BALANCE AND PLYOMETRIC TRAINING IN VISUALLY IMPAIRED STUDENTS: RCT IN A ROMANIAN SCHOOL

INTERVENTI DI EQUILIBRIO E PLIOMETRIA IN STUDENTI IPOVEDENTI: RCT IN UNA SCUOLA RUMENA

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ABSTRACT

Balance without visual stimuli impairs vestibular and proprioceptive integration, leading to instability. Comparative studies show deficits on unstable surfaces, though compensatory mechanisms appear with proprioceptive stimulation or plyometric exercises. This study assessed 36 students with visual impairment after 15 weeks of plyometric training, showing improved stability and reduced postural oscillations.

L'equilibrio senza stimoli visivi compromette l'integrazione vestibolare e propriocettiva, portando all'instabilità. Studi comparativi mostrano deficit su superfici instabili, anche se appaiono meccanismi di compensazione con la stimolazione propriocettiva o con esercizi pliometrici. Questo studio ha valutato 36 studenti con disabilità visiva dopo 15 settimane di allenamento pliometrico, mostrando un miglioramento della stabilità e una riduzione delle oscillazioni posturali.

KEYWORDS

visually impaired; balance; balance training; plyometric exercise; adapted physical activity
disabilità visive; equilibrio; pliometria; attività fisica adattata

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Introduction

Sight represents one of the major and most important tools that human beings use to explore and relate to their surroundings. Visual perception and stimuli allow feedback on the environment making safe and autonomous movement possible. People with visual impairment, whether total or severe blindness or reduced visual function, constantly face challenges in activities of daily living or in terms of mobility (Masal et al., 2024). Recent estimates and projections by the World Health Organization (WHO), approximately 285 million people worldwide are affected by visual impairment of which 39 million are totally blind with projections estimating exponential increases, approximately 1-2 million per year, without appropriate interventions (Masal et al., 2024). Considering the developmental age group, in children, sight is fundamental to daily life as it contributes to the development of their functional capacities and essential skills needed for school, such as learning and reading (Choi et al., 2022), but also and above all for their motor and autonomous development.

The lack of vision and sight, or the loss thereof, in addition to having practical consequences such as difficulty recognizing environmental obstacles, has a profound effect on motor control and the development and management of postural balance. Sight, in fact, contributes to sensory integration along with the vestibular and somatosensory systems, processes that are fundamental to the development and maintenance of static and dynamic balance (Bednarczuk et al., 2021; Rogge et al., 2021). To maintain a stable posture or to control locomotion and orientation movements, the brain uses the integration of different stimuli and signals from all sensory channels; for this reason, deprivation of vision, even if temporary, affects the accuracy of movement and its perception (Rogge et al., 2021).

Studies in the literature show that people with visual impairments tend to have deficits in balance and posture control (Zetterlund et al., 2018). The absence of adequate visual feedback affects the quality of walking and posture, thus increasing the risk of falls and making interaction with the environment and the development of autonomy more complex (Carretti et al., 2023). Although visual perception facilitates the control of static balance, information derived only from other somatosensory processes enables the acquisition of motor skills in which sight does not participate, especially those tests of balance and locomotion, which means that children who are blind or have low vision develop alternative strategies to

