabajos que existen al respecto. Se realizó una búsqueda bibliográfica en las bases de datos Medline y Scopus. De un total de 128 trabajos y tras los criterios de exclusión se procedió a la lectura exhaustiva de 24 artículos completos, 21 de ellos observacionales y 3 experimentales. Encontramos que la práctica actividad física se correlaciona de manera positiva con la pérdida de peso, no obstante, aunque no existen diferencias significativas entre realizar ejercicio o no realizarlo a corto plazo (primeros seis meses), sí que se empiezan a hacer palpables a medio o largo plazo (+ 9 meses).
Palabras clave: exceso de peso perdido, bypass gástrico, volumen e intensidad del ejercicio

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Submitted: 15/06/2014
Accepted: 30/06/2014

INTRODUCTION

Obesity has become one of the major health problems of today's society. Since the 80s, the number of obese people has increased drastically, becoming an epidemic (Mazure Lehnhoff et al., 2007), and reaching the figure of more than 500 million people in the world in 2008 (World Health Organization, 2014b). This illness causes large health problems because the subjects who suffer from it show a higher risk of suffering severe diseases such as type II diabetes, cancer, cardiovascular risk, hypertension and hiperlipidemia (Shetty & Schmidhuber, 2006). In this regard, there are about 2.6 million obesity related deaths every year (World Health Organization, 2014a).

Subjects were classified as obese according to their body mass index (BMI), which is calculated by dividing weight (in kilograms) by squared height (in meters) (BMI = kg·m-2). This classification defines the subjects in a normal weight range those with BMI ranging between 18.5 - 24.9 kg·m-2. Subjects who are in a weight range between 25 - 26.9 kg·m-2 are defined as grade I overweight subjects, while those in the range between 27 - 29.9 kg·m-2 are defined as grade II overweight subjects. The range between 30 - 34.9 kg·m-2 is described as Type I obesity, the range between 35 - 39.9 kg·m-2 as Type II obesity and the range between 40 - 49.9 kg·m-2 corresponds to Type III obesity, also called morbid obesity. Next we find the Type IV obesity (superobesity) corresponding to a BMI between 50 - 59.9 kg·m-2 and Type V obesity, known as super-super obesity (Rubio et al., 2004; World Health Organization, 2014a), corresponding to a BMI ≥ 60 kg·m-2. The latter obesity types (types III to V) are becoming a major concern, since it has been shown that a BMI ≥ 45 kg·m-2 is correlated with a shorter life expectancy, more specifically, 8 years in white women, 13 years in white men and 20 years in black men (Fontaine, Redden, Wang, Westfall, & Allison, 2003).

In order to reduce the body weight and achieve a healthy condition, people suffering from these types of obesity need to follow medical treatment, including medicine intake, diet, but also become active people (Avenell et al., 2004). However, sometimes these methods are not enough for people who, for example, suffers from type III obesity, associated with comorbidities such as hypertension, type II diabetes or cardiovascular risk, and it´s when the bariatric surgery appears as a possible solution (Brolin, 2002; Rubio et al., 2004). This is a surgical procedure that aims to reduce body weight and can be classified according to the type of technique used. On the one hand, we have restrictive techniques, which try to reduce the capacity of food intake by reducing the gastric cavity (adjustable gastric band, gastric balloon). On the other hand, we have a combination of restrictive-malabsorptive approach type, further reducing the food intake capacity, altering the intestinal route and reducing the

nutrient absorption (gastric bypass) (Mechanick et al., 2008; Rubio et al., 2004; Shah, Simha, & Garg, 2006). People that undergo bariatric surgery have shown great beneficial health effects, reducing comorbidities associated with obesity and diabetes (Dixon et al., 2008; Ricci, Gaeta, Rausa, Macchitella, & Bonavina, 2014), cardiovascular risk (Kwok et al., 2014; Ricci et al., 2014) or hypertension (Ricci et al., 2014; Sjöström et al., 2004), and also promoting the improvement of some psychological factors (self-esteem, body awareness, general wellbeing and depression) (Madan, Beech, & Tichansky, 2008; Mathus‐Vliegen & De Wit, 2007), and their life quality (Mathus‐Vliegen & De Wit, 2007; Tompkins, Bosch, Chenowith, Tiede, & Swain, 2008).

