COMPARISON OF LOW-LOAD BENCH PRESS AND PUSH-UP EXERCISES ON MUSCULAR PERFORMANCE AMONG FEMALE YOUTH

Nur Khairunisa Abu Talip*, Edmund Bonnie*, Zulkifli Ismail and Mohd Rizal Md Razali

Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Sarawak Branch,
Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Perlis Branch,
Translational Research Centre, Institut Sukan Negara Malaysia

*Email: nurkhairunisa331@uitm.edu.my
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Abstract

Introduction: Various fitness challenges had been invented and innovated in order to integrate exercise in life, especially during the new norm of Covid-19 pandemic. There is a lack of study on the effect of push-up exercise on sedentary women. The study aimed to compare the effects of six-week push-up (PU) and low-load bench press (BP) exercise interventions towards muscular strength (MS) and muscular endurance (ME) among healthy sedentary female youth. Methodology: Forty (n= 40) healthy sedentary female youth (aged 18.93 ±.97 years; body mass index 23.44 ±4.5 kg/m^2) were recruited in the study. Participants were divided into two groups of training interventions (push-up and bench press group). Resistance exercise intervention involving four sessions per week for six consecutive weeks. Each session comprised of 3 sets of 12 repetitions with one minute of rest between each set. Bench press exercise was performed at 40% 1RM for bench press group. One-repetition maximum bench press (1RM BP) test and one-minute push-up (1Min PU) test were performed at pre and post-intervention to measure muscular strength and muscular endurance. A 2 x 2 mixed model ANOVA was employed to compare the effects of the two interventions following six-weeks of training. Result: Muscular strength and muscular endurance for the push-up group have significantly improved (p < .05), with at the end of the intervention were 59.75 ±13.91 and 45.05 ±6.59 as compared to during the pre-intervention of 42.0± 11.40 and 28.95 ±5.93, respectively. A similar result also found for bench press group. Muscular strength and muscular endurance for bench press group had significantly increased (p < .05), from the pre-test of 44.50 ±9.58 and 29.95 ±6.28 to the post-test of 60.25 ±10.45 and 41.45 ±6.20, respectively. However, there is no significant difference observed between groups (bench press and push-up protocols) on muscular strength (p= .661) and muscular endurance (p= .472). Conclusions: The present study concludes that push-up and low-load bench press exercise interventions do significantly improve muscular strength and muscular endurance of sedentary female youth, with push-up as an alternative for bench press for sedentary female youth.

Keywords: Push-up, bench press, muscular strength, muscular endurance, one-repetition maximum bench-press and one-minute push-up, sedentary female youth

Introduction

Sedentary behaviour is a critical issue in public health. A study published in the 2016 Lancet Series on Physical activity for 146 countries, showing a global prevalence of insufficient physical activity of 23·3%, with higher levels among female youth and older age groups (Guthold, Stevens, Riley & Bull, 2018). Furthermore, the implementation of restrictive movement instrument due to the pandemic outbreak of COVID-19 needs to be applied in order to contain the spreading. Thus, the potentially detrimental effect of the restrictive movement

applied perhaps worsens the problem with reduced levels of physical activity. A survey conducted by Schmall (2019) aimed to understand the reasons of some individuals do not exercise with claims that the rationales include (and not limited to) lack of time, bad weather, overeats, as well as a limited number of facilities and equipment available.

In order to combat the problem, many ideas were invented and innovated to integrate exercise in everyday life. For instance, various challenges had been created to promote health such as the 30-days push-up challenge by Anna Victoria (Oerman, 2019); a trainer and an Instagram star, as well as the 50 push-up challenge daily for a month; designed by a trainer and a book writer, Shaun Zetlin (Zetlin, 2015). Push-ups are, in general, performed with bodyweight as a load (Tillaar, 2019). Push-up exercise might be a rather convenient solution to promote training because it does not require any equipment, and it can be performed anywhere. Furthermore, bodyweight training was selected in the top 10 fitness trends from 2013 to 2020 in the American College of Sports Medicine (ACSM) (Thompson, 2019). Push-up exercise is widely used, and it claims to be a suitable exercise for sedentary people (Kikuchi & Nakazato, 2017). According to Zetlin (2015), the callisthenics exercise (push-up) challenged multiple muscle groups in the arms, chest, back and core to build overall functional strength. These fitness challenges are only done with a single exercise for a set period, and it is claimed to be beneficial. However, there is a lack of study on the relevance of a single exercise effect on muscular gain.

