Proposal for a body balance training program for children through an integrative literature review

Marta de Vargas Romero
https://orcid.org/0000-0002-1780-932X

Helena Bolli Mota
https://orcid.org/0000-0001-9505-0964

Letícia Arruda Nóro
https://orcid.org/0000-0002-4410-5184

Valdete Alves Valentins dos Santos Filha
https://orcid.org/0000-0002-9397-5039

ABSTRACT

Objective: to verify, in the literature, the proposals to rehabilitate the vestibular function, so as to propose a training program for body balance for children.

Methods: this article sought studies that proposed to rehabilitate or train body balance in the Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed) and Scientific Electronic Library Online (SCIELO) databases, in addition to digital sources from Brazilian public universities. As descriptors, the terms “rehabilitation”, “balance” and “child” were used, combined with the Boolean operator AND. The variables analyzed were: public submitted to the intervention, number of subjects and age group, number and frequency of sessions, number and/or time of execution of the exercise, duration of the session and the program.

Results: 17 (60.74%) articles were Brazilian, 14 (50%) used the Cawthorne and Cooksey protocol, 9 (32.14%) studied children, and the majority (67.85%) organized the program in weeks. A body balance training program, stimulating the three body balance systems, consisting of 30-minute sessions twice a week for 7 weeks, totaling 14 sessions, was developed.

Conclusion: the analysis of the variable related to the protocol/strategy to rehabilitate the vestibular function indicated that no study proposed the stimulation of the three body balance systems, with no standardization for children, adults and the elderly. A vestibular function rehabilitation program was developed for children, with stimulation of these three systems, expanding the therapeutic possibilities in this area.

Keywords: Postural Balance; Rehabilitation; Child
INTRODUCTION

Body balance is a complex sensorimotor phenomenon generated by the integration of information from three sensory systems (visual, proprioceptive and vestibular) and processed in the Central Nervous System\(^1\).

Changes in maintaining body balance can cause symptoms such as tinnitus and hearing loss\(^2\). Pediatric vestibular disorders are of great importance in the course of child development, as they can have a series of repercussions, such as delayed motor development and learning, potentially interfering with language, speech, writing and reading\(^3\).

In addition to identifying schoolchildren at risk for otoneurological disorders, and thus minimizing their effects on child development and academic performance, it is urgent to prepare teachers to recognize these complaints in their students. Moreover, parents should be instructed to take their child through a complete otoneurological assessment in the event of complaints of this nature\(^4\).

In the search to remedy or alleviate symptoms related to changes in the vestibular system, researchers sought alternatives for their treatment. There are several forms of treatment for vestibular disorders, especially drugs, surgeries, nutritional guidance, correction of inappropriate habits, psychotherapy and vestibular rehabilitation (VR)\(^5\).

National\(^6,7\) and international\(^8-13\) studies have proposed rehabilitating children from VR, with some proving that this treatment is effective and safe for children\(^8,9\).

The objective of this study was to verify, in the scientific publications, the proposals to rehabilitate the vestibular function, and based on the data from the integrative review, to propose a body balance training program for children.

METHODS

This is an integrative review, of a documental character, whose research took place in the period from March to September 2018.

The first stage was the selection of studies that dealt with VR. The survey was carried out on the Medical Literature Analysis and Retrieval System Online (MEDLINE/PubMed) and Scientific Electronic Library Online (SCIELO) databases, in addition to the virtual sources of public institutions of Higher Education: Federal University of Santa Maria (UFSM), Federal University of Rio Grande do Sul (UFRGS). A total of 3743 studies were obtained, which were repeated in more than one base of papers.

National and international material was searched by combining the following descriptors in English (DeCS), without restriction of period, language or nationality, using the Boolean operator “AND”:
1. Rehabilitation AND vestibular;
2. Balance AND rehabilitation;
3. Rehabilitation AND vestibular AND child.

The inclusion criteria for selecting the material were:
- a) Full text;
- b) Free access;
- c) To present a therapeutic program or strategy to rehabilitate or train vestibular function (unpublished, adapted or replicated).

After the analysis of the studies, those who did not adhere to the theme of that study or who were repeated in more than one database were excluded. Academic works and texts that were not available in full were also excluded. Thus, a total of 28 studies met the inclusion criteria and were used in this study.

The following analysis variables were considered:
- a) Public submitted to the intervention, including the number of subjects and age group;
- b) Number and frequency of intervention sessions;
- c) Number/time of repetitions of the exercise and/or duration of the session;
- d) Total duration of the program.

The data were analyzed descriptively by means of percentage, which were presented by means of Chart.