compensate for the lack of sight early in life (Rutkowska et al., 2015). It could therefore be deduced that the balanced development process of children with visual impairment may be delayed or proceed differently than that of normal peers. Balance in literature is understood as the ability to maintain the center of gravity in the base of support and is characterized by a complex interaction of visual, vestibular and somatosensory information (Bednarczuk et al., 2021). When referring to the dynamic one, the ability to stabilize the body during movement or after external perturbations is meant. The development of correct and effective balance skills is also essential for the achievement of fundamental motor development milestones. Although the absence of visual input during developmental stages may result in abnormal coordination (Walicka-Cuprys et al., 2022) this may also lead to increased concentration when performing motor tasks that require postural control and balance. However, studies conducted on school-age students with visual impairments show that their static and dynamic balance skills are inferior to peers without disabilities (Walicka-Cuprys et al., 2022).
Maintaining balance, whether static or dynamic, is an essential motor skill for everyday life, as seen above, but also from a sports perspective (Ramachandran et al., 2021). The scientific literature presents a multitude of studies supporting the use of specific training programs for the development and improvement of balance. Plyometric exercise, characterized by rapid movements based on the muscle stretch-shortening cycle, has been shown to improve static and dynamic balance ability (Kons et al., 2023). Evidence reports that plyometric training, horizontal or vertical, maximizes the stabilization effect in trained subjects such as young athletes (Granacher and Behm, 2023) and improves the response to perturbations (Moran et al., 2021). The effectiveness of plyometric exercises can also be tested on subjects with sensory impairments such as visual impairments, who can benefit greatly in terms of proprioceptive and neuromuscular stimulation (Moran et al., 2021; Cetin et al., 2023).
Specific balance exercises, on unstable or reduced surfaces or with reduced residual sensory feedback, contribute to improved postural control and balance (Cai et al., 2023). Considering this evidence, the following study aims to investigate the effectiveness of 12 weeks of balance and plyometric training in addition to curricular physical education sessions in a school for visually impaired students in Romania. The results reported are a preliminary phase of the study and report interim tests carried out ten weeks after the start of the program.

Objectives

Based on the existing literature on visually impaired individuals and their needs, the objectives of this study are:

1) To evaluate the effectiveness of a 10-week intervention program based on plyometrics and balance exercises to improve the static balance of students with visual impairment.

2) To evaluate the effectiveness of a 10-week intervention program based on plyometrics and balance exercises to improve the dynamic balance of visually impaired students.

1. Materials and Methods

The study was conducted in the Special School for the Visually Impaired located in Cluj-Napoca, Romania. A total of 35 students took part in the study, divided into a control group (n=17) and an experimental group (n=18). The students ranged in age from 7 to 22 years. Figure 1 represents the distribution of gender and age groups The sample was selected from students attending the Special School for the Visually Impaired in Cluj-Napoca, Romania. Inclusion was based on the availability and prior informed consent already obtained from the school for participation in educational and physical activity programmes. The selection was managed directly by the PE teacher in charge, who identified students with visual impairments willing to participate in the project. Students with additional disabilities (e.g. cognitive or motor impairments) were excluded to keep the focus on the effects of visual impairment alone. All levels and types of visual impairment were included, from low vision to total blindness. After initial selection, students were randomly assigned to the experimental or control group. Each student was anonymised with a unique ID and stratified randomisation by age group was performed with software to ensure a balanced composition of groups by age and reduce developmental bias.

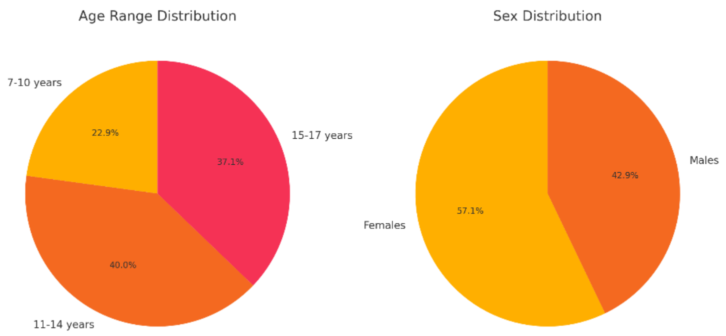

Figure 1. Gender and age distribution

The intervention started during the third week of January and will end in May; therefore, the present data reflect preliminary results. The students attended two physical education sessions per week: a regular curricular lesson and an additional session dedicated to the experimental training programme. The experimental programme consisted of combined plyometric and balance exercises aimed at improving static and dynamic balance skills. The intervention programme included a set of plyometric and balance exercises working on different surfaces, stable and unstable or with reduced surface area and visual residual. The intensity and difficulty of the exercises was progressive and considered the functional level of the participants.

Two instruments were used to assess balance:

- *Balance Board Test*: static balance was measured using a balance board. The final evaluation will be carried out at the end of the complete training programme.
- *BOT-2 Balance Subtest*: the dynamic component of balance was assessed using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Deitz et al., 2007), focusing on specific balance tasks. Components are described in Table 1.

Assessments were conducted at baseline (T0) and after ten weeks of training (T1), providing preliminary data on the effectiveness of the intervention.

