

Shoulder Muscle EMG Activity in Women During Push up on Varying Surfaces.

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Abstract. The unstable surfaces of a BOSU[®] ball and Swiss ball typically have a greater impact on EMG muscle activity during a push up compared to a normal push up done on a flat stable surface. This study's purpose was to determine if performing a push up on a BOSU[®] ball and on an exercise bench influenced EMG muscle activity when compared to the activity of a push up on a stable surface in females. Eighteen females were recruited from a convenience sample of college students. The pectoralis major, rectus abdominus, and external oblique muscles showed the greatest EMG muscle activity. The posterior deltoid showed the lowest activity. Overall, the push up performed on the bench showed the greatest EMG muscle activity compared to the other types of push ups.

1. Introduction:

Unstable surfaces such as a Swiss ball and BOSU[®] ball are used in therapy to increase muscle activation during therapeutic exercise. The emerging use of the BOSU[®] ball in rehabilitation clinics makes this a relevant substitute for the Swiss ball. The BOSU[®] ball has more surface contact with the ground than a Swiss ball, making it a safer alternative during stability training, while simultaneously recruiting greater muscle activation. Electromyography (EMG) measures muscle activity. EMG studies that have looked at muscle activity during therapeutic exercise using varying surfaces included all male subjects or a mix of genders [2,4]. No studies that looked at upper body exercise, push ups, and/or EMG utilized only women as subjects. An EMG study consisting of females performing exercise on many surfaces can expand the literature that involves stability exercises for women. A push up is frequently used in upper extremity EMG studies. The purpose of this study was to determine if an increase in EMG muscle activity occurred while subjects performed a push up on a stable surface compared to an unstable surface. From this information, it may be possible to develop rehabilitation protocols that utilize stable versus unstable surfaces.

2. Experiment, Results, Discussion, and Significances

The sample was 18 women (18-28 years old) from WSU. The 7 muscles onto which EMG electrodes were placed were biceps, triceps, rectus abdominus, external oblique, pectoralis major, latissimus dorsi, and posterior deltoid. Placement of electrodes followed the locations shown in Konrad's *The ABCs of EMG* [1]. Electrodes were placed on the right side to decrease heart beat interference. After electrode placement, maximal voluntary contractions (MVCs) were obtained for each muscle. A MVC is defined as maximal effort during a muscle contraction. These MVCs provided a comparison for the EMG activity of each muscle. The portrayal of this comparison consisted of percent of MVC.

An electrogoniometer placed on the subject's left lateral elbow recorded relative elbow position during the push ups. Subjects were randomly assigned to 1 of 6 related push up orders, with no one order used more than 3 times. The 3 types of push ups included a standard style push up, bench push up with feet on the bench and hands placed on the floor, and a BOSU[®] ball push up with hand placement on the BOSU[®] and feet on the floor (Figure). The trunk was maintained in straight alignment throughout all push ups with the back flat and the pelvis in neutral [2,3].

The EMG started recording muscle activity when the subject was in the top 1 position of the push up. The subject lowered into the bottom (down) position and then returned to the start position (for this paper, called top 2 position) (Figure). Each position was held for 1 second. One second was allowed to assume the next position. A recording was used to verbally cue subjects to change position. Three repetitions for each push up were performed with a 1 minute rest in between trials.

Data were analyzed using SPSS v 13.0TM. The 2-way analysis of variance looked for significant differences between the 3 push up positions and between the 3 push up types.

The largest number of significant changes occurred between push up positions and the 3 push up types in the posterior deltoid. The pectoralis major showed the fewest changes. The triceps had greater EMG muscle activity during the down position than the 2 top positions in all push ups. The pectoralis major, rectus abdominus, and external oblique muscles showed the greatest EMG muscle activity during the 3 types of push ups. Overall, muscles used during a push up performed on the bench showed the greatest EMG muscle activity. Most muscles in the top 2 position had greater EMG muscle activity than the same muscles in the top 1 position.

Unexpectedly, the greatest EMG muscle activity occurred in the rectus abdominus and the triceps muscles on the bench push up compared to the standard push up and the unstable push up, in contrast to Marshal et al's findings [4]. The current study also found unexpected significant changes in latissimus dorsi activity between the standard and bench push up and between the bench and BOSU® for the 2 top positions. Previous researchers had difficulty obtaining data from this muscle [2].

As expected, pectoralis major had greater EMG muscle activity during a stable bench push up than during the BOSU® push up. The greatest EMG muscle activity occurred in the down position of each push up on all 3 surfaces. All muscles showed greater EMG muscle activity at the top 2 position than at the top 1 position. Researchers observed trembling of both arms of some subjects while holding the top 2 position. This might be due to muscle fatigue or residual muscle activation. The combination of using unstable surfaces with resistance exercises, such as a push up, may provide a greater challenge than performing a standard push up.

3. Conclusions

This study showed a significant increase in EMG muscle activity during the bench push up compared to the BOSU® pushup, contradicting the finding of previous research [4]. Female anatomy and physiology (including varying muscle bulk and strength), the use of a BOSU® instead of a Swiss ball, varying hand placement for each participant, and not incorporating manual resistance may have resulted in differences seen in this study as compared to other studies. In a physical therapy clinic, the current study's findings support using a bench push up to elicit greater EMG muscle activity as part of a strength training program for female patients.

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Figure. The push up done on 3 surfaces with 3 positions. Left:standard push up, top 1 position. Middle:Bench push up, down position. Right: BOSU push up, top 2 position