The second stage of this study was the elaboration of the BB training program aimed at children. For the elaboration, the following were determined: frequency of sessions, duration and/or number of repetition of the activity, session time and period of application of the protocol.

The following domains were determined: activity to be performed, focus (BB system prioritized in that activity specifically), duration and/or number of repetition and material to be used.

LITERATURE REVIEW

Chart 1 shows the selected studies. This Chart includes the authors and country in which was developed, the protocol or rehabilitation strategy or vestibular training used, the audience studied, the number of sessions performed by the researcher and the frequency, the number of repetitions of the
Body balance training

exercises, the duration of the session and the therapeutic program.

As shown in Chart 1, it was found that 17 of the selected studies (60.74%) were carried out in Brazil, with the predominant use of the Cawthorne and Cooksey protocol (50%), both in isolated form (32.15%), as associated with other strategies (17.85%).

Regarding to the public studied, the results indicated that nine (32.14%) of the studies investigated the child/adolescent public, which is also the target public of the present study, and the others (67.86%) dealt with the adult and/or elderly public.

Analyzing the studies presented in Chart 1, the number of sessions showed important variability, starting from a single session (7.14%) to 112 sessions (3.57%), predominantly studies that proposed a variable number of sessions (14.28%). Just a study (3.57%) that did not specify the number of sessions.

As well as the number of sessions scheduled, the frequency of these therapeutic sessions was also variable, ranging from single session (7.14%), through biweekly and monthly (7.14%) to daily (3.57%). Two studies (7.14%) did not specify the frequency of the session. Finally, the periodicity prevalent among the selected studies was two weekly sessions, with nine (32.14%) studies adopting this conduct.

Among the studies dedicated to children present in Chart 1, one study (11.11%) stood out that indicated the exercises were repeated 10 times, while two studies (22.22%) indicated the time between one and three minutes per exercise. Finally, one study (11.11%) indicated both the number of repetitions (three to 10) and the duration (one to two minutes).

Concerning the duration of the session, among the studies in Chart 1 with children’s samples, only three (33.33%) indicated in their methodologies the duration of the session, with estimates varying from 20 to 60 minutes, with an average among the three studies of 41 minutes.

From the detailed analysis of the results in Chart 1, the training program presented in Chart 2 was elaborated. The activity, focus and number of repetitions or execution time were presented, and finally the material used.

Chart 1. Studies selected from a bibliographic survey that proposed to rehabilitate or train vestibular function

