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THE USE OF *COREHAB RIABLO* MEDICAL SOFTWARE IN PRIMARY KINETIC PROPHYLAXIS

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Abstract: *Sedentarism is a very actual problem in our society, and it has an increasing rate because of the comfort that technology gives us. It can cause many health issues, starting with obesity and continuing with diabetes, hypertension, dyslipidaemia, cancer, osteoporosis, musculoskeletal diseases, depression and cognitive function disorders. The objective of this study was to test the CoRehab software, which uses interactive games developed for each exercise and prove its efficiency in prophylactic programs. The system uses motion tracking to control the games. The hardware consists of 5 motion tracking sensors, a stabiliser platform and a notebook with the preinstalled software. Between the tests, we followed a prophylactic training program. Results: The scores of the second test in the daily score and precision categories were more miniature at 1.3%, but the values for stability and accuracy were more significant, with 11.5% and 10.5%. So, the program maintained a training level in 2 categories and improved it in the other two categories. Conclusion: Implementing this system in the kinetic prophylactic training programs could increase their efficiency, and it would help to follow the evolution of the subjects using it more accessible.*

Key words: *CoRehab; medical technology, prophylaxis.*

1. Introduction

Sedentarism and a sedentary lifestyle are among the most significant problems today, causing other pathological conditions such as obesity, diabetes, hypertension, atherosclerosis and other ischemic cardiovascular diseases.

An article shows us a close connection between a sedentary lifestyle and the incidence of various disorders. Including cardiovascular diseases, metabolic diseases, osteoporosis, cancer and premature mortality in people who do not have enough physical activity during the day; and spending too much time sitting

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or lying down at work, school or even at home, having an energy consumption of 1.5 METs or less [26].

It has been shown that sitting for 4 hours a day while awake can shut down the activity of genes that regulate the amount of fat and glucose in the body. Thus, disorders and diseases can occur in the body, such as type 2 diabetes. Specialists believe that a sedentary lifestyle can be more dangerous for the body than alcohol and tobacco.

Among the diseases caused by the sedentary lifestyle and its harmful effects, we find the following [28]: Diabetes, Hypertension, Dyslipidaemia, Obesity, Osteoporosis, Musculoskeletal diseases and Depression [1], [2], [5], [6], [12], [13], [14], [18], [36].

A comprehensive review indicated that certain research [10], [24] found significant changes in cognition, whereas other studies [21] found no changes in cognitive performance.

Software programs and systems used in physical therapy

Emerging technology has a complicated function in sedentary behaviour, comparable to a two-sided sword. On the one hand, some technologies, such as consoles and computer video games, have contributed to the pandemic of physical inactivity and sedentary behaviour. On the other hand, new and innovative technologies have been employed more often to encourage people to engage in physical activity and improve their health [4], [33]. For example, emerging technologies such as mobile phone applications, wearable health monitoring devices, video games requiring physical activity and social media have been used for health promotion [8], [15], [20], [30], [32], [37]. As technology becomes an ever-present component of daily existence and population-based health programs seek new ways to increase long-term engagement with physical activity, the two are becoming increasingly connected [10].

Quan et al. investigated patterns of physical activity behaviour in first- and second-grade children while exercising through exergaming. The researchers used accelerometers to measure physical activity and examined four random sessions out of twenty-seven exergaming sessions. They found that the average time spent in sedentary activities was 47.2%, followed by light physical activities at 32.9% and moderate or vigorous physical activities at 19.9% in each 30-minute exergaming session. Additionally, it was also shown that there are no gender differences in these physical activities, fully indicating that exergaming can be a reasonable means to promote light and moderately-intense physical exercises among children of both sexes [28].

Ye et al. investigated the effects of a combined physical education and exergaming program on children's motor skills, expressly object manipulation and locomotor skills, physical fitness and health status, compared to traditional physical education programs. While children in the control group following the traditional physical education program showed a significantly higher cardiorespiratory fitness than those in the other group, the decrease in body mass index (BMI) and the mean age of the research group's children was considerably different from the increased BMI of children in the traditional group [35].

Pope et al. investigated the effectiveness of a 10-week involvement through a smartwatch and social media on the health status of breast cancer survivors [27].

Harris and Chen investigated, using Fitbit, the effect of a four-week recess period in which physical activity was performed during breaks on the cardiovascular fitness and real-time physical activity of fifth-grade children. Students were placed in one of the three following groups: Fitbit-O: wear Fitbit as a self-monitoring accessory; Physical activities participating in the Fitbit plus Brain challenge (PAEB-C): wear the Fitbit and additionally participate in a daily 6-minute physical activity break during each class, and a control group. The results showed that the PAEB-C group had significantly more real-time steps and time spent in physical activities than the Fitbit-O group. Also, the PAEB-C group's fitness levels were significantly different from the control group's, and the Fitbit-O group's fitness levels were significantly different from the control group's. Yet, the PAEB-C and Fitbit-O groups showed no discernible dissimilarities [3].