On the other hand, for some individuals, free weight equipment and exercise machines are preferable. In bench press, a barbell and weights are necessary for training (Calatayud et al., 2015). This requires expensive equipment, which perhaps most people would rather opt for a gym. Calatayud et al. (2015) claimed that the bench press and the push-up are two classic push exercises for strengthening the upper body, which had shown to elicit similar muscle activation patterns on electromyography. Kikuchi and Nakazato (2017) also claimed that low-load bench press (at 40% 1RM) would provide a similar intensity to a push-up. Bench press is a common exercise used for developing upper body muscle; the pectoralis major (Fleck & Kreamer, 2014), as well as to increase muscle strength (American College of Sports Medicine, 2009). For many years, bench press had been used with various form of loading equipment in a strength exercise programme by athletes such as bodybuilder and powerlifter (Barnett, Kippers & Turner, 1995). Although the execution of bench press exercise requires plates and barbell, Blackard, Jensen and Ebben (1999) suggested that the intensity and load of bench press exercise are easily adjusted to the capability of an individual. Thus, the present study investigates the benefits of two exercise selections on muscular strength and muscular endurance among healthy sedentary female youth.

As the pandemic outbreak of COVID-19 has evolved the population with a new way of life; however, the practice of exercise is not exempted from changing to new norms. During the Movement Control Order (MCO), people tend to choose a safer place by avoiding public facilities, which makes their house appear to be the best option. The selection of exercise must be practical for limited space and equipment. Moreover, a previous study claimed that home-based programme was effective and potentially cost-saving; callisthenic exercise was recommended (Calatayud et al., 2015). However, the chronic adaptation of a single push-up exercise is still unclear despite that push-up is widely used as a home-based exercise (Kikuchi & Nakazato, 2017). Hence, the study aims to measure the possible benefits between push-up and bench press exercises (which is performed approximately for 10 minutes per session over a 6-week period) on muscular strength and muscular endurance among healthy sedentary female youth.

Methodology

The study aims to measure the effects of 6-week push-up and bench press exercise interventions towards muscular strength and muscular endurance. Sedentary, healthy university students participated in the present study were exposed to 3 sets of 12 repetitions bench press exercise (at 40% 1RM) for bench press group. Likewise, push-up group of the sedentary healthy females were set for three sets of 12 repetitions push-up exercise. One minute of rest intervals between each set was implemented on both interventions, likewise to the training frequency of 4 times per week for six consecutive weeks. The similar method was used in previous parallel studies (Calatayud et al., 2015; Chulvi- Medrano, Martínez-Ballester & Masiá-Tortosa, 2012).

Sampling

The study recruits a total number of 40 (*n*= 40) (Calatayud et al.,2015; Chulvi-Medrano et al., 2012) sedentary female youth aged between 18 to 25 years old, undergraduate students of Universiti Teknologi MARA (UiTM) Sarawak branch. All the recruited participants were healthy and free from any injury within the previous six months. The present study also excludes participants that took any kind of supplements and drugs six months prior to and throughout the study. The participants were divided into two groups: the push-up group (*n*= 20) and bench press group (*n*= 20).

Procedures

The present study has been approved by UiTM, Sarawak Branch. Prior to data collection, all participants completed the consent form, information sheet and the Physical Activity Readiness Questionnaire (PAR-Q). Participants were briefed about the study, and all questions were answered clearly.

