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ORIGINAL ARTICLE

Efficacy of telehealth core exercises during COVID-19 after bariatric surgery: a randomized controlled trial

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ABSTRACT

BACKGROUND: Bariatric surgery (BS) is presently the most durable and effective intervention to address severe obesity. BS results in significant weight loss and body composition changes, with reductions in both fat mass and lean mass. Conequently, muscle tissue wasting and a reduction in muscle strength and endurance seem to take place. Some studies have evaluated the impact of resistance training on changes in lean body mass and muscle strength either alone or along with protein supplementation in the first year after BS. However, the effects of core stabilization training on core endurance, postural control, and aerobic capacity in patients after BS have not been evaluated.
AIM: This study assessed the effect of a home telehealth core stabilization exercise program on core stability, postural control, and aerobic capacity in patients after BS.
DESIGN: A single-blinded randomized controlled trial.
SETTING: Home-based exercise program.
POPULATION: Patients after BS.
METHODS: Fifty-four patients who underwent BS randomly assigned into study and control groups. The study group followed a telehealth supervised home core stabilization program for 8 weeks, while the control group did not receive any form of exercises. Core endurance tests, postural stability, and aerobic capacity were assessed at baseline and after 8 weeks in both groups.
RESULTS: No significant difference was noted between groups at baseline (P>0.05). The outcome of the group comparisons showed significant improvement in core endurance tests, postural stability, and aerobic capacity in the study group. Between groups comparision showed that the study group scores significantly higher than the control group (P<0.05). However, the control group showed non-significant changes in any measured variables after eight weeks (P>0.05).
CONCLUSIONS: Eight weeks of a home-based telehealth core exercise program improves core endurance, postural stability, and aerobic capacity in patients after BS.
CLINICAL REHABILITATION IMPACT: The core stabilization exercise is an important rehabilitation program that should be implemented after BS. Telehealth is an alternative rehabilitation tool during the COVID -19 pandemic.

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KEY WORDS: Bariatric surgery; Telemedicine; Postural balance; COVID-19.

Over the last few decades, bariatric surgery (BS) has remained an enduring and effective clinical treatment for morbid obesity. The number of BS procedures has grown dramatically owing to its ability in reducing body weight and improving comorbidities and mortality associated with morbid obesity.[1, 2] BS plays a significant role in improving patients' health outcomes, enhancing functional mobility, relieving musculoskeletal pain, and magnifying the patient's quality of life.[3]

Despite the extreme fat mass loss after BS, a considerable loss of lean body mass[4] is noted which can increase the adverse effect on physical activities and muscle strength.[5] Nearly 30% of weight reduction after BS is attributed to a reduction in muscle mass,[6] which leads to a consequent decline in absolute muscle strength and has a direct negative impact on physical function.[7, 8]

Studies have reported that weight loss after BS is associated with low back pain relief.[9] However, the opposite might occur with increasing pain severity and discomfort. A retrospective study found that 30 obese patients (BMI≥30 kg/m^2) were presented with new-onset or exacerbation of pre-existing low back pain following BS.[1] The major factors associated with the back pain were the reduction in intra-abdominal pressure (IAP), spinal instability, and increased loading on the vertebral bodies and discs.[10] It is postulated that IAP improves lumbar stability through the activation of abdominal, diaphragmatic, and pelvic floor muscles.[11] Following BS, the IAP decreases, creating a disequilibrium state in the spine, uneven loading of the discs, and vertebral bodies,[10] leading to low back pain, disc herniation, and radiculopathy.[12]

In the last few years, significant attention has been given to the efficacy of different exercise protocols for patients who have undergone BS. Positive effects of supervised resisted training on physical fitness, functional capacity, and muscle strength were reported.[13, 14] In addition, adding a protein supplement to resisted exercise was effective in enhancing the lower limb muscle strength in patients after gastric bypass surgery.[2] Arman *et al.*,[15] have concluded that 8-week of core stabilization exercise along with physical activities improves functional capacity, physical fitness, the quality of life and reduces fatigue, in obese individuals awaiting BS.

