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Koenig I[1], Blasimann A[1], Hauswirth A[1], Eichelberger P[1], Baeyens J[2], Radlinger L[1]
1. *Bern University of Applied Sciences,* ***2.*** *Vrije Universiteit Brussel*

WAVELET ANALYSIS OF MUSCLE ACTIVITY OF LOWER EXTREMITIES WHILE WALKING OR RUNNING AND PELVIC FLOOR MUSCLES IN WOMEN: A SYSTEMATIC REVIEW

Hypothesis / aims of study

Urinary continence requires strong and rapid pelvic floor muscle (PFM) contractions. PFM must be able to contract reflexively given that sneezing and coughing provoke an expeditious intra-abdominal increase in pressure, whereupon PFM must react [1]. Furthermore, reflex activity is also needed during whole body movements with a high impact load such as running or jumping. Consequently, a better understanding of type I and type II muscle fiber recruitment would support the understanding of how PFM function and dysfunction contribute to continence and incontinence, respectively. PFM electromyography (EMG) is a commonly used method to assess PFM function [2]. Conventional EMG analysis of rectified signals or root mean squared values provide information about timing and intensity of muscle activity without considering frequency components. The gain of a wavelet approach is to provide simultaneous information in the domains of time, frequency and magnitude [3]. Therefore, type I and type II muscle fiber recruitment can be discriminated at a given time. This systematic literature review regarding wavelet functions to analyze EMG muscle activity patterns of the lower extremity (or PFM if available) during walking or running will help to find an appropriate wavelet application to analyze PFM EMG patterns derived from women performing dynamic impact activities in further studies.

Study design, materials and methods

Design

The composition of this systematic review was based on the PICO model and the PRISMA checklist, published in the international prospective register of systematic reviews (PROSPERO) with the identification number CRD42016035986.

Search strategy

The electronic databases PubMed/MEDLINE, EMBASE, CINAHL, Cochrane Library, PEDRO, SURF, Art Source, Business Source Premier, Green File, Health Source and Google Scholar were systematically searched with the search terms ((wavelet AND running) OR (wavelet AND walking) OR (wavelet AND gait) OR (wavelet AND pelvic floor)) AND ((wavelet AND electromyography) OR (wavelet AND EMG)). Additionally, congress proceedings from the International Continence Society (ICS) and the International Urogynecological Association (IUGA) as well as reference lists were scanned. The languages were restricted to English, German, French, Italian, Spanish and Dutch. All study designs were included, except systematic reviews.

Data extraction

Two investigators screened all titles, abstracts and full texts independently for eligibility. In case of disagreement, discussion took place until consensus was achieved. The quality of the included studies and the risk of bias was analyzed with “The Cochrane Collaboration`s tool for assessing risk of bias”. The following data were extracted: Characteristics of the subjects, diagnosis, characteristics of the intervention and the control group (if present), duration of intervention, outcomes including measures and variables and wavelet specifications.

Results

The selection of studies is presented in the study flow diagram (Figure 1). 20 studies investigating EMG activity patterns of the lower extremities suggested the use of a discrete wavelet transform (DWT) analysis. Analyzing muscles of the lower extremities while walking or running, non-linearly scaled wavelets showed good results to discriminate between healthy and different non-healthy conditions. Although wavelet analysis is well established in the field of biomechanics, only two conference proceedings were found analyzing PFM EMG with wavelets. One method was evaluated for the discrimination of healthy women and women with weak PFM performing four maximal voluntary PFM contractions on two different days, based on dyadic discrete wavelet decomposition of EMG.

Interpretation of results

EMG signals of muscle activity of the lower extremities and also PFM measured during dynamic whole body movements have a typically non-stationary nature since the magnitude, the direction of force application and body posture change continuously. Therefore, a DWT approach is also appropriate for PFM EMG analysis. Furthermore, DWT reflects signal components related to activities of slow type I fibers and fast type II firing rate fibers on different scales. This information is needed to support the understanding of how PFM dysfunction contributes to incontinence.