Several previous research has shown that people who underwent bariatric surgery achieved a great weight loss, both in the medium (Mitchell et al., 2001; Schauer, Ikramuddin, Gourash, Ramanathan, & Luketich, 2000) and long term (Angrisani, Cutolo, Formisano, Nosso, & Vitolo, 2013; Kruseman, Leimgruber, Zumbach, & Golay, 2010; O'Brien, MacDonald, Anderson, Brennan, & Brown, 2013). Weight loss surgery is considered successful when a patient loses 50% or more of initial excess weight (EWL) (Freire, Borges, Alvarez-Leite, & Correia, 2012). This percentage of excess weight loss is calculated using the following formula: %EWL = (initial weight - current weight) / (Excess Body Weight) × 100. The Excess Body Weight (EBW) is calculated by subtracting the actual weight from the weight that the subject should have with a BMI of 25 kg·m-2 [EBW = actual weight - (25 × height^2)], using the height in meters (Kruseman et al., 2010).

However, not all subjects are able to reach the 50% of EWL (Kruseman et al., 2010), or if they achieve that, sometimes they fail to maintain it, falling back again to levels below their target values (Freire et al., 2012). In the latter case, physical activity becomes very important. Several studies have shown that factors like age (Kruseman et al., 2010) or the BMI prior to surgery (Giraldo et al., 2012) were related with greater weight loss, and that certain habits such as poor eating behaviours predict failure in weight loss (O'Brien et al., 2013). However, the role of physical activity in weight loss generates some controversy.

Thus, the aim of this study was to perform a systematic review of the scientific literature which relates bariatric surgery and physical activity in order to identify which is the degree of influence of physical activity on weight loss both in the medium and long term.

METHOD

We used a comprehensive and current database to catalogue the bariatric surgery related with physical activity literature. The evidence database for the

catalogue was assembled using established systematic review methods (Cook, Mulrow, & Haynes, 1997; Mulrow & Oxman, 1997).

Data sources

The electronic search was performed using MEDLINE and SCOPUS databases (2000-2014, cut-off date May 31, 2014). A broad search of the English-language literature was performed incorporating both electronic and manual components. The terms used in the search were: bariatric surgery/ laparoscopic, rouex-en-y, exercise, weight loss, physical activity, aerobic, anaerobic, adjustable gastric banding, obesity surgery, weight reduction surgery, gastric bypass, sleeve gastrectomy. The terms were combined in this way: "bariatric surgery" AND "exercise" OR "physical activity"; "bariatric surgery" AND "weight loss" AND "exercise"; "bariatric surgery" AND "weight loss" AND "physical activity"; "laparoscopy" OR "roux-en-Y" AND "exercise"; "laparoscopy" OR "roux-en-Y" AND "physical activity"; "Aerobic" AND "bariatric surgery" AND "weight loss"; "Anaerobic" AND "bariatric surgery" AND "weight loss"; "Adjustable gastric banding" AND "exercise" OR "physical activity"; "obesity surgery" AND "exercise" OR "physical activity"; "weight reduction surgery" AND "exercise" OR "physical activity"; "Gastric Bypass" AND "exercise"; "Gastric Bypass" AND "physical activity".

Literature Screening and Catalogue Construction

Study selection was accomplished through 2 levels of study screening and focused on bariatric surgery and weight loss. At level 1 screening, abstracts were reviewed for the following exclusion criteria: publication of abstracts only, case reports, letters, comments, and reviews; animal or in vitro studies; fewer than 10 patients in the study.

Full articles were then obtained for all studies accepted at level 1 and for any citations for which a determination could not be made from the abstract. For level 2 screening, inclusion required that the studies dealt with at least 1 of the following categories of information: longitudinal studies or observational studies (with at least six months minimum duration) of patients that underwent bariatric surgery (regardless of the surgery method performed), relationship between physical activity and weight loss after bariatric surgery.

Study Selection for Data Extraction

For inclusion in the subset of studies for data extraction, two forms were designed: one in which the basic sample characteristics were collected (age, sample number, gender, initial BMI and the type of surgery performed) and the second form based on design aspects (study length, tool used in physical

activity measurement, type of physical activity performed, groups of the study and results of the study).

Definitions

Surgical procedures. Surgical procedures were grouped into the following categories: laparoscopic adjustable gastric banding (LAGB), gastric bypass (Roux-en-Y variation, RYGB), sleeve gastrectomy (SG), duodenal switch (DS) and vertical banded gastroplasty (VBG).

