Journal of Physical Education and Sport ® (JPES), Vol. 22 (issue 7), Art 208, pp. 1652 - 1658, July 2022
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Using Visual Health Information Software to re-educate balance in older adults

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Published online: July 31, 2022
(Accepted for publication July 15, 2022)
DOI:10.7752/jpes.2022.07208

Abstract:
Balance problems in people of third age are one of the most common issues seen by doctors, kinesiotherapists, and occupational therapists, and they are the second main cause of falls, which in turn leads to the main cause of morbidity and disability in older adults. Balance ensures a person's ability to move and be independent. Both fears of falling and previous falls may lead to physical inactivity, accompanied by an additional physical decline and impaired balance, as well as to a high risk of developing a number of lifestyle-related diseases. Kinesiotherapy outcomes, applied in any form, i.e., recovery or prophylactic, invariably lead to an improvement and healing of a disease or to an improvement of health and quality of life. This paper highlights the use of the visual health information tool as a solution to apply physical exercises based on evidence, developing rehabilitation programs to improve balance, allowing for customization of kinetic programs, and monitoring whether the kinetic treatment exercises are effective, with the option to correct/adjust/customize them. In order to assess the effectiveness of this software, we excluded 18 function tests that can be evaluated using the visual health information software to apply the balance assessment scale in specific activities (ABC test), and the results revealed statistically significant improved score in the experimental batch compared with the control batch (F = 94,285 vs. F = 29,682 at a significant threshold $p< 0,001$). The research design involved the use of two batches: an experimental (n=10) and a control (n=10). Both batches comprised of 20 institutionalized patients. We can conclude that the use of both visual health information exercise programs and the visual health information assessment scales are of real benefit to both specialists overseeing the proper carry out of kinetic-like activities, and the study participants, who can perform the set of exercises easily. This can be achieved owing to the fact that the software provides the possibility to assess how the exercise is performed by monitoring graphical descriptions and the over-time effects of the program during the kinesiotherapy sessions.
Key Words: **kinesiotherapy, balance, older adults, visual health information**

Introduction

The onset of balance and stability disorders is around the age of 55-60 years, with a very significant manifestation between 65-75 years old, as a consequence of various types of wear -like phenomena, inducing a geriatric specific pathology. In 2019, over a fifth of the European Union population was over 65 years old, a weight which will keep rising over the next decade. Word Health Organisation includes aging problems among the first five health issues in the world. Regular physical exercise is key to age healthy and independently in antithesis with the sedentary behaviour with which negative effects on health are associated with, along with a high mortality risk (Pechová, J. et el. 2019; Fisher JP, Steele J, Gentil P, et al. 2017).

Balance deficits in older people are a very frequent pathology which, if associated with other pathologic phenomena, will lead to their functional and psycho-intellectual degradation which, in turn, invariably leads to the decrease in the quality of life (Karinkanta, S., Piirtola, M. el al. 2010). Morphological changes occurring on the three systems involved in maintaining balance (vestibular, visual and proprioceptive), as well as deterioration of the musculoskeletal system (by decreasing bone and muscle mass) lead to the older person's decreased ability to maintain their centre of gravity, thus reducing stability, and so the fall risk is a significant one for this age category (Alhasan, H., Hood, V. et al. 2017; Hafström, A., Malmström, E. M. et al. 2016; Hortobágyi T. et al. 2020).

Fall-related injuries among older people are one of the main causes of morbidity, immobility and mortality, and they are also deemed to be a major source of public health problems, given the fact that there is also a high risk for hospitalisation and institutionalisation, with a prolonged recovery period, which leads to lower quality of patients' life and very high costs for the health system (Al-Aama T. 2011; Halvarsson, A., Dohrn, I. M. et al. 2015; **Sherrington C, Tiedemann A. 2015;** Zecevic, A. et al. 2006).

In order to prevent subsequent consequences of such events, it is very important to reduce the fall risk among this population. Sedentary life is a fact which speeds up body function's decrease and has a negative impact on balance control (Thomas, E.et al. 2019). Almost every study researching the fall risk among the

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elderly population highlights the fact that physical activity, and even leisure-like exercises, is an effective method to maintain optimal control of balance and to prevent falls (Fernandez-Arguelles EL. et al 2015).