Munro et al. [25] designed an augmented reality game to provide a chance for neurorehabilitation at home for children with cerebral palsy. Electrodes for electromyography and acceleration sensors make up the system. in an armband to provide information. For each possible outcome, a trained classifier wills ultimately or not the arm achieves the target neuromotor performance, and the user moves a virtual object according to the movements prescribed by the therapist. Virtual reality also helps physical rehabilitation patients see themselves engaging in uncomplicated motions. It is believed that immersion in virtual reality, combined with the visualisation of patients, can create brain patterns more closely related to motor skills than visualisation alone. This gives patients a significant advantage in recovery [29].

Another study used sEMG sensors and accelerometers in a wearable application paired with a game-based training system and a user feedback system, presenting system performance results, game experience, and training effects [19].

However, the one long-term research that was considered for inclusion in this analysis revealed that both a less sedentary lifestyle and a less sedentary line of work had positive effects on cognitive performance. Incorporating more exercise and less sitting is believed to help improve cognitive functions [9].

2. Materials and methods

2.1. Objective of the research

The objectives of the present study consist of:

—Data collection regarding the CoRehab system;

—Testing the system and determining its advantages and disadvantages;

—Development of a preventive exercise plan.

2.2. Hypothesis of the research

The hypothesis underlying this study is that using the CoRehab (medical solutions based on wearable sensors and interactive software) system in primary prevention, software that uses interactive games and can increase/maintain people's interest in physical activity, thus it becomes a valuable means to promote a healthy lifestyle.

Based on the above statements, the second hypothesis was born, which assumes that the combined system with traditional exercise programs can increase the effectiveness of preventive physical therapy programs and allow better monitoring of results.

2.3. Design of the research

Our study investigates the effectiveness of the CoRehab software program in primary prevention and its potential to become an effective means of promoting physical activity and increasing interest in it. The research was carried out within the Medical and Sports Recovery Center "Kinetica" in Târgu Mureș, which owns the system mentioned above. The period of research was between 26.11.2020 and 09.06.2021.

We conducted the study, and one student from our university and co-author was the subject, wanting to see from the user's perspective the experience offered by the system/software with hardware.

2.4. Applied recovery programs

The CoRehab system is adaptive, consisting of 5 wearable sensors and a stabiliser board that transmits data via Bluetooth to software that provides biofeedback using a video interface. This feedback warns the subject if the exercise is not performed in the correct form so that he can correct his posture. At the end of each meeting, the system prepares a report on the activity of the respective meeting. Thus, allowing physiotherapists to measure subjects' activities and monitor their progress.

This report contains general user data, such as name, gender, year of birth, height, weight and purpose of use. In addition, the report provides a clear explanation of the qualities of precision, stability and accuracy used in it, which have an average score per day represented by the arithmetic mean of the scores achieved within the respective properties and individual scores for each exercise. A daily score is the arithmetic mean of the overall scores achieved in the exercises described below, the number of exercises used in the prophylactic plan, the number of exercises performed and the individual results achieved.

Explanation of the used workouts

The system gives a 5-second break between exercises, and only after this short period can the next exercise begin, but if the subject feels the need for a more extended break, there is also the possibility to start the exercise even later than 5 seconds. The exercises:

Weight Transfer Knee Bent; Weight Lat-Transfer; Stand Hip Abduction/ Abductions of the lower limb from standing; Stand Hip Flexion / Flexions in the hip joint from orthostatic; Romanian Dead Lift; Start Walking; Boost Walking; Calf; Mono Calf and Stand Knee Flexion.

Description of the exercise plan applied between initial and final testing

Considering the circumstances brought on by the COVID-19 epidemic, we have developed an exercise plan that can be easily performed at home, using free exercises, that is, exercises that only use the body weight.

Between exercises, we will have a 1-minute break. The exercises: *Plank; Lateral Plank; Trunk flexion on the pelvis; Flexion of the lower limbs on the pelvis; The imaginary bicycle; Russian twist; Opposite hand and foot; Extensions; Mountain climbers; and Imitation of the swimming motion; Squats; Forward lunges; Lifts on peaks; Flexion of the lower limbs on the pelvis; Side slits; Jumping Jack; Back bends; Splits.*

Centraliser of initial and final test results Table 1

No	Exercises	Overall score		Precision		Stability		Accuracy	
		Initial Test %	**Final Test %**	**Initial Test %**	**Final Test %**	**Initial Test %**	**Final Test %**	**Initial Test %**	**Final Test %**
1	Weight Transfer Knee Bent	78	83	78	83	0	0	100	99
2	Weight Lat-Transfer	80	86	88	93	71	75	67	67
3	Stand Hip Abduction	61	5	74	13	50	66	87	93
4	Stand hip flexion	89	94	92	96	81	91	100	99
5	Romanian Dead Lift	28	19	29	20	0	0	91	92
6	Start Walking	0	78	0	86	0	75	0	85
7	Boost Walking	86	11	98	13	66	95	72	94
8	Calf	59	64	62	69	82	75	100	97
9	Mono Calf	6	47	6	48	96	94	100	98
10	Stand Knee Flexion	63	50	65	56%	89	74	99	91
	Daily averages	**55**	**53.7**	**59**	**57.7**	**53**	**64.5**	**81**	**91.5**

Following the analysis and comparison of the initial and final testing data, we noticed that the results obtained in the final testing were in terms of overall scores and accuracy; in both cases, the results were lower by 1.3%. However, the measured stability and accuracy levels have increased significantly from the initial testing results.