| Authors | Country | Protocol | Audience and Age group (in years) | Sessions | Periodicity | Repetition exercise | Duration Session | Duration Program |
|---------|---------|----------|---------------------------------|----------|-------------|---------------------|-----------------|-----------------|
| Bittar et al. (2002) Brazil | Brazil | Cawthorne and Cooksey | 24 children 4 to 15 | 4 | 1st day 15th day 30th day 60th day | 10 | No | 8 weeks |
| Medeiros et al. (2003) Brazil | Brazil | Cawthorne and Cooksey | 10 children 5 to 10 | 4 | 1st day 15th day 30th day 60th day | No | No | 8 weeks |
| Nishino et al. (2005) Brazil | Brazil | Personalized vestibular rehabilitation (including Cawthorne and Cooksey) | 37 adults 21 to 87 | 1 to 15 | Once a week | No | No | No |
| Ribeiro and Pereira (2005) Brazil | Brazil | Cawthorne and Cooksey | 15 elderly 60 to 69 | 27 | 3 times a week From 4 seconds to 2 minutes | 60 minutes | 9 weeks |
| Zanardini et al. (2007) Brazil | Brazil | Cawthorne and Cooksey | 8 elderly 63 to 82 | 112 | Twice a week | No | No | 8 weeks |
| Mantello et al. (2008) Brazil | Brazil | Cawthorne and Cooksey | 40 elderly 60 to 84 | 4 to 8 | Biweekly | No | No | No |
| Patatas et al. (2009) Brazil | Brazil | Personalized vestibular rehabilitation (based on Cawthorne and Cooksey, Herdmann, Davis and O’Leary ) | 22 adults 16 to 87 | Variable | Once a week | No | No | Minimum 6 weeks |
| Rogatto et al. (2010) Brazil | Brazil | Association between sensory integration therapy with protocol of Cawthorne and Cooksey | 1 adult 47 | 10 | Twice a week | 10 | 30 minutes | 10 weeks |
| Mirelman et al. (2011) Israel | Israel | Activities for posture, static and dynamic balance through audio-bio-feedback (ABF System) | 7 adults 59 to 85 | 18 | 3 times a week | No | 45 minutes | 6 weeks |
| Authors Country | Protocol Strategy | Audience and Age group (in years) | Sessions | Periodicity | Repetition exercise | Duration Session | Duration Program |
|-----------------|-------------------|----------------------------------|----------|-------------|---------------------|------------------|------------------|
| Morezetti et al. (2011) Brazil | Exercises de Davis & O’Leary (1994) and UNIFESP standardized vestibular rehabilitation protocol | 20 adults 33 to 88 | 8 | Once a week | 10 | 10 a 45 minutes | No |
| Martini (2012) Brazil | Virtual reality strategy using Wii Fit® da Nintendo | 7 adults 55 to 75 | 10 | Twice a week | 3 to 6 | No | 5 weeks |
| Ricci (2013) Brazil | Cawthorne e Cooksey (conventional) and Cawthorne e Cooksey (modified) | 82 elderly equal or over 65 | 16 | Twice a week | No | 50 minutes | 8 weeks |
| García et al. (2013) Brazil | Vestibular rehabilitation through Balance Rehabilitation Unit (BRU) (experimental group) | 44 adults 18 to 60 | 12 | Twice a week | No | No | 6 weeks |
| Maroni et al. (2013) Italy | Isolated exercises protocol and combined exercise protocol (vestibular rehabilitation assisted by computerized posturography) | 28 elderly mean 74 | 6 | Once a week | 1 minute (isolated exercises) and 2 minutes (with support of posturography) | 30 minutes | 6 weeks |
| Alahmari et al. (2014) USA | Personalized protocol (control) and protocol based on virtual reality | 38 adults 27 to 78 | 6 | Once a week | 4 minutes | 45 a 60 minutes | 6 weeks |
| Leong et al. (2014) USA | Saccadic training through The King-Devick Remediation Software | 76 children mean 6,58 | 18 | 3 times a week | No | 20 minutes | 6 weeks |
| Rocha Junior et al. (2014) Brazil | VertiGO protocol (based on Cawthorne and Cooksey) | 9 elderly equal or over 60 | 30 | Twice a week | 30 to 50 | 50 minutes | 12 weeks |
| Macedo (2014) Brazil | Cawthorne and Cooksey | 36 elderly 65 to 70 | Variable | Twice a week | No | 50 minutes | Minimum 12 and maximum 16 weeks |
| Goulême et al. (2015) France | Estrategy Multitest Equilibre from Framiral | 32 children Mean 9,9 | 1 | Single | Single 3 minutes | 3 minutes | 1 day |
| McCoy et al. (2015) USA | Sensorimotor Training to Affect Balance, Engagement and Learning (STABLE) system (virtual reality) | 22 children 8 to 16 | 1 | Single | 3 blocks 6 minutes | No | 1 day |
| Tsukamoto et al. (2015) Brazil | Personalized protocol - Manual cervical therapy -Exercises for shoulder girdle -Cawthorne and Cooksey -Proprioceptive and balance training | 20 adults 20 to 80 | 12 | Once a week | No | 60 minutes | 12 weeks |
| Ozgen et al. (2016) Turkey | Personalized protocol designed for the study | 40 adults 22 to 60 | 8 | Once a week | Approximately 1 minute | 30 to 45 minutes | 8 weeks |
| Fong et al. (2016) Hong Kong | Protocol based on Movement Assessment Battery for Children Manual – MABC | 88 children mean 7,9 | 24 | Twice a week | 5 to 10 minutes | No | 12 weeks |
| Lofti et al. (2016) Iran | Pediatric balance therapy – PTB | Children 4 to 12 | No | No | 8 to 10 repetitions (1 to 2 minutes) | No | Variable 4 to 10 weeks |
| Manso et al. (2016) Brazil | Cawthorne e Cooksey (control group) and ocular fixation stimulus protocol (experimental group) | 40 adults 23 to 63 | 12 | Twice a week | 1 to 3 minutes | 40 minutes | 6 weeks |
| Jafarlou et al. (2017) Iran | Protocol based on oculomotor tests of vectoelectronystagmography | 50 children 8 to 12 | 16 | Twice a week | No | 60 minutes | 8 weeks |
| Ebrahimi et al. (2017) Iran | Own protocol | 24 children 7 to 12 | 24 | 3 times a week | 1 a 2 minutes | 45 minutes | 8 weeks |
| Longo et al. (2018) Brazil | Cawthorne and Cooksey | 13 adults 42 to 65 | 8 | No | No | 20 minutes | No |

Captions: UNIFESP: Federal University of São Paulo, USA: United States of America.
The results indicated that most studies (67.85%) proposed therapeutic programs organized in weeks, with an average of eight weeks. Still, it was found that four studies (14.28%) did not specify the time required by the therapeutic program, while two studies (10.52%) indicated a single therapeutic session.