Barriers to healthcare access, such as distance, time, and expense, may be overcome with technological breakthroughs. COVID-19 had a striking effect on healthcare services globally, with many physiotherapy services rapidly transitioning to telehealth. Evidence has shown that telehealth is an effective delivery model to offer physiotherapy services with results equal to or even superior to face-to-face musculoskeletal care management.[16] Telehealth is a safe and beneficial mode of delivering physiotherapy to patients with various diseases.[17]

Despite the benefits associated with telehealth for an exercise program, no previous studies have investigated the effects of supervised telehealth core stabilization exercise programs in patients who have undergone BS. This study aimed to assess the effect of a home telehealth core stabilization exercise program with supervision on core endurance, postural control, and aerobic capacity in patients after BS.

Materials and methods

Study design

This is a single-blinded randomized controlled trial study.

Participants

In this study the inclusion criteria was at least 6 months after BS. Subjects who were involved in a structured physical activity program; subjects with systematic or visceral diseases, nerve root compression, spine disorders, previous surgery, lower limb injury, or pregnant females were excluded from the program.[18] This study was approved by BMC Ethical Board (UB-RES-2021-0021) with Clinical Registration No. (NCT04932694). Eligible subjects were randomly assigned with the study and control groups by a blinded independent researcher. Randomization was performed to allocate groups using generated computer numbers in sealed opaque envelopes. Informed consent was obtained from the eligible patients after being presented with a detailed description of the study's aims and procedures. The study protocol was conducted according to the Declaration of Helsinki, and the sample size was calculated based on the core endurance test, which was the primary outcome of this study. The G power software (Universities, Dusseldorf, Germany) was used to estimate the sample size following the power of 80%, a P value of 0.05, and an effect size of 0.82. A sample size of 25 subjects in each group was required, and 61 subjects were initially included to account for dropouts (Figure 1).

Outcome measure

Measurements were conducted by a blinded assessor on two occasions; baseline and after the study was completed.

Primary outcome measures

The core endurance tests

McGill's tests were used to examine participants' core endurance. The maximum duration was recorded in seconds when the person is attempting to hold four positions: sit-up position with trunk supported at 60° of trunk flexion (the trunk

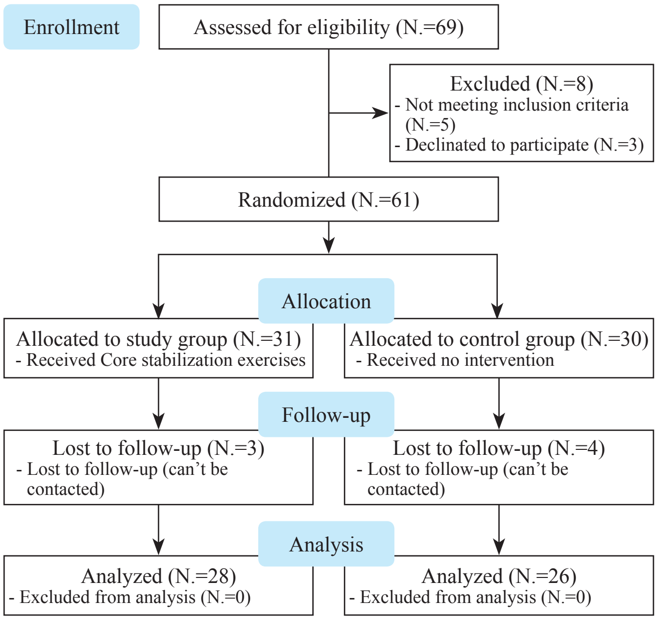

Figure 1.—Study flow chart.

anterior flexor test), side-lying bridging while resting on the forearm with extended knees (the right and left lateral plank), and prone with the trunk, and upper extremities out of the table (the trunk posterior extensor test). The detailed procedures of these tests are fully described in a previous study.[19]

Secondary outcome measures

POSTURAL STABILITY ASSESSMENT

Biodex Balance System (BBS) (Biodex medical system, Shirley, NY, USA) is a valid and reliable method to assess dynamic balance and postural stability.[20] The measured postural stability indices comprised the Overall Stability Index (OSI) used to assess the postural control in all directions; the Anteroposterior Stability Index (APSI) assessed the postural control in the sagittal plane, and the Mediolateral Stability Index (MLSI) assessed the postural control in the frontal plane. All patients were tested on stability level 8 for 30 seconds. BBS assessment followed numerical values, where higher values indicated a lower level of stability, and a lower value was a higher level of stability.[21]