Physical activity level. Most studies had assessed the physical activity level using questionnaires: The International Physical Activity Questionnaire short form (IPAQ-short), Sport Index of the Baecke Questionnaire (BAQ), Short Questionnaire to Assess Health Enhancing Physical Activity, Bariatric Surgery Self-management Questionnaire PA subscale, The Baecke Physical Activity Questionnaire, The second version of the Global Physical Activity Questionnaire (GPAQ) and The Godin Leisure Time Questionnaire (GLTQ). Other minority methods were used to assess the physical activity level: interviews, self-assessment of physical activity, pedometers and bangles.

Statistical Analysis

Analyses were performed only on the data from the studies in the data extraction subset. Study, patient, and treatment-level data were summarized using basic descriptive statistics (simple counts and means).

RESULTS

Data Retrieval

A flow diagram outlining the systematic review process is presented in Figure 1. The initial literature review identified 128 citations for screening. 96 articles were rejected after reviewing the abstracts. Of the remaining 32 articles, 8 did not meet inclusion criteria for the catalogue: 3 articles did not compare physical activity group and sedentary group after bariatric surgery (Baillot, Mampuya, Comeau, Méziat-Burdin, & Langlois, 2013; Carrasco et al., 2007; Nijamkin et al., 2012), 1 article had minors in the study sample (Baillot et al., 2013), 2 articles used a crossover design (Freire et al., 2012; Herman, Carver, Christou, & Andersen, 2014), 1 article compared a bariatric surgery group with an obese group which did not undergo surgery (Dixon et al., 2008) and in 1 article the weight loss was not measured (Ruiz-Tovar et al., 2014). Finally, 24 articles were selected because they established some kind of relationship between bariatric surgery, exercise and weight loss.

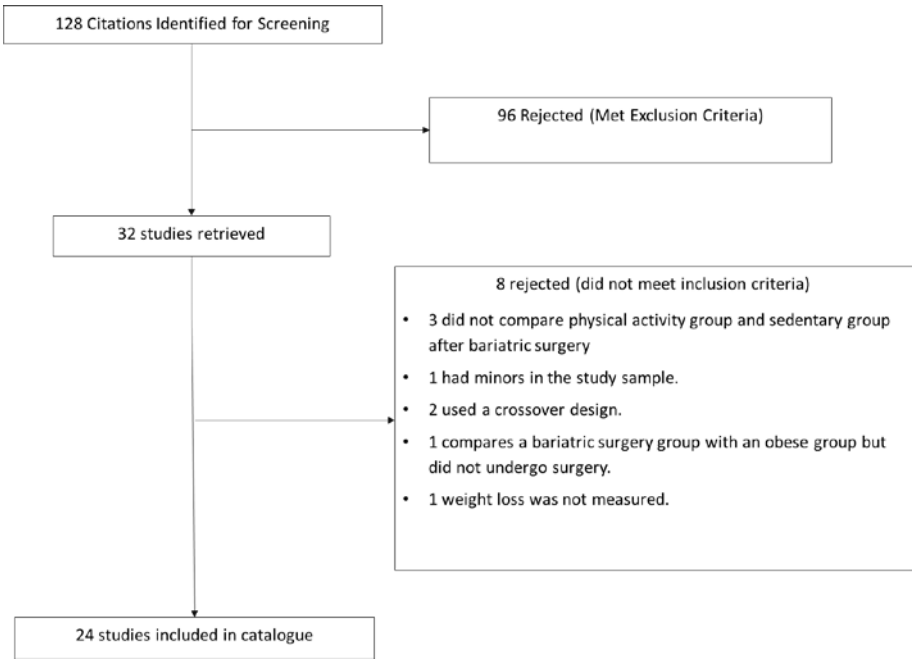

FIGURE 1: Study Attrition Diagram

Study characteristics

The total number of subjects included in this systematic review was 4132, out of which 3503 were women. The subjects' period assessment was carried out between 6 months and 84 months. Tables 1 and 2 show the characteristics of the observational and experimental studies.

Observational studies

From the 21 observational studies (Boddu, Snyder, Wilson, & Wilson, 2012; Bond et al., 2004; Bond et al., 2009; Bueter et al., 2007; Colleen & Edwards, 1999; Colles, Dixon, & O'Brien, 2008; Forbush, Nof, Echternach, Hill, & Rainey, 2011; Hernandez-Estefania et al., 2000; Josbeno, Kalarchian, Sparto, Otto, & Jakicic, 2011; Larsen et al., 2006; Latner, Wetzler, Goodman, & Glinski, 2004; Livhits et al., 2010, 2011; Metcalf, Rabkin, Rabkin, Metcalf, & Lehman-Becker, 2005; Mundi, Lorentz, Swain, Grothe, & Collazo-Clavell, 2013; Rosenberger, Henderson, White, Masheb, & Grilo, 2011; Shada, Hallowell, Schirmer, & Smith, 2013; Silver, Torquati, Jensen, & Richards, 2006; Welch et al., 2008; Welch et al., 2011; Wolfe & Terry, 2006) included in this review, in 16 of them (Bond et al., 2004; Bond et al., 2009; Bueter et al., 2007; Colleen & Edwards, 1999; Colles et al., 2008; Forbush et al., 2011; Hernandez-Estefania et al., 2000; Josbeno et al., 2011; Latner et al., 2004; Livhits et al., 2010; Metcalf et al., 2005; Mundi et al.,