The degree of stability increased by 11.5% compared to the values measured at the beginning of the research, and the accuracy index had an increase of 10.5% compared to the initial scores. For the mathematical analysis of the data, we used the arithmetic mean. By applying this method, we calculated the average of the values of the characteristics used in the activity report, and the results were as follows:

Overall Score: $$\frac{78+83+80+86+61+5+89+94+28+19+0+78+86+11+59+64+6+47+63+50}{20}=54{,}35\%$$

Precision: $$\frac{78+83+88+93+74+13+92+96+29+20+0+86+98+13+62+69+6+48+65+56}{20}=58{,}45\%$$

Stability: $$\frac{0+0+71+75+50+66+81+91+0+0+0+75+66+95+82+75+96+94+89+74}{20}=59\%$$

Accuracy: $$\frac{100+99+67+67+87+93+10+99+91+92+0+85+72+94+10+97+100+98+99+91}{20}=86{,}55\%$$

3. Discussions

No studies similar to this research were found that discussed the use of the CoRehab system in primary kinetic prevention programs. However, a study by Ghanbari Ghoshchi [11] discusses the system's effectiveness within post-stroke neurorehabilitation protocols [11].

The above study involved 50 patients aged 18 to 66 who had a stroke six months ago in 3 neurorehabilitation hospitals in Italy. The patients were divided into a conventional group and a group receiving rehabilitation employing a technology system by probability sampling with the random number table method. Patients in the technology group who were in wheelchairs could not stand up and had more impaired fine motor skills following a rehabilitation program with the SonicHand system.

Weight-bearing systems are frequently used to rehabilitate patients who cannot maintain their balance. To reduce the load on the lower limbs, facilitate movement and provide self-support during walking, a robot was created to assist in the rehabilitation exercises of locomotor dysfunctions at the lower train level [34].

Among these advantages are the following: it provides the chance for ecological validity; stimulus control and consistency; real-time feedback on performance level; independent practice; changes in stimuli and responses, which are conditioned by the physical abilities of the user; a safe testing and training environment; the opportunity for gradual exposure to stimuli; the ability to distract or enhance the user's attention, and perhaps the most essential factor for therapeutic intervention is the motivation for the user [16].

Augmented reality gadgets like Google Glass and mixed reality systems such as HoloLens have been implemented in multiple industrial and business settings, and lately, there is growing interest in their use in healthcare. In order to provide a significantly more immerse experience and to make it possible to interact with holographic objects, these systems have become an increasing amount more complicated. Previously, they relied on the technique of digital information overlaying; now, they use positional tracking and depth sensors. A growing number of studies have reported positive outcomes in rehabilitation using a combination of sensors and interactive gaming or virtual reality environments [17], [31].

In a randomised controlled masked clinical trial investigating 59 stroke survivors, McEwen et al. found that virtual reality exercise interventions for inpatient stroke rehabilitation improved mobility outcomes [23].

Virtual reality and augmented reality technologies have substantial potential to enhance recovery programs and provide real-time feedback to the patient and their therapist. However, there is limited evidence on the long-term effectiveness of these systems and whether they offer sustained improvements over traditional approaches. Alternatively, recent research by Massetti et al. [22] suggests that the virtual reality intervention generated improvements in motor functions, increased community participation, and improved cognitive and psychological functions. As augmented reality and virtual reality system technologies continue to develop, additional clinical studies are needed to build the evidence base demonstrating the utility and effectiveness of these systems for clinical treatment and rehabilitation research [7].

4. Conclusions

The experience of using the system confirms the first hypothesis of the study. By implementing interactive games for each exercise in the system, the audio-visual feedback used and the implementation of activity reports, the software provides a pleasant and fun user experience but at the same time prompts the user to pay attention to the form of the exercise and motivates him to next time he wants to surpass his previous results.

The study's second hypothesis was confirmed by the results obtained in the final testing being close to the results collected during the initial testing and exceeding them. The system met the main objectives of primary kinetic prophylaxis, which are to maintain a training level or increase it.

Following the research, we concluded that we could increase their effectiveness by integrating this system into the primary kinetic prophylaxis programs. In addition, in this way, the evolution of system users can be tracked much more precisely.

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