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Motivation and physical activity levels in bariatric patients involved in a self-determination theory-based physical activity program

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ABSTRACT

Objective: This study examines the associations between pre-to post-intervention changes in motivation and physical activity (PA) levels of bariatric patients involved in a 6-month postoperative PA program based on self-determination theory (SDT). We also explore the extent to which patients' perception of autonomy support and basic psychological need satisfaction during the program were associated with changes in their motivation to exercise.

Method: Forty patients were assigned to a motivational PA intervention (MPAI-G) or to a control group (CG). Both groups completed questionnaires assessing the variables of interest and wore GT3X accelerometers before surgery and after the program.

Results: Thirty-two participants (78.1% female) completed all measures and were included in the present analyses. CG showed greater increases in integrated ($d = -1.60$, 95% CI [−2.40, −0.81]) and identified regulation ($d = -0.75$, 95% CI [−1.47, −0.03]) than MPAI-G. However, the MPAI-G experienced increases in introjected regulation ($d = 1.95$, 95% CI [1.11, 2.79]) and greater decreases in external regulation ($d = -1.00$, 95% CI [−1.74, −0.27]) than CG, which were associated with decreases in sedentary activity and increases in light and total PA. Oppositely to the CG, amotivation decreased in the MPAI-G ($d = -2.98$, 95% CI [−3.98, −1.97]) and it was related to increases in light and total PA. Changes in exercise motivation were associated with perceived autonomy support and basic psychological need satisfaction during the program.

Conclusion: The SDT-based PA program gave rise to greater changes in controlled forms of motivation and amotivation than in autonomous motivation in post-bariatric surgery patients.

1. Introduction

Bariatric surgery candidates report several obesity and non-obesity related barriers towards physical activity (PA) (Beltrán-Carrillo et al., 2019; Zabatiero et al., 2018). In this regard, research has shown that non-obesity related barriers (e.g., lack of self-efficacy, motivation, or knowledge to engage in PA) largely persist after surgery (Zabatiero et al., 2018). This fact could explain the few or non-existent pre-to post-surgery changes in PA levels found in this population (Herring et al., 2016; Jacobi, Ciangura, Couet, & Oppert, 2011).

One of the most frequent non-obesity related barriers reported by bariatric patients to engage in PA is lack of motivation (Dikareva, Harvey, Cicchillitti, Bartlett, & Andersen, 2016; Peacock, Sloan, & Cripps, 2014; Zabatiero et al., 2016). For instance, Dikareva et al. (2016) showed that some patients describe exercise as "a chore" and a "waste of time". Peacock et al. (2014) showed that nearly 80% of bariatric patients reported difficulties to maintain exercise behavior, to make exercise a priority, or simply to enjoy it. Participants included in the study of Zabatiero et al. (2016) highlighted that initiating PA every day was an arduous task for them. Therefore, promoting PA among bariatric patients represents a major challenge for health-care practitioners, PA professionals and public health authorities, which needs to be

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addressed.

Self-determination theory (SDT; Ryan & Deci, 2017) has been widely used to describe the motivational processes underlying behavioral maintenance, including long-term PA adherence (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). According to SDT, individuals' optimal motivation, development, and wellness requires them to perceive that their basic psychological needs are being fulfilled: the need for autonomy (to feel a sense of choice and self-endorsement towards the behavior); competence (to feel a sense of capacity and mastery to accomplish the behavior); and relatedness (to feel meaningfully connected to others). In PA settings, the satisfaction of basic psychological needs has been empirically associated with more autonomous (internal, non-controlled) forms of motivation and positive outcomes related to behavioral persistence and well-being (Ng et al., 2012; Ntoumanis et al., 2020; Vallerand, 2007). Nevertheless, when these psychological needs are thwarted, people tend to regulate their behavior based on external contingencies and self-judgments (i.e., to develop controlled forms of motivation), which lead to behavioral non-adherence and negative psychological consequences (Santos, Silva, & Teixeira, 2016; Vansteenkiste & Ryan, 2013). For these reasons, SDT could provide a basis on which behavior change interventions, such as those focused on improving PA adherence, can be supported.