**Chart 2.** Body balance training program with the proposed activity, the main focus of each activity, time/repetition and material used

| Activity                                                                 | Focus                  | Time/repetition          | Material                      |
|--------------------------------------------------------------------------|------------------------|--------------------------|-------------------------------|
| To keep feet apart (approximately 10 cm between feet) on a stable base   | Vestibular, Somatosensory, Visual | 1 minute, Repeat 3 times | —                             |
| with open eyes directed at a fixed point on the wall.                    |                        |                          |                               |
| To keep feet apart on a stable base (approximately 10 cm between feet)   | Vestibular, Somatosensory | 1 minute, Repeat 3 times | —                             |
| with closed eyes.                                                        |                        |                          |                               |
| To keep feet together on a stable base with open eyes directed           | Vestibular, Somatosensory, Visual | 1 minute, Repeat 3 times | —                             |
| at a fixed point on the wall.                                            |                        |                          |                               |
| To keep feet together on a stable base with closed eyes.                 | Vestibular, Somatosensory | 1 minute, Repeat 3 times | —                             |
| To walk in a straight line between 2 tapes with 20 cm between them and   | Vestibular, Visual      | To take the round trip    | Blue adhesive tape            |
| 5 m long (in the first free attempt, being able to look at the floor,    |                        | 3 times                   |                               |
| and in the next ones looking at a fixed point on the wall). *            |                        |                          |                               |
| To walk in a straight line between 2 tapes with 20 cm between them and   | Vestibular              | To take the round trip    | Blue adhesive tape            |
| 5 m long with closed eyes *                                               |                        | 3 times                   |                               |
| To look to the right without visual stimulation (only eyes move, the     | Visual                  | Repeat 3 times            | —                             |
| head remains immobile). Stay in position for 10 seconds. Return to the   |                        |                          |                               |
| Center.                                                                  |                        |                          |                               |
| To look to the left without visual stimulation (only eyes move, the      | Visual                  | Repeat 3 times            | —                             |
| head remains immobile). Stay in position for 10 seconds. Return to the   |                        |                          |                               |
| Center.                                                                  |                        |                          |                               |
| To look up without visual stimulation (only eyes move, the head          | Visual                  | Repeat 3 times            | —                             |
| remains immobile). Stay in position for 10 seconds. Return to the center. |                        |                          |                               |
| To look down without visual stimulation (only eyes move, the head        | Visual                  | Repeat 3 times            | —                             |
| remains immobile). Stay in position for 10 seconds. Return to the center. |                        |                          |                               |
| Play: imitation of animals (in group).                                   | Each child was given the |                          | Animal figures: Frog, bird,   |
|                                                                           | figure of 1 animal to    |                          | horse, snake, lion, alligator, |
|                                                                           | imitate. Colleagues      |                          | kangaroo                      |
|                                                                           | should guess.            |                          |                               |

**DAY 2**

| Activity                                                                 | Focus                  | Time/repetition          | Material                      |
|--------------------------------------------------------------------------|------------------------|--------------------------|-------------------------------|
| To keep feet together on a stable base with open eyes directed at a      | Vestibular, Somatosensory, Visual | 1 minute, Repeat 3 times | —                             |
| fixed point on the wall.                                                 |                        |                          |                               |
| To keep feet together on a stable base with closed eyes.                 | Vestibular, Somatosensory | 1 minute, Repeat 3 times | —                             |
| To place the right foot in front of the left on a stable base looking    | Vestibular, Somatosensory, Visual | 1 minute, Repeat 3 times | —                             |
| at a fixed point on the wall.                                            |                        |                          |                               |
| To place the left foot in front of the right on a stable base looking    | Vestibular, Somatosensory, Visual | 1 minute, Repeat 3 times | —                             |
| at a fixed point on the wall.                                            |                        |                          |                               |
| To place the right foot in front of the left on a stable base with      | Vestibular, Somatosensory | 1 minute, Repeat 3 times | —                             |
| closed eyes.                                                             |                        |                          |                               |
| To place the left foot in front of the right on a stable base with      | Vestibular, Somatosensory | 1 minute, Repeat 3 times | —                             |
| closed eyes.                                                             |                        |                          |                               |
| To walk in a straight line between 2 tapes with 15 cm between both and  | Vestibular, Visual      | To take the round trip    | Blue adhesive tape            |
| 5 m long (in the first free attempt, being able to look at the floor,    |                        | 3 times                   |                               |
| and in the next ones looking at a fixed point on the wall). *            |                        |                          |                               |
To walk in a straight line between 2 tapes with 15 cm between both and 5 m long with closed eyes. *