All these misfortunate circumstances have led to the need for implementation of therapeutic intervention strategies which turned out to be effective in prevention of falls among older people, the most effective approach being the kinetic one. The kinetic strategy aims to improve symptoms and preserve/increase independence in patients with fall deficits, and it is conceived depending on the disease's functional-anatomic-and clinical stage, on comorbidities and related risk factors. The Visual Health Information software is a solution to apply physical exercises based on evidence developing rehabilitation programs to improve balance, monitoring whether the kinetic treatment exercises are effective or not, with the option to correct/adjust/customize them (Dunsky A. 2019; Burcea C.C, Neagoe I.C. et al. 2019).

Material & methods

The purpose of this paper is to present what benefits does the use of Visual Health Information tool have, applied in kinesiotherapy services within nursing homes for the elderly persons, which implies standardizing kinetic exercises applied specifically to the pathology selected, easing keeping of records of exercises done and increases the accuracy of the testing and assessment methods, contributing to the improvement of body's functional status. Assessments done and recorded graphically enable the dynamic monitoring of the recovery process's effectiveness and efficiency.

We thus started from the hypothesis that use of the Visual Health Information tool enables identification of protocols for kinesiotherapeutic programs, easy to monitor, that the patient will apply consciously and systematically.

The research was conducted on a batch of institutionalized subjects over the course of three months. A number of 40 subjects was included in the trial, ages ranging from 64 and 72 years old, who suffered from rheumatological and neurological conditions which mainly affected walking and balance. Research subjects were randomly divided into two groups: experimental group (20 subjects) which underwent a set of Visual Health Information exercises, further to functional tests' assessment done with VHI software, and the control group (20 subjects), which benefited from a classic kinesiotherapeutic treatment. During the research's carry out, both groups benefited from aids, associated to kinetic treatment, provided by the treatment facility: massage, electrotherapy, ultrasounds. Apart from these means, subjects were given the option to perform (voluntarily) physical exercises like walking, and outdoor walks.

With regard to the kinetic program applied to recover/improve balance, it was used as described by the software, but it could also be modified to fit the resources available, conditions present and groups of patients. Even if the kinetic program prepared by the software was modified, this was done based on the theoretical foundation of balance control, basic principles of exercises and increasing difficulties – meaning it always comprised more and more complex exercises, involving both motor tasks, and cognitive ones. By using the Visual Health Information tool, subjects were able to: understand the meaning of functional evaluations' interpretation, thanks to the fact that charts are accompanied by explanation of the score achieved; receive a kinetic intervention plan which can be done outside the kinesiotherapy sessions, under a kinesiotherapists supervision ; compare the results obtained after carrying out the physical exercises program; interpret the results based on the evidence-based standards; keep the results to see how effective the programs underwent are.

Subjects included in the study participated in the programme of activities proposed within the nursing homes, but only those in the experimental group benefited from the programs provided by the VHI software. In order to assess the effects from applying this type of services to improve balance in the institutionalised older persons, we selected the balance assessment scale in specific activities – the ABC test, which consists of a list of daily activities (walking around the house, climbing up or down the stairs etc.) for patients and requires that they specify them, on a scale from 0% to 100%, and to what extent to they believe they will keep their balance in performing the respective activities. A low score equals a low balance level; high score equals a high balance level.

Results

The primary objective of the applied research was to capture the experimental sample's evolution, as compared to the control sample one.

Evaluation of changes recorded between the three tests (initial, intermediate and final tests) features specific statistical procedures.

The ABC test is a test which assesses balance in specific activities (daily activities of the type: walking around the house, climbing up or down the stairs etc.). The score obtained by a patient to this test is indicative of their trust that they will be able to maintain balance in performing the respective activities. Scores obtained are interpreted as follows: low score indicates low balance level and a high score indicates high balance level.

The difference between the values recorded by the "score to the ABC test" variable in the ten successive evaluations was reviewed using the ANOVA test for repeated measures. The test value was statistically significant both for the control group ($F = 29,682$, $p< 0,001$), and for the experimental group ($F = 94,285$, $p<$

0,001). Thus, there were significant differences between the successive tests inside both samples; the subject of interest is now when do such differences occur and how large are they.