To date, few studies have used SDT as the theoretical frame of reference when designing programs to promote PA adherence in bariatric patients. In the *Bari-Active* project, Bond et al. (2015, 2016, 2017) used some SDT tenets (along with other psychological theories) to improve pre- and postoperative PA levels of patients seeking bariatric surgery. Interestingly, they found that preoperative increases in bout-related moderate-to-vigorous PA (MVPA) remained six months post-surgery (Bond et al., 2015), which were accompanied by both a decrease in patients' levels of amotivation and increases in autonomous forms of motivation (Bond et al., 2016). However, they reported no relationships between changes in bout-related MVPA and motivational variables (Bond et al., 2016). The fact that these studies conducted face-to-face counselling, but not practical PA sessions in which patients exercised together in a need-supportive environment, could be a plausible explanation for this lack of correspondence between motivation and PA. Later, González-Cutre, Megías, Beltrán-Carrillo, Cervelló, and Spray (2020) carried out a 6-month postoperative SDT-based program where patients qualitatively reported many factors that contributed to their psychological need satisfaction (e.g., instructors caring about their opinion, fitness improvement, or knowledge acquisition about PA), which in turn enhanced patients' autonomous motivation and their intention to be physically active. Unfortunately, findings from a subsequent quantitative study with the same patients suggested that such intervention enhanced several dimensions of their health-related quality of life, but did not lead to significant increases in their objectively assessed PA levels at either 7 or 13 months post-surgery when compared to a control group (Jiménez-Loaisa, González-Cutre, Beltrán-Carrillo, & Alcaraz-Ibáñez, 2020).

The present research is based on these PA results found by Jiménez-Loaisa et al. (2020). By analyzing the same participants, this study tried to shed light on the motivational factors that influenced patients' PA levels after a 6-month SDT-guided PA intervention. For that purpose, the objectives of this study were: 1) to examine the associations between pre-to post-intervention changes in exercise motivation and objective PA levels of bariatric patients involved in the postoperative program, comparing with a control group who did not receive the intervention; and 2) to explore the extent to which patients' perception of autonomy support and basic psychological need satisfaction during the program were associated with changes in their motivation to exercise. Therefore, while Jiménez-Loaisa et al. (2020) focused on analyzing the effects of the motivational PA intervention (MPAI) on patients' PA levels from pre-surgery to the end of the MPAI (7 months post-surgery) and 13 months post-surgery, this study tried to delineate the motivational processes that occurred during the intervention, by using the pre-surgery and 7-month post-surgery measurements points, and their associations with PA levels. Several SDT-based variables related to motivational mechanisms underlying PA adoption which were not analyzed in Jiménez-Loaisa et al. (2020), as autonomy support (Ntoumanis et al., 2020), basic need satisfaction (Ryan & Deci, 2017), and motivational regulations (Teixeira et al., 2012) were included on this occasion. Additionally, in contrast with Bond et al. (2016), we also included light PA to provide a more complete understanding of the behavioral paths chosen by this population to participate (or not) in PA.

Previous research in the field of bariatric surgery and PA have shown high rates of physical inactivity after surgery (Herring et al., 2016; Jacobi et al., 2011), and both theory (Jiménez-Loaisa et al., 2020) and non-theory-guided (Herring et al., 2017; Stolberg et al., 2018) postoperative PA programs have failed to increase patients' PA levels over time. For that reason, analyzing the associations between motivational processes and different forms of PA could be helpful for future behavior change interventions aimed at promoting PA adherence in these patients.

We hypothesized that the MPAI would influence the development of more autonomous forms of motivation towards PA, while decreasing those of a controlled nature and also amotivation; and that potential positive changes in more autonomous forms of motivation would be positively related to changes in PA (light and MVPA). On the other hand, we expected that changes in controlled types of motivation and amotivation would be negatively associated with changes in PA, but positively associated with changes in sedentary activity. Finally, we expected that patients' perception of autonomy support and basic psychological need satisfaction would be positively associated with changes in their autonomous motivation, and negatively associated with controlled motivation and amotivation.

2. Method

2.1. Participants and study design

Adult participants, aged between 31 and 60 years, diagnosed with severe obesity (body mass index [BMI] $\geq$ 40 kg/m^2) were recruited from a Spanish hospital between November 2011 and May 2013. Requirements for sleeve gastrectomy (SG) also included having failed previous attempts of sustained weight loss after endocrinology and nutritional counselling, and not having any physical, medical or psychosocial contraindications.

The details of the intervention design have been previously reported (González-Cutre et al., 2020; Jiménez-Loaisa et al., 2020). CONSORT flow diagram is available at Jiménez-Loaisa et al. (2020). Briefly, patients were recruited preoperatively by their clinical psychologist (100% of patients asked) and were assigned to a motivational PA intervention group (MPAI-G) or a control group (CG). Forty patients were recruited at an initial stage. As one of our main goals was that patients exercised together with their peers, we decided to assign patients following a 10:10 procedure, so that the first 10 patients who attended the baseline meeting were assigned to the MPAI-G, and the next 10 assigned to the CG. This pseudo-randomized procedure was repeated with the next 20 participants. In this way, of the initial 40 participants allocated to groups, 32 (n = 17 MPAI-G; n = 15 CG; 82% of retention) completed all assessment measures and were included in the present analyses. In the CG, reasons for not being included were having invalid accelerometer data (n = 1) or declining to participate at post-intervention assessment (n = 4). In the MPAI-G, a participant did not receive the intervention alleging personal reasons (n = 1), while some patients presented invalid accelerometer data (n = 2). Participants' characteristics are presented as supplemental material (Appendix 1).