Concluding message

Although DWT is often used to analyze gait data of the lower extremities and although the relevance for women suffering from stress urinary incontinence is high, there are no existing studies analyzing PFM EMG patterns from activities of daily life such as walking or running with a wavelet approach. Therefore, it is an important task for future studies.

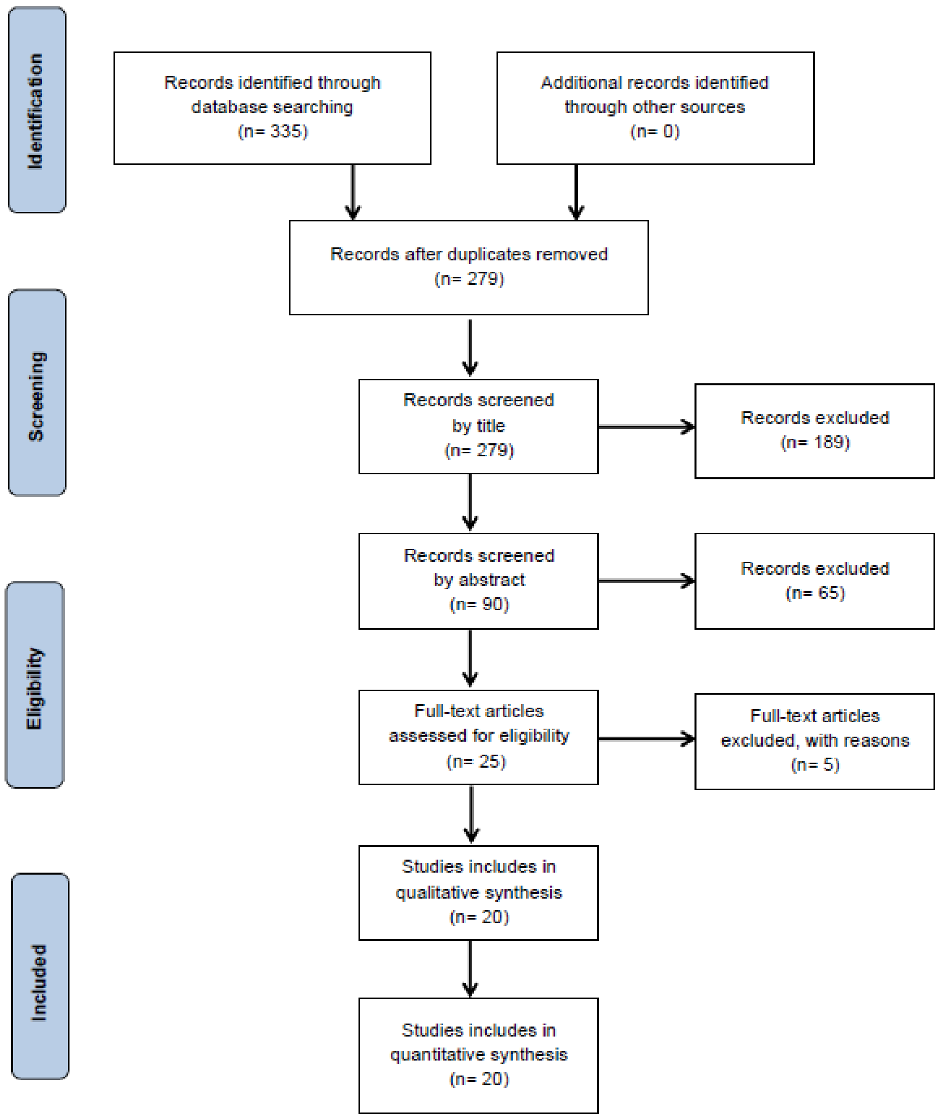

Figure 1: PRISMA flow diagram

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