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Edson Soares da Silva

A INFLUÊNCIA DA PRÁTICA ESPORTIVA NO EQUILÍBRIO, RESISTÊNCIA MUSCULAR, VELOCIDADE DE CAMINHADA E MEDO DE CAIR EM PESSOAS COM DEFICIÊNCIA VISUAL

Porto Alegre

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Orientador: Prof. Dr. Leonardo Alexandre Peyré-Tartaruga

Coorientador: Ms. Rodrigo Gomes da Rosa

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RESUMO

Introdução: Os desafios enfrentados pelas pessoas com deficiência visual na mobilidade podem influenciar diretamente na segurança e autoconfiança no caminhar, sendo uma possível causa do sedentarismo nessa população. Embora a prática esportiva e exercícios físicos regulares possam modificar os fatores de risco de quedas, a relação e os parâmetros de locomoção e equilíbrio não estão estabelecidos. Objetivo: Avaliar e comparar o equilíbrio estático, a variabilidade dinâmica da caminhada, a velocidade autosselecionada de caminhada, o índice de reabilitação locomotor, a resistência muscular de membros inferiores e o medo de cair em deficientes visuais praticantes de esportes adaptados e pessoas com visão. Métodos: A amostra do estudo contou com 12 atletas de futebol e *goalball* com deficiência visual, classificação visual B1, idade: 31,5 ± 10,8 anos, massa corporal: 77,9 ± 16,9 kg e estatura: 169,2 ± 12,8 cm (grupo cegos GB) e 12 pessoas com visão preservada, idade: 26,5 ± 7,7, massa corporal: 74,5 ± 15,0 kg e estatura: 177,5 ± 11,5 cm (grupo controle CG). As variáveis de caracterização da amostra foram: idade, massa corporal, estatura, comprimento de membros inferiores, índice de massa corporal e nível de atividade física. Foram avaliados o equilíbrio estático, a variabilidade dinâmica da caminhada (CoV), a velocidade autosselecionada de caminhada (VAS), o índice de reabilitação locomotor (IRL), a resistência muscular de membros inferiores e o medo de cair em ambos os grupos. Para normalidade e homogeneidade dos dados, foram utilizados o teste de Shapiro-Wilk e Levene, respectivamente. Para verificar a diferença entre os dois grupos foi utilizado o teste T para Amostras Independentes para as variáveis paramétricas, e o teste U de Mann-Whitney para as não paramétricas no (SPSS 20.0) e α= 0,05. Resultados: BG apresentaram menor equilíbrio estático 42,00 ± 17,01s do que CG 45,00 ± 00s (p = 0,039) quando CG realizaram o teste com os olhos abertos, porém não foi encontrada diferença quando CG realizou com os olhos fechados CG = 30,28 ± 17,02 (p = 0,843). Além disso, BG teve maior CoV de tempo de contato da perna direita (p=0,010), menor comprimento de passada (p=0,013), maior medo de cair (p = 0,014) que CG. Não foram encontradas diferenças entre BG e CG na resistência muscular dos membros inferiores BG (p = 0,319), SSWS (p = 0,076) e ILR (p = 0,201). Conclusão: A participação nos esportes com deficiência, além de garantir a resistência muscular dos membros inferiores que são importantes para as atividades de vida diária, parece tornar BG mais confiante em ter SSWS e ILR semelhantes às pessoas com visão preservada.

Palavras-chaves: Locomoção, Esporte Adaptado, Marcha, Biomecânica, Funcionalidade, Deficiência Visual.

ABSTRACT

Introduction: The challenges faced by people with visual impairment in mobility can directly influence the safety and self-confidence in walking, being a possible cause of sedentarism in this population. Although sports practice and regular physical exercise can modify risk factors for falls, the relationship and parameters of locomotion and balance are not yet established. Objective: To evaluate and compare static balance, dynamic walking variability, self-selected walking speed, locomotor rehabilitation index, muscular endurance of lower limbs and fear of falling between visually impaired athletes, practitioners of disability sports, and sighted individuals. Methods: The sample comprised 12 soccer and goalball players with visual impairment, visual classification B1, age: 31.5 ± 10.8 years, body mass: 77.9 ± 16.9 kg and height: 169.2 ± 12.8 cm (blind group GB) and 12 sighted individuals, age: 26.5 ± 7.7 years, body mass: 74.5 ± 15.0 kg and height: 177.5 ± 11.5 cm (CG control group). The variables used to express the profile of the sample were: age, body mass, stature, lower limbs length, body mass index and physical activity level. Static balance, dynamic walking variability (CoV), self-selected walking speed (SSWS), locomotor rehabilitation index (LRI), muscular endurance of lower limbs and fear of falling in both groups were evaluated. For normality and homogeneity of data, Shapiro-Wilk and Levene tests were applied respectively. To verify the differences between groups BG and CG, Independent T (parametric) and Mann-Whitney U tests (non-parametric) were carried out (SPSS 20.0) and α=0.05. Results: BG had lower static balance 42.00 ± 17.01s than CG 45.00 ± 00s (p=0.039) when CG performed with their eyes open, however no difference was found when CG performed with their eyes closed CG = 30.28 ± 17.02s (p=0.843). In addition, greater CoV of contact time of right leg (0.010), shorter stride length (0.013), higher average in fear of falling (p=0.014). No differences were found between BG and BC in muscular endurance of lower limbs BG (p=0.319), SSWS (p=0.076) and ILR (p=0.201). Conclusion: Disability sports participation, in addition to ensure muscular endurance of lower limbs that are important for daily living activities, it seems to become BG more confident in having SSWS and ILR similar to people with preserved vision.

Key Words: Locomotion, Disability Sports, Gait, Biomechanics, Functionality, Visual Impairment.

SUMÁRIO

LISTA DE SIGLAS, ABREVIATURAS E SÍMBOLOS

%	Percentual
α	Alfa
±	Mais ou menos
<	Menor
≥	Maior ou igual
=	Igual
m	Meters
Hz	Hertz
s	Seconds
m/s	Meters per seconds
ACERGS	Associação de Cegos do Rio Grande do Sul
BMI	Body mass index
BG	Blind group
CG	Control group
CoV	Coefficient of variation
IBSA	International Blind Sports Association
OWS	Optimal walking speed
RLI	Rehabilitation locomotor index
SSWS	Self-selected walking speed
VAS	Velocidade autosselecionada de caminhada
VI	Visual impaired

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1. INTRODUÇÃO

1.1 O PROBLEMA E SUA IMPORTÂNCIA

A visão desempenha um papel crucial na locomoção humana. O sistema visual é singular em sua capacidade de fornecer informações ambientais próximas e distantes, que instantaneamente são utilizadas para regular a locomoção em um nível local (passo a passo) e em um nível global (planejamento de rotas), sendo o único sistema sensorial que pode fornecer informações sobre os recursos inanimados à distância (PLATA, 1997).

Todo o processo evolutivo da caminhada humana, como parte do processo evolutivo da própria espécie, foi dependente da capacidade da visão. A locomoção fez com que o homem pudesse identificar situações de perigo eminente, localizar suas caças e avistar outras fontes de alimentação, zelar pela família ou pela tribo (SAIBENE; MINETTI, 2003), entre outras atividades. A visão permite ao homem manter-se equilibrado durante a caminhada, além de deslocar-se por terrenos planos ou íngremes, superfícies diversas e ambientes familiares e não familiares, assumindo velocidades diferentes de marcha.

Atualmente, o número de pessoas de todas as idades com deficiência visual no mundo é estimado em 285 milhões, dos quais aproximadamente 39 milhões são cegos. Pessoas com 50 anos ou mais representam 65% e 82% dos deficientes visuais e cegos, respectivamente. As principais causas da deficiência visual são erros não corrigidos de refração (43%) e limitações ocasionadas por catarata (33%); já a primeira causa de cegueira é catarata (51%) (PASCOLINI; MARIOTTI, 2002).

As diversas deficiências influenciam consideravelmente os níveis habituais de atividade física. No caso da deficiência visual, os indivíduos costumam ter uma flexibilidade, resistência cardiovascular, resistência muscular e equilíbrio significativamente menores quando comparados a pessoas com a visão preservada (SKAGGS; HOPPER, 1996; HALLEMANS et al., 2010). Esse déficit pode ser explicado em partes pelo sedentarismo, uma vez que a deficiência visual é um dos três tipos de deficiências que mais causam a inatividade, juntamente com a física e intelectual (LONGRNUIR; BAR-OR, 2000). Além disso, há uma escassez de práticas corporais que tenham como objetivo melhoras no condicionamento físico, autonomia, socialização e autoconfiança para a realização atividades de vida diária, como a caminhada.

Os desafios de caminhar sem a utilização de *inputs* de *feedbacks* visuais na detecção de objetos no plano horizontal e vertical são enormes. Adicionalmente, os problemas de acessibilidade das cidades resultam em estresse psicológico e aumento dos níveis de ansiedade, gerando como resposta, modificações fisiológicas como o aumento da frequência cardíaca de repouso e do consumo de oxigênio durante a caminhada (KOBBERLING; JANKOWSKI; LEGER, 1989). Diante desses desafios diários, essa população adota estratégias mais seguras para a manutenção do controle postural durante a caminhada, adaptando os padrões da marcha e da postura. Tais estratégias, descritas na literatura, são: uma postura contraída, inclinação do tronco para trás, inclinação da cabeça para baixo, menor comprimento de passada, maior tempo na fase de apoio, contato com a planta do pé na fase de contato e uma menor velocidade de caminhada quando comparadas com pessoas com visão e pessoas com diferentes níveis de perda visual (HALLEMANS et al., 2010; KAY, 1974; DAWSON, 1980; NAKAMURA, 1997).

O equilíbrio dinâmico tem um papel fundamental durante a caminhada, pois a estabilidade da marcha é uma das fontes do gasto energético (ORTEGA; FARLEY, 2015). A baixa visão, por sua vez, afeta diretamente a estabilidade dinâmica da marcha (HALLEMANS et al., 2010), e está relacionada com a redução do equilíbrio do deficiente visual na realização de atividades cotidianas, sendo elemento preocupante por ser um fator preponderante para indicar maior risco de quedas (CLOSE, 2001).

O pêndulo invertido pode ser descrito como um modelo conceitual para explicar a minimização do custo energético durante a caminhada (SAIBENE; MINETTI, 2003). A velocidade na qual ocorre esta minimização corresponde à velocidade autosselecionada (VAS) para sujeitos sem deficiência visual. Peyré-Tartaruga e Monteiro (2016) descrevem um índice de reabilitação, o qual pode ser utilizado para avaliar se o sujeito caminha na velocidade de menor custo energético. A relação entre a VAS e a estabilidade pode indicar se a deficiência visual prejudica o desempenho da marcha.