All participants performed both push-up and bench press exercises occasionally and categorised as beginner. Two familiarization sessions that included testing procedure was done by all participants to make sure the participants were familiarized to the techniques (Calatayud et al., 2015). Participants were measured for pre and post-test, with 6-week of the intervention programme in between in order to measure the chronic effects of exercise (Taylor, Keating, Holland, Coombes & Leveritt, 2018). 1RM bench press test was used to evaluate muscular strength, while 1-min push-up test to indicate muscular endurance. Muscular strength refers to the ability of the muscle to exert force; in contrast, muscular endurance refers to the muscular ability to continually perform in a specific period without fatigue (Wilmore, 1974). 1RM bench press test procedure was adopted from Cummings and Finn (1998). Each participant warm-up a set of 5 to 10 repetitions lightweight bench press, then rested for 1 minute and performed light stretching. After that, more load was added for a 3 to 5 repetitions warm-up. A small increase in load was made, and a 1RM bench press attempted. If this attempt succeeded easily, the participant waited for 5 minutes and added 4.5 to 6.8 kg weight. While, if the attempt was difficult, the participant waited 5 minutes, and added only 2.3 kg. The process continued until an attempt failed, but was completed within 5 to 6 attempt to reduce muscle fatigue. 1RM determined as the weight of the last successfully completed lift. While, 1-minute push-up test procedure was adopted from Baumgartner, Oh, Chung and Hales (2002). Participants executed push-ups on the hands and knees for one-continuous-minute. Participants started in the "up" position with the arms straight, lowers the body to the "down" position, and then raised to the "up" position. Throughout the execution of a push-up, the body was kept straight. Failure to correctly assume the "down" position or "up" position, or keep the body straight, resulted in a push-up not being counted. The push-up was done as many as possible in the 1-minute period and counted by the tester.

The pre-test was done prior to assigning the participants into two intervention groups which were push-up (*n*=20) and bench press (*n*=20) in order to avoid bias. The push-up treatment group was assigned to 3 sets of 12 repetitions of push-up exercise throughout the 6-week intervention, while bench press group was assigned to 3 sets of 12 repetitions of bench press exercise (at 40% 1RM bench press). 40% of 1RM bench press was used in the treatment in order to avoid bias, due to the fact that it provides a similar intensity to a push-up (adopted from Kikuchi and Nakazato (2017). Meanwhile, Beachle and Earle (2008) claim that a volume of 12 repetitions and three sets would impose hypertrophy. Thus, in total, each exercise session comprised of 36 repetitions of a single push-up or bench press exercise (depending on group assigned), with 1 minute of rest in between each set. In order to avoid bias, the frequency of 4 sessions per week for consecutive six weeks was implemented for both groups. All training session was performed at a gymnasium in Faculty of Sports Science and Recreation, Universiti Teknologi MARA, Sarawak, Malaysia at evening, and supervised by the researcher's team. Post-test was performed using the same testing procedure as the pre-test.

Statistical Analysis

The data were analyzed using the Statistical Package of Social Science (SPSS) version 22.0. Significant level set at .05 ($p < .05$). The Shapiro-Wilk, F_{max} and Levene's test statistic were used to test the assumptions of normality and homogeneity of variance. Descriptive data were presented in mean (*M*) and standard deviation (*SD*). A mixed model ANOVA within and between-subject factors were used to investigate the impact of push-up and bench press exercise on the muscular strength and muscular endurance among sedentary female youth. In contrast, the impact of types of exercise on muscular strength and muscular endurance was also investigated.

Results

The present study aims to compare the effects of 6-week of training between bench press exercise intervention (*n*=20) and push-up exercise (*n*=20) among healthy sedentary female youth. The assumptions for a mixed ANOVA were not violated (p >.05). Thus, no significant difference in the baseline strength and endurance were reported among the different groups (displays in Table 1). Table 2 shows the demographic data of the participants. While Table 3 shows the descriptive statistic for pre and post-test of muscular strength and muscular endurance for both interventions.

Table 1: Baseline muscular strength and endurance of the subjects

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	*Sig.*	*Statistic*	*df*	*Sig.*
MS	.122	40	.138	.977	40	.580
ME	.076	40	.200	.980	40	.676

Table 2: Characteristics of subjects in the study

	n	*Mean*	*Std. Deviation*
Age (years)	40	18.93	.97
Height (cm)	40	156.05	5.24
Weight (kg)	40	57.37	13.30
BMI	40	23.44	4.5

Table 3: Descriptive statistic for pre and post-test of PU and BP interventions on muscular performance