### Vestibular
### Somatosensory
### To take the round trip 3 times
### Blue adhesive tape

To follow object movement (ball) slowly to the right and to the left (movement of the eyes only). Stay in position for 10 seconds and return to the center, moving to the other side. *

### Visual
### To repeat 3 times (round trip)
### Toy bowling ball (black)

To follow up and down object movement (ball) (up and down) (only eyes move, the head remains immobile). Stay in the position for 10 seconds and returns to the center, moving to the other position. *

### Visual
### Repeat 3 times
### Toy bowling ball (black)

### Play: to play with large ball (in group).

#### Reinforce trained movements and postures
- 1. Sitting in a circle, play ball with your hands at random for your colleague.
- 2. Standing, kicking, throw the ball at random to colleagues.
- 3. Standing, throw the ball with your hands at your colleagues, randomly.

### Volleyball

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To place your right foot in front of the left side on the stable base looking at the fixed point on the wall. | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | ——— |
| To place the left foot in front of the right on a stable base looking at a fixed point on the wall. | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | ——— |
| To place the right foot in front of the left on a stable base with closed eyes. | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | ——— |
| To place the left foot in front of the right on a stable base with closed eyes. | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | ——— |
| To stand on a stable and elevated base with both feet supported with open eyes looking at a fixed point on the wall. * | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| To stand on a stable and elevated base with both feet supported with closed eyes. * | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| To walk in a straight line between 2 tapes with 10 cm between the tapes and 5 m long (in the first free attempt, being able to look at the floor, and in the next ones looking at a fixed point on the wall). * | Vestibular Somatosensory Visual | Repeat 3 times round trip | Adhesive tape in blue color (very prominent white floor) |
| To walk in a straight line between 2 tapes with 10 cm between tapes and 5 m long with closed eyes. * | Vestibular Somatosensory Visual | Repeat 3 times round trip | Adhesive tape in blue color (very prominent white floor) |
| To follow object movement (ball) in a circular direction (clockwise) only with eye movement, head remains immobile. * | Visual | Repeat 3 complete spins | Toy bowling ball (black) |
| To follow object movement (ball) in a circular direction (counterclockwise) with eye movement only, head remains immobile. * | Visual | Repeat 3 complete spins | Toy bowling ball (black) |

### Play: play with small ball (in group)

#### Train movements used in the session
- 1. Sitting in a circle, play ball with your hands at random for your colleague;
- 2. Standing, kicking, throw the ball at random to colleagues.
- 3. Standing, throw the ball with your hands at your colleagues, randomly.

### Tennis ball

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To stand on a stable and elevated base with both feet supported with open eyes looking at a fixed point on the wall. * | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| To stand on a stable and elevated base with both feet supported with closed eyes. * | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| Activity | Focus          | Time/repetition | Material                                      |
|----------|----------------|-----------------|-----------------------------------------------|
| To stand with your right foot supported on a stable base, with your left leg bent (foot off the ground), with open eyes looking at a fixed point on the wall. | Vestibular | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| To stand with your left foot supported on a stable base, with your leg bent (foot off the ground), with open eyes looking at a fixed point on the wall. | Vestibular | 1 minute Repeat 3 times | Wooden bench height 22 cm and seat with a diameter of 24 cm |
| To stand with your right foot supported on a stable base, with your leg bent (foot off the floor), with closed eyes. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To stand with left foot supported on a stable base, with leg bent (foot off the ground), with closed eyes. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To walk straight on tape for 5 m in length (in the first free attempt, being able to look at the floor, and in the next ones looking at a fixed point on the wall). | Vestibular | Repeat 3 times round trip | Blue adhesive tape |
| To walk straight on tape for 5 m with closed eyes. | Vestibular | Repeat 5 times round trip | Blue adhesive tape |
| To follow object movement (ball) in a circular direction (clockwise) only with eye movement, head remains immobile. | Visual | Repeat 5 complete spins | Toy bowling ball (black) |
| To follow the movement of the object (ball) in a circular direction (counterclockwise) with only the movement of the eyes, the head remains immobile. | Visual | Repeat 5 complete spins | Toy bowling ball (black) |