As atividades físicas têm apresentado efeitos benéficos sobre o equilíbrio de pessoas com deficiência visual. Sabe-se que intervenções com Tai Chi (CHEN et al., 2011), *goalball* (AYDOG et al., 2006) e Dança (SILVA et al., 2008) resultaram em ganhos significativos tanto no equilíbrio estático, quanto no equilíbrio dinâmico. Além disso, estudos têm demonstrado que a melhora no equilíbrio dinâmico e estático tem relação com a especificidade de cada modalidade, ou seja, as trocas de direção e a exigência física em determinada posição (ZEMKOVÁ, 2013). Aydog et al. (2006) encontraram melhores valores de equilíbrio dinâmico médio-lateral em deficientes visuais jogadores de *goalball* em comparação com deficientes visuais sedentários.

Para Nogueira, Shibata e Gagliardi (2009), além da especificidade das modalidades, a força de membros inferiores é um importante componente na manutenção do equilíbrio dinâmico e estático.

Do ponto de vista do conhecimento sobre a estabilidade da caminhada de deficientes visuais, existem lacunas na literatura sobre a influência do nível de atividade física na redução do risco de queda e no custo energético da caminhada dessa população.

1.2 OBJETIVO GERAL

Avaliar e comparar as variáveis funcionais, velocidade de caminhada, índice de reabilitação locomotor e medo de cair em deficientes visuais praticantes de esportes adaptados e pessoas com visão.

1.3 OBJETIVOS ESPECÍFICOS

Avaliar e comparar entre deficientes visuais praticantes de esportes adaptados e pessoas com visão:

- Velocidade autosselecionada de caminhada;
- Índice de reabilitação locomotor;
- Variabilidade dinâmica da caminhada;
- Equilíbrio estático;
- Resistência muscular de membros inferiores;
- Medo de queda.

1.4 HIPÓTESE

Deficientes visuais praticantes de esportes adaptados apresentarão uma velocidade de caminhada, índice de reabilitação locomotor, variabilidade dinâmica, equilíbrio estático, resistência muscular de membros inferiores e o medo de queda semelhantes na comparação com pessoas com visão preservada.

2. APRESENTAÇÃO GERAL DA MONOGRAFIA

A presente monografia será apresentada no formato de dois artigos. O artigo I – intitulado “Gait in individuals with visual impairment – literature overview and new insights” teve como objetivo revisar na literatura as características típicas da caminhada de pessoas com deficiência visual e as estratégias de manutenção do equilíbrio dinâmico da marcha nessa população. O artigo II – intitulado “Effects of disability sports participation on functional parameters, rehabilitation locomotor index and fear of falling of visually impaired individuals” objetivou avaliar e comparar as variáveis funcionais, o medo de cair e o índice de reabilitação locomotor entre atletas com deficiência visual participantes de esportes adaptados e pessoas com visão preservada.

3. ARTIGO I

Gait in individuals with visual impairment – literature overview and new insights

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Abstract

The visual system provides information on the static and dynamic features of the environment, playing an important role in the control of human locomotion. In this paper, we reviewed the typical characteristics of gait in individuals with visual impairment and aimed to identify global gait impairments and their underlying mechanisms. Three main hypotheses of balance gait control in visually impaired individuals are discussed in literature: lack of anticipatory mechanisms, balance problems and the use of foot probing strategy. The most common observations in spatiotemporal parameters are: decreased gait speed, shorter step lengths, greater time of stance phase, greater step width and longer double stance phase. Long cane, guide-dog and sighted guide are mobility aids that allow anticipatory feedbacks and improve walking efficiency in people who are visually impaired. The gait in visually impaired individuals seems to be influenced by the duration of vision loss, use of mobility aids and psychological stress, resulting in a lower walking speed than sighted individuals. Studies investigating the effect of physical activity participation on dynamic stability, fear of falling and mobility in this population should be encouraged to better understand potential contributions to enhance gait.

Key Words: Mobility; Walking; Visually Impairment; Posture

Introduction

Vision plays an important role in the control of human locomotion (Patla A.E, 1997). The visual system can provide information on the static and dynamic features in the environment nearby and further ahead. The central nervous system uses appropriate anticipatory avoidance strategies to control the stability during walking, either on local (step by step) and global levels (involved in route planning) (Patla A.E, 1997). Therefore, it is not surprising that gait is impaired in individuals with visual impairment (VI) (Dawson, 1981).

Visual skills are commonly qualified under the parameters of the International Classification of Diseases – 10. This classification organizes visual function in four different categories: normal vision, moderate VI, severe VI and blindness, being moderate VI and severe VI usually grouped into one category, under the term 'low vision'. Visual impairment is generally attributed to individuals under both conditions – low vision or blindness (WHO, 2014).

It is well established that even within a group of individuals with a similar level of VI, the extent of gait impairment can vary substantially (Nakamura, 1997). Furthermore, gait typically improves from young to adult age in individuals with VI (Hallemans et al., 2011). Together, these findings suggest that gait in individuals with VI can be potentially improved through training or rehabilitation.

In this paper, we review the typical gait characteristics in individuals with VI and aim to identify global gait impairments and their underlying mechanisms. Identifying these underlying mechanisms will allow for targeted gait rehabilitation, interventions aimed at improving the overall mobility and gait quality in individuals with VI.

Hypotheses of dynamic gait control

In a classical descriptive study, Dawson (1981) evaluated selected kinematic gait parameters in adults with VI during walking with a long cane. She compared gait for familiar and unfamiliar sidewalk courses to understand how familiarity of the surroundings affects the dynamic gait control in individuals with VI. The study showed that although the average walking speed was slower in the unfamiliar setting, differences in gait parameters between familiar and unfamiliar settings were minimal. The participants adopted a backwards inclined trunk, which was suggested to function to maintain the line of gravity relatively posteriorly within the base of support at heel strike, which would provide more stability in the anterior-posterior direction. This would also allow the individuals to use the foot of their leading leg as a probe to survey the area in front of the body before shifting weight. Such strategy would also explain the reduced extension of the leading leg during heel strike observed in these individuals (Dawson, 1981).

This concept – that individuals with VI would use the foot of their leading leg as a probe to survey the area in front of the body – is also referred to as the haptic exploration hypothesis (Hallemans et al., 2011; Gazzellini et al., 2016).

In addition to this hypothesis, two other hypotheses of dynamic gait control in VI have been discussed in literature (Gazzellini et al., 2016). These alternative hypotheses are related to balance deficits and a lack of anticipatory control mechanisms.

The balance deficit hypothesis was explicitly addressed by Hallemans et al. (2011), in a cross-sectional cohort study investigating the age-related changes in gait of individuals with low vision and blindness. Both the haptic exploration and the balance deficit hypothesis are related to the often-observed prolonged duration of double stance phase in the gait pattern of individuals with VI when compared to individuals with normal vision (Hallemans et al., 2011; Nakamura, 1997). Prolonging the double stance phase allows the foot to provide sensory feedback, i.e. using it for haptic exploration, to compensate for vision loss (Hallemans et al., 2011; Dawson, 1981). A prolonged double stance phase is also considered a safety strategy because it is a period of balance recovery and a preparatory period to accelerate the body forward in the next step. As such, the prolonged double stance phase could be considered as an indicator of balance problems.

The third hypothesis addresses lack of anticipatory mechanisms. It can be observed during walking in individuals with VI, through a cautious posture adopted (Dawson, 1981) and lower walking speed when they move independently (Nakamura, 1997; Uysal et al., 2010). This adaptive self-protection model is originated from the lack of anticipatory feedback or feedforward input from visual systems, and could reduce, as an effect, dynamic stability of gait

(Gazzellini et al., 2016). Figure 1 illustrates an overview of the three main hypotheses:

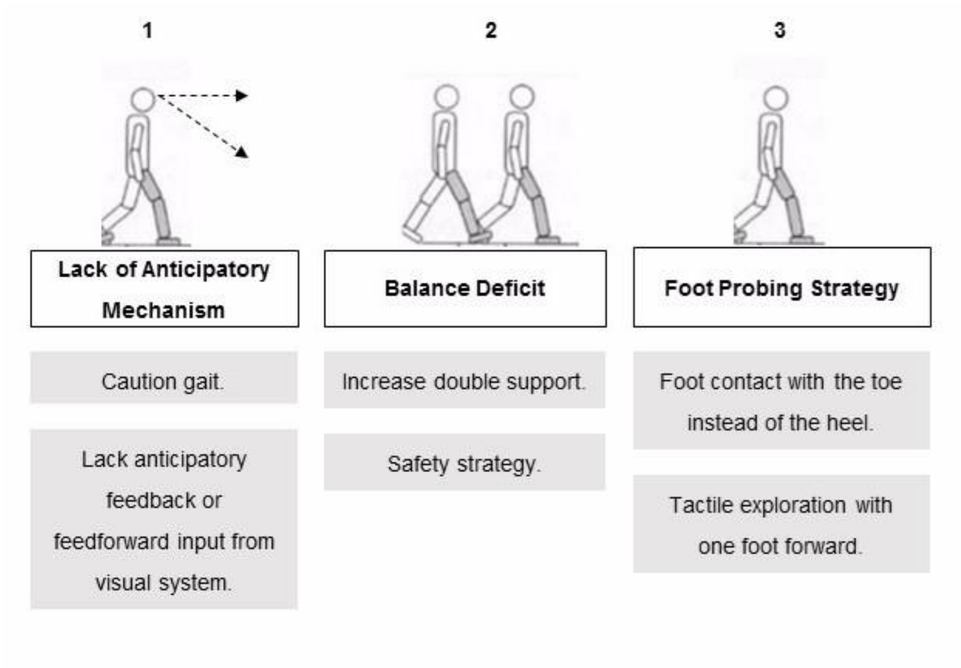

Figure 1 - In summary, the three hypotheses of balance control in VI individuals (1- Lack of Anticipatory Mechanisms, 2- Balance deficits and 3 - Foot Probing Strategy).