2013; Rosenberger et al., 2011; Shada et al., 2013; Welch et al., 2008; Welch et al., 2011) there was a positive correlation between the physical activity level and the weight loss. One of the 5 articles (Silver et al., 2006) without correlation between physical activity and weight loss showed that lower levels of physical activity correlated with a bigger BMI (r = -.25, p = .006). In another of these 5 articles (Livhits et al., 2011), a lower level of physical activity was a strong predictor of weight regain (OR: 5.51; p = .02). However, in the remaining 3 articles (Boddu et al., 2012; Larsen et al., 2006; Wolfe & Terry, 2006) there was no correlation between the physical activity level and the weight loss.

There seems to be a relationship between high physical activity volumes (minutes/week), length of the physical activity program (between 6 and 12 months) and EWL percentage (Bond et al., 2009; Livhits et al., 2010; Shada et al., 2013; Welch et al., 2011). These studies classified the participants based on the volume (e.g., minutes) of weekly physical activity, considering physically active those individuals that exceeded 150 - 200 minutes per week. The physically active groups have the largest declines in EWL (greater or equal than the 50%).

There are few studies that take into account the intensities at which physical activity is performed (Mundi et al., 2013; Rosenberger et al., 2011). In both studies, the physical activity intensity was assessed by questionnaire (GLTQ, IPAQ-SF or The Baecke Questionnaire) and associated the largest declines in EWL with the volume of intense physical activity.

Finally, there are several factors which can predict weight reduction, including physical activity after the bariatric surgery (Colles et al., 2008; Livhits et al., 2010; Mundi et al., 2013; Silver et al., 2006; Welch et al., 2008; Welch et al., 2011), the weight or the BMI before the bariatric surgery (Colles et al., 2008; Silver et al., 2006; Welch et al., 2011), the diet control (Colles et al., 2008) and the subject´s age (Silver et al., 2006).

Experimental studies

There are few studies that have performed a physical activity monitored program with this population. In this review we included only 3 studies (Castello et al., 2011; Shah et al., 2011; Stegen, Derave, Calders, Van Laethem, & Pattyn, 2011) that tested the weight evolution of the subjects. In these 3 studies the experimental groups underwent a physical activity program which lasted for 12 weeks. In two of them (Castello et al., 2011; Stegen et al., 2011), the control groups were only monitored, while the experimental groups followed a physical activity program consisted in aerobic and resistance exercise (Stegen et al., 2011) or only aerobic exercise (Castello et al., 2011). In the third study (Shah et al., 2011), the diet of the control and experimental group was monitored and the experimental group also followed an aerobic exercise

program. All the studies obtained similar results: there were no significant differences between groups in weight loss. Only a significant difference was found in the study that combined aerobic and resistance exercises (Stegen et al., 2011), in which the experimental group strength levels decreased less than in the control group.

DISCUSSION

This systematic review aims to establish the possible beneficial effect of physical activity in subjects who have undergone bariatric surgery and its relation to weight loss. Results suggest that higher volumes of physical activity lead to higher weight loss (Bond et al., 2009; Forbush et al., 2011; Livhits et al., 2010). The American College of Sports Medicine (ACSM) recommendations for weight loss and prevention of weight regain for adults, consisting of perform 150 minutes per week of moderate or vigorous physical activity (moderate < 3-6METs, vigorous > 6 METs; Ainsworth et al., 2000), agrees with the data reported by the different studies when classifying subjects between physically active or sedentary (Jakicic et al., 2001).