Statistical analyses were performed using the statistical software Jamovi, chosen for its user-friendly interface. Descriptive statistics (means and standard deviations) were calculated for all variables. Paired-sample t-tests were conducted to compare scores before and after the intervention (T0 vs T1) within each group. Independent-sample t-tests were used to compare improvements (delta scores) between the experimental and control group. In addition, Pearson correlation coefficients were calculated to assess the relationship between participants' age and changes in balance performance. The significance level was set at $p < 0.05$ for all tests.

Balance subtests	Eyes	Condition for maximum score	Score range
1. Standing with feet apart on a line	Open	10 sec	0-4
2.Walking forward on a line	Open	6 steps	0-4
3.Standing on one leg on a line	Open	10 sec	0-4
4.Standing feet apart on a line	Closed	10 sec	0-4
5.Walking heel to toe on a line	Open	6 steps	0-4
6.Standing on one leg on a line	Closed	10 sec	0-4
7.Standing on one leg on a balance beam	Open	10 sec	0-4
8.Standing heel to toe on a balance beam	Open	10 sec	0-4
9.Standing on one leg on a balance beam	Closed	10 sec	0-5

Table 1. BOT-2 tests and scores

During the 60-minute intervention sessions once a week, carried out with the experimental group that was met in small groups during the week, plyometrics and balance exercises were performed. The exercises included maintaining posture in bipodal, monopodal stance, moving on different surfaces, using surfaces with different materials that provided different perceptions, exercises with large jumps, small jumps, jumps in sequence, jumps from different heights. Tools such as balls, hoops, obstacles were used to increase motor commitment and difficulty. In addition, the exercises were performed with and without shoes to increase the level of proprioception and sensory stimulation.

2. Results

At the initial T0 point, when the initial tests were carried out, both the EG experimental group and the CG control group showed similar levels of performance on the BOT-2 subtests. The mean scores showed slight differences, in terms of higher or lower scores, but were generally comparable.

After ten weeks of intervention, the tests at T1 were performed again. The EG showed significant improvements in the balance exercises, improvements that were smaller or absent in the control group. The descriptive statistics, mean and standard deviation, are shown in Table 2 and 3. The experimental group averages improved exponentially, and the standard deviations decreased, showing an alignment of the subjects in the group. In tests with an increase in task difficulty and the reduction of the sensory component or surface the results were very notable (e.g. T8 avg= 3.94 avg initial=2.22 with a reduction SD = 0.236 from an initial SD = 0.943). Some tests, which were complex, showed a notable improvement in the mean (e.g. Test 9 T1=4.33) but with a standard deviation increased or reduced slightly.

In all tests, the mean increased in the experimental group but what sometimes remains quite high is the SD value which shows that some students made very high progress. However, this says nothing about the goodness of the intervention as much as it does about the subjective response of the students to the intervention itself as well as the presence of very different visual residuals.

The control group showed slight improvements, practising only the curricular PE sessions, but with a high standard deviation showing an improvement of only a few but not of the group.

Descriptives

	Test 1 T0	Test 1 T1	Test 2 T0	Test 2 T1	Test 3 T0	Test 3 T1	Test 4 T0	Test 4 T1	Test 5 T0	Test 5 T1	Test 6 T0	Test 6 T1	Test 7 T0	Test 7 T1	Test 8 T0	Test 8 T1	Test 9 T0	Test 9 T1
N	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18
Mean	3.33	3.89	2.61	3.89	2.44	3.89	2.56	3.89	2.39	3.83	2.33	3.78	2.33	3.67	2.22	3.94	2.22	4.33
Median	4.00	4.00	3.00	4.00	3.00	4.00	3.00	4.00	3.00	4.00	2.00	4.00	2.50	4.00	2.50	4.00	2.50	5.00
Standard deviation	1.03	0.323	0.698	0.323	0.784	0.471	0.705	0.471	0.778	0.514	0.840	0.548	0.840	0.686	0.943	0.236	0.943	1.19

