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Comportamento do pé no período de balanço do ciclo da marcha de mulheres: estudo comparativo entre diferentes faixas etárias e sua relação com as quedas

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Dedico este trabalho ao Dr Cláudio de Almeida Borges, meu mentor intelectual (in Memoriam). Obrigado pelos valiosos ensinamentos e exemplo de vida, desde o início da graduação até os primeiros anos da minha vida profissional. À minha amada esposa Ana Clara Bittencourt Santos Morais pelo apoio, incentivo, amor e cuidado com a nossa família. Aos meus pais, Heloiza Helena de Castro Ribeiro e Geraldo Martins Ribeiro Sobrinho, pelo apoio incondicional.

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A Deus, pela graça da vida. A Ele, toda a honra e toda a glória, hoje e para sempre.

Aos familiares e amigos que me apoiaram e entenderam as inúmeras ausências.

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SUMÁRIO

TABELAS, FIGURAS, APÊNDICES E ANEXOS

SÍMBOLOS, SIGLAS E ABREVIATURAS

VMP	Velocidade Máxima do Pé
MFV	Maximum foot velocity
LMP	Liberação mínima do pé
MFC	Minimum foot clearance
TCLE	Termo de consentimento livre e esclarecido
UFG	Universidade Federal de Goiás
UEG	Universidade Estadual de Goiás
UNB	Universidade de Brasília
SPSS	Statistical Package for Social Sciences
UNB	Universidade de Brasília
y	Years
m	Metros
kg	Kilogramas
m/s	Metros por segundo
%	Porcentagem

RESUMO

Introdução: O tropeço é um evento comum associado a quedas entre idosos. A liberação mínima do pé (LMP) é um fator crítico no controle do período de balanço da marcha associado a tropeços e quedas. **Métodos**: Estudo observacional transversal aprovado pelo comitê de ética em pesquisa da Universidade Federal de Goiás com parecer de número 741.298. Foi realizada a análise tridimensional da marcha de 55 mulheres saudáveis (20 jovens, 20 meia idade e 15 idosas) com o objetivo de avaliar se há diferença nas características do LMP entre os três grupos etários. A ANOVA foi utilizada para comparar os grupos. A Regressão Linear Múltipla foi utilizada para testar a previsão da amplitude de movimento do tornozelo e joelho, idade e velocidade máxima do pé sobre a LMP. **Resultados**: As mulheres idosas caminharam mais lentamente, com menor LMP e menor velocidade máxima do pé no período de balanço que jovens e o grupo de meia-idade. Houve maior amplitude de flexão do quadril e menor amplitude de dorsiflexão durante a LMP no grupo de idosas. Há forte relação positiva entre dorsiflexão e LMP. A amplitude de dorsiflexão do tornozelo foi a variável com mais capacidade de previsão sobre a LMP. **Discussão**: Mulheres idosas caminham mais lentamente, com menor LMP e menor amplitude de dorsiflexão que jovens. O aumento da flexão do quadril pode representar uma adaptação para evitar tropeços. A velocidade de marcha não mostrou relação com esses achados. Nenhuma diferença foi encontrada entre o grupo jovem e de meia-idade.

PALAVRAS-CHAVE: Acidentes por quedas; Marcha; Pé; Saúde da Mulher; Tecnologia Biomédica.

ABSTRACT

Background: Tripping is a common event leading to falls amongst elderly. Minimum foot clearance (MFC) is a critical swing phase control factor associated with tripping and falls. **Research question**: Is there differences in MFC characteristics among three age groups of women? **Methods**: Cross-sectional observational study approved by the research ethics committee of the Federal University of Goiás under protocol number 741.298 . Tridimensional gait analysis of 55 healthy women. ANOVA was used to compare MFC characteristics among young, middle-aged and elderly groups. Multiple Linear Regression Analysis was used to test prediction over MFC. **Results**: Elderly women walked slower, with lower MFC and lower maximum toe velocity during swing (MFV) than young and middle-aged women. There were more hip flexion and less ankle dorsiflexion during MFC among elderly. There is a strong positive relationship between dorsiflexion and MFC. And ankle dorsiflexion was the most predictive variable over MFC. **Discussion**: Elderly women walk slower with lower MFC value and less ankle dorsiflexion than gender-matched young controls. Increased hip flexion may represent a gait adaptation to avoid tripping. Gait speed had no effect on those findings. No differences were found between the young and middle-aged group.

KEYWORDS: Accidental Falls; Gait; Foot; Women's Health; Biomedical Technology.

1 INTRODUÇÃO GERAL

O caminhar é a forma de locomoção bípede adotada pelos seres humanos. Apesar de sua complexidade e eficiência, o gasto energético da marcha normal é mínimo[1].

Durante a marcha, os membros inferiores alternam períodos em que o pé está apoiado no chão (período de apoio) com períodos em que o mesmo avança em um movimento pendular (período de balanço)[2]. Durante o período de balanço, o membro que avança chega a alcançar um pico de 4,6m/s de velocidade linear, o que corresponde a aproximadamente o quádruplo da velocidade de marcha[3]. Segundo o mesmo autor, no instante em que atingimos a velocidade máxima do pé (VMP), o ponto mais distal desse segmento alcança sua distância mínima até o chão. É comum utilizar-se o termo "liberação mínima do pé" (LMP) para nos referirmos a essa aproximação máxima do pé com a superfície de apoio[4-10]. Essas características do período de balanço fazem com que o instante da VMP seja de alto risco para tropeços e quedas[11, 12].

Os efeitos do envelhecimento na marcha de indivíduos saudáveis já foram extensivamente investigados[13-18]. Os efeitos típicos do envelhecimento nos parâmetros básicos de marcha incluem redução no comprimento do passo e cadência, aumento no tempo do período de apoio e no tempo de suporte duplo[18-20] . O envelhecimento também está associado à redução na LMP[18]. Algumas dessas alterações já foram identificadas como fatores intrínsecos de risco de quedas em idosos[21]

As quedas são um importante problema de saúde pública e estão associadas a significativa morbidade e mortalidade[22, 23] além dos altos custos assistenciais[24]. Suas causas são multifatoriais e associadas a mecanismos que desafiam a estabilidade postural[25]. Um evento frequentemente reportado como causa de quedas é o tropeço durante a marcha[11, 22 ,26-30]. Segundo Khandoker[4], a LMP e a VMP são medidas críticas para o controle do período de balanço da marcha associadas a tropeços e quedas. Hitt e colaboradores[31] testaram a associação de múltiplas características da marcha com quatro instrumentos de avaliação de fragilidade (Fenótipo de Fragilidade, Escala de Fragilidade Clínica, Índice de Fragilidade e Índice de Fragilidade Baseado em Avaliação Geriátrica Abrangente) e encontraram associação entre LMP e todos os instrumentos. Também já foi demonstrado que idosos que experimentaram episódios de quedas apresentam LMP menor do que os que não caíram[32].