	Group	***M (Pre)***	***SD***	***M (Post)***	***SD***	***n***	***Mean diff (M post - M pre)***	***% of diff***
MS	PU	42.00	11.40	59.75	13.91	20	17.75	42.26
	BP	44.50	9.58	60.25	10.45	20	15.75	35.39
	Total	43.25	10.47	60.00	12.14	40		
ME	PU	28.95	5.93	45.05	6.59	20	16.1	55.61
	BP	29.95	6.28	41.45	6.20	20	11.5	38.4
	Total	29.45	6.05	43.25	6.574	40		

Effects of 6-Week Push-Up and Bench Press Intervention on Muscular Strength

The test of within-subjects effect for push-up and bench press interventions on muscular strength shows a significant main effect for time, F (1, 38) = 174.956, p = .0001, partial n^2 = .82 with muscular strength levels after-the-training (M = 60.0, SD = 12.14) being significantly higher than before-the-training (M = 43.25, SD = 10.47). Examination of the means indicated that there was a remarkable improvement observed in muscular strength of push-up group before-the-training (M = 42.0, SD = 11.40) to after-the-training (M = 59.75, SD = 13.91), with 17.75kg (42.26%) of 1RM improvements. There was also a large change in muscular strength of bench press group [before-the-training (M = 44.50, SD = 9.58); after-the-training (M = 60.25, SD = 10.45)], with 15.75kg (35.39%) of 1RM improvements in 6 weeks. Figure 1 illustrates the effects of 6-week intervention programme (push-up and bench press) on muscular strength among sedentary female youth.

Meanwhile, the tests of between-subject effects indicate that there was no significant main effect found for setting, F (1, 38) = .196, p = .661, partial n^2 = .005. Hence, the present study claims that there was no significant difference found between push-up and bench press interventions on muscular strength (p= .661).

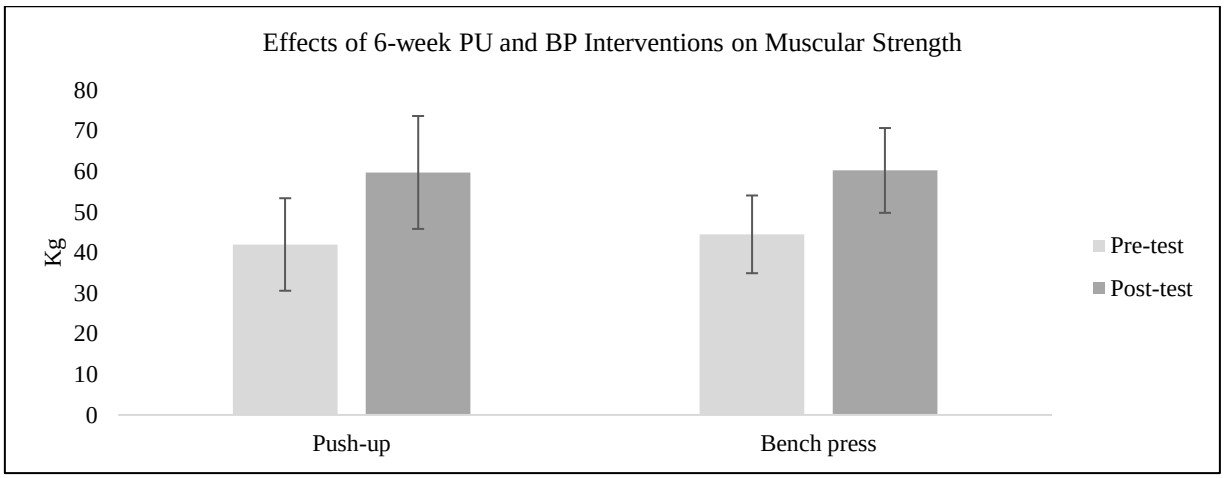

Figure 1: Effects of PU and BP interventions on MS. The present study observed a statistically significant effect on MS after six-week of PU (p = .0001) and BP (p = .0001) treatment between pre-test and post-test.