Informed consent was obtained from all participants included in the current intervention study. All research was conducted according to the Helsinki Declaration, approved by the hospital and the first author's university, and registered at ClinicalTrials.gov (registration number

NCT03666481). The quality of the study was assessed using the "Consolidated Standards of Reporting Trials" (CONSORT). The study fulfills 20 of the 25 criteria of the CONSORT checklist (Appendix 2).

2.2. Procedure

The MPAI started one month after surgery and lasted 6 months. To be included, all patients had to get the consent of both their surgeon and clinical psychologist and had to confirm their availability to attend the program. Consent implied favorable compliance with the usual post-operative medical evaluations of bariatric patients (e.g., regarding medication or nutrition). Exclusion criteria included unavailability to attend the program regularly, having any physical complication derived from SG, as well as suffering any other medical or psychological condition that prevented habitual participation in PA during the course of the study.

MPAI sessions took place in a public fitness center located at the first author's university. All activities were guided by two sport sciences professionals who received standardized training in the application of SDT-based motivational strategies (see Appendix 3). As previously described (González-Cutre et al., 2020; Jiménez-Loaisa et al., 2020), instructors' training was divided in two blocks. The first one consisted of a 10-h theoretical and practical seminar about SDT-based motivational strategies in exercise. In the second block (2-month long), the instructors applied these strategies in a real-world setting, where an external observer with expertise in SDT rated their agreement with the strategies using an observation sheet. After that, feedback was provided to the two instructors to improve their need-supportive style.

The frequency and duration of the sessions increased while the program was progressing. Concretely, the MPAI consisted of two sessions per week during the first two months, three sessions per week during the intermediate two months, and four sessions per week during the last two months (~70 exercise sessions). Patients' training attendance was recorded through a follow-up sheet. The sessions lasted about 60 min during the first two months, increasing to approximately 90 min during the following months. This approach was adopted to address the evolution of the physical training variables considered in the research project. In this regard, the content of the sessions was directed in two ways: sessions with activities focused on working physical capabilities with machines (e.g., cardiorespiratory fitness, muscular strength); and innovative sessions to enhance psychosocial aspects among participants (e.g., body expression, beach and pool activities, trekking, traditional Spanish games). The SDT-based motivational strategies were applied in both types of sessions.

The MPAI, therefore, involved two main goals. First, to provide a need-supportive environment focused on the satisfaction of the basic psychological needs for autonomy, competence, and relatedness to improve patients' motivation towards PA, and therefore increasing their PA participation after the program. Second, to translate the physical and psychosocial benefits of the MPAI on patients' perceived quality of life.

The CG verbally received general recommendations of PA from their doctors as part of their usual care, which were focused on trying to maintain an active lifestyle after surgery, but without giving specific information regarding the type, frequency, duration or intensity of the physical activities.

The measurements were carried out before SG (2 weeks pre-surgery) and after the intervention (7-months post-SG). At both measurement points, patients from both groups filled in a questionnaire related to their motivation towards exercise and were encouraged to wear an accelerometer for a week to measure their PA levels. Patients' autonomy support and basic psychological need satisfaction were only measured in the MPAI-G after the program.

2.3. Measures

Motivation to exercise. The 23-item Spanish version of the Behavioral Regulation in Exercise Questionnaire (BREQ-3; González-Cutre, Sicilia, & Fernández, 2010) was used to measure patients' motivation to exercise. BREQ-3 assesses different types of exercise motivation, comprising 6 minor subscales: *amotivation* (e.g., "I don't see why I have to do it"), *external regulation* (e.g., "Because other people say I should"), *introjected regulation* (e.g., "I feel guilty when I don't exercise"), *identified regulation* (e.g., "I value the benefits of exercise"), *integrated regulation* (e.g., "I consider exercise a fundamental part of who I am"), and *intrinsic regulation* (e.g., "I exercise because it's fun"). This questionnaire is rated on a 5-point Likert-scale, from 0 ("totally disagree") to 4 ("totally agree"). External and introjected regulations represent controlled forms of motivation, whereas intrinsic, integrated, and identified regulations represent autonomous forms of motivation (major subscales). Higher BREQ scores on subscales representing more autonomous types of motivation have shown to be predictive of higher levels of PA (Thøgersen-Ntoumani & Ntoumanis, 2006; Markland & Tobin, 2004).

Physical activity levels. Actigraph™ GT3X accelerometers (Pensacola, FL) were used to measure PA. Participants were asked to wear the triaxial accelerometer at their right hip for a 1-week period, excepting for activities that could damage the device (e.g., for sleeping, showering or bathing). Wear-time required to estimate PA levels was as follows: a minimum of 3 days with at least 10 h of wearing-time per day at all measurements (Trost, McIver, & Pate, 2005). Non-wear time was defined as 60 min of consecutive zeros, allowing for 2 min of non-zero interruptions (Troiano et al., 2008). Sedentary, light, and moderate-to-vigorous intensity activities were defined as $\leq$ 100, 101–3027, and $\geq$3028 counts per minute, respectively (Hanggi, Phillips, & Rowlands, 2013; Santos-Lozano et al., 2013). Total PA was obtained through the sum of light PA and MVPA.