Várias investigações já foram conduzidas comparando os valores da LMP entre idosos e jovens[6-9, 33-37]. Nesses estudos, os autores não reportaram diferença no valor da LMP entre os dois grupos, porém os grupos avaliados eram compostos exclusivamente por homens ou uma amostra mista de homens e mulheres, contudo, é sabido que mulheres idosas tropeçam mais[33], caem mais[38] e têm LMP menor que homens idosos[39, 40].

Compreender as diferenças na mecânica do período de balanço entre diferentes faixas etárias de mulheres saudáveis pode trazer informações que permitam traçar estratégias de prevenção de quedas em grupos etários que apresentem condições de risco. Assim como o proposto por Winter[3], a hipótese desta investigação é que, entre mulheres idosas, a LMP seja menor quando comparada a de mulheres jovens ou de meia-idade.

2 OBJETIVO

O objetivo desta investigação foi comparar a liberação mínima do pé, velocidade máxima do pé e cinemática dos membros inferiores no instante da VMP, entre três faixas etárias de mulheres hígidas, e descrever as diferenças enfatizando aquelas reconhecidas como indicativas do risco de quedas.

3 PUBLICAÇÃO

Artigo submetido

Fall-Related Foot-Ground Clearance Characteristics In Women: A Comparison Across Different Ages

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Cover letter

1st May 2018

Dr Julie Stebbins
Editor
Gait and Posture
Elsevier

Dear Dr Stebbins,

Please find attached the manuscript “Fall-Related Foot-Ground Clearance Characteristics In Women: A Comparison Across Different Ages”, which I would be grateful if you could consider for publication in Gait and Posture.
Each of the authors has read and concurs with the content in the final manuscript. The material within has not been and will not be submitted for publication elsewhere except as an abstract.

Authors’ contribution and roles:

Darlan Martins Ribeiro: Conception and design of the study, acquisition and interpretation of data, drafting the manuscript and revising it critically for important intellectual content, final approval of the version to be submitted.

Guilherme Augusto Santos Bueno: Acquisition, analysis and interpretation of data, revising the manuscript critically for important intellectual content, final approval of the version to be submitted.

Flavia Martins Gervásio: Conception and design of the study, acquisition and interpretation of data, revising the manuscript critically for important intellectual content, final approval of the version to be submitted.

Ruth Losada de Menezes: Conception and design of the study, revising the manuscript critically for important intellectual content, final approval of the version to be submitted, supervision of the whole process.

Best wishes

Darlan Ribeiro

Highliths

- Elderly women walk slower and show lower minimum toe clearance than young
- Ankle dorsiflexion critically influences toe clearance
- Increased hip flexion in elderly indicates a gait adaptation to avoid tripping
- Gait speed have no effect on these parameters

Title page

Fall-Related Foot-Ground Clearance Characteristics In Women: A Comparison Across Different Ages

(Original article)

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Fall-Related Foot-Ground Clearance Characteristics In Women: A Comparison Across Different Ages

1. ABSTRACT

Background: Tripping is a common event leading to falls amongst elderly. Minimum foot clearance (MFC) is a critical swing phase control factor associated with tripping and falls. **Research question**: Is there differences in MFC characteristics among three age groups of women? **Methods**: Cross-sectional observational study. Tridimensional gait analysis of 55 healthy women. ANOVA was used to compare MFC characteristics among young, middle-aged and elderly groups. Multiple Linear Regression Analysis was used to test prediction over MFC. **Results**: Elderly women walked slower, with lower MFC and lower maximum foot velocity during swing (MFV) than young and middle-aged women. There were more hip flexion and less ankle dorsiflexion during MFC among elderly. There is a strong positive relationship between dorsiflexion and MFC. And ankle dorsiflexion was the most predictive variable over MFC. **Significance**: Elderly women walk slower with lower MFC value and less ankle dorsiflexion than gender-matched young controls. Increased hip flexion may represent a gait adaptation to avoid tripping. Gait speed had no effect on those findings. No differences were found between the young and middle-aged group.

KEYWORDS: Minimum-toe-clearance, accidental-falls, elderly, gait, foot, women's health.

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2. INTRODUCTION

Falls in the elderly population are an important public health problem related to morbidity and mortality [1], with tripping during gait been reported as a frequent event leading to falls [1, 2]. During swing phase, the lower limb acts like a compound pendulum and its distal point reaches the highest speed of the role gait cycle at approximately half of the swing phase period [3, 4]. Throughout the foot trajectory, the maximum toe velocity (MFV) and minimum toe clearance (MFC) are reached simultaneously. MFC is defined as the minimum distance between the foot and the ground during swing. MFC and MFV are identified as critical swing phase control factors associated with tripping and falls[5]. MFC was also associated with frailty [6]. Elderly fallers have lower MFC values than non-fallers [7] and elderly women are at increased tripping risk [8], show lower MFC [9, 10] and fall more frequently than age-matched men [11]. Several authors did not report MFC difference between young and elderly persons [8, 12-14] although none of those investigations have assessed a sample composed exclusively of women.

Gait speed effect on lower limb kinematics was already tested [15] and the range of motion changes influenced by speed might bring information about gait motor control strategies.

Understanding swing phase mechanics between different ages might bring insights that help to develop fall-preventing strategies to groups with fall-risk. As proposed by Winter[3], our hypothesis is that MFC is lower among elderly women when compared to younger gender-matched groups.

The aim of this investigation was to compare MFC, MFV and lower limb kinematics across three age groups of healthy women emphasising those differences known to be fall-risk related.

3. METHODS

A cross-sectional study conducted at the State University of Goias gait laboratory, Goiânia, Brazil. Prior to data collection, all participants provided informed consent approved by Human Research Ethics Committee of the Federal University of Goias.