AEROBICS CAPACITY

A 6-minute walking test (6MWT) is a valid and reliable method for assessing aerobic functional ability by measuring the distance covered within 6 minutes. A higher distance indicates better aerobic capacity.[22] The 6MWT test was performed following the standard protocol of the American Thoracic Society guidelines. Subjects were asked to walk for 6 min on a straight, flat, and hard surface hallway at their own pace with the encouragement of a physiotherapist. The 6MW distance covered during the test was recorded in meters and the heart rate was measured before and after the test.[23]

Interventions

Subjects in the study group performed two equal phases of core stabilization exercises 3 days per week, for 8 weeks. The exercise program was adopted from the procedures developed by Narouei *et al.*[18] Each phase consisted of five exercises repeated in 2 circuits with each exercise performed in 8-15 reps with 5-10 s hold based on the subject's physical ability for each contraction. Thirty seconds of rest were allotted to the subjects after each exercise and two min rest between circuits. Subjects started the training with warm-up exercises in the form of low-intensity aerobic exercises, general stretching exercises for 5 minutes, and cool down for 5 minutes.[18, 24] Participants in the control group did not perform any core exercises.

Following the recommendation of the American Physical Therapy Association (APTA), the core program was conducted at home with remote supervision. APTA recommends that physical therapists should use telehealth services during the COVID-19 pandemic to limit the spread of the disease.[25] Patients were provided flyers with full descriptions and illustrations of the exercises to guide them about the exercise at home. Patients were asked to attend the physical therapy lab at the start and end of the exercise program. In the first session, the patients were evaluated and received a full demonstration of the exercise program. In addition, patients were asked to sign consent forms, which were collected. Once a week, a physical therapist supervised the exercise program remotely.[26]

Exercises completed in Phase one were as follows:

1.1. Abdominal drawing: subjects pulled in the belly button without stopping the breathing from a crock lying position.

1.2. Alternate arm and leg lift: subjects elevated the upper and lower extremities to approximately 10 cm from a prone position with a pillow under the abdomen.

1.3. Unilateral glute bridging: from a supine lying position, the pelvis was elevated straight while one leg flexed to 90, and the second leg was positioned in neutral alignment on the ground. The exercise was conducted on right and left sides.

1.4. Quadruped contralateral arm and leg lift: subjects positioned in a quadruped position with erect trunk and elevated opposite upper and lower extremities simultaneously parallel to the ground.

1.5. Curl up: from a hook lying position, subjects placed both hands under the lumbar region to support the spine, pulled in the abdomen to flatten the lumbar spine, and raised the head and upper trunk straight to pull the inferior angle of the scapula off the ground.

Exercises completed in Phase two were as follows.

2.1. Sideway bridging: from the side-lying position, the weight was supported on one elbow while the other arm was placed across the chest, knees almost extended, and feet stacked over each other. The subject lifted the pelvis straight off the ground.

2.2. Diagonal curl up: subjects were placed on a hook lying with hands altogether, elevated head and upper trunk to raise the scapula lower angle to reach the opposite knee.

2.3. Sit back: subjects were positioned by sitting with the knee flexed 90^0,feet on the floor, drawing the abdomen and elevating the upper trunk to an angle of 45^0 from the ground, and holding the position.

2.4. Single leg deadlift: subjects stood on a single limb with 30^0 flexion of the hip; knee joints and ipsilateral hand moved slowly to the lateral malleolus and extended the opposite hip.

2.5. Prone hip extension: from a prone position with a third of the lower extremity on a table, subjects held the edges of the table with their hands and moved both lower extremities up with their extended knee.[27] Exercises in both phases are shown in Figure 2.

Statistical analysis

Shapiro-Wilk Test, drawing box blot and histogram, were used to check homogenity of the measured outcomes. All measured parameters (postural stability, back endurance tests, and 6 MWT) exhibited a parametric distribution. Two-way mixed model MANOVA was used to distinguish between and within the measured outcomes. Unpaired T-Test was applied to compare the participants' demographic data, chi-square test was used for comparison of categorical data, and were. Quantitative data are displayed as mean and standard deviation. The significance level was set at $P \leq 0.05$ with a confidence level of 95%. All statistical analyses were performed with IBM® SPSS® Statistics Version 20.