Spatiotemporal gait parameters

Several studies have investigated gait differences between VI individuals and people with normal vision in different ages (Nakamura, 1997; Ray et al. 2007a; Uysal et al., 2010; Hallemans et al. 2010; Hallemans et al. 2011; Gazzellini et al. 2016). The most common observations are: reduced gait speed (Nakamura, 1997; Ray et al., 2007; Uysal et al., 2010; Hallemans et al., 2010; Hallemans et al., 2011; Gazzellini et al., 2016), shorter step lengths (Nakamura, 1997; Uysal et al., 2007; Erden; Akabayrak, 2010; Hallemans et al., 2010; Hallemans et al., 2011; Gazzellini et al., 2016), greater time of stance phase (Nakamura, 1997), greater step width (Gazzellini et al., 2016) and longer double stance phase (Hallemans et al., 2011; Gazzellini et al., 2016).

The gait speed is an important spatiotemporal parameter for human locomotion. It is well known that declines in gait speed can predict dependence for daily life activities (Perera et al., 2015) and survival outcomes throughout the aging process in older adults (Studenski et al., 2011). From a biomechanical point of view, the decision of walking on slower or high speed far from optimal walking speed (self-selected walking speed), implies an increase in energy expenditure, as a result of impairment in the inverted pendulum model (Saibene and Minetti, 2003).

In VI individuals, from childhood to adult phase, there is a trend of self-selected walking speed to be slower in comparison to normal vision people, as described in Table 1. This could be a reason for blind teenagers to spend greater oxygen consumption (+24.4%) when compared to sighted individuals at the same speed when they all were walking at 4.8 km/h (Kobberling, Jankowski and Leger, 1989). The authors attributed differences to physical conditioning, however, it is necessary to emphasize that they were evaluated above their usual self-selected walking speed.

Table 1 - Self-selected walking speed in visually impaired and sigthed individuals

Study	VI		Control		Visual Function	VI	Control
	Subjects	Age	Subjects	Age			
Gazzellini et al., 2016	12	7.9 ± 3.0	11	8.3 ± 2.8	CB	0.82 ± 0.27	1.14 ± 0.24
Uysal et al., 2010	20	12.2 ± 2.5	20	9.3 ± 0.6	CB	0.20 ± 0.08	0.96 ± 0.15
Hallemans et al., 2010	10	26.7 ± 12.7	20	28.1 ± 6.6	B and LV	1.09 ± 0.25	1.27 ± 0.13
Hallemans et al., 2011	9	1.3 to 40	60	3.6 to 46	LV	0.42 ± 0.12	0.46 ± 0.07
Hallemans et al., 2011	22	1.3 to 40	60	3.6 to 46	B	0.26 ± 0.12	0.46 ± 0.07
Ray et al., 2007	15	38.1 ± 13.4	15	38.1 ± 13.2	VI	0.87 ± 0.30	1.07± 0.18
Nakamura, T., 1997	15	36 to 54	15	40 to 50	LB	0.86 ± 0.09	1.50 ± 0.08
Nakamura, T., 1997	15	39 to 48	15	40 to 50	CB	1.11 ± 0.13	1.50 ± 0.08

VI- visually impaired individuals; Control- sigthed individuals; SSWS (m/s), CB- Congenital blindness; B - Blind; LV- Low Vision; LV- Late Blind;

The duration of vision loss should also be considered for the evaluation of gait characteristics in VI individuals. In other words, it is important to differentiate a person who had previous visual experiences and acquired VI throughout life (acquired blind), and a person who was born blind (congenitally blind).

Childhood is a very sensitive period for motor development. It has been shown that congenitally blind children have deficits in development of bilateral coordination and the ability to use left and right sides of the body (Rutkowska et al., 2016), skills that can be considered essential for walking. In addition, congenitally blind individuals have a deficit in the integration of auditory and visual information, used to identify interpretation cues during locomotion, because this auditory-spatial representation is usually developed during childhood, coming from visual experiences (Gori et al., 2017).

In line with the above, Nakamura (1997) quantitatively compared spatiotemporal gait parameters in 15 late blind, 15 congenitally blind and 15 age-matched sighted adults. The author found that late and congenitally blind had slower walking speed and longer time of stance phase compared to sighted adults. Additionally, late blind walked faster than congenitally blind. It was accompanied by a greater stride length and shorter time of stance phase. According to the progress of duration of the vision loss, there was a tendency for gait patterns of the late blind to approximate to congenitally blind group, what was demonstrated by an increase in time of stance phase along 0 to 12 years of vision loss. It was justified by adjustments and relearning of gait.

Hallemans et al. (2010) compared gait patterns between 10 young adults with VI and 20 young adults with normal vision (26.7 ± 12.7 and 28.1 ± 6.6 years, respectively). Lower self-selected walking speed was observed in visual impairment group. Also, both groups – blind and normal vision when blindfolded – touched the ground with the largest part of the foot's plantar surface at heel strike. It seems to confirm the hypothesis for haptic exploration by the legs of visually impaired individuals.

Blind and low vision children, five to seven years old, differentiated between them only at the trunk position from a sagittal plane standpoint, when head, trunk, shoulders and elbows were analyzed during foot strike, support and swing phases of gait (Sankako et al., 2014). Blind group presented a greater anterior tilt of trunk when compared to the other groups. All subjects in this study retained a fixed positioning regarding the rotation of head and trunk in the four phases of the gait cycle, and they did not perform arm swinging, suggesting that children with VI have limited rotation of trunk.

Although the kinematic differences previously described, kinetically, in terms of mediolateral and vertical ground force reactions, there are similarities in walking patterns between blind, sighted and blindfolded individuals (Knutzen, Hamill and Bates, 1985). However, due to a delay in orientation of foot horizontally to the center of mass during contact, it produces greater braking and propelling forces in blind subjects when compared to sighted and blindfolded persons (Knutzen, Hamill and Bates, 1985).

During walking, head, trunk, and upper extremities position can influence gait efficiency and lead postural problems related to pain, muscular weakness and shortening (Sankako et al., 2014). Normally, head moves vertically to perform rotations (lower during the loading response and pre-swing, and higher in medium support and medium swing), moves laterally in a single support and is expected to have a neutral position during double support (Sankako et al., 2014). Furthermore, the arms produce a rhythmic gait and provide balance after perturbation (Meyns, Bruijn and Duysens, 2013) as well as decrease energy expenditure when they move in opposite to rotation of trunk (Umberger, 2008).

Anticipatory feedback during walking

The most popular mobility aids for individuals with VI are the long cane and the guide dog (Johnson, et al. 1998; Clark-Carter, Heyes, and Howarth, 1987). The long cane is commonly used for cost-benefit reasons and provides anticipatory feedback by the exploration of the environment on spatial information created in front of the body (Johnson, et al. 1998; Mount, et al. 2001).

Clark-Carter, Heyes, and Howarth (1986) compared the use of long cane and guide dog on walking efficiency in blind pedestrians, based on a percentage of the preferred walking speed. This experiment showed that the guide-dog allows to reach speeds above preferred walking speed (108%) in comparison to long cane (74%), suggesting that energy expended is higher when using the long cane rather than walking accompanied by a guide-dog. In addition, walking efficiency using a long cane is modulate to the route complexity adopted, decreasing according to simple, medium and complex route, respectively.

Johnson et al. (1998) investigated gait and the cane mechanism in individuals with VI and mobility instructors with their eyes closed. The authors showed the cane technique used by these groups did not ensure an appropriate foot placement protection, since, from a mediolateral displacement standpoint, they moved the cane in a way to obtain a side-to-side coverage much wider than where their feet could land. This result was the opposite of what was expected, once the cane tip should sweep the ground in the same direction of the feet, in order to protect against surface abnormalities before the contact with the ground (Johnson, et al. 1998). Therefore, a special attention to this strategy could provide a better walking for individuals with VI, decreasing their vulnerability to holes, depressions, elevations or other surface obstacles.

Aiming to compare the long cane technique and gait parameters in VI individuals, subjects were exposed to the following mobility situations: (1) normal walking with long cane, (2) using long cane and receiving hearing aid, (3) using long cane and reacting to a simulated drop-off, and (4) using long cane with simultaneous hearing and simulated drop-off incentives. Ramsey et al. (1999) found no differences between groups. However, they noted significant oscillations in speed walking, stride length, and hip flexion velocity, which might indicate a great variation of gait cycle, mainly when VI individuals perform in dual task.

Another strategy described to improve the gait of individuals with VI is walking accompanied by a sighted guide (Clark-Carter, Heyes, and Howarth, 1987). The authors found an increase in the self-selected walking speed (1.439 to 1.797 m/sec), stride length (0.853 to 0.946 m) while the stride duration decreased (0.610 to 0.527 s) compared to when they were walking independently. Again, these findings point out how important it is for individuals with VI to have availability of the best possible guidance strategies to enhance their gait performance. However, having a sighted guide available will not always be a possibility. Thus, improving independent techniques for the gait of individuals with VI is still a key point.

Tactile surface indicators in sidewalks help VI individuals to distinguish them by stepping onto its convexities, making it possible to follow them to achieve some specific direction. These indicators are useful as leading indicators and warning indicators, calling attention to places ahead which require caution (Kobayashi et al, 2005). Additionally, in a comparison between trapezoidal and sinusoidal tactile surface indicators, VI individuals using their long cane walked more efficiently in trapezoidal than sinusoidal indicators, suggesting that sinusoidal indicators could potentially increase the risk of fall (Ranavolo et al, 2011).

Despite all tools for assisting the mobility of individuals with VI already developed, and particularly the promising Electronic Travel Aid (ETA) recently introduced, which has shown positive results to improve obstacle detection (Jeong and Yu, 2016), the independent locomotion for a VI individual is still a daily challenge, inducing to several situations that may generate psychological stress (Beggs, 1991; Nakamura, 1997). Besides these mechanisms, there is still a lack of interventions focused on the intrinsic factors to overcome the mobility limitation of individuals with VI.

Perspectives

Individuals with vision loss are resistant to utilize movements that compromise their center of gravity (Ray et al., 2007a) such as during walking. Additionally, previous authors supported that VI individuals have more difficulties with functional mobility tasks that require speed, muscular strength, balance and gait skills, if compared to sighted people (Horvat et al., 2004; Ray et al., 2007b).

Physical activity should be encouraged in VI individuals to develop the muscular strength necessary for performing functional tasks, providing self-sufficiency and independence (Ray et al., 2007a). Aydog et al. (2006) demonstrated that postural balance, in terms of mediolateral stability in blind goalball players practicing 1-2 times per week, was better than sedentary blinds. This result in mediolateral control was justified by the specific characteristics of this sport: in goalball the players try to defense the ball thrown by opponents, going or sometimes jumping to the sides (left and right).