3.1. PARTICIPANTS

A group of healthy women from a community assistance program of the State University of Goias were invited. All participants were part of another study already published [16]. They were assigned to three age groups as proposed by other authors [12]: A (young 20-39y), B (middle-age 40-59y) and C (elderly over 60y). All were pain-free, able to walk without assistive devices, had no history of lower limb, pelvis or spine surgery, no falls reported in the past 12 months, body mass index (BMI) below 30kg/m^2, no alcoholic ingestion 24 hours prior to data collection. All over 60-year-old participants scored over 20 on Mini-Mental State Examination.[6]

The sample size was calculated using a confidence interval of 95% and power of 85% for MFC with Cohen Effect Size of 0,481. Total sample size should be 56 participants, considering 10% loss.

3.2. EXPERIMENTAL PROCEDURES

A three-dimensional motion analysis system (Peak Performance Technologies, Englewood, Colorado, EUA) was used with 6 cameras (Pulnix® TM 6701AN). Markers trajectory was sampled at 120Hz and processed with a fourth order Butterworth filter cut-off frequency of 10Hz [17]. The conventional gait model was used and the most distal point of the feet was defined according to the published elsewhere [4, 18]. Manual event detection technic was used [19] since there is no significant accuracy difference between manual and automated detection technics [20]. All data were normalized by the gait cycle. MFV was defined as the peak forward foot velocity between foot-off and the subsequent foot contact and MFC was the minimum vertical distance from the foot's distal point to the ground measured in time synchrony with MFV. The swinging limb's hip coronal and sagittal kinematics along with knee and ankle sagittal kinematics and opposite limb knee sagittal kinematics were all collected in synchronicity with the MFV.

Each participant wore minimum clothes and walked barefoot, looking straight ahead at a self-selected comfortable speed through an eight meters walkway. Data collection started after three steps and finished three steps before the end of the walkway. Data from both lower limbs were used for analysis. Height and body mass (BM) were assessed as well.

3.3. DATA ANALYSIS

All analyses were performed using SPSS 23.0 (IBM Corp, Armonk NY, USA). Normalcy distribution was tested using Shapiro-Wilk test. Groups were compared using ANOVA with Tukey's post hoc test. The relationship was tested using Pearson and multiple linear regression analysis was performed to test age, gait velocity, MFV, hip, knee and ankle kinematics and opposite knee kinematics on predicting MFC ($p \leq 0,05$).

4. RESULTS

A total of 55 women (110 limbs) participated in this study. Group A (40 limbs; 29,15y ±5,48; height 1,585m ±0,059; BM 55,17kg/m^2 ±7,03), group B (40 limbs; 48,65y ± 6,07; height 1,57m ±0,51; BM 58,71 ±6,42) and group C (30 limbs; 65,73y ±4,39; height 1,55m ±0,054; BM 62,56 ±9,83). Table 1 shows the result of ANOVA. Age was different among all groups and height showed no difference (p=0,266).

Insert Table 1 about here

Between A and C, BM (p0,019) and BMI (p<0,001) were different. Group C walked slower (p=0,001), with shorter steps (p<0,001) and lower cadence (p=0,006) than group A.

MFV was higher on group A than on C (p<0,001), as well as MFC (p=0,036). MFC and MFV timings were not different among the three groups (p=0,689) and occurred at 79% of the gait cycle.

Hip and ankle kinematics at MFV were different between groups as well. Group C showed more hip flexion (p=0,04) and less ankle dorsiflexion (p=0,028) than group A. No difference was found between groups A and B. Coronal hip and sagittal opposite knee kinematics were not different among groups.

Relationship test results (table 2) showed that age has moderate negative relationship with gait velocity (r = -0,563; p<0,000) and MFV (r = -0,490; p<0,000). Gait velocity showed moderate positive relationship (r = 0,486; p<0,000) with MFV, weak negative relationship with hip flexion (r = -0,228; p=0,018) and no relationship with MFC (p=0,107), knee kinematics (p=0,911) or ankle kinematics (p=0,180).

Ankle dorsiflexion showed strong positive relationship with MFC (r = 0,68; p<0,000).

Insert Table 2 about here

Multiple linear regression analysis (table 3) revealed that ankle dorsiflexion has the highest predictive value over MFC (R^2ajusted 0,457; p<0,000) followed by knee kinematics (R^2ajusted 0,076; p=0,002), age (R^2ajusted 0,056; p=0,008) and MFV (R^2ajust 0,046; p=0,015).

Insert Table 3 about here

5. DISCUSSION

This investigation aimed to compare the characteristics of minimum toe clearance, maximum toe velocity and lower limb joint kinematics on MFV amongst three group ages of healthy women emphasizing those characteristics known to be fall-risk indicative. As found by other authors [12, 21, 22], the central tendency measures of gait velocity and step length were lower in elderly and no difference was found between the young and middle-aged group or between middle-aged and elderly. In this study, it was expected to find differences between young and middle-aged that could be early indicators of fall-risk, although no tested variable was different between those groups. That might indicate that the onset of gait functional decline is only detectable after 60 years of age and, following Guillain[9], increases after 70 years of age.

As shown by some investigators [5, 10, 22], our data showed that the elderly group had lower MFC values than young. Other authors did not find any difference between those age groups [8, 12-14, 24]. However, none of those studies assessed a sample that was exclusively women composed.

MFC on MFV is known to be a critical swing control factor that can lead to tripping and falls [3, 25]. This study investigated MFC control assessing lower limb joint kinematics in time synchronicity with MFV. It is known that ankle joint movement has an important role on MFC [18, 26-28]. Those authors suggest that ankle dorsiflexion is a critical factor in MFC control, which is confirmed by our data. The multiple linear regression analysis demonstrated that ankle dorsiflexion was the

main MFC predicting variable, while knee movement, age and MFV had much lower predicting capacity (table 3).

It was demonstrated that gait velocity has a positive relationship with MFC [26, 27]. Those authors did not assess gender influence as well. Our data did not reproduce those findings whereas, in this investigation, gait velocity had no relationship with MFC (p=0,107). Alcock[11] had stated that swing phase mechanics changes in elderly women cannot be fully explained only by gait speed and age. It is possible that MFC is influenced by the typical ageing motor decline process [29] or mediated by declines in muscular strength, flexibility and postural control, common in the elderly [30, 31].