**Play: hopscotch (individual).**

| Activity | Focus          | Time/repetition | Material                                      |
|----------|----------------|-----------------|-----------------------------------------------|
| To keep feet apart (approximately 10 cm between feet) on an unstable base with open eyes directed at a fixed point on the wall. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep feet apart (approximately 10 cm between feet) on an unstable base with closed eyes. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To jump with feet together on 5 m long tape (first try you can look at the floor, on the others to look at the fixed point on the wall). | Vestibular | Repeat 3 times round trip | Adhesive tape in blue color (very prominent white floor) |
| To follow with the eyes (child's eye height) the approach and removal of object (ball). | Visual | Repeat 3 times round trip | Toy bowling ball (black) |

| Activity | Focus          | Time/repetition | Material                                      |
|----------|----------------|-----------------|-----------------------------------------------|
| To keep feet together on an unstable base with open eyes directed at a fixed point on the wall. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep feet together on an unstable base with closed eyes. | Vestibular | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To jump over 5m long tape with your right foot, go back with your left foot (first try you can look at the floor, the others try to look at the fixed point on the wall). | Vestibular | Repeat 3 times | Adhesive tape in blue color (very prominent white floor) |
On a stable base, look for a luminous point (laser) in the 4 cardinal points projected on the wall (only with the eyes, the head remains immobile). Order of presentation: right, left, top, bottom, left, right, bottom, top.

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| Play: bowling game | Reinforce trained movements and postures | Each throw tossed the ball 5 times | Bowling game |

### DAY 7

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To keep feet together on an unstable base with open eyes directed at a fixed point on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep feet together on an unstable base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep your right foot in front of your left on an unstable base with your open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep your left foot in front of your left on an unstable base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep right foot in front of the left on an unstable base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep left foot in front of the left on an unstable base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Silicone cushion (measuring 40 cm x 50 cm) |
| To keep your eyes fixed on an object (ball) and turn your head towards NO. | Vestibular Visual | Repeat 3 complete round-trip times | Toy bowling ball (black) |
| To keep staring at object (ball) and turn your head towards YES. | Vestibular Visual | Repeat 3 complete round-trip times | Toy bowling ball (black) |
| Play: bowling game (darts) * | Reinforce trained movements and postures | Each throw tossed the ball 5 times | Target shooting game (darts) |

### DAY 8

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To stand on the unstable, vertically stable, again on the unstable base, keeping your open eyes directed to a fixed point on the wall. ** | Vestibular Somatosensory Visual | Repeat 3 times complete (exit and return to trampoline) | Silicone cushion (measuring 40 cm x 50 cm) |
| To stand on the unstable base, jump on the stable, jump back to the unstable base with your closed eyes. ** | Vestibular Somatosensory | Repeat 3 times complete (exit and return to trampoline) | Silicone pad (measuring 40 cm x 50 cm) |
| To sit on an unstable and elevated base and move your body (feel the elasticity) with your eyes open. * | Vestibular Somatosensory | Stay 1 minute | Trampoline (jump) |
| To sit on an unstable and elevated base and move your body (feel the elasticity) with your closed eyes. * | Vestibular Somatosensory | Stay 1 minute | Trampoline (jump) |
| Standing on the stable base, rotate the body 90° clockwise. Do 4 consecutive spins, completing 360°. Keep your eyes open. | Vestibular Somatosensory Visual | Complete 3 complete spins (respecting individual limits) | ____ |
| To keep your eyes fixed on an object (ball) and turn your head in the direction of MAYBE. | Vestibular Visual | Repeat 3 complete round-trip times | Toy bowling ball (black) |
| Play: target shooting (darts) * | Reinforce trained movements and postures | Each throw tossed the ball 5 times | Target shooting game (darts) |

### DAY 9

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To sit on an unstable and elevated base and move your body (feel the elasticity) with open eyes * | Vestibular Somatosensory Visual | Stay 1 minute | Trampoline (jump) |
| To sit on an unstable and elevated base and move your body (feel the elasticity) with your closed eyes * | Vestibular Somatosensory | Stay 1 minute | Trampoline (jump) |
| Standing with feet apart on an unstable and elevated base with eyes open looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with feet apart on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory | 1 minute Repeat 3 times | Trampoline (jump) |
To follow with eyes (head remains immobile) movement of moving point on the wall (laser) horizontally (child's eye height) unstable and elevated base with closed eyes. **

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| Stand with feet apart on the unstable and elevated base (with your open eyes looking at the fixed point on the wall). ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with feet apart on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with your feet together on an unstable, elevated base, with your open eyes, staring at the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with feet together on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |

To follow with the eyes (head remains immobile) movement of a moving point on the wall (laser) vertically.