Conclusions and future research goals

Several studies have shown a slower walking speed in people with visual impairment when compared to people with vision. The potential confounding factors in the biomechanical analysis of the walking of this population are in the comparison between control and experimental groups that, although walking at their self-selected walking speeds, present different velocities. The walking speed can influence directly in the variables space length, frequency, time of contact, time of balance. However, the self-selected walking speed in different groups is used because it represents real situations.

Three hypotheses of balance gait control in VI individuals are discussed in literature: lack of anticipatory mechanisms, balance problems and the use of foot probing strategy. The main changes in spatiotemporal patterns in VI individuals are a caution gait posture, decrease in walking speed accompanied by a shorter stride length and prolonged time of stance phase compared with sighted persons. In addition, VI individuals produce greater braking and propelling forces during walking compared to sighted pairs.

The adequate techniques for the use of a long cane, dog-guide, sighted guide and either the tactile surfaces are described as successful anticipatory feedbacks during walking, to increase gait performance of VI individuals. On the other hand, when VI individuals are faced to walking independently, psychological stress is induced, as seeing with an increase in heart hate.

The gait in visually impaired people seems to be influenced by the time of vision loss, use of mobility aids and psychological stress, resulting in a lower walking speed, comparing with sighted persons. Future studies should be focused in the potential of physical activities or adapted sports to improve gait parameters and overall health in VI individuals.

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4. ARTIGO II

Effects of disability sports participation on functional parameters, rehabilitation locomotor index and fear of falling of visually impaired individuals

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Abstract

Introduction: Although disabilities sports participation and regular physical activities can ensure self-confidence and modify risk factors for falls, the relationship and parameters of locomotion and balance are not yet established. Objective: To evaluate and compare static balance, dynamic walking variability, self-selected walking speed, locomotor rehabilitation index, muscular endurance of lower limbs and fear of falling between visually impaired athletes, practitioners of disability sports, and sighted individuals. Methods: The sample comprised 12 soccer and goalball players with visual impairment, visual classification B1, age: 31.5 ± 10.8 years, body mass: 77.9 ± 16.9 kg and height: 169.2 ± 12.8 cm (blind group GB) and 12 sighted individuals, age: 26.5 ± 7.7 years, body mass: 74.5 ± 15.0 kg and height: 177.5 ± 11.5 cm (CG control group). The variables used to express the profile of the sample were: age, body mass, stature, lower limbs length, body mass index and physical activity level. Static balance, dynamic walking variability (CoV), self-selected walking speed (SSWS), locomotor rehabilitation index (LRI), muscular endurance of lower limbs and fear of falling in both groups were evaluated. For normality and homogeneity of data, Shapiro-Wilk and Levene tests were applied respectively. To verify the differences between groups BG and CG, Independent T (parametric) and Mann-Whitney U tests (non-parametric) were carried out (SPSS 20.0) and α=0.05. Results: BG presented lower static balance (42.00 ± 17.01s) than CG (45.00 ± 00s) (p=0.039) when CG performed with their eyes open. However, no difference was found when CG performed with their eyes closed (CG = 30.28 ± 17.02s) (p=0.843). In addition, greater CoV of contact time of right leg (0.010), shorter stride length (0.013), higher average in fear of falling (p=0.014) were all features found in BG. No significant differences were found between BG and BC in muscular endurance of lower limbs BG (p=0.319), SSWS (p=0.076) and ILR (p=0.201). Conclusion: Disability sports participation, in addition to ensure muscular endurance of lower limbs – important for daily living activities – seems to become BG more confident to perform gait, by having SSWS and ILR similar to people with preserved vision.

Key Words: Disability; Walking; Visually Impairment; Posture; Sports.

Introduction

Disability sports comprise a set of sports that were designed to be practiced by athletes with some type of disability (Blauwet and Willick, 2012) and have had their visibility increased due to the Paralympic movement. While disabilities are strongly related to sedentary lifestyle, depression, obesity and other consequences, the practice of sports, brings many benefits to individuals either at a recreational or a competitive level, promoting inclusion, health and the improvement of the quality of life (Blauwet and Iezzoni, 2014).

According to the World Health Organization, the estimation of visually impaired (VI) people worldwide is 285 million individuals. An amount of 39 million people are blind, while 246 million present low vision. It is well known that young and middle–aged adults with visual impairment maintain low levels of physical activity (Marmeleira et al., 2014) and greater sedentary behavior (Lenz et al., 2015) than the overall population.

Lower strength, power (Horvart et al., 2004), static and dynamic control (Ray et al., 2008; Giagazoglou et al., 2009; Tomomitsu et al., 2013) as well as lower walking speed (Nakamura, 1997; Ray et al., 2007; Tomomitsu et al., 2013, Uysal; Erden; Akabayrak, 2010; Hallemans et al., 2010; Hallemans et al., 2011; Gazzellini et al., 2016) are functional parameters commonly impaired, as a reality faced by VI individuals in comparison to sighted persons.

An important consequence of visual impairment is the fear of falling. In a general way, fear can be understood as an emotion or shock that comes from the perception of present and urgent danger, which threatens the preservation of the individual (Rezende et al, 2009). Daily life activities may offer different degrees of risk with regard to the chance of falling. The execution of these activities by visual impaired individuals may have their level of difficulty significantly increased. On the other hand, some factors decrease fear of falling, such as the individual's familiarity with the task or environment, visual acuity, and a better ability to move (White et al, 2015).

Walking at lower speeds could be a safe strategy when a person needs to walk without the perfect condition of the visual system. Individuals with VI increase the double contact to the ground, adopting a caution posture demonstrated by a backwards inclined trunk. They use their foot as a probe to survey the area in front of the body, to identify obstacles during walking, as a strategy for gait control (Silva et al. in review). On the other hand, lower walking speed increases the gait variability, being a non-efficient situation if compared to the self-selected walking speed (Clark-Carter, Heyes, and Howarth, 1986; Jordan et al., 2007; Beauchet et al., 2009). In addition, slower walking speed causes higher energy expenditure, explained by an inverted pendulum not optimized (Saibene and Minetti, 2003).

There is a lack of information about the effects of physical activities or disability sports participation on functional parameters, locomotor abilities and fear of falling in VI individuals. Interventions that increase self-confidence to walking faster and reduce walking variability could reinforce the power of disability sports participation as rehabilitation and the role to avoid the risk of falling for this population.

This study aimed to compare the differences in static balance, dynamic variability of gait, muscular endurance of lower limbs, self-selected walking speed, locomotor rehabilitation index (LRI) and fear of falling between VI athletes and sighted individuals. We hypothesize that, due to a transference effect related to the sports-specific balance (Zemková, 2014) and previous benefits of some physical activities (Aydod et al., 2006) VI athletes will have the same physical performance in all tests, including the fear of falling, in comparison to sighted individuals.

Materials and Methods

Participants

Twelve (four female and eight male, age: 31.5 ± 10.8, range 18 to 50 years), football and goalball players with blindness, and 12 sighted individuals (four female, eight male, age: 26.5 ± 7.7, range 23 to 48 years) participated in the study as subjects. They all have been checked and revealed to be free of bone and/or musculoskeletal and neurological disorders, back problems or any chronic joint pain, for the previous six months. This was taken as an inclusion criteria.

All football and goalball players of blind group (BG) were members of Associação de Cegos do Rio Grande do Sul (ACERGS), Porto Alegre, Brazil. For the control group (CG) of physically active sighted individuals, physical education students and other subjects associated to Escola de Educação Física, Fisioterapia e Dança of Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil were invited. Sedentary subjects and those who failed to perform all evaluations were excluded from the study.

A visual sports classification recommended by the International Blind Sports Federation (IBSA) was adopted. The determination was based upon the eye with better visual acuity and fields, which includes central and peripheral zones. Athletes with visual acuity poorer than LogMAR 2.6 were classified as B1. For visual acuity ranging from LogMAR 2.6 and/or visual field constricted to a diameter of less than 10 degrees, these individuals were classified as B2. Athletes who had visual acuity ranging from LogMAR 1.4 to and/or visual field constricted to a diameter of less than 40 degrees were classified as B3.

The sample size was determined using G*Power software (version 3.1) for a power of about 0.95 (significance level of 0.05) based on self-selected walking speed, contact time phase and stride length data of Nakamura (1997) study. This calculation showed the need of nine participants for each group; however, we adopted 12 subjects for each group to avoid samples and data losses.

The study was approved by local ethics committee of Universidade Federal do Rio Grande do Sul - UFRGS. All subjects and Sports and Culture Coordinator of ACERGS signed consent form for giving permission for collecting data. The researcher read consent form aloud before BG signed.

Procedures

All measurements were conducted in the same section and day. Prior to testing, the procedures were explained to subjects, as well as possible risks and benefits to participate. An anamnesis to access general data, visual classification, history of sports participation of individuals, and other relevant information was applied. Posteriorly, the same researcher conducted physical activity level and fear of falling questionnaires. Finally, anthropometrics data, static balance test, self-selected walking speed, and sit and stand test were performed following the order described.

Physical Activity Level

To evaluate Physical Activity Level, the International Physical Activity Questionnaire (IPAQ) short version, validated for Brazil by Matsudo et al. (2001) was used. It was considered: Very active = the subjects who fulfilled the recommendations of: a) vigorous: ≥ 5 days/week and ≥ 30 minutes per session; b) vigorous: ≥ 3 days/week and ≥ 20 minutes per session + moderate and/or walk: ≥ 5 days/week and ≥ 30 minutes per session. Active = those who fulfilled the recommendations of: a) vigorous: ≥ 3 days/week and ≥ 20 minutes per session; b) moderate or walking: ≥ 5 days/week and ≥ 30 minutes per session; or c) any activity added: ≥ 5 days/week and ≥ 150 minutes/week (moderate + vigorous + walk). Irregularly Active = those who perform physical activity, but insufficiently to be classified as active because they do not comply with the recommendations regarding frequency or duration.

To accomplish the Irregularly Active classification, frequency and duration of the different types of activities (moderate + vigorous + walk) were added. This group was split into two subgroups according to the presence or absence of some of the recommendation criteria. Irregularly Active A = those who meet at least one of the criteria of recommendation regarding frequency or duration of activity: a) frequency: 5 days/week or b) duration: 150 minutes/week; and Irregularly Active B = those who did not meet any of the criteria of recommendation regarding frequency or duration. Last, were considered Sedentary = those who did not perform any physical activity for at least 10 continuous minutes during the week.

