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Does Weight-bearing Exercise for Better Balance (WEBB) program by telerehabilitation improve balance and walking speed in obese men?

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Abstract--Obesity and various other pathologies increase postural instability which will lead to the risk of falling. Several anthropometric measurements (height and weight) showed a significant effect on postural stability. This study examines the effects of the telerehabilitated Weight Bearing Exercise for Better Balance (WEBB) program on balance and walking speed in obese men. Ten adult males with grade 2 obesity participated in this study and received a telerehabilitative WEBB exercise intervention 3 times a week for 8 weeks. Static and dynamic balance were assessed by the One Leg Stance test (OLS) and Four Square Step Test (FSST), while walking speed was assessed by the 10 Meter Walk Test (10MWT). The study found that there was a significant improvement in both leg static balance ($p=0.005$; $p=0,003$), dynamic balance ($p=0.005$), and walking speed ($p=0.00$) in obese male subjects. In conclusion, the WEBB

program in telerehabilitation can significantly improve balance and walking speed in obese men.

Keywords---balance, obesity, telerehabilitation, walking speed, weight-bearing exercise for better balance.

Introduction

Obesity is defined as excessive fat accumulation due to an imbalance in energy intake with energy expenditure for a long time (Kemenkes, 2017). Obesity is one of the risk factors for the emergence of various degenerative diseases such as heart disease and stroke (Sofa, 2018). Excess body weight results in impaired balance and gait which have been identified as strong risk factors for falls (Sarkar et al., 2011; Teasdale et al., 2013; Vafaenasab et al., 2018). The obese group had a prevalence of tripping while walking by 32%, while the non-obese group was only 14%. The obese group also had a fall prevalence of 27% while without obesity it was lower at 15% (Fjeldstad et al., 2008).

A study showed that only four minutes of balance exercise included in daily physical exercise activities improved postural stability in severely obese patients (Cimolin et al., 2020). Weight-bearing Exercise for Better Balance (WEBB) is a balance exercise consisting of warm-up, coordination exercises, and a combination of coordination exercises with muscle strengthening (Abd El Mohsen et al., 2016). From several studies it was reported that WEBB exercise was useful for improving patient balance function, but there were no studies using adult male subjects with obesity. Telerehabilitation is a method that can connect clients with doctors through information and communication technology to improve access to services for hard-to-reach populations (Chumbler et al., 2010; Sarsak, 2020). This telerehabilitation method is one of the solutions for rehabilitation programs during the Covid 19 pandemic that are sweeping the world today. This study was conducted to determine the effectiveness of telerehabilitated WEBB on balance and walking speed in obese subjects. The indicators used are One Leg Stance (OLS), Four Square Step Test (FSST) and 10 Meter Walk Test (10MWT).

Method

The subjects in this study were 10 male students of Faculty of Medicine, Universitas Airlangga with obesity grade 2 ($BMI \geq 30 \text{ kg/cm}^2$). All subjects were given the WEBB exercise program with telerehabilitation 3 times a week for 8 weeks. Exercise consists of warm-up, coordination exercises, and a combination of coordination and strengthening with duration and intensity of exercise increased every 2 weeks.

The research was carried out from August to December 2021. Before being given the exercise, the subjects were asked to come to the Medical Rehabilitation Clinic at Dr Soetomo Hospital to be given a detailed explanation about the study, fill out informed consent and collect data before training. After completing the exercise for 8 weeks, the subject was asked to come back for post-intervention data

collection. The data taken include static balance by OLS test, dynamic balance as assessed by FSST, and walking speed by 10MWT. This research received ethical approval from the Health Research Ethics Committee of the Dr. Soetomo Regional General Hospital with No. 0488/LOE/301.4.2/VI/2021.

The inclusion criteria in this study were male students of the Faculty of Medicine, Universitas Airlangga with obesity grade 2 according to the BMI criteria of Asian people ($BMI \geq 30 \text{ kg/cm}^2$), aged between 18-40 years. The exclusion criteria were participants with chronic diseases such as Diabetes Mellitus (DM), cardiovascular problem such as hypertension and history of heart disease, respiratory problem such as persistent asthma and Chronic Obstructive Pulmonary Disease (COPD), neuromusculoskeletal and vascular disorders in the lower limbs, and visual and hearing impairments.

Interventions

The WEBB program in this study was provided with telerehabilitation through exercise videos that had been given to all subjects when filling out informed consent. The exercises were carried out independently by following the video instructions every Tuesday and Thursday, after that the subjects were asked to fill out an exercise diary and send photos and videos of the exercises to the researcher. At the end of the week, a group exercise was carried out through a zoom meeting by all subjects and researchers. The WEBB exercise protocol was adapted to the recommendations of [Sherrington et al. \(2008\)](#), the exercise consisted of a warm-up with high stepping on the spot. Furthermore, coordination exercises consisting of standing with decreased base and stepping in different directions. The next exercise is a combination of muscle strengthening and coordination consisting of sit to stand, heel raise, lateral and forward step up. The intensity including time, set, and repetition of exercise is increased every two weeks according to the established protocol.

