Medicina Sportiva
Med Sport 18 (4): 160-164, 2014
DOI: 10.5604/17342260.1133106

ACUTE EFFECTS OF DIFFERENT STRENGTH INTENSITIES ON UNSTABLE AND STABLE PLATFORMS ON STRENGTH PERFORMANCE AND SUBJECTIVE EFFORT PERCEPTION IN BENCH PRESS EXERCISE

Amanda F. Brown[1(A-F)], Jeferson M. Vianna[2(A,D-F)], Ingrid B. Dias[3(C-F)], Humberto L. Miranda[1(A,C-E)], Gabriel Rodrigues Neto[1(C-F)], Jefferson S. Novaes[1(A,D-G)]

[1]Physical Education Post Graduate Program, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil
[2]Physical Education Post Graduate Program, Federal University of Juiz de Fora, Juiz de Fora, Brazil
[3]Clinical Medicine Post Graduate Program, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil

Abstract

Introduction: The Swiss ball is an unstable platform that is becoming an important tool in the application of strength exercises because of the greater requirements on the neuromotor and neuromuscular systems.

Objective: To investigate whether a change in the type of platform in different intensities (60 and 80% 1MR) in bench press exercise can affect the strength performance and the subjective effort perception (SEP) of trained men.

Methods: Twenty-six apparently healthy men (23.2 ± 3.7 years, 1.77 ± 0.07 m, 79.6 ± 12.3 kg, 25.4 ± 2.9 kg/m^2) performed the test and retest of 1RM of a bench press (BP) on a stable platform (SP). The subjects were randomly divided into four experimental situations, in which all of them performed the BP tests at 60% and 80% of 1RM on the UP and 60% and 80% of 1MR on the SP.

Results: The strength performance (the number of repetitions and total volume) of the BP exercise was significantly higher on a SP compared to an UP ($P < 0.001$) for both intensities. The SEP was significantly higher on the UP compared to the SP ($P < 0.001$) and at an intensity of 80% of 1RM compared to 60% of 1RM ($P < 0.001$).

Conclusion: Acutely, regardless of the intensity, the BP exercise promotes better strength performance when performed on a SP and provides a greater effort sensation when performed on the UP.

Key words: *resistance exercise, Swiss ball, number of repetitions, total volume, scale of subjective effort perception*

Introduction

The traditional strength exercises performed on stable platforms. The use of an unstable surface is becoming an important strategy as applied to strength exercises because of its greater requirements on the neuromotor and neuromuscular systems [1]. The Swiss ball provides an instable surface and is considered an important device that offers an improvement in fitness programs for health [2]. Accordingly, some studies have investigated its effects as an instability platform on exercise performance [1,3-15]. Regarding the bench press exercise specifically, studies have suggested that the unstable surface may generate greater activation of the stabilisers of the shoulder and trunk [1,4,6,8] may also increase the myoelectric activity with smaller or similar strength production of the involved muscles [9,12,14, 5]. According to Anderson and Behm [4], the bench press exercise as performed on an unstable platform generates lower isometric force production compared to a stable platform. As concerns dynamic performance, Koshida et al. [9] observed a strength reduction of 6% in the bench press exercise performed at 50% of 1 RM on the ball compared to the same exercise performed on the bench. Marinkovic et al. [14] analysed the maximal strength of 1 RM on the bench press after eight weeks of training under instability conditions. The subjects were trained at the same intensity used by Koshida et al. [9] and although strength increased after the experimental intervention period, the results indicated that the exercises on unstable surfaces were not more effective that the similar exercises conducted on a stable platform. Similarly, Saeterbakken and Fimland [15] by comparing loads of six maximal repetitions of the bench press exercise performed on three different surfaces (bench, balance disc and Swiss ball), concluded that under stable conditions the strength of 6 RM was higher as compared to unstable conditions. Only the study of Goodman et al. [1] did not demonstrate a difference between stable and unstable surfaces in the 1RM strength in the bench press exercise, indicating that training on both platforms may improve strength levels.

Related to the subjective effort perception (SEP) of the exercises performed on unstable platforms, cant evidence exists in the literature reviewed [6,16]. Marshall and Murphy [6] compared the SEP (Borg) in the bench press exercise at 60% of 1RM as performed on an unstable platform (Swiss ball) and on a stable platform (straight bench). The authors concluded that the subjects had a higher perceived effort regarding the exercise conducted on the unstable platform. Alternatively, Panza et al. [16], using the OMNI-RES scale, observed the effects of the bench press exercise at 80% of 1RM on unstable and stable platforms and did not observe significant differences in the SEP between the surfaces.

