24th CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS

BIOMECHANICAL ANALYSIS OF YOUNG ADULTS AND ELDERLY INDIVIDUALS DURING WALKING AND RUNNING

[1]Cristina Porto Alves Alcantara, [1]Raquel Castanharo, [2]Marcos Duarte
[1]Physical Education and Sport School, University of Sao Paulo, Brazil
[2]Biomedical Engineering, Federal University of ABC, Brazil

INTRODUCTION

Despite the growing interest in running by older adults, the biomechanics of running for this population is still poorly known. In general, we know there is an age-related decrease of motor and sensorial functions and changes in the movement pattern during walking and running [1-4]. The aim of this study was to investigate the biomechanics of young adults and elderly individuals during walking and running. For a greater understanding of such changes we also compared sedentary elderly individuals with elderly runners.

METHODS

Twenty-two young adult runners (age 22-39 years-old; mass 72±10 kg; height 173±10 cm), 23 elderly runners (age 60-76 years-old; mass 66±10 kg; height 169±6 cm) and 13 sedentary elderly individuals (age 60-71 years-old; mass 80±13 kg; height 171±7 cm) participated in this study. The inclusion criteria required that the subjects were free of any sign or symptom which may interfere with their locomotion and they signed an informed consent form. All participants executed all tasks.

All participants walked at 5 km/h and ran at 7 km/h wearing the same type of shoes. The tasks were performed on an instrumented treadmill with two independent belts and force plates embedded (Bertec Instrumented Treadmill). After a familiarization period, the data were collected for 20 seconds for each condition.

The kinematic data were acquired using a motion analysis system (Motion Analysis Corporation, Santa Rosa, CA), with eight cameras at 100Hz and low-pass filtered at 6 Hz with a Butterworth filter. The force plate data were acquired at 600Hz and low-pass filtered at 100Hz with a Butterworth filter. The data were collected and digitized using the software Cortex (Motion Analysis Corporation, Santa Rosa, CA) and were processed using the software Visual3D (C-Motion INC, Rockville MD).

The variables analyzed were: maximum and minimum values at the sagittal plane of the hip, knee and ankle angles and moments of force; range of motion of these joints; mean value of the toe-out angle; peak of the knee adduction moment of force; stride length; and peak of the impact force, defined as the maximum inclination of the vertical ground reaction force curve between the heel strike and the peak of impact force.

The data was analyzed using Matlab and the statistical analysis was done using Matlab and SAS. The normality of variables was tested with the Kolmogorov-Smirnov test. The variables joint angles and moments were analyzed with the Wilcoxon Signed-rank test with Bonferroni correction. The toe-out angle, the knee adduction moment peak, the peak of impact force and the stride length were analyzed with a one-way ANOVA. The significant level considered was 0.05.

RESULTS AND DISCUSSION

The biomechanical patterns during walking and running of the elderly runners were more similar to the sedentary elderly individuals than to the young adult runners (Figures 1 and 2). For the studied variables (see Table 1), most differences were between the sedentary elderly individuals and the others two groups. Surprisingly, the toe-out angle didn't present any difference between groups in any condition, contradicting previous studies. The knee adduction moment peaks during walking and running were smaller for the sedentary elderly individuals than for the young adults and elderly runners. However, contrarily to previous results [5], we did not observe a relationship between the knee adduction moment peak and the toe-out angle for any of the groups. This lack of relation might be due to the fact that there was no difference in the toe-out angle between groups; we did not observe large values of the toe-out angle for the elderly individuals as reported elsewhere [5]. The fact that the individuals walked and ran on a dual-belt treadmill might have constrained the way their feet landed on the ground.

For the stride length, there was no difference between groups during walking, but during running the stride length was shorter for both elderly groups in comparison to the young adults.

The peak of impact force was greater for both elderly groups in comparison with the young adults group, in agreement with a previous study [4].