Outcome measures

The outcome measures in this study were balance and walking speed. Two aspects of balance, namely static and dynamic balance, were assessed in this study. Static balance was assessed using OLS test. This examination is performed by standing comfortably on two legs, with the hands on the chest while closing the eyes, then instructed to elevate one leg as long as possible. The timer is stopped if the support leg shifts or moves in any direction or the non-supporting foot touches the floor. This test was carried out 3 times to minimize the occurrence of errors, and the highest score was taken for analysis. Dynamic balance was assessed by the FSST. It is done by asking the subject to walk as fast as possible through four squares on a flat floor with a determined sequential distance and direction, and the time is calculated. The track is made by joining four squares, and given a marker (90 cm long tape) that delimits each box. Subjects were asked to walk as quickly as possible across the four squares in the order specified in the image below three times and the best time was recorded, to ensure the subject understood the instructions and the sequence. Walking speed using 10MWT at participants' comfortable and fastest speed over the middle 10 meter of a level.

Statistical analysis

Prior to statistical tests, a normality test was performed for all variables. Variables with data that were normally distributed were then tested statistically with a parametric paired sample T-test, while for variables with data that were not normally distributed, a statistical test was performed using a non-parametric test, namely the Wilcoxon signed-rank test.

Result

Table 1
Characteristics and homogeneity of subjects

Variable	Mean±SD	P Value
Age (Years)	20,7±2,11	0,011
Body weight (kg)	98,3±13,6	0,126
Body height (cm)	167,3±5,89	0,734
Body Mass Index (kg/m²)	35,1±4,37	0,134
Waist-Hip Ratio	0,93±0,065	0,098
Daily Food Intake (kcal)	6,92±2,51	0,677

*The Saphiro Wilk test is normally distributed if the p value>0.05

The averages for age, weight, height, Body Mass Index (BMI), Waist Hip Ratio (WHR) and daily food intake were 20.7±2.11 years, 98.3±13.6 kg, 167, 3±5.89 cm, 35.1±4.37 kg/cm², 0.93±0.065, 6.92±2.51 kcal respectively, as presented in Table 1.

The normality test of the research subject characteristics data was carried out using the Shapiro-Wilk. Table 1 shows the distribution of data that is normally distributed ($p>0.05$) on the variables of weight, height, BMI, Waist-Hip Ratio (WHR), and daily food intake. Variables of age is not normally distributed ($p=0,011$).

The results of the paired sample T-test showed significant differences in the left leg OLS variables ($p=0.003$) and 10MWT ($p=0.000$) before and after the intervention. The results of the Wilcoxon signed rank test showed significant differences in the right leg OLS variables ($p=0.005$) and FSST ($p=0.005$) before and after the intervention.

Table 2
Effect of WEBB program by telerehabilitation on static and dynamic balance

Variabel	Before Intervention (second)	After Intervention (second)	Significance
OLS Left	19.1830	46.1890	0,003
OLS Right	21.4810	40.1040	0,005
FSST	6.5530	5.1790	0,005

* Paired T-test and Wilcoxon signed rank test were meaningful when the p value <0.05

The mean value of left OLS before and after the intervention was 19.18 and 46.18 seconds with p value=0.003 (Table 2), while the right OLS before and after the intervention was 21.48 and 40.10 seconds with p value=0.005 (Table 2). This shows that there is an increase in the static balance of both the right and left legs. The mean value of FSST before and after the intervention was 6.5 and 5.1 seconds with p value=0.005 (Table 2). This shows that the subject can perform FSST in a shorter time after receiving the intervention.

To assess the large difference between groups, the mean effect size was calculated with effect size values of 0.2-0.49 being considered small, 0.5-0.79 being considered medium, and >0.8 being considered large. The results of the calculation of the mean effect size showed large results for the left leg OLS variable (Cohen's D = 1.2), while for the FSST variable (Cohen's D = 0.62) and right leg OLS (Cohen's D = 0.62) variable, the results showed medium results.

Table 3
Effect of exercise on walking speed

Variabel	Before Intervention	After Intervention	Significance
10MWT	4.4640	3.5090	0,00

* Paired T-test is meaningful when the p value <0.05

The mean value of 10MWT before exercise was 4.46 seconds and after exercise was 3.50 seconds, with p value=0.00 (Table 3). The subject's walking speed values after being converted were 2.24 m/s (before exercise) and 2.85 m/s (after exercise). To assess the large difference between groups, the mean effect size was calculated with effect size values of 0.2-0.49 being considered small, 0.5-0.79 being considered medium, and >0.8 being considered large. The results of the calculation of the mean effect size show large results (Cohen's D = 2.1).