Results

A total of 54 individuals (35 females and 19 males) who were referred by surgeons from local hospitals and medical Private centers participated in the study. The study

TABLE I.—*Demographic and clinical characteristics of both groups.*

Characteristics	Study group (N.=28) (M±SD)	Control group (N.=26) (M±SD)	P value
Age (years)	35.3±8.74	32.9±8.75	0.333
Height (cm)	168.8±9.2	170±7.13	0.625
Weight (kg)	87.8±7.6	90.1±7.2	0.270
BMI (kg/m)	30.8	31.1	0.380
Sex			
M (N. [%])	9 (32.1%)	10 (38.5%)	0.627
F (N. [%])	19 (67.9%)	16 (61.5%)	
Duration after BS (months)	9.79±1.8	8.81±1.88	0.06
Hypertension	2 (7.1%)	3 (11.5%)	0.663
DM	3 (10.7%)	4 (15.4)	0.699
Dyspnea on exertion	6 (21.4%)	5 (19.2%)	0.414
Medication for comorbidities	4 (14.3%)	6 (23.1%)	0.208

P value: significance level; M±SD: mean±standard deviation; N.: number; BMI: Body Mass Index; DM: diabetes mellitus; M: male; F: female; %: percentage; BS: bariatric surgery.

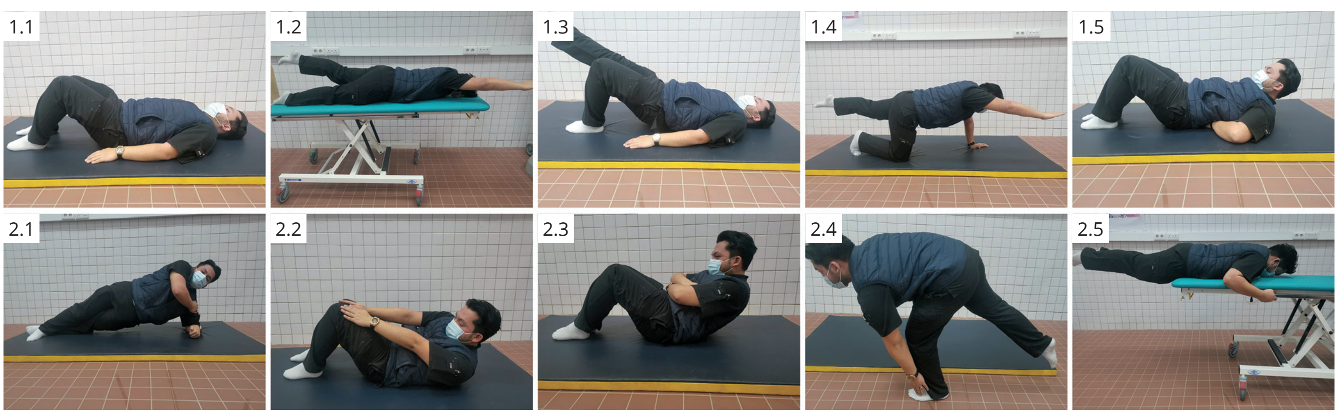

Figure 2.—The core stabilization exercises in both phases.

flowchart is presented in Figure 1. The participant's age was 18-40 years, and the demographic characteristics of the participants are shown in Table I. No significant difference was noted between the two groups regarding age, weight, height, BMI, duration after BS, sex, participants' clinical characteristics, and the baseline values of the measured outcomes of P>0.05, as displayed in Table I, II.