Fear of Falling Assessment

The Efficacy Scale of Falls - International - Brazil (FES-I-Brazil), validated and adapted for Brazil by Camargos et al (2010), was applied to evaluate the subjects concerns about the possibility of falling. The scale consists of 16 items that represent three categories: daily life activities, physical activities and social activities. The subjects express his/her feelings about each item through the options: I am not worried (1 point), a little worried (2 points), moderately worried (3 points) and very worried (4 points). Answers were summed and the minimum score that could be reached was 16, corresponding to the absence of concerns, while 64 would be the maximum, meaning an extreme concern of the subject in relation to suffering falls. It contains activities related to the locomotion, the accomplishment of domestic tasks, the execution of activities of personal hygiene and care, and also some activities of social life. Again, for GB, the questions were read aloud and completed by the researcher.

Anthropometric Assessment

Data on body mass (weight) and stature (height) was measured to analyze the Body Mass Index (BMI) for both groups. It is defined as the weight in kilograms divided by the square of the height in meters (kg/m^2), according to the World Health Organization (WHO, 2000; WHO, 2004). The international BMI classification of adults is based on main cut-off points, generating four main categories and their subdivisions. First is 'underweight' (<18.50), subdivided in severe (<16.00), moderate (16.00 to 16.99) and mild thinness (17.00 to 18.49). Second is 'normal range' (18.50 to 24.99). Third is overweight (≥25.00), subdivided in pre-obese (25.00 - 29.99). Fourth is 'obesity' itself (≥30.00), subdivided in class I (30.00 to 34.99), class II (35.00 to 39.99) and class III (≥40.00).

Static Balance Test

In order to evaluate the static balance, the unipodal posture test was selected and applied (Springer et al., 2007). Subjects folded his/her arms over the chest, wearing comfortable shoes, maintaining the dominant leg on the ground and raising the non-dominant leg up close to the ankle of the leg support, but without touching it. A 45-second count started at the exact moment that the subject's leg lost contact with the floor. In case subjects uncross or use the arms to maintain balance, move the raised foot or touch the floor with the foot raised, move the support foot to maintain balance, exceed the maximum duration of 45 seconds, or open the eyes during the attempts, the test was finalized. Three attempts were performed with the eyes closed and three attempts with open eyes (only for CG), of which the best scores were considered for analysis. There was an auxiliary researcher close to subjects in order to avoid falls.

Self-Selected Walking Speed and Dynamic Variability of Gait

For Self-Selected Walking Speed (SSWS) assessment, a distance of 15 meters was demarcated using two markers on the floor, in an area totally free of obstacles and not slippery. In addition, other two markers were positioned at a distance of 2.5 meters from initial mark and 2.5 meters from final mark. This protocol aimed to exclude the acceleration and braking phase of walking analysis, ensuring 10 meters at constant speed.

Before trials, a familiarization with the environment was performed by each individual of BG, without using their long canes. At the examiner´s command, subjects walked the 15 meters at a self-selected speed. Times were registered using a stopwatch for the length of 10 meters. Speed was calculated by dividing distance (10 meters) and time traveled. Three trials were recorded, and the highest and lowest speed were both excluded, being considered for the analysis the intermediate speed. BG performed all trials without their usual long cane. For safety and orientation of the VI individuals, another assistant researcher remained in the end of hallway giving to them the same verbal command: “Go, Go”.

For the assessment of the dynamic variability of gait, a camera (Casio EX-ZR1000) was positioned in the sagittal plane and a video was recorded with sampling frequency (120 Hz) in simultaneous SSWS trials. In the software (Kinovea, 0.8.15), three complete strides were selected and spatiotemporal variables: contact time, time of swing, stride length and stride frequency for right and left legs were calculated using a mathematical routine at software LabVIEW 8.5 (National Instruments). The dynamic variability was calculated using the coefficient of variation (CoV) of the spatiotemporal variables according to previously studies (Oliveira et al., 2013; Monteiro et al., 2016).

Locomotor Rehabilitation Index

The locomotor rehabilitation index (LRI) was calculated according to Peyré-Tartaruga and Monteiro (2016). This index represents how close the SSWS is to the OWS (Optimal Walking Speed). The OWS results from the square root of the multiplication between Froude number (0.25), gravity (9.81 m/s) and lower limbs length – LLL (vertical distance between the major trochanter of the femur and the ground), according to an equation bellow:

$$OWS = \sqrt{0.25 \times gravity \times LLL}$$

Then, LRI was calculated from the division between the SSWS and the OWS, multiplied by 100, following this equation:

$$LRI = 100 \times \frac{SSWS}{OWS}$$

Muscular Endurance of Lower Limbs

The sit and stand test was performed during one minute to evaluate the muscular endurance of the lower limbs (Strassmann et al., 2013). For the test, a padded chair without armrest was provided. It was positioned against a wall to maintain stability. In addition, an auxiliary examiner was positioned close to the subjects, to ensure safety in performing the test. Subjects were stand up completely from the chair and remain fully upright, after which they returned to the initial position (sitting) by leaning their back on the chair, repeating this sequence as often as possible during one minute. At the end of the one-minute attempt, in case the subjects performed more than half the movement to reach the standing position, it was considered as a complete repetition.

For the analysis of the muscular endurance of the lower limbs, the number of repetitions performed by the subjects was registered for comparisons between both groups, based on normative values and previous studies (Strassmann et al., 2013; Ray et al*.,* 2007).

Statistical Analysis

Descriptive analysis (averages and standard deviation) of the general characteristics and anthropometric measures for each group were calculated. To ensure the normality and homogeneity of the data, Shapiro-Wilk and Levene tests were used respectively. To verify the objectives of the study, Independent T (parametric) and Mann-Whitney U tests (non-parametric) were carried out in order to analyze the differences between control and blind group. Statistical Package for the Social Sciences (SPSS) 20.0 was used for all analyses, considering significance at $\alpha = 0.05$.

Results

Statistical analysis revealed no significant differences between BG and CG for age ($p=0.319$), height ($p=0.408$), weight ($p=0.799$), lower limbs length ($p=0.096$) and body mass index ($p=0.459$). Table 1 details the characterization variables for both groups. In table 2, a specific descriptive analysis for BG is presented, opening data by sports, participation time, sports, visual classification, and duration of visual loss. All subjects of this group were classified as B1; seven goalball and five football players ranged from three months to 29 years of sports participation time; several origins of visual disease and duration of visual loss were revealed.

Table 1 Characteristics of subjects

Subjects	Age (years)	Height (cm)	Weight (kg)	LLL (m)	BMI	IPAQ
Blind Group						
1	36	168.0	90.0	0.90	Obese class I	Active
2	50	185.0	80.0	0.93	Normal range	Active
3	33	166.0	54.0	0.81	Normal range	Active
4	24	145.0	48.5	0.68	Normal range	Active
5	48	175.0	83.0	0.87	Pre-obese	Active
6	18	165.0	47.0	0.85	Mild thinness	Active
7	45	149.0	53.0	0.76	Normal range	Active
8	30	180.0	84.0	0.94	Pre-obese	Active
9	24	169.0	75.8	0.82	Pre-obese	Very Active
10	25	170.0	90.0	0.74	Obese class I	Active
11	45	160.0	70.0	0.86	Pre-obese	Active
12	28	187.0	89.0	0.98	Pre-obese	Active
Mean (SD)	31.5 (10.8)	168.2 (12.8)	77.9 (16.9)	0.86 (0.09)	Pre-obese	
Control Group						
13	23	163.0	76.0	0.93	Pre-obese	Active
14	26	179.0	65.0	0.95	Normal range	Active
15	48	153.5	50.9	0.81	Normal range	Active
16	30	181.0	80.0	0.97	Normal range	Very Active
17	24	178.0	78.0	0.93	Normal range	Very Active
18	26	155.0	49.0	0.86	Normal range	Active
19	23	179.0	73.0	0.96	Normal range	Active
20	35	181.0	102.0	0.81	Obese class I	Active
21	38	174.0	78.0	0.78	Pre-obese	Active
22	25	177.0	84.0	0.97	Pre-obese	Active
23	33	189.0	71.0	1.02	Normal range	Active
24	23	160.0	56.0	0.86	Normal range	Very Active
Mean (SD)	26.0 (7.7)	177.5 (11.5)	74.5 (15.0)	0.93 (0.07)	Normal range	

Lower limbs length (LLL), Body Mass Index (BMI), International Questionnaire of Physical Activity (IPAQ).

Table 2 Characteristics of Blind Group

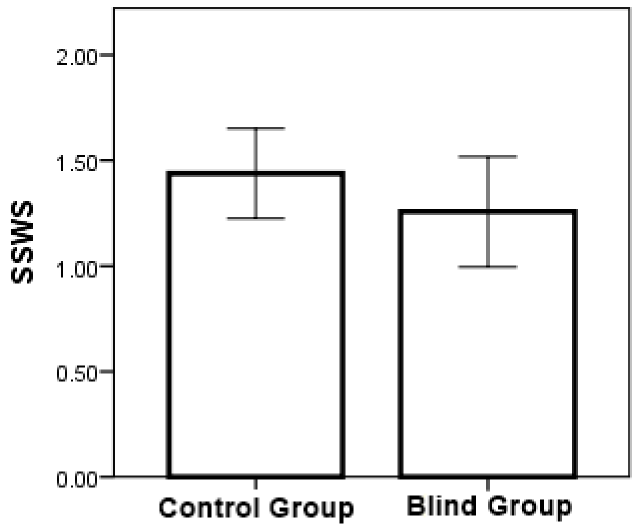
Subjects	Sports	Participation time	Classification	Visual disease	Duration of visual loss (years)
1	Goalball	7 years	B1	Retinitis pigmentosa	Congenital
2	Football	29 years	B1	Retinitis pigmentosa	Congenital
3	Goalball	6 month	B1	Stevens-johnson syndrome	9
4	Goalball	3 month	B1	Toxoplasmosis	9
5	Football	22 years	B1	Toxoplasmosis	28
6	Goalball	6 month	B1	Retinopathy of prematurity	Congenital
7	Goalball	13 years	B1	Glaucoma	Congenital
8	Football	5 month	B1	Retinitis pigmentosa	Congenital
9	Football	9 years	B1	Glaucoma	10
10	Football	6 years	B1	Glaucoma	9
11	Goalball	5 years	B1	Retinitis pigmentosa	Congenital
12	Goalball	2 years	B1	Accident	3

As per the ‘Sit and Stand Test’, no statistic difference was found (p=0.319) between BG (32 repetitions ± 7.83) and CG (29.50 repetitions ± 3.36). These values are in accordance with reference values for the population investigated (Strassmann et al., 2013).