Table 2. BOT-2 mean and standard deviation of EG

Descriptives

	Test 1 T0	Test 1 T1	Test 2 T0	Test 2 T1	Test 3 T0	Test 3 T1	Test 4 T0	Test 4 T1	Test 5 T0	Test 5 T1	Test 6 T0	Test 6 T1	Test 7 T0	Test 7 T1	Test 8 T0	Test 8 T1	Test 9 T0	Test 9 T1
N	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17
Mean	3.00	3.65	2.41	3.65	2.53	3.35	2.47	3.35	2.29	3.06	2.47	3.06	2.00	2.71	1.94	2.82	1.88	2.88
Median	3	4	3	4	2	4	2	4	2	4	2	4	2	3	2	3	2	3
Standard deviation	1.06	0.606	0.795	0.786	0.943	1.11	0.717	1.11	1.05	1.25	1.23	1.14	1.12	1.26	1.20	1.13	1.22	1.62

Table 3. BOT-2 mean and standard deviation of CG

Using the Jamovi software, a paired-samples t-test was performed for the control and experimental group between each of the subtests at T0 and T1. The paired-samples t-tests revealed significant improvements from T0 to T1 with $p < 0.05$ in almost all subtests. The greatest improvements were seen in the tests involving closed eyes or dynamic balance. The control group showed a change but not statistically significant ($p > 0.05$). Table 3 shows the paired t-test values of the individual subtests at T0 and T1.

								95% Confidence Interval				95% Confidence Interval	
			statistic	df	p	Mean difference	SE difference	Lower	Upper		Effect Size	Lower	Upper
Test 1 T0	**Test 1 T1**	**Student's t**	-2.56	17.0	0.020	-0.556	0.217	-1.01	-0.0972	Cohen's d	-0.603	-1.10	-0.0915
Test 2 T0	**Test 2 T1**	**Student's t**	-9.44	17.0	<.001	-1.278	0.135	-1.56	-0.9921	Cohen's d	-2.224	-3.09	-1.3415
Test 3 T0	**Test 3 T1**	**Student's t**	-8.70	17.0	<.001	-1.444	0.166	-1.79	-1.0940	Cohen's d	-2.049	-2.86	-1.2153
Test 4 T0	**Test 4 T1**	**Student's t**	-9.52	17.0	<.001	-1.333	0.140	-1.63	-1.0379	Cohen's d	-2.244	-3.11	-1.3561
Test 5 T0	**Test 5 T1**	**Student's t**	-9.95	17.0	<.001	-1.444	0.145	-1.75	-1.1383	Cohen's d	-2.346	-3.24	-1.4290
Test 6 T0	**Test 6 T1**	**Student's t**	-6.65	17.0	<.001	-1.444	0.217	-1.90	-0.9861	Cohen's d	-1.567	-2.25	-0.8595
Test 7 T0	**Test 7 T1**	**Student's t**	-8.25	17.0	<.001	-1.333	0.162	-1.67	-0.9922	Cohen's d	-1.944	-2.73	-1.1383
Test 8 T0	**Test 8 T1**	**Student's t**	-8.17	17.0	<.001	-1.722	0.211	-2.17	-1.2773	Cohen's d	-1.925	-2.71	-1.1245
Test 9 T0	**Test 9 T1**	**Student's t**	-9.30	17.0	<.001	-2.111	0.227	-2.59	-1.6320	Cohen's d	-2.191	-3.05	-1.3180

Table 4. Paired-samples t-tests of EG

			statistic	df	p	Mean difference	SE difference	95% Confidence Interval Lower	Upper		Effect Size	95% Confidence Interval Lower	Upper
Test 1 T0	**Test 1 T1**	**Student's t**	-3.10	16.0	0.007	-0.647	0.209	-1.090	-0.204	Cohen's d	-0.751	-1.28	-0.201
Test 2 T0	**Test 2 T1**	**Student's t**	-5.64	16.0	<.001	-1.235	0.219	-1.700	-0.771	Cohen's d	-1.367	-2.02	-0.688
Test 3 T0	**Test 3 T1**	**Student's t**	-3.00	16.0	0.008	-0.824	0.274	-1.405	-0.242	Cohen's d	-0.728	-1.26	-0.182
Test 4 T0	**Test 4 T1**	**Student's t**	-3.92	16.0	0.001	-0.882	0.225	-1.359	-0.405	Cohen's d	-0.951	-1.52	-0.364
Test 5 T0	**Test 5 T1**	**Student's t**	-3.79	16.0	0.002	-0.765	0.202	-1.192	-0.337	Cohen's d	-0.920	-1.48	-0.339
Test 6 T0	**Test 6 T1**	**Student's t**	-3.05	16.0	0.008	-0.588	0.193	-0.997	-0.179	Cohen's d	-0.740	-1.27	-0.192
Test 7 T0	**Test 7 T1**	**Student's t**	-3.77	16.0	0.002	-0.706	0.187	-1.103	-0.309	Cohen's d	-0.915	-1.47	-0.335
Test 8 T0	**Test 8 T1**	**Student's t**	-3.27	16.0	0.005	-0.882	0.270	-1.454	-0.311	Cohen's d	-0.794	-1.33	-0.237
Test 9 T0	**Test 9 T1**	**Student's t**	-4.41	16.0	<.001	-1.000	0.227	-1.481	-0.519	Cohen's d	-1.069	-1.66	-0.458

