Comparison of Muscle Activation between Traditional, Clap and Power Push Up Among Trained Men

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Abstract. This study was conducted to compare the muscle activation during traditional, clap and power push up among trained men. A total of thirty trained men that are physically active and have at least one year experienced in fitness training and having good techniques in push up exercises were recruited as study participants. Participants were required to perform all three types of push up in a randomised order to avoid bias in the exercise sequence. Electromyogram was used to detect the muscle activites of pectoralis major, triceps brachii and anterior deltoids. Muscle activation was reported as percentage of the maximum voluntary contraction value. The results showed that the muscle activation was highest during the clap push up followed by the power push up and traditional push up. As a conclusion, increasing the difficulty by applying plyometric technique during push up give a significant impact in terms of muscle activation in which is believed to be affect the muscle strength and size in long term.

1. Introduction

Push up is a common body weight exercise that has long been performed as a way to improve upper body strength and endurance [1-4]. This exercise is easy and convenient to be done as only bodyweight and gravity become the load while performing it. Push up emphasized the pectoralis major, anterior deltoid, triceps brachii, latissimus dorsi, and rectus abdominus [5]. Besides been performed as a training exercise, push up has also become one of the major muscular endurance test for the upper body [6, 7].

Push up always been performed on a flat, stable surface, with the hands placed slightly wider than shoulder-width apart, and fingers pointed forward with the body horizontal to the surface. Individual must keep the back and knees straight. The individual needs to lower the body to a predetermined point until there is a 90-degree angle at the elbows, then return back to the starting position with the arms extended. This movement is repeatedly done as this can strengthen the involved muscles [8]. However, there are many variations of push up that can be done including by changing the hand and leg placement, and also the speed of doing it [9, 10].

One of difficult variations of push up is when performing push up by pliometric method. Davies, Riemann, and Manske [11] stated that plyometric exercise is an exercise that related to explosive movements. Plyometric exercise will increase muscle power as the muscle is required to produce rapid
and fast movements in a short period of time. Plyometric exercise involves hopping, jumping, and leaping movements that can produce explosive power [12].

Although the traditional push up is known and practiced by almost all athletes and practitioners of fitness, but still less studies was done in comparing the differences of muscle activation between traditional and plyometric push up. Therefore, the purpose of this study was to compare pectoralis major, triceps brachii and anterior deltoids muscle activation during traditional and plyometric push up (clap and power push up).

2. Methodology
2.1. Participant
A total of thirty trained men aged 20-25 years old were recruited as participants in this study. Participants were physically active and consistently active in fitness training for the previous one year. Participants commenced free of injury or any medicine, which may have inhibited the performance. Participants were screened via Physical Activity Readiness Questionnaire (PAR-Q) and gave their written consent after being informed of the aims and possible risks involved in this study.

2.2. Instrument
Muscle activation were recorded from pectoralis major, triceps brachii and anterior deltoids by using electromyogram (EMG) with wireless electrodes (Trigno, Delsys, USA). Electrode was placed in the middle of the sternum and shoulder for pectoralis major muscle. For tricep brachii muscle, electrode was placed in parallel line between the posterior crista of the acromion and the olecranon. For anterior deltoid, electrode was placed in distance of one finger width in line between the acromion and the thumb. The Surface EMG for Non-Invasive Assessment of Muscles (SENIAM) was used as guideline to conduct the EMG test for the three muscles including the maximum voluntary contraction (MVC) test [13].

2.3. Procedure
Participants were involved in familiarization session to have better understanding of the procedure to be conducted. After the familiarization session, participants were divided into three sequences of push up in a randomised order to avoid bias in the exercise sequence. Participants underwent MVC test before the push up test were started. The MVC data is important as the EMG data was reported in the form of percentage of MVC value.

Traditional push up started with the face-down prone position on the floor, both hands shoulder-width apart or a little bit wider. As participants bend their elbows and lower toward the ground, their elbows should be at about 45-degree angle to their body. For clap push up, they will begin in the plank position with the hands slightly wider apart than the shoulders. The elbows then need to be bent to lower the chest as close to the floor as possible. In one smooth movement, they need to forcefully push the body upward by straightening the arms and lift the hands off the floor, bringing them together to clap once. Lastly, they need to land with the hands back on the floor and a little bend in the elbows. Power push up is the same as the traditional push up but with the addition of the jumping to perform such movement.

2.4. Data and Statistical Analyses
Statistical analyses were conducted using Statistical Package for Social Science (SPSS) version 20. Repeated measure analysis of variance (ANOVA) was used to examine the differences in muscle activities in three types of push up exercises (traditional, clap and power push up). P-values less than 0.05 were considered statistically significant.
3. Result

Table 1 showed the physical characteristics of participants involved in this study.

| Variables                | Mean ± SD     |
|--------------------------|---------------|
| Age (years old)          | 21.01 ± 2.34  |
| Body Mass (kg)           | 68.92 ± 5.30  |
| Height (cm)              | 168.24 ± 4.02 |

Table 2. showed that there was a significant main effects found for pectoralis major \( F(1,29)=13435.57, p<.05 \); anterior deltoid \( F(1,29)=1980.93, p<.05 \) and triceps brachii, \( F(1, 29) = 556.257, p<.05 \). Using pairwise comparison, results showed the activation of pectoralis major, anterior deltoid and triceps brachii were significantly greater during clap push up compared to power push up and traditional push up. All the muscles also were shown to be significantly greater during power push up compared to traditional push up.

| Muscle                  | Clap Push Up M ± SD | Power Push Up M ± SD | Traditional Push Up M ± SD |
|-------------------------|---------------------|----------------------|---------------------------|
| Pectoralis major (% MVC)| 66.91 ± 3.65        | 63.69 ± 2.63         | 55.88 ± 5.52              |
| Anterior deltoid (% MVC)| 50.51 ± 5.07        | 47.88 ± 4.19         | 35.49 ± 5.11              |
| Tricep brachii (% MVC)  | 49.02 ± 6.83        | 45.73 ± 6.91         | 40.69 ± 6.04              |

4. Discussion

This study was conducted to compare the differences in muscle activities of the triceps brachii, pectoralis major, and anterior deltoids when performing traditional and plyometric push up among trained men. Muscle activation of pectoralis major, anterior brachii and triceps brachii were obtained and compared between traditional, clap and power push up by using electromyography method.