The elderly group had more hip flexion during MFC than younger group (p=0,04) and walked slower (p=0,001). Schwartz [15] tested the influence of gait speed on lower limb kinematics and had demonstrated that hip flexion during swing phase decreases with slower gait speeds in typically developing children and stated that these findings could be extrapolated to adults. In contrast, our data showed weak negative relationship (R -0,228; p=0,018) between speed and hip flexion during MFC. The observed hip flexion increase might indicate a gait adaptation to the MFC decrease in order to reduce the likelihood of tripping over the swinging foot trajectory.

A limitation of this investigation is that the elderly group is relatively young (65,73y ±4,39) and does not include participants over 80-year-old. An older sample could highlight those differences um swing phase mechanics.

6. CONCLUSION

This study endorses previous literature reports indicating that elderly women walk slower and show lower minimum toe clearance than young. Our findings confirm that ankle dorsiflexion critically influences toe clearance and that gait speed may have no effect on these parameters.

Increased hip flexion in the elderly group might indicate a gait adaptation to avoid tripping.

Further investigations assessing factors like muscle strength, postural balance and proprioception with older elderly groups are needed and might yield new insights on the underlying mechanisms of swing phase motor control.

7. CONFLICT OF INTEREST STATEMENT

All authors declare that they have no conflict of interest

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Table 1. Data description and comparison. Young (A), middle-aged (B) and elderly group (C). BMI = body mass index; MFV = maximum toe velocity; MFC = minimum toe clearance; ND = no difference

		N	Mean	SD	ANOVA – one way p	post-hoc Tukey A/B	post-hoc Tukey A/C	post-hoc Tukey B/C
AGE (YEAR)	A	20	29,15	5,48	<0,001	<0,001	<0,001	<0,001
	B	20	48,65	6,07				
	C	15	65,73	4,39				
WEIGHT (kg)	A	20	55,17	7,03	0,025	0,321	0,019	0,317
	B	20	58,71	6,42				
	C	15	62,56	9,83				
HEIGHT (m)	A	20	1,58	0,05	0,266	ND	ND	ND
	B	20	1,57	0,05				
	C	15	1,55	0,05				
BMI (kg/m²)	A	20	21,95	2,60	<0,001	0,135	<0,001	0,042
	B	20	23,58	1,91				
	C	15	25,82	3,40				
GAIT PARAMETERS								
CADENCE (steps/min)	A	20	115,65	7,47	0,009	0,215	0,006	0,237
	B	20	111,42	8,71				
	C	15	107,01	7,13				
GAIT VELOCITY (m/s)	A	20	1,25	0,13	0,001	0,052	0,001	0,180
	B	20	1,14	0,16				
	C	15	1,06	0,10				
STEP LENGTH (m)	A	40	0,65	0,04	<0,001	0,033	<0,001	<0,001
	B	40	0,62	0,06				
	C	30	0,56	0,05				
MFV (m/s)	A	40	4,32	0,45	<0,001	0,123	<0,001	0,037
	B	40	4,11	0,50				
	C	30	3,83	0,46				
MFV TIMING (%)	A	40	79,86	2,39	0,689[1]	ND	ND	ND
	B	40	79,32	2,22				
	C	30	79,83	2,18				
MFC (m)	A	40	0,05	0,01	0,044	0,671	0,036	0,197
	B	40	0,04	0,01				
	C	30	0,04	0,01				
HIP CORONAL	A	40	3,37	3,11	0,881	ND	ND	ND
	B	40	2,98	4,38				

	C	30	3,38	4,08				
	A	40	25,89	9,09				
HIP SAGITTAL	B	40	29,53	4,96	0,031	0,094	0,040	0,861
	C	30	30,49	8,49				
	A	40	49,97	10,19				
KNEE SAGITTAL	B	40	52,03	6,01	0,593[1]	ND	ND	ND
	C	30	50,32	11,95				
	A	40	2,83	5,59				
ANKLE SAGITTAL	B	40	2,90	5,65	0,031[1]	0,789[2]	0,028[2]	0,031[2]
	C	30	-1,09	8,27				
	A	40	6,01	5,72				
OPPOSITE KNEE SAGITTAL	B	40	7,76	4,83	0,243	ND	ND	ND
	C	30	8,12	4,97				

Notes:([1]) Kruskal-Wallis, ([2]) Bonferroni, p ≤ 0,016. Adopted 95% of confidence.

Table 2. Pearson's relationship test. (Spearman for Ankle Sagittal)

		CADENCE (steps/min)	GAIT SPEED (m/s)	STEP LENGTH (m)	MFV (m/s)	MFC (m)	HIP CORONAL	HIP SAGITTAL	KNEE SAGITTAL	ANKLE SAGITTAL
AGE (years)	r	-0,461**	-0,563**	-0,593**	-0,490**	-0,255**	-0,043	0,263**	-0,039	-0,242*
	p	0,000	0,000	0,000	0,000	0,008	0,660	0,006	0,690	0,012
WEIGHT (kg)	r	-0,164	-0,178	-0,192*	-0,273**	-0,246*	0,121	0,093	0,038	-0,183
	p	0,086	0,063	0,045	0,004	0,010	0,214	0,338	0,694	0,058
HEIGHT (m)	r	0,336**	0,407**	0,353**	0,095	0,068	0,127	-0,145	0,071	0,033
	p	0,000	0,000	0,000	0,327	0,482	0,191	0,136	0,465	0,738
BMI (kg/m²)	r	-0,355**	-0,409**	-0,402**	-0,357**	-0,297**	0,054	0,181	-0,004	-0,213*
	p	0,000	0,000	0,000	0,000	0,002	0,578	0,062	0,969	0,027
CADENCE (steps/min)	r	1	0,856**	0,517**	0,485**	0,230*	0,085	-,0230*	0,064	0,138
	p		0,000	0,000	0,000	0,017	0,382	0,016	0,511	0,154
GAIT SPEED (m/s)	r	0,856**	1	0,772**	0,486**	0,156	0,160	-,0228*	0,011	0,130
	p	0,000		0,000	0,000	0,107	0,099	0,018	0,911	0,180
STEP LENGTH (m)	r	0,517**	0,772**	1	0,453**	0,227*	0,260**	-0,250**	0,017	0,234*
	p	0,000	0,000		0,000	0,018	0,007	0,009	0,865	0,015
MFV (m/s)	r	0,485**	0,486**	0,453**	1	0,234*	-0,011	-0,256**	0,079	0,032
	p	0,000	0,000	0,000		0,015	0,908	0,008	0,419	0,740
MFC (m)	r	0,230*	0,156	0,227*	0,234*	1	0,021	-0,167	0,291**	0,680**
	p	0,017	0,107	0,018	0,015		0,828	0,085	0,002	0,000
HIP	r	0,085	0,160	0,260**	-0,011	0,021	1	0,102	0,202*	0,075