Table 5. Paired-samples t-tests of CG

An independent t-test was carried out between the control and experimental group to compare the deltas of EG and CG. The results reveal a pattern in favour of the experimental group, particularly in the more challenging subtests (e.g. eyes closed, monopodalic or on the beam). Significant differences ($p < .05$) are found, as hoped, in tests 5 to 9, in which the experimental group showed higher delta scores than the control group.

In these comparisons, the Cohen's d values ranged from 0.81 to 1.16, indicating a large effect size and thus confirming that the improvements correlated with a positive impact of the plyometrics and balance programme. In tests 1 to 4, variations were found but were not significant and in fact both groups had very similar scores. This suggests that tests in which postural control is less complex, did not have much impact with the intervention or, more likely, were already more accessible to the subjects even without a targeted training protocol.

Test 1 Δ	**Student's t**	0.303	33.0	0.764	0.0915	0.302	-0.523	0.7061	Cohen's d	0.1024	-0.562	0.7650
Test 2 Δ	**Student's t**	-0.167	33.0	0.868	-0.0425	0.254	-0.560	0.4751	Cohen's d	-0.0565	-0.719	0.6069
Test 3 Δ	**Student's t**	-1.961	33.0	0.058	-0.6209	0.317	-1.265	0.0232	Cohen's d	-0.6633	-1.340	0.0232
Test 4 Δ	**Student's t**	-1.723	33.0	0.094	-0.4510	0.262	-0.983	0.0815	Cohen's d	-0.5827	-1.256	0.0990
Test 5 Δ	**Student's t**	-2.760	33.0	0.009	-0.6797	0.246	-1.181	-0.1786	Cohen's d	-0.9333	-1.627	-0.2272
Test 6 Δ	**Student's t**	-2.934	33.0	0.006	-0.8562	0.292	-1.450	-0.2626	Cohen's d	-0.9924	-1.690	-0.2813
Test 7 Δ	**Student's t**	-2.546	33.0	0.016	-0.6275	0.246	-1.129	-0.1260	Cohen's d	-0.8609	-1.549	-0.1606
Test 8 Δ	**Student's t**	-2.469	33.0	0.019	-0.8399	0.340	-1.532	-0.1479	Cohen's d	-0.8351	-1.522	-0.1368
Test 9 Δ	**Student's t**	-3.459	33.0	0.002	-1.1111	0.321	-1.765	-0.4575	Cohen's d	-1.1697	-1.882	-0.4422

Table 6. independent t-test between EG and CG shows increasing results in EG's tests with large effect size in tests 5,6,7,8,9.

Finally, considering the different ages and thus different motor developments, a Pearson correlation analysis was performed between the age of the participants and the delta scores. The analysis revealed no statistically significant associations (p > 0.05). The improvements thus appear to be independent of age and therefore dependent on the goodness of the intervention and the subjective response. Table 4 shows the results of the Pearson correlation.

