How to normalize electromyography signal in low back pain workers performing manual handling tasks— a systematic review

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1. Introduction
For the correct interpretation of electromyographic (EMG) signals, it is important to normalize data through a reference contraction of the same muscle. Typically, the EMG signals are normalized by a maximal voluntary contraction (MVC) in healthy subjects. However, it is likely that symptomatic subjects cannot perform maximum effort. There is no consensus about the most appropriate method of normalization for this population. Thus, the purpose of this systematic review was to identify the methods used to normalize EMG in low back pain workers performing manual handling tasks.

2. Method
An electronic search was performed in Scielo, Cinahl, Embase, Lilacs, Pedro, Pubmed/Medline, Scopus, Web of Science, Science Direct e Cochrane (Central). Keywords were combined in the following string: (“Low Back” OR “Lower Back”) AND (“Lifting” OR “Handling strategies” OR “Manual material handling” OR “Manual handling”) AND (“Electromyography” OR “EMG”). No filter was applied and the last search was performed at March, 2014. Two independent reviewers selected the studies by reading titles, abstracts and, if necessary, the complete text. The inclusion criteria were primary studies that assessed the EMG of the low back during manual handling tasks in symptomatic subjects. The exclusion criteria were studies that did not assess symptomatic subjects, low back muscles and manual handling of boxes.

3. Results
1,565 studies were retrieved, being 1,078 duplicates between databases. The remaining 149 papers were read and 10 studies were included. Studies were published between 1990 and 2013. The sample size varied between 12 and 123 subjects. Two studies assessed only males. All studies evaluated both symptomatic and asymptomatic individuals. Eight studies did not describe the type of work the subjects are used to do, one evaluated office workers and other one evaluated workers returning from sickness absence. The manual handling task protocol was very different through the studies. The duration of the task was not described by 5 studies, and varied between 5 seconds to 30 minutes in the other studies. The weight lifted varied from 4 to 12 kilograms. The box features were described in 5 studies. The initial and final heights were described in 7 studies. Three studies performed a task with trunk rotation. The repetition/velocity information was described in 6 studies. The normalization method adopted for the majority of the studies (n=5) was the submaximal contraction. Four of these studies, used a procedure to estimate the maximal contraction value from the submaximal one. The other one performed MVCs. Other 2 studies did not perform a reference
contraction. Authors controlled, instead, the factors that influence the EMG signal (skin thickness, room temperature, distance between the electrodes, electrode placement). One study used the maximal value obtained in the task as reference; one used the mean value of the signal and one did not describe any normalization method.

4. Discussion

The results showed that submaximal contraction was the most used method to normalize electromyography of low back muscles in symptomatic workers performing manual material handling task. Besides this, if a reference contraction will not be used, care must be taken in order to control the factors that may influence the signal. MVC is not recommended for symptomatic subjects, since its execution may exacerbate symptoms, and it was not used in the majority of the identified studies. The use of the mean value or maximal task value decreases the variability between subjects (Burden, 2010), so must be used carefully. Thus, the recommendation for studies evaluating manual handling tasks in laboratory is that the protocol features must be detailed described in order to allow the comparison between studies.

References

BURDEN A. How should we normalize electromyograms obtained from healthy participants? What we have learned from over 25 years of research. Journal of Electromyography and Kinesiology 20:1023-1035, 2010.