CORONAL	p	0,382	0,099	0,007	0,908	0,828		0,293	0,036	0,443
HIP SAGITTAL	r	-0,230*	-0,228*	-0,250**	-0,256**	-0,167	0,102	1	0,340**	-0,167
	p	0,016	0,018	0,009	0,008	0,085	0,293		0,000	0,085
KNEE SAGITTAL	r	0,064	0,011	0,017	0,079	0,291**	0,202*	0,340**	1	0,350**
	p	0,511	0,911	0,865	0,419	0,002	0,036	0,000		0,000
ANKLE SAGITTAL	r	0,138	0,130	0,234*	0,032	0,680**	0,075	-0,167	0,350**	1
	p	0,154	0,180	0,015	0,740	0,000	0,443	0,085	0,000	

**. p< 0,01 (2 tails). *. p< 0,05 (2 tails).

Table 3. Multiple Linear Regression Analysis: Ankle and knee sagittal, age and maximum toe velocity (MFV) predicting minimum toe clearance.

MFC/ Variables	R	R^2	R^2 adjusted	Standard error	p value
Ankle sagittal	0,680	0,462	0,457	0,012	<0,001
Knee sagittal	0,291	0,084	0,076	0,016	0,002
Age (year)	0,255	0,065	0,056	0,016	0,008
MFV (m/s)	0,234	0,055	0,046	0,016	0,015

CONFLICT OF INTEREST STATEMENT:

All authors declare that they have no conflict of interest

4 DISCUSSÃO GERAL

Este estudo teve por objetivo comparar as características da liberação mínima do pé, velocidade máxima do pé e cinemática dos membros inferiores no instante da VMP, entre três faixas etárias de mulheres hígidas, e descrever as diferenças enfatizando aquelas reconhecidas como indicativas do risco de quedas.

Como encontrado por outros autores[11, 34, 41], as medidas centrais de velocidade da marcha e comprimento do passo foram menores no grupo de idosas e não houve diferença entre jovens e meia-idade ou entre meia-idade e idosas. Esperava-se, neste estudo, encontrar diferenças entre o grupo jovem e o grupo de meia-idade que pudesse sugerir o início precoce do risco, porém, na comparação dos grupos usando ANOVA, o grupo de meia-idade não mostrou diferenças significativas em relação ao grupo jovem, exceto uma pequena diferença no comprimento do passo, indicando que o declínio funcional na marcha, especialmente no que diz respeito à liberação mínima do pé só é apreciável após os 60 anos e, segundo Guillain et al[39], acentua a partir dos 70 anos. A comparação entre o grupo jovem e idosas, revelou, como demonstrado em outros estudos[4, 40-42], que a LMP foi menor nas idosas. Outros investigadores não encontraram diferença significativa nas medidas de tendência central da LMP entre jovens e idosos[6, 9, 33, 34, 37] no entanto, todos esses estudos avaliaram idosos do sexo masculino ou uma amostra mista. Nenhum reportou resultados que investigassem as características da liberação mínima do pé em uma amostra exclusiva de mulheres idosas comparando-as com um grupo controle de mulheres jovens, portanto, provavelmente essa variável seja menor entre idosas. A LMP mensurada no mesmo instante da VMP é reconhecida como uma função crítica do período de balanço, cujo controle pode influenciar as chances do pé fazer contato com o chão no momento em que a velocidade anterior-posterior do pé é maior e aumentar o risco de quedas[3, 36]. Por isso, nosso estudo investigou o controle da LMP avaliando a cinemática sagital das articulações dos membros inferiores.

O papel da articulação do tornozelo no controle da liberação mínima do pé já foi descrito anteriormente[35, 43-45]. Esses autores argumentam que a amplitude de dorsiflexão é um fator crítico no controle da LMP, o que foi confirmado neste estudo.

A análise de regressão múltipla deste estudo concorda com essa argumentação e demonstrou que a amplitude de movimento sagital do tornozelo foi a principal variável preditora da liberação do pé, enquanto as variáveis independentes amplitude de movimento do joelho, idade e velocidade máxima do pé previram, quando somadas, somente 17,8% (tabela 3).

Uma diferença marcante está na influência da velocidade de marcha como fator de confusão. Em estudos prévios[43, 44] foi demonstrado que a velocidade tem uma relação direta com a LMP. Nesses estudos também não se investigou a influência do sexo nessa variável. Nossos dados divergem daqueles, uma vez que não foi encontrada relação entre a velocidade de marcha e o valor da LMP (p=0,107) e a análise de regressão não identificou significância na influência da velocidade em mulheres. Alcock et al[38] demonstraram que as alterações na mecânica do balanço em mulheres idosas não podem ser totalmente esclarecidas apenas pelas alterações na velocidade de marcha e idade. É possível que as alterações na LMP sejam influenciadas por processos do controle motor próprios do envelhecimento[46] ou mediados por declínios de força muscular, flexibilidade e controle postural, comum em idosos[47, 48].

A flexão do quadril no instante da LMP foi maior entre as idosas, apesar da velocidade de marcha ser menor. Em um estudo onde comparou-se a cinemática sagital em várias velocidades[49] foi demonstrada a influência da mesma na amplitude de movimento durante a marcha. Segundo esses autores, em aproximadamente 79% do ciclo (instante do VMP e LMP) a amplitude de flexão do quadril diminui com a redução da velocidade. Nossos achados mostraram relação inversa fraca (R -0,228; p=0,018) entre a amplitude de flexão do quadril e velocidade de marcha. O aumento da flexão do quadril pode representar uma compensação à redução da LMP e reduzir as chances de contato do pé com o solo ao longo da trajetória do pé no período de balanço.

Uma limitação do presente estudo é o fato do grupo de idosas ter uma média de idade relativamente baixa por não incluir pessoas acima dos 80 anos. Um grupo com média de idade mais avançada poderia acentuar as diferenças em relação ao grupo jovem.

5 CONCLUSÕES

- Mulheres idosas caminham mais lentamente e têm liberação mínima do pé menor do que os outros grupos investigados.
- A amplitude de dorsiflexão tem importante influência na liberação mínima do pé e apresenta um valor menor em mulheres idosas.
- O aumento da flexão do quadril pode representar uma adaptação para evitar tropeços no grupo de idosas
- A velocidade de marcha não mostrou relação com a liberação mínima do pé, amplitude de flexão do quadril ou de dorsiflexão em todos os grupos estudados.

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ANEXOS

Anexo 1 – APROVAÇAO DO COMITÉ DE ÉTICA

UNIVERSIDADE FEDERAL DE GOIÁS - UFG

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: ANÁLISE DA MOBILIDADE, FORÇA MUSCULAR, CONDIÇÕES FÍSICO FUNCIONAIS E RISCO DE QUEDAS DE IDOSAS A PARTIR DOS 60 ANOS.

Pesquisador: Flávia Martins Gervásio

Área Temática:

Versão:

CAAE: 33089614.4.0000.5083

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DADOS DO PARECER

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Data da Relatoria: 04/08/2014

Apresentação do Projeto:

ANÁLISE DA MOBILIDADE, FORÇA MUSCULAR, CONDIÇÕES FÍSICO FUNCIONAIS E RISCO DE QUEDAS DE IDOSAS A PARTIR DOS 60 ANOS. Pesquisador: Flávia Martins Gervásio. Instituição Proponente: Universidade Estadual de Goiás. Trata-se de um estudo transversal analítico, com mulheres idosas a partir de 60 anos de idade, provenientes da cidade de Goiânia, que serão submetidas a avaliações por questionários e testes (sócio demográfico, estado de saúde, IPAQ, time up and go, (TUG), BERG, dinamometria, risco de quedas(Quickscreen), índice de marcha dinâmico e POMA II), associados a avaliação de marcha computadorizada e equilíbrio em plataformas de força (estabilometria) e baropodometria, realizados no laboratório de Movimento da Universidade Estadual de Goiás, onde a pesquisa será realizada.

Objetivo da Pesquisa:

Objetivo Primário: Estudar a mobilidade e os fatores relacionados ao risco de quedas em idosas. Objetivo Secundário: 1.Descrever e verificar a variabilidade entre os ciclos de marcha dos parâmetros tempo espaço e lineares tanto na caracterização do tempo de duração quanto na representação do ciclo da marcha, como por exemplo cadência, velocidade, comprimentos de passo e passada, largura da base, períodos do passo, passada, suporte simples e duplo, apoio unipodálico, bipodálico e balanço; 2. Descrever a cinemática sagital e frontal de pelve, quadril,

joelho e tornozelo em idosas a partir dos 60 anos; 3. Descrever a velocidade angular e linear no plano sagital das articulações quadril, joelho e tornozelo e o deslocamento dos segmentos corporais pododactilos e calcanhar nos eixos x e y das diferentes faixas etárias entre as idosas; 4. Estabelecer associação entre as variáveis de marcha supracitadas; 5. Avaliar o equilíbrio com uso de plataformas de força e baropodometria (estabilometria);6. Avaliar a simetria da marcha entre os lados direito e esquerdo; 7. Avaliar clinicamente a marcha por meio dos testes índice de marcha dinâmica e POMA e compará-los aos testes laboratoriais de marcha; 8. Analisar o risco de quedas por meio dos questionários Berg, time up go, quickscreen; 9. Relacionar os questionários de avaliação do risco de quedas com as medidas de marcha e estabilometria; 10. Estabelecer intervalos de valores limítrofes, que associem as variáveis de marcha relacionadas aos testes clínicos de equilíbrio e risco de quedas, no intuito de estabelecer uma escala de classificação clínica que não utilize de laboratório de movimento para determinação da fragilidade da mobilidade do idoso; 11. Descrever as variações de mobilidade funcional, equilíbrio e força das idosas; 12. Relacionar o equilíbrio e a faixa etária das idosas; 13. Relacionar o equilíbrio, a força e faixa etária das idosas; 14. Avaliar o índice de massa corpórea com a faixa etária das idosas; 15. Correlacionar o índice de massa corpórea e a força de idosas de acordo com a faixa etária; 16. Avaliar o nível de atividade física das idosas; 17. Correlacionar o nível de atividade física e o grau de força das idosas; 18. Relacionar a força de preensão manual e as variáveis de marcha e equilíbrio supracitadas. 19. Relacionar a média de força de preensão manual com o valor máximo da força normalizado e o equilíbrio.

Avaliação dos Riscos e Benefícios:

Riscos:

Os riscos são mínimos, pois não haverá mudanças na rotina de atividades semanais das idosas em relação às atividades já desenvolvidas na universidade. Elas manterão dias e horários de deslocamentos, apesar de sempre haver possível risco de acidente durante a locomoção até o a universidade, local determinado para a coleta. Para evitá-los os voluntários receberão as idosas na universidade para suas atividades de rotina, onde então serão convidadas para as avaliações. Os testes foram divididos em duas etapas para minimizar o risco de cansaço e fadiga, associado as estratégias: tempo de descanso entre as coletas e utilizar da observação atenta, próxima e constante da pesquisadora como amparo. As avaliações computadorizadas da marcha e do equilíbrio ocorrerão depois do intervalo de uma semana, sempre com pré-agendamento. Estas avaliações ocorrem em um sala fechada, climatizada garantindo tranquilidade e privacidade

durante o exames. No intuito de minimizar possíveis riscos e oferecer atendimento imediato a unidade ESEFFEGO possui médicos em diferentes dias e horários que prestam atendimento às pessoas vinculadas aos programas institucionais como ocorre com a amostra deste estudo, além disso, a serviço de fisioterapia nos períodos matutino e vespertino de segunda a sexta feira que podem ser oferecidos à idosa na presença de qualquer injúria. Na presença de acidentes o sujeito tem o direito de pleitear indenização e também o direito de ressarcimento de despesas pela sua participação.

Benefícios:

As idosas receberão uma avaliação ampla com resultado imediato de suas condições musculoesqueléticas cita-se: grau de força muscular, IMC, avaliação computadorizada de marcha, estabilometria, avaliações clinicas de marcha e risco de quedas de forma minuciosa e sem custos com esclarecimento de quais medidas devem adotadas para melhorar possíveis alterações identificadas além do encaminhamento aos serviços de saúde da terceira idade da universidade.

A pesquisadora assegura à participante que os testes são seguidos por ela com a assistência dos outros participantes da equipe, que na instituição podem contar com o atendimento médico pois existem profissionais à disposição para as pessoas vinculadas aos programas institucionais e, no caso, as participantes são recrutadas nesta população. Garante ainda privacidade durante os exames. Com relação aos benefícios, além das avaliações em aparelhagem moderna sem custo para a participante, a pesquisadora garante a devolutiva a cada uma na forma de orientações e medidas relacionadas aos resultados.

Comentários e Considerações sobre a Pesquisa:

Projeto bem estruturado com 60 participantes: mulheres com mais de 60 anos recrutadas junto às pessoas já vinculadas à instituição proponente como participantes de serviços de saúde da terceira idade da universidade. A pesquisadora apresenta compromisso da equipe com os requisitos da CNS 466/2012. Na descrição do projeto,relaciona os cuidados com as participantes, garante privacidade e ainda a devolutiva a cada uma com entrega do exame com laudo,orientações e medidas cabíveis em cada caso.

Considerações sobre os Termos de apresentação obrigatória:

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A pesquisadora apresenta projeto completo com termos de anuência necessários (UNATI- ESEFFEGO e laboratório do movimento).Apresenta ainda TCLE adequado, em linguagem acessiva e garantias claras relacionadas à segurança da participante durante os testes.

Recomendações:

- corrigir a frase seguinte do TCLE: "1.9 Você pode pleitear indenização a qualquer tempo decorrente de sua participação na pesquisa" por : "1.9 Você pode pleitear indenização a qualquer tempo em caso de dano decorrente de sua participação na pesquisa"

Conclusões ou Pendências e Lista de Inadequações:

SMJ do comitê recomendo aprovação do projeto

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

Considerações Finais a critério do CEP:

Enviar relatórios parcial e final.

GOIANIA, 06 de Agosto de 2014

Assinado por:
João Batista de Souza
(Coordenador)

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Anexo 2 - Normas de publicação do periódico

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All authors should have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

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It is not necessary to include detailed descriptions on the program or type of grants and awards. When funding is from a block grant or other resources available to a university, college, or other research institution, submit the name of the institute or organization that provided the funding.

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This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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AUTHOR INFORMATION PACK 12 May 2018 www.elsevier.com/locate/gaitpost 10

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1. Amis AA, Dawkins GPC. Functional anatomy of the anterior cruciate ligament. J Bone Joint Surg [Br] 1991; 73B: 260-267

2. Insall JN. Surgery of the Knee. New York: Churchill Livingstone; 1984
3. Shumway-Cook A, Woollacott M. Motor Control: Theory and Practical Applications. Baltimore: Williams and Wilkins; 1995.

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Examples:
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[1] J. van der Geer, J.A.J. Hanraads, R.A. Lupton, The art of writing a scientific article, J. Sci. Commun. 163 (2010) 51–59.
Reference to a book:
[2] W. Strunk Jr., E.B. White, The Elements of Style, fourth ed., Longman, New York, 2000. Reference to a chapter in an edited book:
[3] G.R. Mettam, L.B. Adams, How to prepare an electronic version of your article, in: B.S. Jones, R.Z. Smith (Eds.), Introduction to the Electronic Age, E-Publishing Inc., New York, 2009, pp. 281–304. Reference to a website:
[4] Cancer Research UK, Cancer statistics reports for the UK. http://www.cancerresearchuk.org/ aboutcancer/statistics/cancerstatsreport/, 2003 (accessed 13 March 2003).
Reference to a dataset:
[dataset] [5] M. Oguro, S. Imahiro, S. Saito, T. Nakashizuka, Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1, 2015. https://doi.org/10.17632/ xwj98nb39r.1.

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AUTHOR INFORMATION PACK 12 May 2018 www.elsevier.com/locate/gaitpost 12

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Anexo 3 – Mini Exame do Estado Mental (Minimental)

MINI EXAME DO ESTADO MENTAL – MEEM

Orientação Temporal (um ponto para cada resposta correta)

( ) Que dia é hoje?
( ) Em que dia da semana estamos?
( ) Em que mês estamos?
( ) Qual a hora aproximada?
( ) Em que ano estamos?

Orientação Espacial(um ponto para cada resposta correta)

( ) Em que local nós estamos? (consultório, dormitório, sala, não apontando para o chão)
( ) Em que bairro nós estamos ou qual o nome de uma rua próxima.
( ) Que local é este aqui? (apontando ao redor num sentido mais amplo: hospital, casa de repouso, própria casa).
( ) Em que cidade nós estamos?
( ) Em que estado nós estamos?

Memória Imediata

( ) Eu vou dizer três palavras e você irá repetí-las a seguir: carro, vaso, tijolo (dê um ponto para cada palavra repetida corretamente)**.** Use palavras não relacionadas.

Atenção e Cálculo

( ) Peça ao paciente que conte de trás para frente, começando do nº 100, de 7 em 7. Pare depois da 5ª resposta. Considere 1 ponto para cada resultado correto. Se houver erro, corrija-o e prossiga. Considere correto se o examinado espontaneamente se autocorrigir.

Memória

( ) Peça que ele repita as três palavras ditas anteriormente. Dê um ponto para cada resposta correta.

Linguagem

( ) Mostre um lápis e um relógio, peça-lhe que os nomeie (2 pontos).

Repetição

( ) Peça que repita o seguinte: “nem sim, nem não, nem porque” (Considere somente se a repetição for perfeita (1 ponto).

Comando

( ) Dê as 3 seguintes ordens: “Pegue este papel com a mão direita (1 ponto), dobre-a ao meio (1 ponto) e coloque-a no chão (1 ponto). Se o sujeito pedir ajuda no meio da tarefa não dê dicas.

Leitura

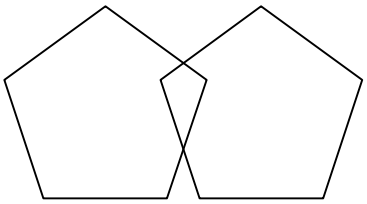
( ) Mostre a frase escrita :”FECHE OS OLHOS” e peça para o indivíduo fazer o que está sendo mandado. Não auxilie se pedir ajuda ou se só ler a frase sem realizar o comando. (1 ponto)

Frase

( ) Peça ao indivíduo para escrever uma frase. Se não compreender o significado, ajude com: alguma frase que tenha começo, meio e fim; alguma coisa que aconteceu hoje; alguma coisa que queira dizer. Para a correção não são considerados erros gramaticais ou ortográficos (1 ponto).