Autonomy support. The 12-item Spanish version of the Perceived Autonomy Support Scale for Exercise Settings (PASSES, Moreno-Murcia, Parra, & González-Cutre, 2008) was used to measure the autonomy support that patients perceived of their instructors during the program (e.g., "I feel that the instructor provides me with choices, options, and opportunities about whether to do active exercise in my free time"). This questionnaire is rated on a 7-point Likert-scale, from 1 ("totally disagree") to 7 ("totally agree"), where higher scores represent higher perceptions of autonomy support provided by instructors.

Basic psychological needs in exercise. The 12-item Spanish version of the Basic Psychological Needs in Exercise Scale (BPNES; Sánchez & Núñez, 2007) was used to assess the extent to which the psychological needs of the patients were satisfied during the program. The questionnaire is rated on a 5-point Likert-scale, from 1 ("totally disagree") to 5 ("totally disagree"), which allows to measure *autonomy* (e.g., "The way I exercise is in agreement with my choices and interests"), *competence* (e.g., "I feel I perform successfully the activities of my exercise program"), and *relatedness* (e.g., "My relationships with the people I exercise with are very friendly"). Higher scores represent higher needs' satisfaction.

Other measures. Age, sex, race/ethnicity, level of education, socioeconomic status, and marital status were reported by all participants at study entry. Anthropometric data (i.e., height and weight) was assessed at both assessment moments.

2.4. Data analysis

Analyses were performed using SPSS 25.0 (IBM, Corp., Armonk, NY, USA) software, excluding effect sizes (ES) which were extracted online (Lenhard & Lenhard, 2016). Participants' descriptive values for studied variables are presented as relative frequencies (%) or means $\pm$ standard deviations (M $\pm$ SD). Changes in motivation and PA levels between groups from pre-SG to 7 months post-SG were estimated using analysis of variance (ANOVA), adjusting for sex, age and percentage of excess weight loss (% EWL). These covariates were included for three reasons: 1) to maintain consistency with Jiménez-Loaisa et al. (2020), 2) previous evidence supporting differences according to sex, age and % EWL in PA (Josbeno, Kalarchian, Sparto, Otto, & Jakicic, 2011;

Stroebele-Benschop, Damms-Machado, Milan, Hilzendegen, & Bischoff, 2013; Westerterp, 2018), and 3) % EWL is the most common weight loss-related variable used in bariatric surgery research (Brethauer et al., 2015). Bivariate correlations between all covariates and outcome variables are available at Appendix 4.

Additionally, to examine associations between changes in motivation and PA variables from pre-SG to 7 months post-SG, and between autonomy support/need satisfaction and changes in motivation, partial correlations were calculated. Sex, age and % EWL were also used as moderators for partial correlations. % EWL was determined by using the midpoint of the 1983 Metropolitan Life Insurance tables for a medium frame: [(operative weight – follow-up weight)/operative excess weight)] x 100. Bivariate correlations can be consulted at Appendix 5 and 6.

ES with 95% confidence intervals were calculated to estimate the magnitude of the difference between groups in the motivation variables and PA levels, which were considered not statistically significant when the confidence interval encompassed the zero value (Nakagawa & Cuthill, 2007). Intra-group differences in descriptive values are also available at Appendix 7. To interpret these differences, threshold values for Cohen's *d* were used as small (<0.3), moderate (around 0.5) and large (>0.8). ES proposed by Morris (2008) was also indicated for weighting the differences of the pre-post-means via pooled pretest standard deviation. For ES of differences between partial correlations across CG and MPAI-G, Cohen's *q* was determined by considering <0.1 as no effect, 0.1 to 0.3 small effect, 0.3 to 0.5 intermediate effect, and >0.5 as large effect (Cohen, 1988). Finally, magnitude of correlations between autonomy support/need satisfaction and changes in motivation for MPAI-G were interpreted based on the Gignac and Szodorai (2016) normative correlation guidelines, where $r = 0.10$, 0.20, and 0.30 represent relatively small, typical, and relatively large associations, respectively.

3. Results

3.1. Descriptive data

Patients' attendance rate for the MPAI-G sessions was 80% on average (range, 68.1–88.9). Demographic and bariatric characteristics did not differ ($p > 0.05$) between participants who provided complete data from those who did not provide them. The descriptive values for motivation and PA variables are shown in Table 1. Preoperatively, both groups differed significantly only in MVPA, which was higher in the CG ($d = -0.72$, 95% CI [−1.44, −0.01]).