After 8 weeks of core training, improvements were

Table II.—*Within and between groups' comparisons of the outcome measures.*

Variables	Study group (N.=28) (M±SD)	Control group (N.=26) (M±SD)	P value
The trunk anterior flexor test (sec)			
Baseline	60.8±12.55	62.5±14.6	0.645
Post treatment	77.7±13.0	59.77±11.93	<0.001
P value*	<0.001	0.337	
MD (95% CI)	16.93(22.4-11.5)	2.73(2.93-8.38)	
Percentage of treatment effect	31.14%	0.81%	
The trunk posterior extensor test (s)			
Baseline	50.86±11.76	46.62±9.5	0.153
Post treatment	59.5±11.8	45.81±10.97	<0.001
P value*	<0.001	0.703	
MD (95% CI)	8.64(12.72-4.57)	0.81(3.42-5.0.03)	
Percentage of treatment effect	20.14%	0.03%	
Right lateral plank test (s)			
Baseline	36.7±8.6	37.1±4.83	0.836
Post treatment	41.1±10	36.8±5.5	0.048
P value*	<0.001	0.725	
MD (95% CI)	4.36(6.25-2.5)	0.35(1.61-2.31)	
Percentage of treatment effect	13.13%	0.58%	
Lt lateral plank test (s)			
Baseline	33.9±4.4	35.23±4.64	0.269
Post treatment	37.3±6.8	33.6±6	0.041
P value*	0.004	0.167	
MD (95% CI)	3.4(5.7-1.11)	1.65(4.02-0.71)	
Percentage of treatment effect	10.98%	4.52%	
Overall Stability Index (OSI)			
Baseline	1.6±0.38	1.73±0.52	0.278
Post-treatment	1.5±0.45	1.61±0.37	<0.001
P value*	<0.001	0.207	
MD (95% CI)	0.45(0.26-0.63)	0.12(-0.31-0.07)	
Percentage of treatment effect	27.34%	1.2%	
Anteroposterior Stability Index (APSI)			
Baseline	1.21±0.53	1.25±0.56	0.701
Post treatment	0.88±0.35	1.2±0.5	0.005
P value*	0.027	0.816	
MD (95% CI)	0.31(0.36-0.58)	0.03(0.25-0.32)	
Percentage of treatment effect	12.98%	12.66%	
Mediolateral Stability Index (MLSI)			
Baseline	0.81±0.1	0.91±0.25	0.10
Post treatment	0.67±90.25	0.96±0.26	<0.001
P value*	0.001	0.124	
MD (95% CI)	0.143(0.07-0.22)	0.06(0.14-0.018)	
Percentage of treatment effect	17.72%	8.9%	
6 MWT (m)			
Baseline (% of max predicted HR)	458±28.5 (67±9.3%)	456.88±33.8 (66±10.4%)	0.896
Post treatment (% of max predicted HR)	492.9±33.3 (56±7.5%)	454.31±32.7 (64±11%)	<0.001
P value*	<0.001	0.667	
MD (95% CI)	34.9(46.4-23.39)	2.58(9.36-14.51)	
Percentage of treatment effect	7.93%	0.5%	

P value*: within group significance level; P value: between groups significance level; 6 MWT: 6 Minutes Walking Test; M±SD: mean±standard deviation; N.: number; CI: confidence interval; HR: heart rate.

noted in the study group regarding the core endurance tests ($P<0.05$), postural stability indices OSI, API, MLI, ($P<0.001$, 0.027, and 0.001), respectively, and aerobic capacity ($P<0.001$). However, within group comparisons of the control group showed a nonsignificant differences in measured outcomes ($P>0.05$). When compared the study group with the control group, significant differences were displayed in measured outcomes ($P>0.05$) after 8weeks, as shown in Table II.

Discussion

In the first six months after BS, patients experienced rapid weight loss and a significant decrease in fat-free mass, accounting for 30-35% of the total body weight loss. The weight loss peaks over a 2-year remain relatively stable from 2 to 20 years.[28] Excessive weight loss, malabsorption due to surgery, and insufficient protein intake contribute to muscle tissue wasting and a reduction in muscle strength and endurance[2, 29] Slow core muscles with predominantly oxidative metabolism are more susceptible to atrophy than muscles with fast-twitch fibers because of the severe effects on their oxidative enzyme content.[29] This previously mentioned study reveals that structured core stability programs that focus on muscle activation, neuromuscular control, and dynamic stability could improve core muscle endurance for functional demands associated with most daily living and sport activities.[30]

This randomized controlled trial showed that 8 weeks of telehealth-supervised core stabilization exercise program (CSEP) improved core endurance, postural control, and 6 minutes walking test (6 MWT) in patients after BS compared with the controls who did not participate in the core training. The results would help in organizing effective programs to reduce the incidence of postoperative complications following BS. Core stability exercises are common component of musculoskeletal injury pervention programs. Previous studies have reported that impaired core stability is a risk factor for low back pain and lower extremity injury rates.[31]