Effects of 6-Week Push-Up and Bench Press Intervention on Muscular Endurance

The test of within-subjects effect for push-up and bench press intervention on muscular endurance observed a significant main effect for time, F (1, 38) = 265.373, p = .0001, partial n^2 = .875. Muscular endurance levels at post-test (M = 43.25, SD = 6.57) were significantly higher than the pre-test (M = 29.45, SD = 6.05). The mean results indicated that there was statistically significant improvement of muscular endurance before (M = 28.95, SD = 5.93) and after-the-training (M = 45.05, SD = 6.59) in push-up group, with an additional 16.1 repetitions (55.61%) observed in the 1-minute Push-Up Test. There was also a significant improvement observed in muscular endurance of bench press group [pre-test (M = 29.95, SD =6.28); post-test (M = 41.45, SD = 6.20)], with the mean total of 11.5 repetitions (38.4%) enhancement. Figure 2 shows the effects of 6-week intervention programme (push-up and bench press) on muscular endurance among sedentary female youth.

Meanwhile, the tests of between-subject effects observed an insignificant main effect for setting, F (1, 38) = .529, p = .472, partial n^2 = .014. Thus, the present study also suggests that there was no significant difference between push-up and bench press exercise interventions on muscular endurance (p= .472).

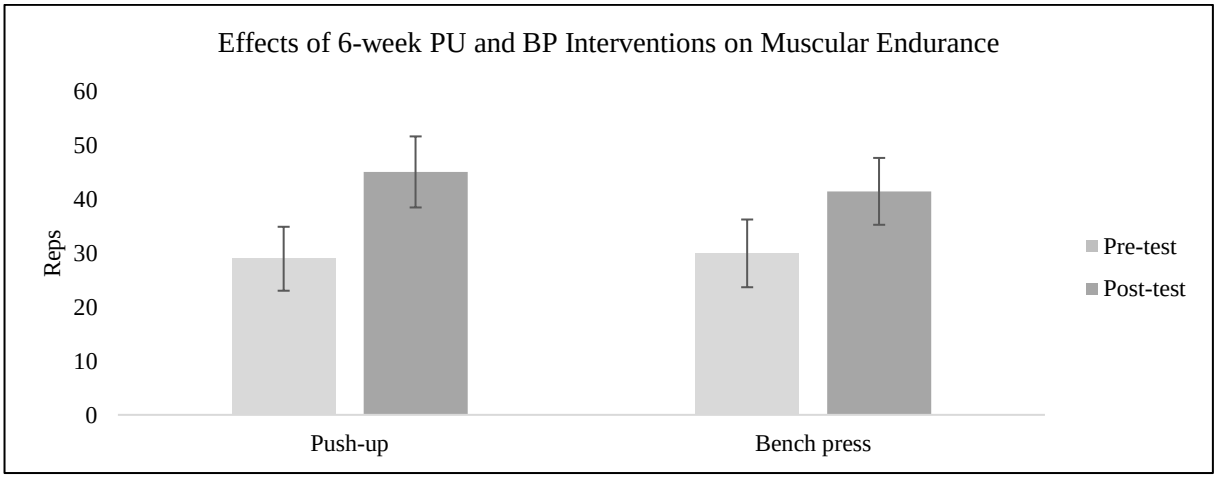

Figure 2: Effects of PU and BP interventions on ME. There is a significant effect following the 6-week PU intervention (p = .0001) and BP intervention (p = .0001) between pre-test and post-test.

Discussion

In the present study, there was a significant effect between pre and post-test push-up intervention on muscular strength and muscular endurance, in which the result improved by 17.75 kg (42.26%) and 16.1 repetitions (55.61%), respectively. Thus, this study concludes that push-up is a suitable and effective exercise for

sedentary female youth to improve muscular performance. Push-up exercise requires minimum stability and balance (of the arms) to perform. Thus, participants may focus on extending the arms with the minimum time needed for strength-developing phase. Aligning to that, the researcher observed that the push-up intervention group in the present study was getting familiar with push-up and progressed throughout the six-weeks of training. This might be the factor for allowing the sedentary female to focus on the targeted muscles. The World's Best Push-Up Workouts (2012) suggested the sedentary population to focus on perfecting the exercise (push-up) techniques in the first week of exercise despite a lower repetition exercise. Followed by that, continuous training and a progressive number of repetitions could be done to improve muscular performance. Shah (2012) and Contreras et al. (2012) also proposed push-up as a practical alternative for non-equipped exercise, to develop muscular performance for the upper body, as well as promoting balance and stability for several muscles such as pectoralis major and deltoid. Obviously, the push-up is a definite convenient choice for sedentary youth population. Besides, for those who are lack of muscular endurance (including and not limited to those who are not familiar with exercise, or sedentary people) still can perform push-up with some modification or variation. This is due to the fact that push-up exercise intensity can be adjusted with different body positioning (including push-up on knee, incline push-up and/or wall push-up) without requiring any equipment.