Thus, the present study aimed to compare the acute effect of a strength exercise at different intensities (60% and 80% of 1RM) on a stable platform (straight bench) and an unstable platform (Swiss ball) on the strength performance and the subjective effort perception of recreationally trained men.

Methods

Participants

Twenty-six recreationally trained men (23.2 ± 3.7 years, 79.6 ± 12.3 kg, 1.77 ± 0.07 m, and 25.4 ± 2.9 kg/m^2) volunteered for the study. The sample size was determined using the G*Power 3.1.0 software and the procedures followed the recommendations of Beck [17]. Based on an a priori analysis, we adopted a potency of 0.85, $\alpha = 0.05$, coefficient of correlation of 0.5, non-sphericity correction of 1 and an effect size of 0.25. For both, an n of 26 subjects was calculated. This a priori analysis of the statistical power was conducted to reduce the type II error probability and to determine the minimal number of subjects necessary for this investigation. The sample size was verified sufficient to provide 85.1% statistical power.

Excluded from the study were the following: (a) smokers, (b) men who presented some type of musculoskeletal injury to the upper or lower limbs and (c) men who answered positively to any of the items on the Physical Activity Readiness Questionnaire / PAR-Q [18]. After the risks and benefits of the study were explained, the subjects signed the term of free and informed consent (TFIC) elaborated according to the Helsinki declaration. The study was approved by the Ethics and Research Committee of the Universidade Federal de Juiz de Fora (ERC/UFJF), with protocol number 101/2010.

Data collection

The study was conducted across nine visits, in non-consecutive days. On the first visit, the subjects read and signed the term of free and informed consent and submitted to an anthropometric assessment, followed by the 1RM test. On the second visit, the 1RM retest was conducted. From the third to the fifth visit, the subjects underwent a familiarisation of the bench press exercise on the unstable platform, as well as familiarisation with the OMNI-RES scale of subjective effort perception. From the sixth visit, the subjects were randomly and evenly divided to the following experimental situations: a) 60% of 1RM on a stable platform; b) 80% of 1RM on a stable platform; c) 60% of 1RM on an unstable platform; d) 80% of 1RM on an unstable platform.

For the assessment of the maximal dynamic strength following the recommendations of ACSM [19] the bench press exercise with dumbbells on a straight bench was employed. The subjects performed the 1RM test and were retested after 48 hours to verify the reproducibility of the observed loads. The higher load as determined between the two measurements. Relevant standardised instructions to the procedures were previously provided and various strategies were adopted to minimise possible errors during the 1RM test. The subjects were verbally encouraged and realised four trials for each exercise, with standardised rest intervals of five minutes between the attempts. The maximal load obtained in the last complete performance was registered as 1RM. The assessment of the subjective effort perception was determined using the OMNI-RES scale proposed by Robertson et al. [20] that ranks the intensity of the resistance exercise with numerical and verbal descriptors similar to the Borg scale and with visual descriptors. The effort perception was verified immediately after the session, emphasising the peripheral fatigue.

Statistical analysis

The parametric assumptions of normality and sphericity were validated by the Kolmogorov-Smirnov test and Mauchley tests, respectively. The results were presented as the means ± standard deviation (M ± SD), except for the SEP for which the median (1º - 3º quartiles) was used.

ANOVA was used to test the effect of the intensity and the type of the resistance exercise platform on the dependent variables (the number of repetitions and total volume) using the two factors of the repeated measures. When the interaction between the factors was significant, paired t tests with Bonferroni corrections were used to detect the specific differences. To analyse the SEP variable, the Friedman ANOVA was used, followed by the Wilcoxon tests to detect the specific differences. The magnitude of the differences between the experimental conditions was assessed by the effect size (the difference between the means divided by the standard deviation) as proposed by Rhea [21] for recreationally trained subjects (trivial < 0.35, small 0.35 – 0.80, moderate 0.80 – 1.50, and large > 1.50). The reproducibility of the measures was assessed by the intraclass correlation coefficient (ICC). All the analyses were conducted using SPSS software (v.19, SPSS Inc., Chicago, IL, USA) with the adoption of s significance level of 5% ($P \leq 0.05$).

Results

The intraclass correlation coefficient was used to verify the reproducibility of the mean values in the 1RM tests. High correlation coefficients ($r \geq 0.99$) were observed with no significant differences ($P < 0.001$) between the test and retest of 1RM.