In relation to Static Test, a significant difference between BG (42.00 ± 17.01 seconds) and CG (45.00 ± 00 seconds) (p=0.039) was pointed out, when CG performed with their eyes open. However, this difference disappears when CG performed the same test with their eyes closed (CG = 30.28 ± 17.02 seconds) (p=0.843).

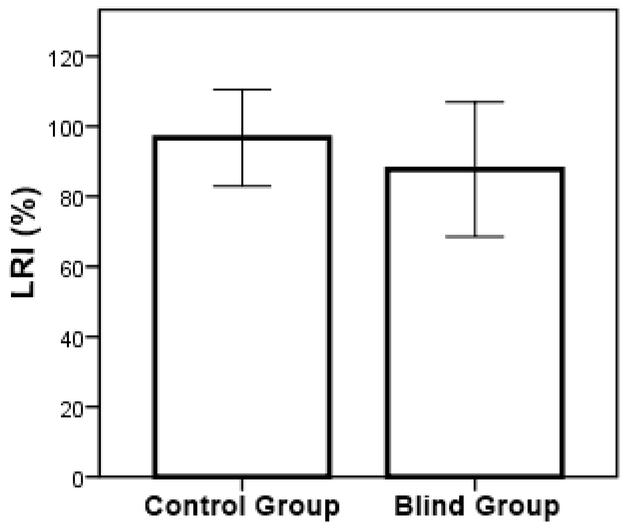
The averages and standard deviation for locomotor variables (SSWS and LRI) are described in figure 1 and 2, respectively. No statistical differences between BG and CG for self-selected walking speed (p=0.076) and locomotor rehabilitation index (p=0.201) were found.

Figure 1 - Self-selected walking speed for control and blind group



The Efficacy Scale of Falls demonstrated differences between BG and CG (p=0.014) in terms of fear of falling. The general average of CG was lower (17.50 ± 3.04) than BG (22.58 ± 3.40), though both groups were classified as "I am not worried". Further data on this tests are presented in the appendix.

Figure 2 - Locomotor rehabilitation index for control and blind group



For spatiotemporal parameters, BG had shorter stride length and greater coefficient of variation in contact time of right leg than CG. All variables are demonstrated in Table 3.

Table 3 Spatiotemporal gait parameters and coefficient of variation

Variables	Control Group	Blind Group	*p* value
Contact time right (s)	0.64 ± 0.56	0.64 ± 0.10	0.869
Contact time left (s)	0.65 ± 0.08	0.67 ± 0.11	0.424
Time of swing right (s)	0.37 ± 0.02	0.38 ± 0.04	0.442
Time of swing left (s)	0.37 ± 0.02	0.37 ± 0.04	0.643
Stride length (m)	1.38 ± 0.16*	1.26 ± 0.16*	0.013
Stride frequency (hz)	0.99 ± 0.07	0.97 ± 0.13	0.941
CoV Contact time right (%)	1.71 ± 0.76*	3.23 ± 1.48*	0.010
CoV Contact time left (%)	1.99 ± 1.52	2.84 ± 2.41	0.242
CoV Time of swing right (%)	2.17 ± 1.27	1.54 ± 1.63	0.647
CoV Time of swing left (%)	5.07 ± 2.17	3.64 ± 3.50	0.260
CoV Stride length (%)	1.47 ± 0.65	1.87 ± 0.63	0.528
CoV Stride frequency (%)	1.47 ± 0.65	1.87 ± 0.63	0.532

Coefficient of variation (CoV)

Discussion

The study aimed to compare the differences in static balance, dynamic variability of gait, muscular endurance of lower limbs, SSWS, LRI and fear of falling between VI athletes and sighted individuals. It can be state that the hypothesis that VI athletes would have similar performance in all parameters in comparison to sighted individuals was considerably confirmed. The main findings showed no significant statistic differences in SSWS, LRI and muscular endurance of lower limbs between both groups. However, BG had less static balance, shorter stride length, greater CoV of the contact time of right leg, and slightly greater fear of falling than CG.

Muscular strength and endurance are important for mobility and they are predictors of mortality in patients with chronic diseases (Bautmans et al., 2004). In ‘sit and stand test’, muscular strength and endurance of lower limbs can be assessed through the number of repetitions achieved by the subjects when standing up and sitting down on a regular chair (Strassmann et al., 2013). It has been shown that VI individuals had impairments with functional mobility tasks that require speed, muscular strength and power to overcome problems with balance and gait, when compared to sighted person (Horvat et al., 2004; Ray et al., 2007).

In our study, we did not find significant differences in ‘sit and stand test’ between both groups. The number of repetitions is in accordance with normative amounts for population at similar age of these groups: 29 to 48 repetitions (Strassmann et al., 2013). It can be considered a good indicator that disability sports participation is providing functionality to this population for daily living activities.

Aydog et al. (2013) compared dynamic postural stability of 20 blind goalball players, 20 sedentary individuals and 20 people with vision using the Biodex Stabilty System. The sedentary blind had worse results among the three groups, while people with vision were the best. In addition, although the control group was better with the eyes open and closed, goalball athletes who practiced twice a week had a mediolateral index better than the sedentary blind group. The authors attributed this finding to the specific characteristics of the modality involving lateral displacements to defend the opponent's ball and jumps to the sides.

Physical activity for people with visual impairment, involving rotational movements of the body stimulating the vestibular system such as dance (Silva et al., 2008) and the proprioceptive system in muscle strength development as in Tai-Chi (Chen et al., 2011) showed to be efficient for the improvement the dynamic and static balance of this population.

Static balance is required in walking performance, daily living activities, stair climbing, changing clothes, among other tasks, and decays with aging (Springer et al., 2007). In the present study, BG group composed by football and goalball players had a lower static balance (42.00 ± 17.01) compared to CG (45.00 ± 00), however, this difference disappeared when CG performed the closed eyes test (30.28 ± 17.02). BG values are below the reference values for people with eyesight between 18-39 years with eyes open (44.7 ± 3.1) and within the values (15.2 ± 13.3) for the same age with closed eyes. One possibility to explain this difference in static balance could be attributed to large ranges of periods of sports practice (from 3 months to 29 years), which can be an important factor for balance gains. In all cases, this aspect should be more deeply investigated.

The walking speed in VI individuals throughout life is lower, as result of poor remaining or residual vision, or any feedback of visual system, as well as social and psychological stress generated by the necessity to face these dynamic tasks. There are few controlled studies to confirm the effect on vision (total blindness vs. low vision) and time of vision loss (congenital blindness vs. acquired blindness) in walking speed, this probably because it is difficult to set up homogeneous groups for the proper assessments. However, there seems to be a tendency for persons who were born with blindness to walk slower than those who acquired blindness in life (Nakamura, 1997). In addition, congenital blind individuals also walk slower than congenital low vision individuals (Hallemans et al., 2011).

In our study, no statistic differences in SSWS between BG (1.29 ± 0.26 m/s) and CG (1.39 ± 0.21 m/s) were found. This is a positive finding, because it might represent that BG was confident in walking with similar speed than CG. In comparison to previous studies in VI individuals at the same age (no physical level described), despite BG was composed of 50% congenital and 50% acquired blindness individuals, BG walked faster than congenitally blind (0.86 ± 0.09 m/s) and acquired blind (1.11 ± 0.13 m/s) (Nakamura, 1997). Similar results are found when we compare results of our BG with individuals with blindness (0.87 ± 0.30 m/s) (Ray et al., 2007) and young adults with blindness (1.09 ± 0.25 m/s) (Hallemans et al., 2010).

Spatiotemporal gait parameters showed that BG had shorter stride length (1.26 ± 0.16 m) than CG (1.38 ± 0.16 m). This result was not surprising, since single support phase is considered a critical moment in maintaining dynamic stability. On the other hand, double support phase is the period of balance recovery (Hallemans et al., 2011). Probably, BG has reduced their stride length to avoid longer time in single support phase, ensuring greater double support phase.

VI individuals have poor efficiency in terms of percentage of SSWS (Clark-Carter, Heyes, and Howarth, 1986). When they walk with their long cane, it represents 74% of their SWSS, this physical efficiency increases to 108% when they use dog-guides. In our study, we did not measure the percentage of SWSS, because this protocol uses the arm of sighted guide to set the pace which they prefer (100% of SSWS), and after, it is necessary to evaluate SSWS again in other conditions, to find out the efficiency. Since sighted healthy individuals reach their SSWS without any aid, we adopted LRI for this comparison.

LRI is a simple and integrative method to evaluate pathological gait and represents how close is SSWS to OWS (Peyré-Tartaruga and Monteiro, 2016). During walking, for each step the energies of the body center of mass (gravitational potential and kinetic) alternate. These changes behave as an inverted pendulum and optimizes muscular work, which occurs when we walk on OWS. In individuals without restriction, SSWS coincides with OWS (Cavagna and Kaneko, 1977; Saibene and Minetti, 2003).

Blind athletes in this study did not differentiate in LRI (88.93 ± 19.24%) when compared to control group (95.42 ± 13.78%). This result could represent that pendular mechanism is optimized for BG as well as for CG. This could also mean that less energy is being expended for walking in both groups, since the values are close to ideal (100%). In other populations with movement disorders, LRI was sensibly impacted depending on the specificity and the features of the disorders, representing a good indicator of how movement can be affected. Individuals with Parkinson's disease, presenting tremor, postural and balance problems, showed 42 to 57% LRI (Monteiro et al., 2016). Patients with chronic heart failure, presenting limited ventilatory efficiency, showed 51 ± 2 % LRI (Figueiredo et al., 2013).

The physical limitations generated by the diseases analyzed in these studies, resulted in a reduction in the walking speed, decreasing LRI of the individuals. However, in our study, the fact that BG maintained an LRI similar to CG suggests that visual impairment in this group of physically active blind individuals is not adversely affecting LRI.

Walking at low speeds is not a dynamically stable situation. Studies that have investigated the effect of speed on gait cycle variation, indicate that coefficient of variability (CoV) has a U-shaped behavior (Beauchet, 2009). CoV increases in lower and high walking speeds, being minimized between 100 and

110% of SSWS (Jordan, Challis and Newell, 2007). Both walking at low speeds, and higher CoV values may indicate some gait instability (Beauchet et al,. 2009; Hausdorff, Rios and Eldelberg, 2001).