Variation of scores between successive tests is detailed below, separately for the two samples.

Difference between successive tests – control sample

The table of descriptive statistics indicators shows an increase in the mean values of the score to the ABC test, from 54,33 in the initial test to 62,50 in the final test; this variation of scores between tests was gradual.

By reference to the standard, mean scores obtained by subjects indicate a moderate balance level for all tests. Patients' confidence level that they will not lose balance when carrying out a series of daily activities is average.

The synthetic table of basic statistics indicators and the Boxplot-like chart presented below are an illustration of the score's evolution in the ABC test between the ten tests for the control sample.

Table 1. Basic statistical indicators – ABC score. Control sample (n= 20)

	Mean	Standard deviation	Minimum	maximum
Initial testing	54,33	15,062	28	79
Intermediate testing	56,97	15,044	31	83
Final testing	62,50	15,520	34	91

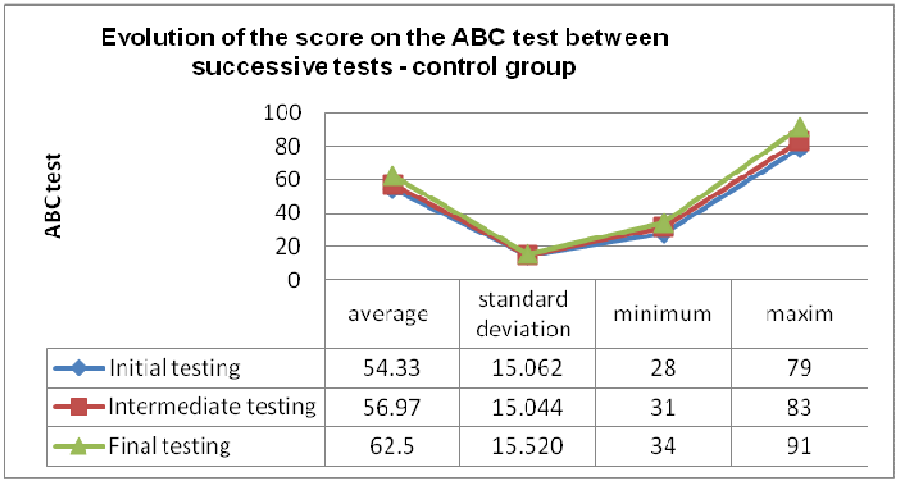


Figure 1. Evolution of the score on the ABC test between successive tests- control sample

The (*Student)* t-test for two pair samples revealed that the difference of scores in the ABC test between successive tests was statistically significant ($p < 0,05$) for all test pairs.

The following table shows the (Student) t-test results for the variable researched.

Table 2. T-test results – ABC score. Control sample (n= 20)

	Differences between pairs		t	p
	mean	std. deviation		
ABC_intermediate 1 - initial	-0,200	0,484	-2,262	0,031
ABC_intermediate 2 - intermediate	-0,833	1,147	-3,979	0,000
ABC_final - intemediate 3	-0,700	0,702	-5,460	0,000

Difference between successive tests- experimental sample

The table of descriptive statistical indicators shows an increase in mean values of the score to the ABC test from 53,37 in the initial testing to 71,03 in the final testing; this variation of scores between successive tests was gradual.

The synthetic table of basic statistics indicators and the Boxplot-like chart presented below are an illustration of the score's evolution in the ABC test between the ten tests for the experimental sample.

Table 3. Basic statistical indicators – ABC score. Experimental sample (n= 20)

	Mean	Standard deviation	Minimum	maximum
Initial testing	53,37	14,245	29	79
Intermediate testing	58,00	14,544	33	85
Final testing	71,03	14,060	50	95