Table 1 presents the results of the effects of the intensity and the type of platform on the number of repetitions, the total volume and the SEP. For the number of repetitions, significant differences were observed related to the intensity ($P < 0.001$) and the type of platform ($P < 0.001$). This result indicates that a significantly higher number of repetitions at the intensity of 60% of 1RM compared to the intensity of 80% of 1RM was observed as was also observed on the SP compared to the UP. For the same effort intensity, the effect size of the number of repetitions between the platforms was considered moderate (Table 2).

Similarly, with respect to the total volume (repetitions x load), significant differences were observed in the intensity ($P < 0.001$) and in the type of platform ($P < 0.001$) (Table 1). The total work was higher at the intensity of 60% of 1RM compared to 80% of 1RM and on the SP compared to the UP. For the same effort intensity, the effect size of the total volume between the platforms was considered small for the intensity of 60% of 1RM and moderate for 80% of 1RM (Table 2).

The SEP analysis showed significant differences between the experimental conditions (X^2=48.142, gl=3, $P < 0.001$) with higher values obtained at the intensity of 80% of 1RM when compared to 60% of 1RM and on the UP compared to the SP (Table 1). For the same effort intensity, the effect size of the SEP between the platforms was considered small at the intensity of 60% of 1RM and moderate at the intensity of 80% of 1RM (Table 2).

Discussion

The present study aimed to compare the acute effect of the bench press exercise performed on the UP and on the SP, at the intensities of 60% and 80% of 1RM, on the strength performance and the SEP. The results showed that at both intensities (60% and 80% of 1RM) the exercise realised on the SP provided better strength performance. In reviewing the literature, no studies were found that verified the strength performance by the number of repetitions and total volume. However, five studies assessed the effects of strength production in the bench press exercise in comparing the UP with SP [1,4,9,14,15].

Anderson and Behm [4] evaluated power output using electromyography. Ten healthy male subjects performed the bench press at 75% of 1RM on the bench and on the ball. The isometric strength production was lower on the UP as compared to the SP. However, the isometric measure verifies the strength production only in a determined joint angle. This method may not have practical application because the functionality of daily tasks requires the production of dynamic strength in unstable conditions. Despite the methodological differences, comparing the current study to the one reported by Anderson and Behm [4], it is possible that both the performance and the strength production were lower on the UP due to the necessity of joint stabilisation.

Table 1. *Strength performance and perceived exertion after a bench press exercise session at 60% and 80% of 1RM performed in stable and unstable platform conditions (mean ± standard deviation and median [1st - 3rd quartiles], respectively)*

	60% SP	60% UP	80% SP	80% UP
RM (repetitions)	$41.1 \pm 8.1^{*\neq}$	$34.5 \pm 7.8^{*}$	$22.3 \pm 5.1^{\neq}$	18.1 ± 5.0
TV (repetitions x load)	$1798.5 \pm 405.5^{*\neq}$	$1513.2 \pm 397.7^{*}$	$1300.5 \pm 320.7^{\neq}$	1049.0 ± 286.4
PE (OMNI-RES)	5.0 (2.0)	$6.0\ (2.0)^{\neq}$	$7.0\ (2.0)^{*}$	$8.0\ (1.0)^{*\neq}$

SP = stable platform; UP = unstable platform; RM = maximum repetitions; TV = total volume; PE = perceived exertion
* significant difference between the intensities (60% vs. 80%); ≠ significant difference between the platforms (SP vs. UP); (P<0.05)

Table 2. *Effect size and magnitude of the strength performance and perceived exertion following bench press exercise session with 60% and 80% of 1RM performed using stable and unstable platforms*

	60% SP vs. UP	80% SP vs. UP
RM	0.83	0.82
Magnitude	Moderate	Moderate
TV	0.71	0.83
Magnitude	Small	Moderate
PE	0.74	0.86
Magnitude	Small	Moderate

SP = stable platform; UP = unstable platform; RM = repetitions maximum; TV = total volume; PE = perceived exertion

Regarding strength production, Goodman et al. [1] did not find significant differences in strength levels when assessing the bench press 1RM strength on the SP (bench) and the UP (Swiss ball). This result may be explained by the study limitation of not controlling the Swiss ball internal pressure, which must have resulted in a flattening of the circumference according to the overload of the test, causing more stability of the surface. Under this assumption, although in our study the internal pressure of the ball was also not controlled, the submaximal intensities used perhaps explained the differences observed in the strength performance between the platforms.