3.2. Changes in Motivation/PA

Changes in motivation and PA levels, controlling for sex, age, and % EWL, are shown in Table 2. CG showed greater increases in integrated regulation ($d = -1.60$, 95% CI [−2.40, −0.81]), identified regulation ($d = -0.75$, 95% CI [−1.47, −0.03]), and smaller decreases in MVPA ($d = -0.72$, 95% CI [−1.44, −0.01]) than MPAI-G. Otherwise, MPAI-G showed increases in introjected regulation, while CG showed a decrease in this variable ($d = 1.95$, 95% CI [1.11, 2.79]). MPAI-G also showed greater decreases in external regulation ($d = -1.00$, 95% CI [−1.74, −0.27]) than CG. Finally, MPAI-G showed a decrease in amotivation, while CG showed increases in this variable ($d = -2.98$, 95% CI [−3.98, −1.97]).

3.3. Associations between changes in motivation and PA variables

Partial correlations (adjusted by sex, age, and % EWL) between changes in motivation and PA across groups are presented in Table 3. In this vein, four main groups of results deserve to be highlighted:

Changes in motivation and sedentary activity. Changes in introjected regulation and sedentary activity were negatively related in the MPAI-G, inversely to the CG ($q = 0.80$, large). Moreover, changes in external regulation and sedentary activity were positively related for the MPAI-G, opposed to the CG ($q = 0.37$, intermediate).

Changes in motivation and light PA. Changes in intrinsic regulation and light PA were positively associated for both groups ($q = 0.36$, intermediate). Changes in introjected regulation and light PA were positively related in the MPAI-G, contrary to the CG ($q = 0.59$, large). Lastly, changes in external regulation and amotivation were negatively associated with light PA for the MPAI-G, whereas CG showed the inverse pattern ($q = 0.64$ and 0.41, large and intermediate, respectively).

Changes in motivation and MVPA. Changes in identified regulation and MVPA were negatively associated in the MPAI-G, inversely to the CG ($q = 0.43$, intermediate). In the same way, changes in amotivation and MVPA were positively related for the MPAI-G, opposed to the CG ($q = 0.39$, intermediate).

Changes in motivation and total PA. Changes in intrinsic regulation and total PA were positively associated for both groups ($q = 0.33$, intermediate). For MPAI-G, changes in introjected regulation and total PA were positively related, opposed to the CG ($q = 0.59$, large). Finally, changes in external regulation and amotivation were negatively correlated with total PA for the MPAI-G, inversely to the CG ($q = 0.47$ and 0.31, intermediate).

Table 1
Between-groups descriptive values (M ± SD) for motivation variables and physical activity levels from pre-SG to 7 months-after SG.

Variables	Pre-SG			7 months-after SG			d_{Morris}
	CG ($n = 15$)	MPAI-G ($n = 17$)	*d*	CG ($n = 15$)	MPAI-G ($n = 17$)	*d*	
BREQ-3 scores (0–4)							
Intrinsic	2.50 (±1.57)	2.44 (±1.43)	−0.04	3.03 (±1.10)	3.01 (±0.95)	−0.02	−0.03
Integrated	2.00 (±1.32)	1.98 (±1.23)	−0.02	2.88 (±1.14)	2.31 (±1.08)	−0.51	0.44
Identified	3.02 (±1.38)	3.04 (±1.20)	0.02	3.35 (±0.83)	3.29 (±0.75)	−0.08	0.07
Introjected	1.10 (±0.97)	1.07 (±0.88)	−0.03	0.80 (±0.94)	1.34 (±0.96)	0.57	−0.59
External	0.87 (±1.25)	1.22 (±1.28)	0.28	0.60 (±0.97)	0.59 (±0.78)	−0.01	0.32
Amotivation	0.37 (±0.45)	0.50 (±0.69)	0.22	0.43 (±0.57)	0.19 (±0.34)	−0.52	0.71
GT3X (min/day)							
Sedentary activity	628.45 (±140.42)	620.25 (±132.96)	−0.06	617.09 (±166.66)	614.87 (±168.20)	−0.01	−0.04
Light PA	332.66 (±125.36)	368.89 (±122.60)	0.29	368.34 (±155.27)	378.38 (±161.94)	0.06	0.18
MVPA	47.98 (±29.67)	29.84 (±20.25)	−0.72[a]	43.26 (±31.45)	25.73 (±22.85)	−0.64	−0.02
Total PA	380.64 (±143.22)	398.74 (±132.96)	0.13	411.60 (±173.83)	404.11 (±168.20)	−0.04	0.16

Note. SG = Sleeve gastrectomy, CG = Control group, MPAI-G = Motivational physical activity intervention-group, PA = Physical activity, MVPA = Moderate-to-vigorous physical activity. d_{Morris} = Raw differences between groups of the pre-post means divided by the pooled pretest standard deviation.
[a] Significant differences considering that the effect size 95% CI did not include the zero value.