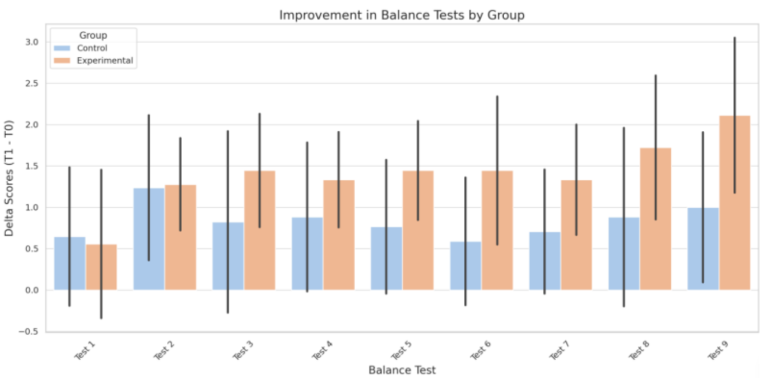

Figure 2. Comparison of mean delta scores (T1-T0) in balance tests between EG and CP. Improvements were generally higher in EG. Error bars represent SD.

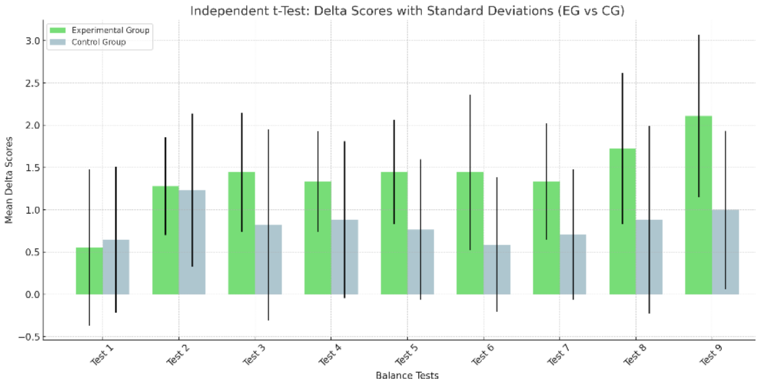

Figure 3. Comparison of mean delta scores (T1-T0) in nine balance tests. EG showed greater improvement, particularly in tests 5 to 9, which involved more demanding dynamic balance tasks.

3. Discussion

Preliminary results of this study showed that the use of a specific training program involving the use of plyometric and balance elements can significantly improve dynamic and static balance skills in visually impaired students. The experimental group in this study (EG) showed greater improvements than the control group (CG), particularly in more complex balance tasks such as those involving reduced sensory feedback or the use of a reduced or more unstable surface in BOT-2. These results are consistent with scientific literature and research showing a positive impact of plyometric training and proprioceptive stimulation in improving postural control and balance in individuals with visual impairment.

The results confirm a positive impact of a 10-week intervention, with a training frequency of once a week, on the balance and postural control of subjects with visual impairment. The use of plyometric and balance elements that utilise the shortening-extension cycle or the reduction of sensory feedback and/or support surface provided statistically significant results as demonstrated by large effect sizes p value < .05. This therefore confirms the two initial objectives.

The first objective was whether plyometric and balance training protocols could improve static balance. The answer is positive considering that improvements were seen in the performance of bipodal and monopodal standing tests. However, tests 1 to 4 did not have large gains but this was influenced by an already accessible initial state. The second objective was aimed at improving dynamic balance and the BOT-2 subtests show exponential growth derived from the use of exercises that exploited the components of balance on different axes and planes and with different surfaces, exploited the use of obstacles and tools that amplified the condition of instability and the complexity of the task.

The greatest improvements in the more challenging tests were therefore expected but mostly in line with the assumptions and initial conditions of the students. The more complex tests are based on the reduction of visual feedback or support surface and these conditions increase instability and dependence on proprioceptive and vestibular signals. In contrast, unexpected but plausible, is the little increase and difference in improvement between the two groups in the initial tests, but because, as already noted, in the initial state the tasks did not present themselves as inaccessible to the students, most of whom retain partial vision. Therefore, there was less room for improvement, which was nonetheless present. The training did, however, lead to significant improvements in postural control, concentration and quality of foot support.

Several factors may have influenced the results obtained. Although the students are all visually disabled, there are individual differences in residual vision, visual field and degree of blindness, as well as different types of correction and age and the state of development of the internal structures. Field observations carried out during the T1 tests revealed a phenomenon that was unusual or at least unexpected to those involved: some students performed better with their eyes closed, a fact repeated in the various test attempts, due to the decrease in visual interference (e.g. shadows) or probably because they had greater internal concentration; others, on the other hand, benefited from visual input depending on the nature of the deficit and residual visual capacity. This highlights the complexity of sensory compensation in the visually impaired population, but especially the strong subjectivity of motor and developmental stages in the visually impaired population.