Although most of the articles are focused on measuring physical activity volume performed, we think that it is important to take into account another factor, which is the physical activity intensity. Traditionally, the moderate intensity aerobic exercise has been recommended to lose weight (Hainer, Toplak, & Mitrakou, 2008; Poirier & Després, 2001). However, in two of the articles included in this review, in addition to physical activity volume the physical activity intensity was also measured with questionnaires, highlighting that exercise intensity is a differential point in weight loss. These findings are in line with recent studies (Trapp, Chisholm, Freund, & Boutcher, 2008) that evidenced that higher exercise intensities produce the largest losses of fat mass and general weight loss (Mundi et al., 2013; Rosenberger et al., 2011). In fact the intensity factor has been inversely related with BMI in subjects that were waiting for bariatric surgery (King et al., 2008).

Although the correlations between physical activity and weight loss in observational studies were positive, surprisingly, no significant differences in weight loss have been found between experimental and control groups. This could be due to the short study length (12 weeks) added to the greater weight loss during the first year, fact which could be attributed to the bariatric surgery (Rosenberger et al., 2011). Moreover, also in observational studies, we can observe a similar pattern during the first six months after the surgery, without significant differences in weight loss between active or sedentary people (Boddu et al., 2012; Metcalf et al., 2005; Shada et al., 2013) However, it is from the ninth month after surgery when the differences between groups (physically

active or sedentary) begin to appear (Hernandez-Estefania et al., 2000; Shada et al., 2013). This argument would support the idea that short physical activity intervention periods (less than 6 months) were not enough to increase the weight loss. Another possible explanation for the lack of differences between groups after surgery, it seems that activity volumes and intensities were too low to produce an increase in weight loss. In this regard, the use of different volumes and intensities warrants future studies.

A possible question against the previously presented information is the role of physical activity or how it benefits bariatric surgery patients. In the first months after bariatric surgery, the oxygen consumption (Shah et al., 2011) and lipid profile improves (Ruiz-Tovar et al., 2014), with an increasing in the heart rate variability (Castello et al., 2011). These factors are outlined as indicators of wellbeing and good health and therefore, it can be stated that the practice of physical activity will show different benefits and a better future quality of life in this population.

While, based on the present review, it seems that physical activity does not have a significant short-term effect on weight loss, it would help to the maintenance of long term weight loss (Freire et al., 2012; Pontiroli et al., 2007). This could be because over time, the weight loss effect due to bariatric surgery would be less important, and other psychosocial aspects like the physical activity performed and the nutritional habits would come into play.

Another aspect to take into account is the lower physical activity levels that the subjects presented before the bariatric surgery. Generally, these subjects did not meet the ACSM weekly recommendations, with a low percentage of them being physically active (Bond, Jakicic, Vithiananthan, et al., 2010; King et al., 2008). This should lead us to ask whether the bariatric surgery is necessary for all subjects, because it is an aggressive process, which has about 1% risk of death (Thomas & Agrawal, 2012). Moreover, it would be interesting to see if a healthy lifestyle intervention, including the diet control and the inclusion of individually prescribed physical activity programs, would lead to a weight loss increase and therefore, to avoid the surgery.

LIMITATIONS

Most of the studies included in this systematic review were observational and therefore, it is not possible to establish causal relationships. Another possible limitation is that the subject´s physical activity was measured using questionnaires and, as highlighted by one of the reviewed studies (Bond, Jakicic, Unick et al., 2010), the subjects did not report correctly the physical activity level performed. After being monitored for seven days with an accelerometer, the subjects completed questionnaires (e.g., daily physical activity performed).

Results showed that subjects reported in the questionnaires an accomplishment of 55% of the physical activity recommended, while the accelerometers showed that they only accomplished a 5%.

Another limitation found was how the subjects were classified as active or sedentary in some studies (Bond et al., 2009). These studies only assessed the physical activity level performed the last seven days before using the questionnaires, and therefore, could lead to wrong conclusions. Moreover, the methodology used to assess the weight loss can also be misleading. Most of the articles used the decreases in overall weight as weight loss measurement. We should take into account that the subjects can lose fat mass and increase muscular mass when they are performing physical activity (Thivel & Seabra 2014), achieving a healthier body composition, but at the same time maintaining their overall weight. Thus, future studies should include anthropometric measurements to obtain more reliable information.

Finally, the use of different bariatric surgery techniques makes it difficult to control the effect that they have on weight loss, especially if we take into account that, for example, the gastric bypass has shown greater weight losses (Shah et al., 2006).

FUTURE RESEARCH

The role of physical activity in people who have undergone bariatric surgery leaves many unsolved questions, including the recommended volumes and intensities of physical activity, the role of aerobic and resistance exercise and the most efficient aerobic exercise mode (continuous vs. intermittent; low intensity vs. high intensity exercise) on weight loss management.

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