Table 2
Changes in motivation and physical activity levels from pre-SG to 7 months-after SG adjusted by sex, age and % EWL.

Variables	CG ($n = 15$)		MPAI-G ($n = 17$)		d_{Cohen}	95% CI
	M (SD)	95% CI	M (SD)	95% CI		
BREQ-3						
Intrinsic	0.56 (±0.41)	[−0.28, 1.40]	0.55 (±0.38)	[−0.23, 1.34]	−0.02	[−0.72, 0.67]
Integrated	0.84 (±0.31)	[0.21, 1.47] [a]	0.36 (±0.29)	[−0.23, 0.95]	−1.60	[−2.40, −0.81] *
Identified	0.42 (±0.33)	[−0.26, 1.10]	0.18 (±0.31)	[−0.46, 0.81]	−0.75	[−1.47, −0.03] *
Introjected	−0.20 (±0.20)	[−0.62, 0.22]	0.18 (±0.19)	[−0.21, 0.57]	1.95	[1.11, 2.79] *
External	−0.31 (±0.30)	[−0.93, 0.32]	−0.60 (±0.28)	[−1.18, −0.02] [a]	−1.00	[−1.74, −0.27] *
Amotivation	0.16 (±0.19)	[−0.24, 0.55]	−0.39 (±0.18)	[−0.76, −0.01] [a]	−2.98	[−3.98, −1.97] *
GT3X						
Sedentary activity	1.64 (±34.42)	[−68.98, 72.25]	−16.85 (±32.18)	[−82.88, 49.19]	−0.56	[−1.26, 0.15]
Light PA	22.93 (±33.03)	[−44.84, 90.69]	20.74 (±30.89)	[−42.63, 84.11]	−0.07	[−0.76, 0.63]
MVPA	−1.94 (±6.64)	[−15.56, 11.68]	−6.56 (±6.21)	[−19.30, 6.18]	−0.72	[−1.44, −0.01] *
Total PA	20.99 (±35.60)	[−52.05, 94.02]	14.18 (±33.29)	[−54.12, 82.48]	−0.20	[−0.89, 0.50]

Note. SG = Sleeve gastrectomy, % EWL = Percentage of excess weight loss, CG = Control group, MPAI-G = Motivational physical activity intervention-group, PA = Physical activity, MVPA = Moderate-to-vigorous physical activity.
[a] Intra-group significant differences considering that the effect size 95% CI did not include the zero value. * Between-group significant differences considering that the effect size 95% CI did not include the zero value.

3.4. Associations among patients' perception of autonomy support, basic psychological need satisfaction, and changes in motivation

Partial correlations (adjusted by sex, age, and % EWL) among patients' perception of autonomy support, basic psychological need satisfaction, and changes in motivation for the MPAI-G are showed in Table 4. The descriptive values (M ± SD) for autonomy support and need satisfaction at the end of the intervention are also presented. When examining the correlations among the study variables, autonomy support was positively associated with changes in integrated and identified regulations, and negatively associated with changes in introjected regulation, external regulation, and amotivation. Autonomy satisfaction were negatively associated with changes in introjected regulation, whereas competence and relatedness' satisfaction were negatively associated with changes in introjected regulation, external regulation, and amotivation.

4. Discussion

The present study sought to explore the motivational processes involved in a SDT-based PA program by examining the associations between pre-to post-intervention changes in motivation and PA levels of bariatric patients, and also the extent to which patients' perception of autonomy support and basic psychological need satisfaction during the program were associated with changes in their exercise motivation. In line with our initial hypothesis, bariatric patients belonging to the MPAI-G decreased their external regulation for exercise (the most controlled form), which was related to reduced sedentary activity and increased light and total PA, and decreased their levels of amotivation, which was related to higher light and total PA. However, increases in levels of introjected regulation (also a controlled form of motivation) were observed in this group when compared to the CG, although those were negatively associated with sedentary activity and positively associated with light and total PA.

These results are similar to the ones found in previous studies conducted in adolescents and adults with overweight and obesity (Silva et al., 2011; Verloigne et al., 2011). Higher levels of introjection have usually been linked to the adoption of short-term health behaviors (Ng et al., 2012; Pelletier, Fortier, Vallerand, & Brière, 2001), although they are usually accompanied by states of anxiety and dissatisfaction, which lead to negative psychological outcomes and long-term behavioral non-adherence (Ng et al., 2012). The fact that our intervention program offered a great variety of activities and information regarding PA within a short period of time might have "overloaded" the patients and unintentionally stimulated internal feelings of pressure, guilt and self-criticism when they did not perform sufficient levels of PA.