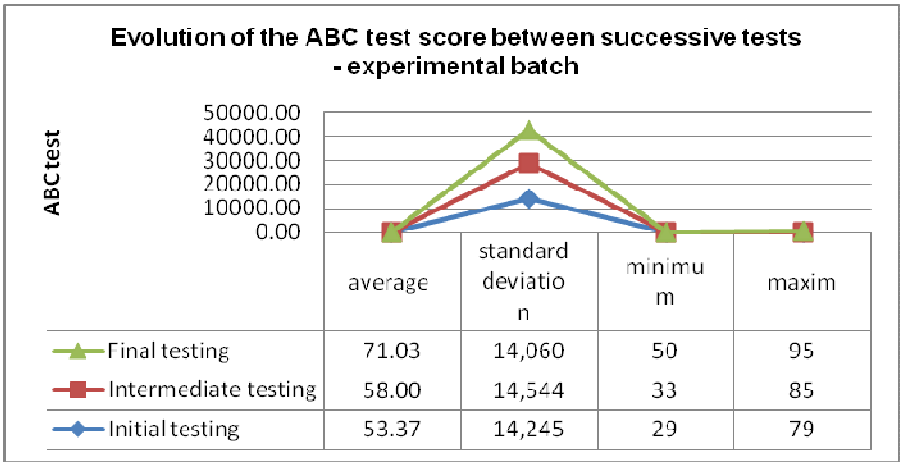


Figure 2. Evolution of the score on the ABC test between successive tests- experimental sample

The (*Student)* t-test for two pair samples revealed that the difference of scores in the ABC test between successive tests was statistically significant ($p < 0,05$) for all test pairs.

The following table shows the (Student) t-test results for the variable researched.

Table 4. T-test results – ABC score. Experimental sample (n= 20)

	Difference between pairs		t	p
	Mean	Std. deviation		
ABC_intermediate 1 - initial	-0,200	0,484	-2,262	0,031
ABC_intermediate 2 - intermediate	-2,733	1,081	-13,854	0,000
ABC_final – intermediate 3	-2,667	1,398	-10,449	0,000

In order to test the differences between the control sample and the experimental one, the (Student) t-test two independent samples was used.

In the initial testing phase, there was no statistically significant difference between the experimental sample and the control one with regard to the "score on the ABC test" variable ($p > 0,05$); As a matter of fact, this was a prerequisite for the study's carry out.

Differences between the two samples, however, were found on the final testing, when the mean for the experimental sample was 71,03, as compared to 62,70 in the control sample.

Tables of the statistical test are presented below – a table of descriptive statistical indicators (presented by comparison for the two samples) and a table of results in the actual statistical test.

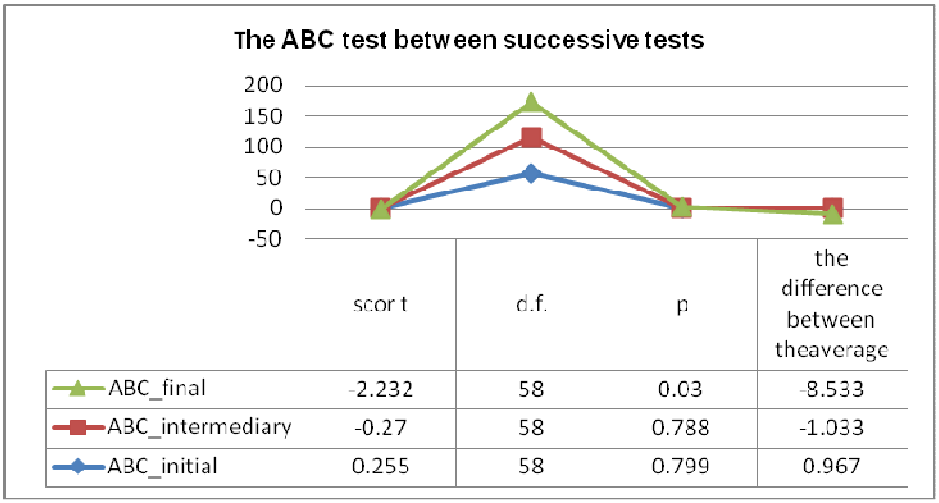
Table 5. Mean values of the score to the ABC test to successive tests

	Sample	Mean	Standard deviation
ABC_initial	control sample	54,33	15,062
	experimental sample	53,37	14,245
ABC_intermediate	control sample	56,97	15,044
	experimental sample	58,00	14,544
ABC_final	control sample	62,50	15,520
	experimental sample	71,03	14,060