The improvement of core endurance in the study group could be explained by the fact that most of the type I core muscle fibers could benefit from the adopted high-repetition exercise program.[32] Other adaptations to core training increased blood supply to muscles, improved coordination of motor units, and increased the fuel storage in muscles, which ultimately enhanced endurance.[33] At the cellular level, the mitochondrial content increases rapidly after 6 weeks of training as reported by Henriksson.[34]

Our results are consistent with those of Sandrey and Mitzel[35] who reported that after 6 weeks of a core stabilization program in high school track and field athletes, a significant increase in the core endurance tests was noted after conducting an abdominal fatigue test, back extensor test, and side bridge test for both the right and left side. Hoppes *et al.*,[36] found that an eight-week of core stabilization exercise program significantly improved three timed physical endurance tests, such as the horizontal side support, extensor endurance, and flexor endurance in active-duty US Service members.

Obesity is a risk factor for falls and fear of falls because of postural deviations and loss of balance.[37] Beside obesity, other risk factors for falls include demographic characteristics, physical health status, comorbidities, emotional status, cognitive function, and physical activity habits.[38] Ercan *et al.*,[39] investigated the effect of obesity using gender on balance, the risk of falls, and the fear of falls in a sample of 125 obese persons. The authors concluded that obese females had a high fear of falls and low confidence in daily activities. A significant inverse relationship was found between Body Mass Index and loss of balance. These balance-related problems may continue even after the weight loss surgery considering, almost 80% of patients who have undergone BS are women.[40] Our study also demonstrated that the OSI, APSI, and MLSI improved significantly following the CSEP. These improvements can explained by the positive effects of core stability exercise on the neuromuscular system specifically, ideal lumbar-pelvic-hip chain mobility, optimal movement acceleration and deceleration, proper muscle balance, and efficient proximal stability.[15]

Additionally, gains in core muscle strength and endurance are vital because they maintain and stabilize the spinal segments against external stresses. Previous studies reported a positive correlation between core endurance and balance in different sex and age populations. It was hypothesized that a strong core structure allows less postural oscillations of the thoracolumbar fascia and distal body parts.[41, 42] These results agree with Lugo-Larcheveque *et al.*,[43] who find that core training improves core muscular strength and body movement stability during the limit of stability tests, which requires good upper and lower extremity limb coordination.

Finally, the significant improvement in 6 MWT can be attributed to an increase in blood flow, cardiac output, and VO_{2max} that occur during exercises. During core strengthening exercises, the core muscles' co-contraction and pressure changes by the diaphragm help supplying blood and oxygen that the body requires during exercises.[44] The results agreed with previous studies that reported improved aerobic activities such as long-distance running[45] and shuttle run performance[46] after core strengthening programs. The insignificant change in aerobic capacity of the control group found in this study, disagrees with Vargas *et al.*,[47] who reported that BS itself resulted in a significant improvement in physical performance. The study has used the self-reported Short Form 36-Item (SF-36) questionnaire to assess functional capacity while our study used the 6MWT.

This study highlighted the importance of telehealth in improving patients' self-care management and reducing patient time and daily travel expenses. During the COVID-19 pandemic, telerehabilitation helps in continuing therapeutic services and monitoring patients' performance during the treatment programs.[48] In Australia, Russell *et al.*,[49] found that a 6-week telerehabilitation intervention resulted in excellent patient satisfaction compared to normal outpatients' treatment after total knee arthroplasty.

Limitations of the study

This study has some limitations; only short-term effects were assessed. Future studies should investigate the long-term effects of core training in individuals after BS. Moreover, advanced core training using unstable surfaces was excluded from the established program because of the unavailability of training tools at the participants' homes. Finally, the core program is designed to suit individuals after BS and should be revised before it is applied to another pathological population. The literature review showed a lack of consistency in core training programs that could be applied to all populations.[30]

Conclusions

Eight weeks of home-based telehealth core exercise program improves the core endurance, postural stability, and aerobic capacity in patients after BS.

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