In addition, while participants from MPAI-G reduced their external regulation, amotivation, and increased their introjected regulation when compared to the CG, participants from CG experienced greater increases in autonomous types of motivation (integrated and identified regulations) when compared to the MPAI-G. These results were against our hypothesis, but an interesting discussion can emerge from them. On the one hand, behavior change interventions should focus on strengthening autonomous motivation rather than reducing controlled motivation (Koestner, Otis, Powers, Pelletier, & Gagnon, 2008). Nevertheless, considering that bariatric surgery patients usually show a high rejection towards PA (Dikareva et al., 2016; Peacock et al., 2014; Zabatiero et al., 2016), reducing controlled motivation (as was the case of MPAI-G) could perhaps be the first step to increase bariatric patients' PA, particularly in short-term interventions. On the other hand, this study was conducted at an early postoperative stage characterized by a phase of large weight loss. This phenomenon itself might have influenced CG perceptions to autonomously engage in PA. For example, we previously showed that participants from CG experienced remarkable increases in several physical domains of their health-related quality of life (Jiménez-Loaisa et al., 2020), which are associated with enhanced PA in bariatric patients (Sellberg et al., 2019). Moreover, CG showed significantly more MVPA than MPAI-G, both pre- and postoperatively, which might also suggest that CG could be more predisposed to PA than participants enrolled in the MPAI-G.

Changes in intrinsic regulation were positively associated with increases in light and total PA for both groups. In a previous study, Bond et al. (2016) showed no association between changes in PA and motivation variables in 40 bariatric patients participating in a PA intervention. However, these authors only measured bout-related MVPA, and not light PA, as in the present case. Thus, we could speculate that bariatric patients may have a better predisposition to do light PA in early postoperative stages – i.e., may enjoy it more, feel more able to do it and more confident about it –, rather than more vigorous PA. Considering the potential of light PA for achieving health outcomes in population groups who are particularly inactive, and being a more attainable option than MVPA recommendations for initiating exercise (Chastin et al., 2019), we encourage future PA-based interventions to take special account of the role of light PA to optimize motivational processes towards PA in bariatric patients.

Promoting light PA could make more sense if we attend to the controversial relationships found between changes in identified regulation and amotivation with changes in MVPA for the MPAI-G. In

Table 3
Partial correlations among changes in motivation and physical activity from pre-SG to 7 months-after SG.

Variables	Full sample (n = 32)				CG (n = 15)				MPAI-G (n = 17)				q_{Cohen}			
	Sedentary A	Light PA	MVPA	Total PA	Sedentary A	Light PA	MVPA	Total PA	Sedentary A	Light PA	MVPA	Total PA	Sedentary A	Light PA	MVPA	Total PA
Intrinsic	−.27	.30	.12	.30	−.41	.52	.12	.50	−.22	.21	.11	.22	0.21	0.36	0.01	0.33
Integrated	−.33	.34	.18	.35	−.41	.40	.07	.38	−.28	.25	.25	.28	0.15	0.17	0.19	0.11
Identified	−.23	.25	−.08	.22	−.32	.29	.01	.27	−.19	.28	−.40	.19	0.14	0.01	0.43	0.09
Introjected	.01	.08	.06	.08	.44	−.25	−.04	−.24	−.32	.32	.14	.33	0.80	0.59	0.18	0.59
External	.14	−.10	.18	−.06	−.03	.10	.20	.13	.33	−.41	.27	−.33	0.37	0.64	0.07	0.47
Amotivation	.12	−.04	.11	−.01	.08	.09	−.16	.06	.24	−.31	.22	−.24	0.16	0.41	0.39	0.31

Note. SG = Sleeve gastrectomy, CG = Control group, MPAI-G = Motivational physical activity intervention-group, A = Activity, PA = Physical activity, MVPA = Moderate-to-vigorous physical activity. q_{Cohen} = Effect size of differences between partial correlations across CG and MPAI. $q_{Cohen} < 0.1$ - no effect; $q_{Cohen} \geq 0.1$ and < 0.3 - small effect; $q_{Cohen} \geq 0.3$ and < 0.5 - intermediate effect; $q_{Cohen} \geq 0.5$ - large effect. Partial correlations are adjusted by sex, age, and % EWL.

contrast with our hypotheses, in this group we found that increases in identified regulation were related to decreases in MVPA, and increases in amotivation were associated to increases in this type of PA. A plausible explanation for this result may reside in the role that the rise in introjected regulation levels could play over identified regulation: if patients feel guilty and pressured about their performance during the intervention program, they might have not been able to consider PA as an important and valuable part of their lifestyle. Longer-term (follow-up) results may show different clues. Future studies should therefore explore whether this effect of "overloading" messages on the importance of PA can be counterproductive for the internalization processes of this behavior. Likewise, upcoming research should examine the predisposition (or possible rejection) of bariatric patients towards intense forms of PA. Taking into account that performing PA is usually an arduous task for them (Zabatiero et al., 2016), in which they perceive low self-competence (Peacock et al., 2014), promoting MVPA in the initial stages of behavior change interventions could lead to undesirable outcomes related to lack of motivation and enjoyment.