Another element to consider is that although the initial motor levels appeared almost homogeneous, the developmental directions were highly individualized with highly subjective responses to exercise reflecting different motor learning histories with a different expression in adaptive capacity and basic fitness. Furthermore, although the intervention was administered together, the students belonged to different classes and this meant that the physical education and kinesiotherapy lessons were conducted with different teachers, thus bringing different experiences.

Statistical analyses and the Pearson index do not show any correlation between age and increased performance in exercises, but certainly the size of the age group is a factor that cannot be overlooked in any future research, since large differences can lead to natural neuromotor and coordination differences.

An interesting element for the future directions of this type of research is the possibility of making comparisons with similar populations but of able-bodied students to broaden the possibility of generalizing the results and effectiveness of the same protocols on populations with different conditions.

Despite some limitations of the study, including the small experimental sample size, the results strongly support the effectiveness of plyometric and balance training programs for improving postural control and static and dynamic balance, as well as proprioceptive function in visually impaired students.

These findings have significant educational implications, particularly in the context of inclusive physical education. Improving postural control and balance in students with visual impairments not only improves their motor competence, but also positively influences their sense of autonomy, confidence and engagement in school activities. The results suggest that integrating structured training based on plyometrics and balance into the regular school curriculum can be an effective strategy to support the holistic development of students with special educational needs. Furthermore, as improvements have been observed across the age range without significant correlation with age, the intervention appears adaptable and beneficial for both younger and older students. This flexibility favours the creation of differentiated programmes adapted to different developmental stages, contributing to more inclusive, accessible and meaningful PE experiences.

Future studies should involve larger and more homogeneous samples in terms of age and visual ability, monitor long-term results and extend the interventions to different populations. Furthermore, the results confirm a beneficial effect on students with disabilities with only one session per week, thus opening the possibility of strongly beneficial results with interventions at higher weekly frequencies.

Conclusions

The results of this study confirm that a targeted training programme on plyometrics and balance exercises can significantly improve the static and dynamic balance of students with disabilities, as well as postural control and proprioceptive function. In particular, the 10-week intervention produced clear improvements especially in more complex motor tests that required greater postural control under conditions of instability or reduced sensory feedback.

These data not only support the existing, albeit still limited, literature on the subject, but also highlights the importance of adapted exercises that specifically stimulate proprioceptive and vestibular structures and functions in subjects with visual impairment. The individual differences observed between the students in their response to the interventions underline the value and potential of customized activities and programs that are attentive to the sensory and motor demands of special populations.

Despite some limitations present such as the small sample size and the heterogeneity of some of the students' conditions, the study opens promising future perspectives and directions for the practical application of protocols, but also for future methodological in-depth studies. It will be useful, for example, to extend the sample to include normal subjects or to involve more students and thus increase the comparability of the groups and the possibility of generalizing the results. Finally, the introduction of protocols and interventions that aim to improve motor skills influenced by disability, and in this specific case, to improve balance and postural control, also represents an enormous benefit in terms of autonomy, sense of competence, well-being and self-efficacy. Such progress has a direct impact on the motor aspects of life, but also on those in school. Promoting a motor approach that maintains a high level of physical activity with curricular physical education programs but aims to create personalized interventions for special populations is an effective didactic and educational strategy and a future social investment.

Ethical implications

The interventions carried out and the data collection were authorized by the educational institution. No sensitive data was disclosed nor the identities of those involved. The activities were only carried out in the presence of school staff and with school authorization.

Author contributions

Considering that all authors actively contributed to the study and thus to this contribution, individual attributions are indicated below:
Grosu E, F and Colecchia F, P carried out the introduction and structured the theoretical framework that gave rise to the study. Maniu A, Grosu T, V dealt with the methods and instruments. Guerriero M, A, Maniu E, A, Mayol D and Enachie A, V dealt with the results and statistics analysis. The conclusions and discussion are the result of the work and discussion of the entire group.

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