Table 6. T-test for two independent samples- ABC score

	T score	d.f.	p	Difference between means
ABC_initial	0,255	58	0,799	0,967
ABC_intermediate	-0,270	58	0,788	-1,033
ABC_final	-2,232	58	0,030	-8,533

The means chart presented below shows the evolution of scores in the ABC test between tests, by comparison of the two samples. The distribution curve has an ascending shape in both samples, equalling an increase in subjective self-confidence in the ability to maintain balance. The distribution curve for the experimental sample is more abrupt in shape, which equals higher progress of the therapeutic plan.



	scor t	d.f.	p	the difference between theaverage
ABC_final	-2.232	58	0.03	-8.533
ABC_intermediary	-0.27	58	0.788	-1.033
ABC_initial	0.255	58	0.799	0.967

Figure 3. Evolution of mean scores' values of the score to the ABC test between successive tests

Discussion

An ongoing concern among the specialists in the field is to review what are the most effective methods to lower the fall risk in the elderly population. Putting kinetoprophylaxis programs into practice on the elderly population do not only prevent diseases, but can also improve symptoms of chronic diseases already existing, can maintain and improve the overall effort capacity (endurance), balance, muscle strength, joint mobility, ensuring them the independence they need in carrying out daily activities (Rabolu E. 2016).

Studies conducted (Lacroix A. et al. 2016; Marques EA et al. 2017; Leiros-Rodriguez R, Garcia-Soidan JL. 2014; Zhao Y. et al. 2017; Chulvi-Medrano I, Colado JC, Pablos C. et al. 2009) showed positive effects on balance, indicating lower fall risk in the elderly population, by application of kinetic programs entailing the use of exercises involving strength training, those with both aerobe, and anaerobe and proprioceptive components.

Also, engaging elderly population in programs entailing visual biofeedback's application turned out to be effective and it could improve their balance, giving subjects continuous real-time feedback to consolidate physical therapy's objectives (Alhasan, H., Hood, V., & Mainwaring, F. 2017; Zouita, S. et al. 2020; Zijlstra A. et al. 2010; Bieryla KA. 2016) and should be deemed as a therapeutic method for the elderly population because it improves weight distribution, stability and efficiency in preventing falls (Kang K. Y. 2013), underlining the fact that additional research should be done to investigate the type, frequency and duration of the visual biofeedback to assess the long-term and short-term effects in order to lower the incidence rates of falls, as well as the fear of falling (Tobaigy, Abdullah & Alshehri, Mansour Abdullah. 2017).

This study showed that the score to the ABC test achieved by the subjects in the control sample ranged between 34 and 91 points (amplitude of 57 points), the mean being 62,50 points (standard deviation: 15,52 points), and the subjects in the experimental sample achieved a score, in the ABC test, ranging between 50 and 95 points (amplitude of 45 points), the mean was 71,03 points (standard deviation: 14.06 points). In both samples, the "*score to the ABC* test" variable shows an approximately normal distribution (the asymmetry index registering very low values in both samples), which indicates a concentration of the distribution values in the average values area.

Conclusions

Medical problems of the institutionalized persons in their third age vary greatly and some patients suffer from more than one disease. Diagnosis review depending on their nosographic class can show that many patients suffer from disorders where walking and balance are impaired (rheumatic or neurological disorders). Outcomes from following a kinetic program were believed to have been beneficial: overall better health, high interest in living, good movement capacity, good carry out of daily activities, good interpersonal relationships, good sleep and proper food appetite.

The VHI tool's use is associated with balance optimization in specific activities (improved score for the experimental sample, F = 94,285, as compared to the control sample F = 29,682 at a significant threshold p< 0,001). The distribution curve's shape is ascending in both samples, equalling an increase in the subjective self-confidence in their ability to maintain balance. The distribution curve is more abrupt in the experimental sample, equalling higher therapeutic progress.

Application of the Visual Health Information exercise programs and the Visual Health Information evaluation scales are of real benefit to both specialists overseeing the proper carry out of kinetic-like activities, and the researched subjects, who can perform the set of exercises easily, thanks to the fact that the software gives the possibility to see how the exercise is performed, and, based on graphical descriptions and also, over time, see the effects of the program during the kinesiotherapy sessions.

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