The studies of Anderson and Behm [4] and Goodman et al. [1] suggest that the unstable platforms decrease the isometric strength production and are similar to the stable platforms in the 1RM strength. However, Koshida et al. [9], investigating the instability effect in the dynamic movements of 20 athletes who performed the series at 50% of 1RM for the bench press exercise on the bench and on the Swiss ball, showed a significant reduction in the strength in the exercise conducted on the Swiss ball. Our results with percentages of 60% and 80% of 1RM corroborate the findings of Koshida et al. [9], demonstrating that independent of the intensity, the strength generated on the UP is lower than that on the SP. The results of both studies do not provide an explanation of the reasons for the strength decrease on the UP, but the great activation demand of the muscles of the limbs and trunk is speculated.

Marinkovic et al. [14] assessed the differences in the 1RM strength after eight weeks of strength training using instability conditions in 50 physically active and inexperienced students. The sample was divided into two groups (instability and traditional training) with bench press exercise training two times a week at 50% of 1RM. The results do not corroborate the fact that the strength exercises when realised in unstable conditions are more effective for the improvement of the maximal muscle strength of inexperienced subjects. In the present study, the strength performance in the bench press exercise performed on the UP and the SP was only verified in the acute setting. Our results are similar to the findings by Marinkovic et al. [14], although the latter study was conducted with inexperienced subjects. Another important factor to emphasise is that concerning strength, significant gains are recommended at percentages above 80% of 1RM [22], which must have interfered with the results of the studies previously mentioned.

Recently, Saeterbakken and Fimland [15] compared the maximal loads of 6RM in the bench press on three surfaces: bench, balance disc and Swiss ball. Sixteen trained men conducted the exercise randomly on the three surfaces. The authors concluded that the subjects who executed the exercise on the SP showed higher 6RM strength performance than that obtained under unstable conditions. Notably, this study has greater practical applicability because it used a higher number of repetitions compared to the aforementioned studies [1,4,9,14]. Despite the methodological differences in the assessment of the strength performance, the results of Saeterbakken and Fimland [15] are similar to ours with regard to the strength decrease in the unstable conditions.

Another important finding in our study was the increase in the SEP after the bench press exercise as realised on the UP at both intensities (60% and 80% of 1RM). This finding corroborates with the study of Marshall and Murphy [6], that analysed the SEP by the Borg scale using the same exercise at 60% of 1RM and that concluded that the effort sensation was significantly higher on the Swiss ball than on the SP. These results may possibly be explained by the fact that the subjects were not familiar with the exercises under unstable conditions. According to Behm and Anderson [23], the exercises performed on unstable surfaces require greater activation of the auxiliary muscles and this observation might justify the higher effort sensation recognised by Marshall and Murphy [6] as was observed in the present study.

Recently, Panza et al. [16] compared the SEP (OMNI-RES) in the bench press at 80% of 1RM on an unstable platform and a stable platform. Ten trained men participated in the study and the results did not show significant differences between the surfaces. Although there are methodological similarities, for the same intensity, the study in question demonstrated a higher SEP on the unstable platform. The small sample size used in the above study might possibly explain the divergent results.

In conclusion, our findings indicate that independent of the intensity, the strength performance in the bench press exercise was better on the SP, whereas the SEP was higher on the UP.

Conclusion

Our study supports the hypothesis that the strength exercise performed on the SP appears to provide better strength performance associated with a lower perceived effort. We suggest that during the elaboration of a strength training program, some exercises variations beyond the traditional exercises that use unstable platforms, such as the Swiss ball, be prescribed. Considering that the fitness population largely aims to achieve maximal physical results in minimal time, this methodology may assist in the adherence of physical activity practitioners because by performing unstable exercises, it is possible to maximize the heightened effects on the neuromuscular and neuromotor systems in training sessions involving limited time.

Finally, some limitations of this study should be considered as, for example, was not controlled internal pressure of the Swiss ball and not the 1RM test was performed on unstable platform, however, we recommend that further studies are conducted controlling such limitations.

Declaration of interest

The authors report no conflicts of interest.