Few studies have investigated the effect of walking speed on CoV of individuals with visual impairment. Mason, Legge and Kallie (2005) compared the CoV of step frequency and step length when walking in slow, SSWS and fast conditions. The main result supports the idea that in individuals with visual impairment as well as individuals with preserved vision, the SSWS minimizes the variability of the spatiotemporal gait parameters. Therefore, similar SWSS between GB and CG could represent that GB is walking in stable ranges of variability, decreasing the risk of falling.

In relation to (CoV), the present study found higher values of CoV in GB only for 'time of contact of the right leg' (3.23 ± 1.48%) in comparison to CG (1.71 ± 0.76%). Despite of this difference, the values are in agreement with the normative values of CoV for healthy young subjects of 3 to 5% in SSWS (Jordan, Challis and Newell, 2007).

A possible explanation for this CoV for the right leg is the use of the strategy adopted by individuals with visual impairment to maintain the dynamic balance during walking, called "foot as probe" (Dawson, 1987; Hallemans et al., 2011, Gazzellini et al., 2016). Nine out of the twelve blind athletes had the right leg as the dominant, thus, according to this hypothesis, the subjects could have used their dominant leg to explore the area in front of the body, as haptic exploration, and for this reason, caused this greater variation in contact time with the ground.

As for the BG, FES-I-Brazil revealed an average index of 22.58 ± 3.40 points. This index denotes low fear of falling, differently than might be expected in elderly persons with VI (White et al., 2015). One hypothesis for this low index is the fact that BG were physically active adults and not elderly, and then they improved their motor skills by participating in disability sports, making them better prepared to carry out these activities. Nevertheless, it is a higher index than the CG (18.92 ± 3.00 points), in consonance with other studies (Palagyi et al, 2016) that attested a strong impact of physical function on fear of falling in participants with higher visual disability. To reinforce the idea that sports practice can minimize fear of fall, Matos and Menezes (2012) measured this sensation in blind capoeira players and non-practitioner blind individuals, finding an index of 27 ± 7.64 points for the first group and 35 ± 8.12 points for the second.

A more in-depth analysis of the responses from BG showed that the questions that most revealed fear of falling in this group were those that involved locomotion. The item of greatest concern was ‘walking on uneven surfaces’, followed by ‘walking on slippery surfaces’. The third most worrying answer was ‘visiting friends or relatives’. The fourth biggest concern was ‘walking in crowded places’, and the fifth was ‘to go up and down slopes’. For CG, the major concern was ‘walking on slippery surfaces’.

These results seem to confirm the protagonism of vision in gait, since this action is the result of the interaction of neurological, musculoskeletal, vestibular and somatosensory systems (Rezende et al., 2010). The malfunctioning of these systems, either by diseases, injuries or even by the physiological process of aging, can generate negative effects on such biomechanical function with consequent difficulty or dependence to perform daily life activities and locomotion activities (Rezende et al., 2010).

In conclusion, disability sports participation in goalball and soccer athletes with visual impairment ensure muscular endurance of limbs, which are very important for daily living activities. In addition, it seems that subjects were more confident in having walking speed and locomotor rehabilitation index similar to people with preserved vision.

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CONCLUSÃO GERAL DA MONOGRAFIA

O sistema visual é importante para a locomoção humana, e em pessoas com deficiência visual foram encontradas estratégias biomecânicas adaptativas para a manutenção do equilíbrio dinâmico que diferem de pessoas com a visão preservada. Tais adaptações acontecem em diversas fases da vida a partir da infância.

Alguns fatores podem influenciar na interpretação da velocidade de caminhada de pessoas com deficiência visual, tais como: a origem da deficiência visual (congênita ou adquirida), o tempo de perda de visão e o resíduo visual remanescente. As experiências de visão prévia parecem ser importantes tanto para a organização espacial quanto para a velocidade de caminhada. Dessa forma, aquelas pessoas que já nasceram cegas parecem ser mais prejudicadas. Entretanto, essa diferença entre cegos congênitos e adquiridos parece ser atenuada após um período adaptativo.

A participação em atividades físicas ou esportivas traz diversos benefícios físicos, sociais e de qualidade de vida para pessoas com deficiência visual. Do ponto de vista físico, já foram demonstrados ganhos principalmente relacionados ao controle postural estático e dinâmico. Entretanto, os estudos ainda não tinham relacionado tais benefícios como uma possível reabilitação da locomoção nessa população.

A hipótese da presente monografia era de que os atletas que praticassem esportes adaptados teriam resultados similares na velocidade de caminhada, índice de reabilitação locomotor, variabilidade dinâmica, equilíbrio estático, resistência muscular de membros inferiores e medo de queda na comparação com pessoas com visão.

Apesar de menores valores do comprimento de passada, maior variação do tempo de contato da perna direita e maior medo de queda no grupo de cegos que praticam atividades físicas em comparação ao grupo controle com visão, os atletas com deficiência visual foram classificados com baixo grau de preocupação quanto às quedas, assim como o grupo controle.

Dessa forma, a participação esportiva no *goalball* e no futebol de atletas com deficiência visual B1, além de uma resistência muscular diferenciada de membros inferiores – importantes para as atividades de vida diária – parece haver tornado os sujeitos dessa pesquisa mais confiantes em terem a velocidade de caminhada e um índice de reabilitação locomotor similares aos de pessoas com a visão preservada.

Como aplicação prática, para pessoas com deficiência visual que ainda não praticam nenhuma atividade física ou esporte adaptado, o *goalball,* que tem como principal característica a predominância de deslocamentos laterais para a defesa da bola, pode ser uma ótima opção para a iniciação esportiva. A partir de uma autoconfiança maior para deslocamentos em diversos sentidos, corridas e condução da bola na quadra, o futebol 5 poderia ser incluído em um nível mais avançado de progressão pedagógica para essa população.

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ANEXO A – IPAQ

QUESTIONÁRIO INTERNACIONAL DE ATIVIDADE FÍSICA –VERSÃO CURTA

Nome: ____

Data: ______/ _______ / ______ Idade: ______ Sexo: F ( ) M ( )

Nós estamos interessados em saber que tipos de atividade física as pessoas fazem como parte do seu dia a dia. Este projeto faz parte de um grande estudo que está sendo feito em diferentes países ao redor do mundo. Suas respostas nos ajudarão a entender que tão ativos nós somos em relação à pessoas de outros países. As perguntas estão relacionadas ao tempo que você gasta fazendo atividade física na **ÚLTIMA** semana. As perguntas incluem as atividades que você faz no trabalho, para ir de um lugar a outro, por lazer, por esporte, por exercício ou como parte das suas atividades em casa ou no jardim. Suas respostas são MUITO importantes. Por favor responda cada questão mesmo que considere que não seja ativo. Obrigado pela sua participação!

Para responder as questões lembre que:

- atividades físicas **VIGOROSAS** são aquelas que precisam de um grande esforço físico e que fazem respirar MUITO mais forte que o normal
- atividades físicas **MODERADAS** são aquelas que precisam de algum esforço físico e que fazem respirar UM POUCO mais forte que o normal

Para responder as perguntas pense somente nas atividades que você realiza **por pelo menos 10 minutos contínuos** de cada vez.

1a Em quantos dias da última semana você **CAMINHOU** <u>por pelo menos 10 minutos contínuos</u> em casa ou no trabalho, como forma de transporte para ir de um lugar para outro, por lazer, por prazer ou como forma de exercício?
dias _____ por **SEMANA** ( ) Nenhum

1b Nos dias em que você caminhou <u>por pelo menos 10 minutos contínuos</u> quanto tempo no total você gastou caminhando **<u>por dia</u>**?
horas: ______ Minutos: _____

2a Em quantos dias da última semana, você realizou atividades **MODERADAS** <u>por pelo menos 10 minutos contínuos</u>, como por exemplo pedalar leve na bicicleta, nadar, dançar, fazer ginástica aeróbica leve, jogar vôlei recreativo, carregar pesos leves, fazer serviços domésticos na casa, no quintal ou no jardim como varrer, aspirar, cuidar do jardim, ou qualquer atividade que fez

aumentar **moderadamente** sua respiração ou batimentos do coração **(POR FAVOR NÃO INCLUA CAMINHADA)**
dias _____ por **SEMANA** ( ) Nenhum

2b Nos dias em que você fez essas atividades moderadas por pelo menos 10 minutos contínuos, quanto tempo no total você gastou fazendo essas atividades **por dia**?
horas: ______ Minutos: _____

3a Em quantos dias da última semana, você realizou atividades **VIGOROSAS** por pelo menos 10 minutos contínuos, como por exemplo correr, fazer ginástica aeróbica, jogar futebol, pedalar rápido na bicicleta, jogar basquete, fazer serviços domésticos pesados em casa, no quintal ou cavoucar no jardim, carregar pesos elevados ou qualquer atividade que fez aumentar **MUITO** sua respiração ou batimentos do coração.
dias _____ por **SEMANA** ( ) Nenhum

3b Nos dias em que você fez essas atividades vigorosas por pelo menos 10 minutos contínuos quanto tempo no total você gastou fazendo essas atividades **por dia**?
horas: ______ Minutos: _____

Estas últimas questões são sobre o tempo que você permanece sentado todo dia, no trabalho, na escola ou faculdade, em casa e durante seu tempo livre. Isto inclui o tempo sentado estudando, sentado enquanto descansa, fazendo lição de casa visitando um amigo, lendo, sentado ou deitado assistindo TV. Não inclua o tempo gasto sentando durante o transporte em ônibus, trem, metrô ou carro.

4a Quanto tempo no total você gasta sentado durante um **dia de semana**?
______horas ____minutos

4b Quanto tempo no total você gasta sentado durante em um **dia de final de semana**?
______horas ____minutos

ANEXO B – FES-I-BRASIL

ESCALA DE EFICÁCIA DE QUEDAS – INTERNACIONAL (FES-I)

Agora nós gostaríamos de fazer algumas perguntas sobre qual é sua preocupação a respeito da possibilidade de cair. Por favor, responda imaginando como você normalmente faz a atividade. Se você atualmente não faz a atividade (por ex. alguém vai às compras para você), responda de maneira a mostrar como você se sentiria em relação a quedas se você tivesse que fazer essa atividade. Para cada uma das seguintes atividades, por favor marque o quadradinho que mais se aproxima com sua opinião sobre o quão preocupado você fica com a possibilidade de cair, se você fizesse esta atividade.

