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GAIT STABILITY OF ADULTS WALKING IN DIFFERENT LIGHT LEVELS

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INTRODUCTION

The gait stability can be defined as a relation between the center of mass (COM) and the base of support (BOS) at different moments, like: heel strike (HS) and foot off (FO). The gait stability also has relation with the walking speed, the step length and the cadence [1-3].

The visual system plays a fundamental role in dynamic stability control. During walking, the visual deprivation induces changes in spatiotemporal parameters: decrease of gait speed, decrease of step length and increase of double stance time [1, 2]. These patterns are adopted to maintain a cautious gait pattern. However, adults apparently have a well defined motor behavior that enables overcome challenges during walk better than other groups [1]. This may suggest that adults can have stability even walking with disturbed visual conditions.

Therefore, the aim of current study is to analyze the gait stability of adults walking in different light levels. We hypothesize that stability will decrease when adults walk in low light levels.

METHODS

Ten young adults (mean [standard deviation]; age: 25.6 [3.3] years; height: 176.4 [8.2] cm; weigh: 77.1 [18.6] kg) with good visual acuity (20/20 in Snellen test) participated voluntarily of the study. They walked barefoot on a walkway (5m) in two different visual conditions of light: full vision (FV) and darkened vision, using masks involved by automotive films (Figure 1) of 50% (V50), 20% (V20) and 5% (V5). Each number percentage represents the light level passing through the film until the eye. The participants walked at two different speeds: self-selected (V_{AUTO}) and 130% of self-selected ($V_{130\%}$) walking speed.

Figure 1: Masks used to decrease light level.

The kinematic data were obtained by VICON system (VICON motion system, UK), with seven infrared cameras operating at 100 Hz. 39 markers were attached to body landmarks in each individual to calculate COM position. All the kinematic data were filtered using a fourth-order Butterworth filter with cutoff frequency set at 8 Hz. HS and FO events were automatically determined from an AMTI OR6-6 2000 (Advanced Mechanical Technologies Inc.) force plate operating at 1000 Hz.

The spatiotemporal parameters assessed were: step length – measured by the distance between the heel markers at HS – and gait velocity – measured by the ratio between distance and time to walking through the walkway. The stability parameters were measured using the extrapolated center of mass (XCOM) concept proposed by Hof [1]. The stability parameters evaluated were: the margin of stability (MOS) and the COM separation (COM_{SEP}) [7] – assessed by the shorter distance between XCOM and BOS limit (BOS_{LIM}) at HS and FO, respectively (Equation 1) – in the anteroposterior (AP) direction. The BOS limit adopted was the AP position of the heel marker at HS (ipsilateral foot) and FO (opposite foot) moments.

Equation 1: $MOS/COM_{SEP} = BOS_{LIM}\,(HS/FO) - XCOM$

The XCOM ($XCOM = COM_{AP} + COM_{VEL}/\sqrt{g.l^{-1}}$) depends of: the instantaneous COM AP position (COM_{AP}), instantaneous COM AP velocity (COM_{VEL}), the distance between COM and centre of ankle joint in the sagittal plane (l) and the acceleration of gravity (g). Both spatiotemporal and stability parameters were normalized by leg length – measured by the distance between anterior sacral iliac marker and medial malleolus of the ankle.

An ANOVA for repeated measures (with Bonferroni post hoc) compared the gait parameters between the different light levels. The significance level adopted for all tests was 0.05.

RESULTS AND DISCUSSION

No differences were seen in the spatiotemporal and stability parameters between the different light levels at both walking speeds (Table 1).

The unstable gait is associated with slower walking velocities [2]. Maybe this is the most important finding of the study. The nonappearance of changes in gait velocities can explain the maintenance of stability even walking in low light levels.

Higher values of MOS represent a safe condition at HS, because the COM is more distant from the BOS limit. A higher COM_{SEP} can be considered an individual ability to displace and capture the COM outside the BOS at FO [2, 7]. We did not observe any changes in these parameters between light levels. Apparently, walking in low light levels is not a challenging situation for young adults.

CONCLUSIONS

The light level does not change the gait stability in adults. This suggests that young adults can control the gait stability even in low light levels.

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Table 1: Spatiotemporal and stability parameters (normalized by leg length) in the different light levels at both walking speeds. Results are display in mean (standard deviation).

	V_{AUTO}					$V_{130\%}$				
	FV	**V50**	**V20**	**V5**	**p**	**FV**	**V50**	**V20**	**V5**	**p**
Gait velocity	1.51	1.55	1.54	1.46	0.17	1.97	2.01	2.01	1.89	0.17
($m.s^{-1}/m$)	(0.25)	(0.29)	(0.23)	(0.21)		(0.32)	(0.38)	(0.30)	(0.28)	
Step length	0.79	0.80	0.80	0.78	0.40	0.90	0.91	0.91	0.89	0.50
(m/m)	(0.07)	(0.09)	(0.07)	(0.07)		(0.08)	(0.08)	(0.08)	(0.09)	
MOS	0.24	0.24	0.24	0.23	0.16	0.27	0.26	0.27	0.26	0.13
(m/m)	(0.03)	(0.03)	(0.03)	(0.03)		(0.03)	(0.03)	(0.03)	(0.03)	
COM_{SEP}	0.11	0.11	0.11	0.10	0.23	0.14	0.15	0.14	0.14	0.29
(m/m)	(0.03)	(0.04)	(0.03)	(0.03)		(0.03)	(0.03)	(0.03)	(0.03)	

Legend: V_{AUTO} – self-selected gait speed; $V_{130\%}$ – 130% of self-selected gait speed; FV – full vision; V50/V20/V5 – darkened vision using masks with 50%, 20% and 5% of light level; MOS – margin of stability; COM_{SEP} – COM separation.