References

1. Goodman CA, Pearce AJ, Nicholes CJ, et al. No difference in 1RM strength and muscle activation during the barbell chest press on a stable and unstable surface. *J Strength Cond Res* 2008; 22: 88-94. DOI: 10.1519/JSC.0b013e31815ef6b3
2. Willardson JM. Core stability training: Applications to sports conditioning programs. *J Strength Cond Res* 2007; 21: 979-85.
3. Behm DG, Anderson K, Curnew RS. Muscle force and activation under stable and unstable conditions. *J Strength Cond Res* 2002; 16: 416-22.
4. Anderson KG, Behm DG. Maintenance of EMG activity and loss of force output with instability. *J Strength Cond Res* 2004; 18: 637-40.
5. Behm DG, Leonard AM, Young WB, et al. Trunk muscle electromyographic activity with unstable and unilateral exercises. *J Strength Cond Res* 2005; 19: 193-201.
6. Marshall PWM, Murphy BA. Increased deltoid and abdominal muscle activity during Swiss ball bench press. *J Strength Cond Res* 2006; 20: 745-50.
7. Marshall P, Murphy B. Changes in muscle activity and perceived exertion during exercises performed on a swiss ball. *Appl Physiol Nutr Metab* 2006; 31: 376-83. DOI: 10.1139/H06-006
8. Norwood JT, Anderson GS, Gaetz MB, et al. Electromyographic activity of the trunk stabilizers during stable and unstable bench press. *J Strength Cond Res* 2007; 21: 343-7.
9. Koshida S, Urabe Y, Miyashita K, et al. Muscular outputs during dynamic bench press under stable versus unstable conditions. *J Strength Cond Res* 2008; 22: 1584-8. DOI: 10.1519/JSC.0b013e31817b03a1
10. Duncan M. Muscle activity of the upper and lower rectus abdominis during exercises performed on and off a Swiss ball. *J Bodyw Mov Ther* 2009; 13: 364-7. DOI:10.1016/j.jbmt.2008.11.008
11. Kohler JM, Flanagan SP, Whiting WC. Muscle activation patterns while lifting stable and unstable loads on stable and unstable surfaces. *J Strength Cond Res* 2010; 24: 313-21. DOI: 10.1519/JSC.0b013e3181c8655a
12. Uribe BP, Coburn JW, Brown LE, et al. Muscle activation when performing the chest press and shoulder press on a stable bench vs. a Swiss ball. *J Strength Cond Res* 2010; 24: 1028-33. DOI: 10.1519/JSC.0b013e3181ca4fb8
13. Araújo RC, Andrade R, Tucci HT, et al. Shoulder muscular activity during isometric three-point kneeling exercise on stable and unstable surfaces. *J Appl Biomech* 2011; 27: 192-6.
14. Marinković M, Bratić M, Ignjatović A, et al. Effects of 8-Week instability resistance training on maximal strength in inexperienced young individuals. *Serb J Sports Sci* 2012; 6: 17-21.
15. Saeterbakken AH, Fimland MS. Electromyographic activity and 6-RM strength in bench press on stable and unstable surfaces. *J Strength Cond Res* 2013; 27: 1101-7. DOI: 10.1519/JSC.0b013e3182606d3d
16. Panza P, Vianna JM, Damasceno VO, et al. Energy cost, number of maximum repetitions, and rating of perceived exertion in resistance exercise with stable and unstable platforms. *J Exerc Physiol* 2014; 17: 77-87.
17. Beck TW. The importance of a priori sample size estimation in strength and conditioning research. *J Strength Cond Res* 2013; 27: 2323-37. DOI: 10.1519/JSC.0b013e318278eea0
18. Shephard RJ. PAR-Q, Canadian Home Fitness Test and exercise screening alternatives. *Int J Sports Med* 1988; 5: 185-95.
19. ACSM. *Manual do ACSM para avaliação da aptidão física relacionada à saúde*. 3ª ed. Rio de Janeiro: Guanabara Koogan; 2011.
20. Robertson RJ, Goss FL, Rutkowski J, et al. Concurrent validation of the OMNI perceived exertion scale for resistance exercise. *Med Sci Sports Exerc* 2003; 35: 333-41.
21. Rhea MR. Determining the magnitude of treatment effects in strength training research through the use the effect size. *J Strength Cond Res* 2004; 18: 918-20.
22. ACSM. American College of Sports Medicine position stand. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise. *Med Sci Sports Exerc* 2011; 43: 1334-59. DOI:10.1249/MSS.0b013e318213fefb
23. Behm DG, Anderson KG. The role of instability with resistance training. *J Strength Cond Res* 2006; 20: 716-22.

Accepted: November 30, 2014
Published: December 23, 2014

Address for correspondence:
Amanda Brown
Department of Physical Education, Graduate Program,
Federal University of Rio de Janeiro
Avenida Pau Brasil 540,
Ilha do Fundão,
Rio de Janeiro, Cep: 21941-590, Brazil.
E-mail: amandafernandesbrown@gmail.com
Phone: +55 (32) 9181-9213

Amanda F. Brown: amandafernandesbrown@gmail.com
Jeferson M. Vianna: jvianna@acessa.com
Ingrid B. Dias: ingrid_barbara@ig.com.br
Humberto L. Miranda: humbertomirandaufrj@gmail.com
Gabriel Rodrigues Neto: gabrielrodrigues_1988@hotmail.com
Jefferson da Silva Novaes: jsnovaes@terra.com.br

Authors' contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection