Mobile application to increase consciousness and strengthening of the pelvic floor muscles

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ABSTRACT

This research included the development of a computer interface for capturing electromyography signals via Bluetooth enabling the transmission of data to mobile devices combined with a specific virtual gaming application to investigate the biomechanical characteristics of the pelvic floor muscles. The capture of data is performed via electrodes placed at specific anatomic pelvic floor sites. The game was designed based on the evidence available on consciousness and strengthening of the pelvic floor muscles, in addition to coordinating training of the muscles at different levels of demand, according to each user.

1. INTRODUCTION

The successful treatment of pelvic floor disorders depends on the disorder severity, anatomical and nerve integrity, as well as the type of training, motivation and patient adherence to therapy (Ferreira & Santos, 2011).

Therefore, it is necessary to develop strategies that increase motivation and patient compliance. In this context, Virtual Reality (VR) is presented as an alternative that can enhance motivation and adherence of individuals, allowing the creation of different scenarios and contexts with a computerized interface in real-time (Adamovich et al., 2009; Bruin, et al., 2010; Levac & Galvin, 2013).

VR systems can include smartphones and tablets which enable the introduction of a new concept: "mobile health" or mHealth. The World Health Organization (WHO) defines mHealth as health practice mediated by mobile devices (Kay, 2011). There are publications about some applications for smartphones and tablets in order to promote rehabilitation (Chan et al., 2011; How et al., 2013; Krpic et al., 2013).

Specific mobile apps can also be found focused on urogynecological needs of women, as is the application "Tät". This application aims to treat urinary incontinence (UI). It has information about the UI, guidance on lifestyle and instructions for an exercise program for pelvic floor muscles that involves visual and audible commands, plus the opportunity to set reminders for carrying on such training (Asklund et al., 2014; Asklund et al., 2015). However, the current devices provide only a series of exercises, without presenting any tool to assess whether the exercise is being done properly and not monitoring the activity by the therapist.

In summary, this study aimed to develop a virtual game for training and consciousness of the pelvic floor muscles, inserted in a mobile application for the Android operating system devices. The proposal is that the virtual game allows patients to play during activities, interacting and controlling through instant feedback of what is being done, given by electromyography (EMG) surface and the transmission of electromyography signal through Bluetooth technology.

2. MATERIALS AND METHODS

This research included the development of a device, a computer interface for capturing electromyographic signals Bluetooth connection enabling data transmission to mobile devices (smartphones and tablets) Android operating system. In combination with a specific virtual gaming application to investigate the physiological and biomechanical characteristics of the pelvic floor muscles.

A portable system was developed that includes hardware and software capable of acquiring EMG signals for Android operating system. The hardware consisted of a board with an electronic circuit that acquire, conditions and transmits the electromyography signal via Bluetooth to mobile devices operating on Android. This equipment works as a central processor, storing the acquired user data and generating graphs and reports with the EMG signal. The device was projected with two channels to make possible the data acquisition through intravaginal probe or surface electrodes adhered to the perineum. Moreover, the electromyographic data were processed by mobile application game software developed specifically for the pelvic floor muscles.

The game was designed based on the evidence available on consciousness and strengthening of the pelvic floor muscles, considering the involvement of the fast twitch muscle fibers and slow twitch muscle fibers. Perineal exercise protocols with evidence in the literature involve contractions lasting from 1 to 4 seconds to fast muscle fibers and 4 to 10 seconds for slow twitch muscle fibers. Furthermore, it is recommended a ratio between contraction and relaxation of 1:2 for fast muscle fibers and 1:1 for slow muscle fibers. (American College of Sports Medicine, 1990; Morkved et al., 2003; Dumoulin et al., 2014; Ayeleke et al., 2015). In addition to respecting these peculiarities, the game was designed to respect the muscular capacity of each application user at different levels of demand.

The idea was to develop an interactive game mechanics in two dimensions (2D), the line definition of art and game interface, the integration between the device and the game and the version of the application generation game designed for mobile devices that operate on the Android system.

3. RESULTS

A portable system was developed including a hardware and software capable of acquiring EMG signals Android operating system devices. Data was obtained through electrodes placed on the pelvic floor, with two options for use: intravaginal probe and one pair of surface electrodes in three and nine o'clock position of the perianal region (Kirby et al., 2011).

Data was paired with the mobile application MyoPelvic, which was designed to be self-explanatory and intuitive. The MyoPelvic allows user registration, as well as provide write and visual information about the placement of electromyographic sensors. The user can choose the type of sensor to be used (internal or external) and when the user try to start a game, from the home screen, the application seeks the developed device and connects to it via Bluetooth. After connection, a screen appears that allows the user access to the tutorial that teaches you how to play the proposed game and offers two game modes: one mode to work fast muscle fibers and a way to work slow twitch muscle fibers. Before the game starts, the application provides a calibration moment. It consists in verify the signal characteristics of the user during both rest and contraction. The calibration also allows to check the sustained time of the contraction that the individual is able to perform.

The concept of the game was inspired by the mountain biking (uphill/downhill) and consists of a mechanical 2D platform where the user controls a cyclist who needs to travel as far as possible on a route up and down the mountains (Figure 1). The game consists of terrain undulations that must be transposed by the rider via the user input contraction. In both modes, the person who is playing must contract and maintain the contraction of the pelvic floor muscles until the rider can reach the top of the mountain, where there is a flag. As he passed the flag, the participant must relax the muscles that were contracting so that the cyclist can go down the mountain. The relaxation should last until the end of the descent, where there is another flag. The passage by the flag at the end of the descent indicates that the woman should contract the muscles again so that the cyclist can climb the next mountain, starting a new cycle of contraction / relaxation.