Discussion

There is a relationship between obesity and postural stability, where obesity causes a decrease in postural stability and balance disorders. In obesity, there is an increase in fat deposits in the muscles which results in a decrease in muscle performance. In addition, posture disturbances also occur which ultimately lead to impaired postural control. In obesity there is an increase in plantar pressure and a decrease in plantar mechanoreceptor sensitivity. This combination increases the occurrence of balance disorders in obesity (Akhmedov & Berdeaux, 2013; Kavounoudias et al., 1998).

WEBB exercises consisting of warm-up, coordination exercises and combined coordination and strengthening exercises performed in this study were statistically proven to provide improvements in static, dynamic balance and walking speed in obesity. In line with previous studies which showed the same results, a significant improvement in balance as assessed by the Berg Balance Scale (BBS) after giving exercise with WEBB for 6 weeks (Abd El Mohsen et al., 2016). Another study showed a significant improvement in the Antero-Posterior Stability Index (APSI) and Overall Stability Index (OASI) on balance function

examinations with the Biodex Balance System (BBS) after the WEBB program (Youssef et al., 2018).

Morris et al. (2017) concluded that exercise intervention could improve balance performance in obese subjects, although the type of exercise provided was different. This study gave exercise on a treadmill for 10 weeks, while the current study provided a WEBB intervention consisting of warm-up, coordination exercises and a combination of coordination and strengthening for 8 weeks. They added that exercise intervention alone without significant weight loss was found to improve balance function. This is supported by a study from Vafaenasab et al. (2018) which concluded that both aerobic and balance exercise were beneficial in improving balance function, both static and dynamic. Another study by Theodora et al. (2019) concluded that moderate intensity treadmill exercise for 4 weeks improves balance function in young adult untrained men.

Another study that showed similar results was a study conducted by Rojhani-Shirazi et al. (2016). The balance exercises provided consisted of standing on one leg, standing in tandem (with gradually increasing duration), walking in tandem, walking with heels and toes, walking sideways, standing with one leg raised with the contralateral arm, walking backwards, and transferring weight from one leg to the other. The study showed significant improvements in static, dynamic, and functional balance as assessed by the Single Leg Stance (SLS) test, Star Excursion Balance Test (SEBT), and the Get Up and Go (GUG) test (Rojhani-Shirazi et al., 2016).

Regardless of the decrease in BMI, undergoing a balance training program can improve balance performance in obese individuals aged 20-50 years (Rojhani-Shirazi et al., 2016). Meanwhile, Maffiuletti et al. (2005) compared the group with the Body Weight Reduction (BWR) program with a combination of balance training BWR. Both groups showed a significant decrease in BMI, but only the balance training group showed improvement in balance and decreased postural sway (Maffiuletti et al., 2005).

Research with the WEBB program was also carried out by Dean et al. (2012). This study states that giving the WEBB intervention for 12 months showed improvements in walking capacity and speed. A systematic review by Keating et al. (2021) showed that strengthening exercise interventions have a positive effect on gait and balance. This suggests improvements in gait and balance are associated with increased leg strength. In this systematic review, the length of the given strengthening exercise varied between 6-32 weeks, both using body weight, elastic bands or machines. Another study was conducted by Palmgren et al. (2020) by providing balance exercises 2 times a week for 10 weeks. This study demonstrated improvements in balance performance as assessed by the Mini-Balance Evaluation Systems Test (Mini-BESTest) and walking speed as assessed by 10MWT. These results are in line with research conducted by Jegede et al. (2017) which indicated that giving an exercise program for weight loss for 12 weeks was effective in increasing walking speed in obese individuals.

Conclusion

From the current study, it was concluded that WEBB program with telerehabilitation for 8 weeks improve both static and dynamic balance, also gait speed in men with obesity.

Limitations in this study include that this study only took male subjects so that the results cannot be generalized, the study was conducted in one group, without any comparison with the control group or groups with different interventions, only assessing parameters before and immediately after exercise, so the long-term effects of this exercise program are unknown. It is also necessary to assess other variables that support the improvement of balance and walking speed, including strength and muscle mass.

Recommendations for further research include research on more varied subjects so that the results can be generalized, comparisons with the control group or groups with different interventions, further research to assess the long-term effects of the WEBB program, and assessment of other variables that support the improvement of balance and walking speed include strength and muscle mass.

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Conflict of Interest

The authors affirm no conflict of interest in this study.

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