A statistically significant effect was found following a 6-week of low-load (40% 1RM) bench press training on muscular strength and muscular endurance. The result was improved by 15.75kg (35.39%) and 11.5 repetitions (38.40%), respectively. Therefore, the present study proposed that muscular endurance of sedentary female youth can be enhanced with a single bench press exercise training in 6-week time (with a total of 36 reps each session 4 times per week). Based on the researcher's observation in the first and second week, bench press group was trying to adapt the arms balancing during bench press exercise. Only after that, the arms were more stable to push the bar. The results of the present study were also parallel with the previous study conducted on junior athletes over a 6-week period (Drinkwater et al., 2005). Previous studies also confirmed this by claiming that bench press exercise would increase the strength or endurance of a particular muscle or muscle group (Calatayud et al., 2015). Hence, the present study claims that 6-week of single exercise (push-up or low-load bench press) training (with 3 sets of 12 repetitions, 4 times a week) with approximately 10 minutes of training would create enough overload to healthy sedentary female youth (principle of overload) which resulted in a significant improvement on muscular strength and endurance.

There was no significant difference observed between push-up and bench press intervention groups on muscular strength and muscular endurance components. One of the possible reasons for the similar improvement was because the participants of push-up and bench press interventions were exposed to identical training load and volume. Hence, the specific-adaptation-imposed-demand training principles of both interventions training might be the factor for similar muscles gain (muscular strength and muscular endurance). Apart from that, during the six-week intervention, both push-up and bench press interventions develop the stability and balance of both arms in performing push-up and bench press. Thus, the exercises perhaps help the participants to focus on extending the arm and the target muscle groups throughout the training program to develop and improve muscle strength.

The result of the present study is parallel to the previous research that claimed bench press and push-up exercise provided similar muscle gains if both exercises were performed at the same intensity and speed (Kikuchi & Nakazato, 2017). The present study also strengthens the previous study, which claimed that 10 to 12 repetitions were proven to improve muscular endurance (Ratamess, Chiarello, Sacco, Hoffman, Faigenbaum, Ross and Kang (2009). Thus, the present study shows that both exercises do significantly improve muscular strength and muscular endurance regardless of using bodyweight or equipment.

As the researcher conducted the research, there are few limitations been encountered, including the commitment of the participants. Participants were university students, thus bonded with class schedule, assignments and projects. However, the researcher managed to persuade participants about the benefits of exercise, as well as the time-effective programme offered by the present research. Thus, this appeared as the advantage of the present research/training programme. Based on the present study, the researcher would like to suggest future studies to implement testing in every 2 weeks to observe the point of change. Apart from that, a future study may perhaps include the use of other exercises as well as comparing the choice of equipment such as elastic band, TRX, ViPR, sandbag, and a kettlebell. Moreover, it would be fascinating for the

prospective study to vary the population scope such as sedentary men, recreationally active populations and special population.

As the practical application notes, the present study suggests that sedentary youth population could enjoy the benefits of increasing muscular strength and muscular endurance with just a 10-minute training of single exercise (push-up or bench press) if it is done for 4 times a week, at least for consecutive 6 weeks of training. The present study would be highly beneficial as it highlights the possibilities to gain muscular strength and endurance among sedentary female youth despite the restricted movement due to the pandemic breakout.

Conclusion

The present study concludes that push-up and low-load bench press exercise interventions that comprised of 12 repetitions for 3 sets, 4 times a week (which can be executed for approximately 10 minutes each session) for consecutive 6 weeks training has significantly improved muscular strength and muscular endurance among sedentary female youth. Besides, the study also suggests that push-up and bench press for strength training can be used interchangeably.

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