As hypothesized for the variables measured only in the MPAI-G, the participants felt high autonomy support provided by their instructors during the program, which was positively related to changes in integrated and identified regulation, and negatively related to changes in introjected and external regulation and also amotivation. Moreover, these patients showed high levels of autonomy, competence, and relatedness satisfaction. In line with SDT tenets, autonomy satisfaction was negatively associated with changes in introjected regulation, while competence and relatedness satisfaction were negatively related to the changes in controlled forms of motivation (i.e., introjected and external regulation) and absence of it (i.e., amotivation). Several SDT-based interventions have previously found similar results in other clinical populations (Mazzoni, Carlsson, Berntsen, Nordin, & Demmelmaier, 2019; Ng et al., 2012). However, small associations were found between patients' psychological need satisfactions and changes in their autonomous forms of motivation. Embracing these results together with the previous ones, we can highlight that the intervention had greater effects on changes in controlled forms of motivation and amotivation (in the expected direction), rather than in autonomous motivation.

In any case, our study highlights the important role of interpersonal support when trying to promote changes in bariatric patients' motivation to PA. Future SDT-based studies (both quantitative and qualitative) should continue examining this topic by exploring what motivational strategies facilitate patients' PA via need satisfaction. In the present study, we did not explore the perceptions of basic psychological need satisfaction when CG received advice during their usual care, and that was a limitation. Moreover, since bariatric surgery has a meaningful impact on bariatric patients' life, it could be desirable that future studies explore its own effect on the patients' psychological needs.

Results found in this study should be interpreted with caution. First, the correlational methodology used in part of this research makes it difficult to infer causality among the studied variables. However, the use of this methodology allowed us to examine some unexplored relationships between motivation and PA variables in two groups of bariatric patients (MPAI-G and CG) that could serve to generate testable hypotheses for future experimental research. Second, we used a pseudo-randomized procedure (rather than a random one) to assign patients to both groups, a fact that might impair the generalizability of our findings. Third, this study involved a small sample size that could have influenced the reporting of unexpected effects for both groups. The limited number of bariatric procedures carried out in the hospital during the intervention period prevented the recruitment of more patients. Nevertheless, to our knowledge, this is the first intervention study carried out entirely under the SDT prism to optimize motivation and consequently increase PA in bariatric patients, an especially inactive population (Bond et al., 2011). Therefore, this research could open the window to future studies based on SDT that try to shed light on the difficult paths towards the internalization of PA in these patients.

Table 4
Partial correlations among patients' perception of autonomy support, basic psychological need satisfaction, and changes in motivation 7 months-after SG.

Variables		MPAI-G (n = 17)					
	M (SD)	Intrinsic	Integrated	Identified	Introjected	External	Amotivation
PASSES (1–7)							
Autonomy support	6.82 (±0.30)	.15 [−0.36, 0.59]	.26 [a] [−0.25, 0.66]	.25 [a] [−0.26, 0.65]	−.41 ** [−0.74, 0.09]	−.40 ** [−0.74, 0.10]	−.21 [a] [−0.63, 0.30]
BPNES (1–5)							
Autonomy	4.40 (±0.61)	−.06 [−0.52, 0.43]	−.06 [−0.52, 0.43]	−.13 [−0.57, 0.37]	−.49 ** [−0.78, −0.01]	−.16 [−0.59, 0.35]	.13 [−0.37, 0.57]
Competence	4.66 (±0.43)	.03 [−0.45, 0.50]	.08 [−0.42, 0.54]	.17 [−0.34, 0.60]	−.40 ** [−0.74, 0.10]	−.54 ** [−0.81, −0.10]	−.25 [a] [−0.65, 0.26]
Relatedness	4.85 (±0.37)	.07 [−0.42, 0.53]	.16 [−0.35, 0.59]	.17 [−0.34, 0.60]	−.23 [a] [−0.64, 0.28]	−.50 ** [−0.79, −0.03]	−.28 [a] [−0.67, 0.23]

Note. SG = Sleeve gastrectomy, MPAI-G = Motivational physical activity intervention-group. Partial correlations are adjusted by sex, age, and % EWL. Magnitude of correlations is based on Gignac and Szodorai (2016) criteria.
[a] Typical magnitude. ** Relatively large magnitude.

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CRediT authorship contribution statement

David González-Cutre: Methodology, Investigation, Resources, Project administration, Funding acquisition, Writing - original draft, Writing - review & editing. **Alejandro Jiménez-Loaisa:** Conceptualization, Methodology, Validation, Formal analysis, Investigation, Visualization, Writing - original draft, Writing - review & editing. **Manuel Alcaraz-Ibáñez:** Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **María Romero-Elías:** Visualization, Writing - review & editing. **Inês Santos:** Visualization, Writing - review & editing. **Vicente J. Beltrán-Carrillo:** Supervision, Project administration, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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