Cópia do desenho

( ) Mostre o modelo e peça para fazer o melhor possível. Considere apenas se houver 2 pentágonos interseccionados (10 ângulos) formando uma figura de quatro lados ou com dois ângulos (1 ponto)



Escore: (/ 30)

APÊNDICES

Apêndice 1 **- Termo de Consentimento Livre e Esclarecido – TCLE**

Sra._____está sendo convidada a participar, como voluntária, da pesquisa intitulada " Análise da mobilidade, força muscular, condições físico funcionais e risco de quedas em idosas a partir de 60 anos". Meu nome é Flávia Martins Gervásio, sou a pesquisadora responsável e minha área de atuação é Fisioterapia. Após receber os esclarecimentos e as informações a seguir, se você aceitar fazer parte do estudo, assine ao final deste documento, que está impresso em duas vias, sendo que uma delas é sua e a outra pertence à pesquisadora responsável. Esclareço que em caso de recusa na participação, você não será penalizada de forma alguma. Mas, se aceitar participar, as dúvidas *sobre a pesquisa* poderão ser esclarecidas pela pesquisadora responsável, via e-mail (gervasio.flavia@gmail.com) e, inclusive, sob forma de ligação a cobrar, através do(s) seguinte(s) contato(s) telefônico(s): (62) 3522-3526/(62) 8176-0363. Ao persistirem as dúvidas *sobre os seus direitos* como participante desta pesquisa, você também poderá fazer contato com o **Comitê de Ética em Pesquisa** da Universidade Federal de Goiás, no telefone(62)3521-1215.

1. Informações Importantes sobre a Pesquisa:

A pesquisa "Análise da mobilidade, força muscular, condições físico funcional e risco de quedas em idosas a partir de 60 anos " objetiva avaliar em você mulher com 60 anos ou mais seus movimentos, especialmente o andar, equilíbrio em pé, força dos músculos e como suas atividades no dia a dia interferem na sua saúde. Isto é importante porque depois dos 60 anos aumentam suas chances de piorar o equilíbrio e o andar com risco de cair e piorar sua saúde.

Todas vocês serão avaliadas de graça, de forma igual, com os mesmos testes e equipamentos, pelas mesmas pessoas uma única vez no estudo. As avaliações serão realizadas em duas etapas, agendas com você de acordo com sua disponibilidade. Todas as avaliações acontecem na ESEFFEGO, no Laboratório de Movimento. No primeiro dia você aceita participar deste estudo e responde sobre a sua capacidade física no dia a dia e faz testes de caminhada, equilíbrio e chance de cair. No segundo dia você é filmada andando e faz dois testes diferentes em pé, parada, pisando em cima de placas de metal posicionadas no chão, para medir seu equilíbrio. Durante os dois dias de testes, eu estarei ao seu lado durante todo o tempo, e também com mais três estudantes que participam deste estudo, para dar apoio caso você tenha medo de cair ou qualquer dúvida na realização das atividades. Ao final dos testes você receberá por escrito os resultados e cópia em um CD da filmagem da sua marcha com explicações de como está sua condição física, seu andar, equilíbrio e se você tem chances decair.

Os desconfortos e riscos na realização dos testes são poucos. As perguntas sobre sua condição física no dia a dia permitem você dizer se você faz esforços frequentemente ou não. Os testes medem como você senta, levanta , anda ou como está seu equilíbrio em pé, situações que você pratica o tempo todo no seu dia a dia. Ao participar deste estudo você terá medidas de como está uma das capacidades mais importantes da sua independência, seu jeito de andar e de equilibrar, o que garante uma boa saúde física com menor chance decair.

Caso você tenha dúvidas, estou com você durante todos os testes explicando

como fazer cada um. Você também pode me ligar a cobrar ou mandar email, escrito na sua cópia deste documento. Além disso, você recebe um laudo escrito e uma filmagem da sua marcha ao final da pesquisa, com os resultados de todos os seus testes que serão explicados a você. Assim você poderá utilizar deste documento para orientar qualquer outro profissional da saúde que acompanha você em consultas ou atividades de educação física, fisioterapia, atividades em grupo, etc. De acordo com o resultado também podemos sugerir quais atividades da ESEFFEGO são melhores para seu bem estar e fazer o encaminhamento. Lembro que toda a avaliação do estudo é de graça e as atividades da ESEFFEGO para atendimento da comunidade também não tem custos.

Não oferecemos pagamento por sua participação no estudo.

Podemos ajudar você com o pagamento do seu vale transporte em todos os dias de pesquisa e ao final das avaliações será oferecido um lanche.

Nenhum dado pessoal ou imagem com seu rosto será divulgado na pesquisa. Apenas os resultados das medidas e das respostas dos questionários, apresentados como a média dos resultados de todas as mulheres avaliadas no estudo. Há sigilo e privacidade de todas as mulheres do estudo.

Você a qualquer momento pode desistir de participar do estudo, sem prejuízo ou penalização alguma.

Você pode pleitear indenização a qualquer tempo decorrente de sua participação na pesquisa;

As medidas de andar e equilibrar ficarão registradas na memória dos computadores utilizados na pesquisa e nas fichas dos testes aplicados. Estas medidas poderão futuramente fazer parte de outros estudos, porém nenhuma medida sua será utilizada sem a devida aprovação dos comitês de pesquisa

2. Consentimento de participação da pessoa como sujeito da pesquisa:

Eu, ..., inscrita sob o RG/CPF/ ....., abaixo assinado, concordo em participar do estudo intitulado “Análise da mobilidade, força muscular, condições físico funcional e risco de quedas em idosas a partir de 60 anos”. Informo ter mais de 18 anos de idade, e destaco que minha participação nesta pesquisa é de caráter voluntário. Fui, ainda, devidamente informada e esclarecida, pela pesquisadora responsável Flávia Martins Gervásio, sobre a pesquisa, os procedimentos e métodos nela envolvidos, assim como os possíveis riscos e benefícios decorrentes de minha participação no estudo. Foi-me garantido que posso retirar meu consentimento a qualquer momento, sem que isto leve a qualquer penalidade. Declaro, portanto, que concordo com a minha participação no projeto de pesquisa acima descrito.

Goiânia, ...de.....de .....

_____

Assinatura por extenso do(a) participante

_____

Assinatura por extenso do(a) pesquisador(a) responsável