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| Stand with feet apart on the unstable and elevated base (wall laser) vertically | Vestibular Somatosensory Visual | 3 repetitions | Laser |
| Stand with feet apart on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 3 repetitions | Laser |

Play: target shooting (darts) *

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| Play: my boss asked | Reinforce trained movements and postures | Each player throws the ball 5 times | Target shooting game (darts) |

### DAY 10

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| Stand with feet apart on the unstable and elevated base (with your open eyes looking at the fixed point on the wall). ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with feet apart on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with your feet together on an unstable, elevated base, with your open eyes, staring at the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| Stand with feet together on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |

To follow with the eyes (the head remains immobile) the movement of a moving point on the wall (laser) in the 8 inverted (horizontal) position in a clockwise direction.

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To follow with the eyes (head remains immobile) movement of a moving point on the wall (laser) vertically. | Vestibular Somatosensory Visual | 3 repetitions | Laser |

To follow with the eyes (head remains immobile) the movement of a moving point on the wall (laser) in the 8 inverted (horizontal) position in a counterclockwise direction.

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To follow with the eyes (head remains immobile) movement of a moving point on the wall (laser) vertically. | Vestibular Somatosensory Visual | 3 repetitions | Laser |

**DAY 11**

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To stand with feet together on an unstable and elevated base with open eyes, looking fixedly on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| To stand with feet together on an unstable and elevated base with closed eyes. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| To jump on an unstable and elevated base (trampoline - jump) with closed eyes. ** | Vestibular Somatosensory Visual | Jump 60 times divided into 3 parts | Trampoline (jump) |
| To jump on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | Jump 60 times divided into 3 parts (20 times each) | Trampoline (jump) |
| To stand with a right foot on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |
| To stand with right foot on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | 1 minute Repeat 3 times | Trampoline (jump) |

On an unstable base keep your eyes fixed on an object (ball) and turn your head in the direction of NO **

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| On an unstable base keep your eyes fixed on an object (ball) and turn your head in the direction of NO ** | Vestibular Somatosensory Visual | Repeat 3 complete round-trip times | Toy bowling ball (black) Silicone cushion |

On an unstable base, keep your eyes fixed on an object (ball) and turn your head in the direction of YES **

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| On an unstable base, keep your eyes fixed on an object (ball) and turn your head in the direction of YES ** | Vestibular Somatosensory Visual | Repeat 3 complete round-trip times | Toy bowling ball (black) |

Play: jump rope

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To jump on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | Jump 60 times divided into 3 parts (20 times each) | Trampoline (jump) |

**DAY 12**

| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To jump on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular Somatosensory Visual | Jump 60 times divided into 3 parts (20 times each) | Trampoline (jump) |

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| Activity | Focus | Time/repetition | Material |
|----------|-------|-----------------|----------|
| To jump on an unstable and elevated base with closed eyes. ** | Vestibular | Jump 60 times divided into 3 parts (20 times each) | Trampoline (jump) |
| To stand with the right foot on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular | 1 minute Repeat 3 times | Trampoline (jump) |
| To stand with the right foot on an unstable and elevated base with open eyes looking at a fixed point on the wall. ** | Vestibular | 1 minute Repeat 3 times | Trampoline (jump) |
| To jump from the unstable and elevated base to the stable base and from the stable base to the unstable and elevated base ** | Vestibular | Repeat 3 times (exit and return to trampoline) | Trampoline (jump) |
| On the unstable base, follow with the eyes (head remains immobile) the movement of a moving point on the wall (laser) in the 8 inverted (horizontal) position in the clockwise direction. ** | Somatosensory | 3 repetitions | Laser |
| On the unstable base, follow with the eyes (the head remains immobile) the movement of a moving point on the wall (laser) in the 8 inverted (horizontal) position in a counterclockwise direction. ** | Somatosensory | 3 repetitions | Laser |
| Play: jump rope | | Reinforce trained movements and postures | Free time | Rope |
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As explained in Chart 2, the three systems of body balance were contemplated, namely: visual, somatosensory and vestibular. These systems were worked on in some activities in isolation and in others simultaneously. In addition to the directed activities, games were proposed to resume the movements or skills stimulated in the directed activity. The directed exercises were progressively increasing the difficulty.

The Cawthorne and Cooksey protocol was adopted as the basis for eye and body movements. However, striving to include the proprioceptive system in the training program, activities were included with some sensory integration strategies (such as staying with and without shoes, on a stable or unstable basis, etc.). The main focus (BB system) was indicated in each activity.

The total number of sessions of the studies shown in Chart 1 was 287 sessions, which divided by the studies that made this specification (23), an average of 16.87 sessions was obtained. For the present program, 14 training sessions were proposed.

It was found the use of repetitions in numbers and in time (isolated or simultaneously) in the selected studies, with values between three and 10 repetitions, and the repetition time between one and three minutes. Therefore, seeking to establish values similar to these, the present program proposes counting the numbers of the exercises (between three and five) and staying between 10 seconds and 1 minute in each exercise.