Results showed the muscles activations were higher during clap push up compared to traditional and power push up in all the three muscles investigated. On the other hand, power push up showed higher muscle activations in all the three muscles tested compared to the traditional push up.

The results were expected, as applying more explosive movement (i.e. clap and power push up) require the muscles to be more activated in order to recruit motor unit to perform such movement. The current finding was in line with the finding of previous study [14] that found different variations of the push-up exercise would result in different levels of muscle activation and generally different technique of push up as performed at higher difficulty levels would result in increased muscle activity compared to traditional push up.

How clap push up provide more challenge can be seen as after the performer goes down, he need to propel himself off the ground so that he will have enough time and space to clap his hands together before landing in the starting position again to get ready for the next rep.

Despite of the more muscle activation during clap and power push up, it is a need for the performer to land with the elbows slightly bent to absorb the impact of the landing. This condition is just the same way as we would land with our knees slightly bent if were jumping on our feet. For those that are new to the clap push up, it is advisable to start with power push up (without clapping), get used to the rhythm of the dynamic movement to avoid any unwanted risks of injury.
5. Conclusion
As a conclusion, performing different types of push up can affect level of muscle activation. The finding of this study showed that plyometric push up (clap and power push up) would be more beneficial compared to traditional push up in term of muscle activation in which later would affect muscle strength and size.

References
[1] Thomas, E., Bianco, A., Mancuso, E. P., Patti, A., Tabacchi, G., Paoli, A., ... & Palma, A. (2017). The effects of a calisthenics training intervention on posture, strength and body composition. *Isokinetics and exercise science, 25*(3), 215-222.
[2] Hassan, S. (2018). The Effects of Push-Up Training on Muscular Strength and Muscular Endurance. *International Journal Of Academic Research In Business And Social Sciences, 8*(11).
[3] Ahmad, A., Jusoh, N., & Tengah, R. Y. (2019). Acute physiological responses and performance following subsequent CrossFit ‘CINDY’ workout with Zea Mays juice. *Physical education of students, 23*(2), 57-63.
[4] Abadi, F. H., Sankaravel, M., Zainuddin, F. F., Elumalai, G., & Razli, A. I. (2019). The effect of aquatic exercise program on low-back pain disability in obese women. *Journal of exercise rehabilitation, 15*(6), 855.
[5] Uhl, T. L., Carver, T. J., Mattacola, C. G., Mair, S. D., & Nitz, A. J. (2003). Shoulder musculature activation during upper extremity weight-bearing exercise. *Journal of Orthopaedic & Sports Physical Therapy, 33*(3), 109-117.
[6] Yusof, Z. M., bin Syed Ambon, S. A. E., & bin Mohamad, J. (2016). Physical fitness assessment of MSKPPM Kedah veteran football players. *Jurnal Sains Sukan & Pendidikan Jasmani, 5*(1), 49-64.
[7] Hashim, A. (2012). Objectivity, reliability, and validity of the 90° push-ups test protocol among male and female students of sports science program. *Journal of Physical Education and Sport, 12*(1), 103.
[8] Contreras, B., Schoenfeld, B., Mike, J., Tiryaki-Sonmez, G., Cronin, J., & Vaino, E. (2012). The biomechanics of the push-up: Implications for resistance training programs. *Strength & Conditioning Journal, 34*(5), 41-46.
[9] Park, S. Y., & Yoo, W. G. (2011). Differential activation of parts of the serratus anterior muscle during push-up variations on stable and unstable bases of support. *Journal of Electromyography and Kinesiology, 21*(5), 861-867.
[10] Seo, S. H., Jeon, I. H., Cho, Y. H., Lee, H. G., Hwang, Y. T., & Jang, J. H. (2013). Surface EMG during the push-up plus exercise on a stable support or Swiss ball: scapular stabilizer muscle exercise. *Journal of physical therapy science, 25*(7), 833-837.
[11] Davies, G., Riemann, B. L., & Manske, R. (2015). Current concepts of plyometric exercise. *International journal of sports physical therapy, 10*(6), 760.
[12] Franchi, M. V., Monti, E., Carter, A., Quinlan, J. I., Herrod, P. J., Reeves, N. D., & Narici, M. V. (2019). Bouncing back! counteracting muscle aging with plyometric muscle loading. *Frontiers in physiology, 10*, 178.
[13] Hermens, H. J., Freriks, B., Disselhorst-Klug, C., & Rau, G. (2000). Development of recommendations for SEMG sensors and sensor placement procedures. *Journal of electromyography and Kinesiology, 10*(5), 361-374.
[14] de Araújo, R. C., Nascimento, V. Y. S., Torres, R. J. B., Trombini-Souza, F., Behm, D., & Pitanguy, A. C. R. (2020). Can the Use of Unstable Surfaces and Instruction for Conscious Abdominal Contraction Increase the EMG Activity of the Periscapular Muscles During the Dynamic Push-Up?. *Journal of Sport Rehabilitation, 29*(2), 225-230.