It is important to emphasize that the mountain ascent time is the time that the user was able to maintain the contraction during calibration and the down time will depend on the game mode. If the game mode is for fast fibers, the time of descent (rest) will be twice the time of contraction and if the game is to work slow fibers, rest time is set for the same time of contraction.

Game modes use the "perina" as a scoring system. The "Perina" are achieved during contractions of the pelvic floor muscles, which are equivalent to higher mountains. The amount of "Perinas" obtained by each user depends of the contraction time (more time, more Perinas) and the amount of mountains covered by the cyclist, i.e., the number of contractions.

The successful ascending mountain is provided by maintaining the force contraction during a certain period of time, both established during calibration. It was established that the failure was given by a decrease of more than 50% of the strength and leads the user to the end of the game. If there was no loss of strength during the match, the end was determined by passing the cyclist for twelve mountains, which corresponds to 12 full contractions.

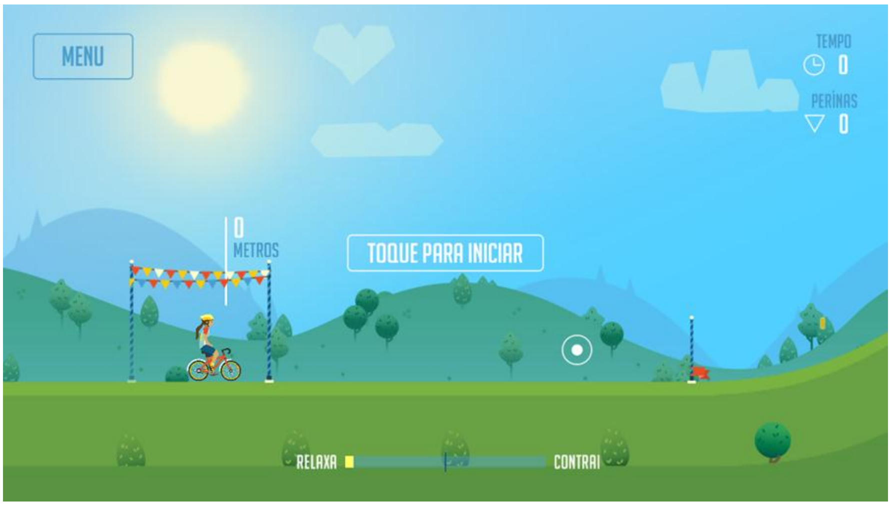

Figure 1. *Myopelvic application.*

In addition, it has a settings screen that enables the exchange of users and sending the history of the final matches information by email.

4. DISCUSSION

The developed game application was named MyoPelvic and has a game mode for the fast muscle fibers and another for slow muscle fibers. Both game modes involve the control by perineal contractions of a cyclist on a road that goes up and down in mountains. It works responding to variations of electromyography data received during times of contraction and relaxation of the pelvic floor muscles.

Searches on major scientific health databases have shown that there are no similar systems to the one developed on this study. However, there are two articles (Asklund et al, 2015; Nystrom et al, 2015) written about an application called "Tat", developed in Sweden. But this application, although has been an effective tool and easily accessible (Asklund et al, 2015,. Nystrom et al, 2015), has only informational purposes and does not provide the user with a reliable feedback of what is being done.

Advanced searches for major mobile application stores has shown that there is a range of applications such as Kegel Exercises, Kegel Trainer, MaxKegel, Pelvic Floor Exercises and Kegel, EjerciciosKegel and Kegel Bootcamp. The main purpose of these applications is to assist the training of the pelvic floor muscles through exercises proposed series. However, these applications seem to have the same weakness as the previous applications found: they do not provide the feedback to the user about the proposed exercises.

Given this gap, some products have been launched in the market by offering feedback to pelvic floor exercises performed in the integrated mobile application systems. They are: Kgoal, Elvie, Skea - Smart Kegel Exercise Aid and Magic Kegel. All these products have a hardware and software system, which involves a silicon device, designed to be inserted into the vaginal canal, and a mobile application. Nevertheless, the information available on these devices are still superficial and commercially based, without evidence that exercise protocols respect the particularities of the pelvic floor muscles and the characteristics of each individual who use these systems. In this context, the MyoPelvic application stands out as a new virtual game based on current scientific evidence on strengthening and awareness of the pelvic floor muscles.

Another important aspect to be considered is related to the difference between the sensors used. While MyoPelvic responds to signals from electromyographic sensors positioned in the perineum, the various systems on the market use intravaginal pressure sensors. However, since the intravaginal pressure is influenced by the activity of the abdominal muscles (Madill & McLean, 2006), the feedback promoted by pressure systems may overestimate the quality of contractions of the pelvic floor muscles and reduce the specificity of the muscles involved in the exercise.

It stands out also that the MyoPelvic application involves capturing electromyographic signal, considered more refined than the pressure signal for enabling the extraction of different important data such as RMS and frequency parameters. Therefore, the developed system appears as a prototype to be improved, but has the potential to further assist the treatment of patients with pelvic floor dysfunction by providing the electromyographic data to the therapist.

The lack of studies comparing different devices systems such as MyoPelvic prevents the development of discussions to a higher level that points advantage between systems. New research studies are suggested to gather the user satisfaction and to evaluate the usability of the MyoPelvic. It also suggests the development of clinical trials to test the efficacy of system utilization in populations with different disorders of the pelvic floor and to test the effectiveness of the MyoPelvic as a telerehabilitation tool.

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