		Nem um pouco preocupado 1	Um pouco preocupado 2	Muito preocupado 3	Extremamente preocupado 4
1	Limpando a casa (ex: passar pano, aspirar ou tirar a poeira).	1 ☐	2 ☐	3 ☐	4 ☐
2	Vestindo ou tirando a roupa.	1 ☐	2 ☐	3 ☐	4 ☐
3	Preparando refeições simples.	1 ☐	2 ☐	3 ☐	4 ☐
4	Tomando banho.	1 ☐	2 ☐	3 ☐	4 ☐
5	Indo às compras.	1 ☐	2 ☐	3 ☐	4 ☐
6	Sentando ou levantando de uma cadeira.	1 ☐	2 ☐	3 ☐	4 ☐
7	Subindo ou descendo escadas.	1 ☐	2 ☐	3 ☐	4 ☐
8	Caminhando pela vizinhança.	1 ☐	2 ☐	3 ☐	4 ☐
9	Pegando algo acima de sua cabeça ou do chão.	1 ☐	2 ☐	3 ☐	4 ☐
10	Ir atender o telefone antes que pare de tocar.	1 ☐	2 ☐	3 ☐	4 ☐
11	Andando sobre superfície escorregadia (ex: chão molhado).	1 ☐	2 ☐	3 ☐	4 ☐
12	Visitando um amigo ou parente.	1 ☐	2 ☐	3 ☐	4 ☐
13	Andando em lugares cheios de gente.	1 ☐	2 ☐	3 ☐	4 ☐
14	Caminhando sobre superfície irregular (com pedras, esburacada).	1 ☐	2 ☐	3 ☐	4 ☐
15	Subindo ou descendo uma ladeira.	1 ☐	2 ☐	3 ☐	4 ☐
16	Indo a uma atividade social (ex: ato religioso, reunião de família ou encontro no clube).	1 ☐	2 ☐	3 ☐	4 ☐

APÊNDICE A – FES-I-BRASIL RESPOSTAS

FES-I BRASIL																		
Subjects	Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	Sport	1	1	1	1	1	1	1	1	1	1	2	2	1	2	1	2	20
2	Sport	1	1	2	2	2	1	2	2	1	1	3	2	1	3	2	2	28
3	Sport	1	1	1	1	2	1	1	2	1	1	2	1	1	2	1	1	20
4	Sport	1	1	1	1	2	1	1	2	1	1	2	2	2	2	1	1	22
5	Sport	1	1	1	2	1	1	1	1	2	1	2	2	1	2	2	1	22
6	Sport	1	1	2	1	1	1	1	2	1	1	2	1	1	2	2	1	21
7	Sport	1	1	1	2	1	1	2	1	1	1	2	1	2	2	2	1	22
8	Sport	1	1	1	1	1	2	2	2	1	1	2	2	2	2	1	1	23
9	Sport	1	1	2	1	2	1	1	1	1	1	2	2	2	2	2	2	24
10	Sport	1	1	1	2	2	1	2	2	1	3	3	2	2	4	2	1	30
11	Sport	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	18
12	Sport	1	1	1	1	1	1	1	1	1	1	2	1	3	3	1	1	21
Mean		**1.00**	**1.00**	**1.25**	**1.33**	**1.42**	**1.08**	**1.33**	**1.50**	**1.08**	**1.17**	**2.17**	**1.58**	**1.58**	**2.33**	**1.50**	**1.25**	**22.58**
SD		**0.00**	**0.00**	**0.45**	**0.49**	**0.51**	**0.29**	**0.49**	**0.52**	**0.29**	**0.58**	**0.39**	**0.51**	**0.67**	**0.65**	**0.52**	**0.45**	**3.40**
Subjects	Group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
1	Control	1	1	1	2	1	2	2	2	1	1	3	1	1	2	2	1	24
2	Control	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	17
3	Control	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
4	Control	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	17
5	Control	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	18
6	Control	1	1	1	1	1	1	1	1	2	1	2	1	1	3	3	1	22
7	Control	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	16
8	Control	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	17
9	Control	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	18
10	Control	1	1	1	2	1	1	2	1	1	1	2	1	1	2	2	1	21
11	Control	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	17
12	Control	1	1	1	2	1	2	2	2	1	1	2	1	1	3	2	1	24
Mean		**1.00**	**1.00**	**1.00**	**1.33**	**1.00**	**1.17**	**1.25**	**1.17**	**1.08**	**1.00**	**1.92**	**1.00**	**1.00**	**1.50**	**1.50**	**1.00**	**17.50**
SD		**0.00**	**0.00**	**0.00**	**0.49**	**0.00**	**0.39**	**0.45**	**0.39**	**0.29**	**0.00**	**0.51**	**0.00**	**0.00**	**0.80**	**0.67**	**0.00**	**3.00**

APÊNDICE B - CIÊNCIA E CONCORDÂNCIA ACERGS

TERMO DE CIÊNCIA E CONCORDÂNCIA

Eu,____ ___________, Coordenador de Esporte e Cultura da Associação de Cegos do Rio Grande do Sul – ACERGS, estou ciente e de acordo com o desenvolvimento do projeto de pesquisa intitulado A INFLUÊNCIA DA PRÁTICA ESPORTIVA NO EQUILÍBRIO, RESISTÊNCIA MUSCULAR, VELOCIDADE DE CAMINHADA E MEDO DE CAIR EM PESSOAS COM DEFICIÊNCIA VISUAL, do aluno de graduação em Educação Física da Universidade Federal do Rio Grande do Sul – UFRGS, Edson Soares da Silva, sobre a orientação do Prof. Dr. Leonardo Alexandre Peyré-Tartaruga.

Na atribuição de minhas funções autorizo os referidos integrantes da pesquisa, utilizar como amostra de pesquisa os atletas participantes das modalidades _______________, ________________, _________________, __________________, _______________, da referida unidade, desde seja feito previamente um convite e explicação detalhada de todos os procedimentos, assinatura do termo de consentimento livre e esclarecido e riscos e benefícios que consiste esse estudo.

Sem mais para o momento atesto a veracidade das informações descritas acima.

Porto Alegre, ________________________________

____

(Assinatura do Coordenador de Esporte e Cultura-ACERGS)

APÊNDICE C – TERMO DE CONSENTIMENTO

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Gostaria de lhe convidar a participar da pesquisa cujo objetivo é comparar e verificar a relação entre estabilidade (estática e dinâmica) e o teste de sentar e levantar entre deficientes visuais praticantes de esportes adaptados e pessoas com visão. Esta pesquisa irá ajudar compreender os benefícios das atividades físicas em pessoas com deficiência visual.

Para coleta de dados serão aplicados dois questionários: FES-I-Brasil e IPAQ-versão curta, e serão realizados três testes funcionais: apoio unipodal, VAS e o teste de sentar e levantar em 1 minuto. O primeiro questionário é composto de 16 itens sobre a sua preocupação com quedas, e o segundo questionário é composto de 4 questões que avalia o seu nível de atividade física. O teste de apoio unipodal irá avaliar o seu equilíbrio estático pela manutenção da postura com apenas a perna dominante durante 45 segundos em 3 tentativas. Na VAS, você irá caminhar três vezes em uma velocidade confortável, numa distância de 15 metros, e a mesma será filmada para o cálculo do índice de reabilitação locomotor, e a estabilidade dinâmica. Por último, o teste de sentar e levantar irá avaliar a resistência dos membros inferiores ao levantar e sentar de uma cadeira durante 1 minuto. As avaliações serão realizadas em apenas um dia, na Escola de Educação Física, Fisioterapia e Dança e a cada teste será feito um intervalo de 10 minutos.

Os possíveis riscos ou desconfortos decorrentes da participação na pesquisa são: fadiga durante o teste de sentar e levar e o risco de quedas durante a realização dos testes. Entretanto, para sua segurança, a cada teste haverá dois assistentes próximos que irá interromper o teste caso haja desequilíbrios graves e garantir a sua segurança. Os possíveis benefícios decorrentes da participação na pesquisa são saber seu equilíbrio estático, estabilidade dinâmica da caminhada e a resistência de membros inferiores. Sua participação na pesquisa é totalmente voluntária, ou seja, não é obrigatória. Caso você decida não participar, ou ainda, desistir de participar e retirar seu consentimento, não haverá nenhum prejuízo ao atendimento que você recebe ou possa vir a receber na instituição. Não está previsto nenhum tipo de pagamento pela sua participação na pesquisa e você não terá nenhum custo com respeito aos procedimentos envolvidos. Caso ocorra alguma intercorrência ou dano, resultante de sua participação na pesquisa, você receberá todo o atendimento necessário, sem nenhum custo pessoal.

Os dados coletados durante a pesquisa serão sempre tratados confidencialmente. Os resultados serão apresentados de forma conjunta, sem a identificação dos participantes, ou seja, o seu nome não aparecerá na publicação dos resultados.

Caso você tenha dúvidas, poderá entrar em contato com o pesquisador responsável Prof. Dr. Leonardo Alexandre Peyré-Tartaruga, pelo telefone (51) 3308-5817 com o Comitê de Ética em Pesquisa da Escola de Educação Física, Fisioterapia e Dança da UFRGS, pelo telefone (51) 3308 3738. Esse Termo é assinado em duas vias, sendo uma para o participante e outra para os pesquisadores.

____

Nome do participante da pesquisa

____

Assinatura

____

Nome do pesquisador que aplicou o Termo

____

Assinatura

Local e Data: ____________________________

APÊNDICE D – CALCULO AMOSTRAL

Velocidade de caminhada

t tests - Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	Two
	Effect size d	=	3,33
	α err prob	=	0,05
	Power (1-β err prob)	=	0,95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	4,7093312
	Critical t	=	2,4469119
	Df	=	6
	Sample size group 1	=	4
	Sample size group 2	=	4
	Total sample size	=	8
	Actual power	=	0,9724230

Comprimento de passada

t tests - Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	Two
	Effect size d	=	1,9
	α err prob	=	0,05
	Power (1-β err prob)	=	0,95
	Allocation ratio N2/N1	=	1

Output:	Noncentrality parameter δ	=	4,0305087
	Critical t	=	2,1199053
	Df	=	16
	Sample size group 1	=	9
	Sample size group 2	=	9
	Total sample size	=	18
	Actual power	=	0,9655194

Tempo de contato

t tests - Means: Difference between two independent means (two groups)

Analysis:	A priori: Compute required sample size		
Input:	Tail(s)	=	Two
	Effect size d	=	1,85
	α err prob	=	0,05
	Power (1-β err prob)	=	0,95
	Allocation ratio N2/N1	=	1
Output:	Noncentrality parameter δ	=	3,9244426
	Critical t	=	2,1199053
	Df	=	16
	Sample size group 1	=	9
	Sample size group 2	=	9
	Total sample size	=	18
	Actual power	=	0,9572572