Among the studies with children’s samples that pointed out the duration of each session in their methodologies (Chart 1), there were times between 20 and 60 minutes. Making the average among all, the value of 41 minutes was obtained. For the present program, a 30-minute session was proposed.

The results showed that most of the studies presented in Chart 1 (67.85%) proposed therapeutic programs organized in weeks, and thus the present program was also organized. The average number of weeks foreseen by these studies was calculated, checking the value of eight weeks. Therefore, the present study organized the body balance training program in seven weeks, staying one week (closing eight) as a technical reserve for possible session recovery.

There was a recurrence of studies addressing the VR in Brazil, given the high percentage of Brazilian studies on the subject. However, this context seems to be restricted to universities, still in the field of research, because in a systematic review on the effectiveness of vestibular rehabilitation in Primary Health Care, no Brazilian studies were identified, indicating that in Brazil the VR seems to still be restricted to academy.

There was a wide use of the Cawthorne and Cooksey protocol\(^6,7,15-18,21-28\), which possibly stems from the fact that this protocol restores dynamic balance and spatial orientation, covering both eye movements and head movements in several directions. In addition, it stimulates the movements of the limbs and trunk to train dynamic balance\(^16\).

In general, the protocols and strategies selected by the studies in Chart 1 primarily stimulated one or another of the pillars of the vestibular system. The vestibular and visual systems are primarily stimulated in the Cawthorne and Cooksey protocol, with an emphasis on eye, head and trunk movement\(^16\), and by virtual reality strategies\(^19\). The somatosensory system is privileged in the sensory integration strategy\(^20\). Again, this seems to be linked to the fact that existing and published studies were restricted to research, when only one element is focused, seeking to understand the impact of this element on the others.

Concerning the age of the participants, there was no uniformity in the classifications of the age groups, with the age of 16, being considered “child”\(^22\) and “adult”\(^30\). Likewise, some studies consider age over 60 to be “adult”\(^19-22,27,31\), while others consider the age of 60 as the lower limit to consider the “elderly” subject\(^23-25\).

The body balance system, whose development occurs throughout life, has peculiarities in each phase, which are relevant and must be considered. For example, changes in BB predispose the elderly to fall, while for the child, the vestibular system represents a regulator and mediator for new motor learning\(^32\).

Adopting a consolidated classification, such as that provided for by child and adolescent statute (Law # 8069/1990)\(^32\) can prevent research bias, attributing greater reliability.

Another highlight is that from the union of the selected studies (Chart 1) with the participation of adults and the elderly, many with overlapping ages (similar ages), it was found that 67.76% of the selected studies deal with this audience. This confirms that the occurrence of complaints and oto-neurological symptoms prevails among the older age groups\(^33\), while the child audience, despite presenting similar symptoms, they present difficulties in identifying and expressing them\(^34\).

According to the Orientation Guide on the performance of the speech therapist in the assessment and rehabilitation of body balance\(^35\), the treatment time is variable and will depend on the oto-neurological picture,
existence of comorbidities, age and the period in which the therapeutic intervention was started. The analysis of the studies in Chart 1 seems to strengthen this position, since there was considerable variability in the duration of the programs presented.

In the BB training program proposed in Chart 2, guided and playful activities were developed, as indicated by some authors\textsuperscript{11}, the first of which progressively increased the degree of difficulty\textsuperscript{8,12-14}.

The present program is dedicated to application especially for children, who, according to the Child and Adolescent Statute\textsuperscript{32}, are individuals up to 12 years old. However, activities require a certain motor and cognitive demand, in addition to the child’s active participation, and are not suitable for children under four years old\textsuperscript{11}.

As in other studies\textsuperscript{36-38}, a program was proposed using the combination of strategies in both directed activities. However, only in this study, all BB systems were stimulated, giving this program an unprecedented character of integral intervention.

**CONCLUSION**

From the variables in this integrative review, especially regarding the protocol or strategy used for the rehabilitation of the vestibular function, no study was found proposing the stimulation of the three BB systems, and those found emphasized one or two of these systems, depending on the study. Still, the lack of standardization found in the analyzed variables, indicated that there is no uniformity regarding the rehabilitation of vestibular function in children, adults and the elderly.

In the present study, a body balance training program was developed, whose domains were adopted based on the integrative review, highlighting the fact that the application of this program in full, guarantees the stimulation of the three systems that make up the BB. Considering the lack of programs for rehabilitation of vestibular function for children, it is estimated that this study has contributed to expand the possibilities in this area.

As a suggestion for future studies, it is considered that the application of this program to the child audience represents an important step towards speech rehabilitation and related areas.

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