CONCLUSIONS

Each of the studied groups, young adult runners, elderly runners and sedentary elderly individuals, presented specific differences between groups when the biomechanics of their walking and running were compared. The running task increased the differences between the young and elderly adult individuals in comparison with the elderly sedentary individuals

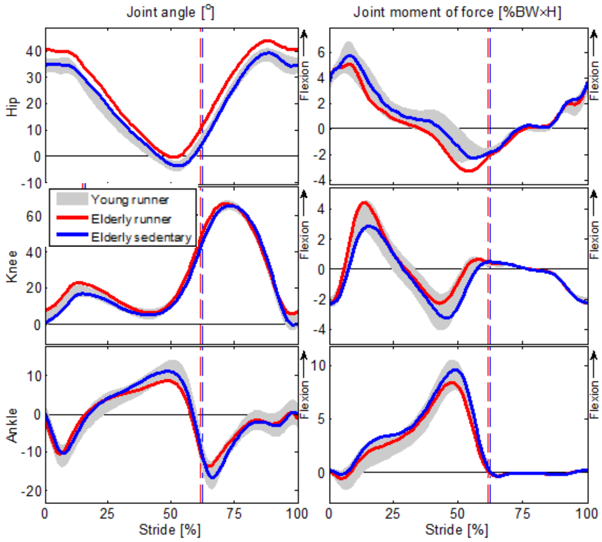

Figure 1. Joint angles and moments during walking at 5 km/h. The grey area represents the young adult runners pattern (mean±SD).

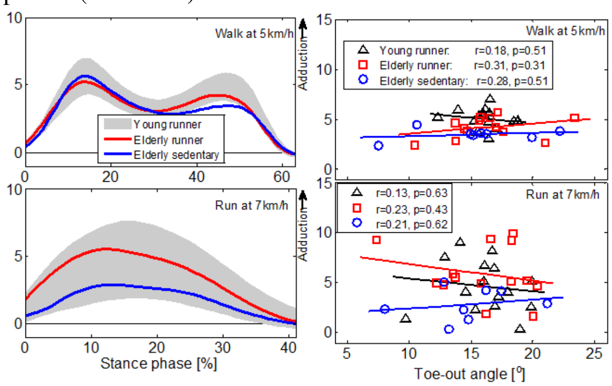

Figure 3. Mean knee adduction moment versus stance phase (left) and the peak of this moment versus the toe-out angle for each participant (right) during walking and running. The grey areas represent mean±SD for the young adult runners.

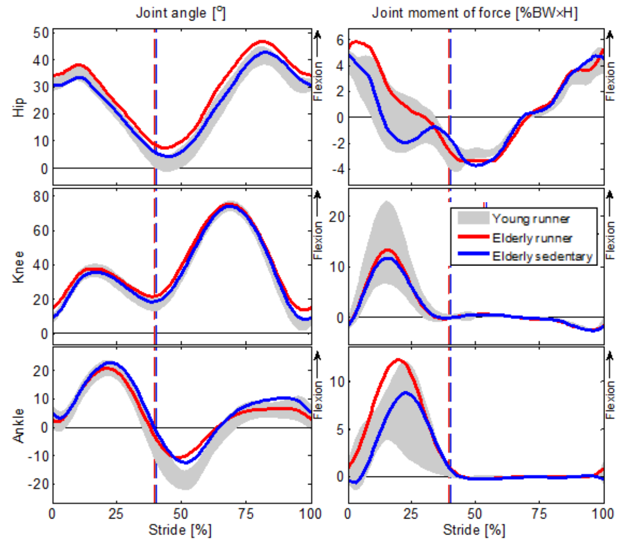

Figure 2. Joint angles and moments during running at 7 km/h. The grey area represents the young adult runners pattern (mean ±1 SD). The dashed lines in each color represent the support phase end of each group.

ACKNOWLEDGEMENTS

The authors acknowledge funding from FAPESP.

REFERENCES

1. Devita P, et al. J Appl Physiol, **88**:1804-1811, 2000.
2. Savelberg HH, et al. Gait Posture, **25**:259-266, 2007.
3. Fukuchi RK, et al. *J Biomech*, **44**:540-542, 2011.
4. Bus SA. Med Sci Sports Exerc, **35**:1167-1175, 2003.
5. Chang AD et al. *Ann Rheum Dis*, **66**: 1271-5, 2007.

Table 1. Mean ± SD values of the studied variables the young adult runners (YR), elderly runners (ER) and sedentary elderly (SE) groups during walking at 5 km/h and running at 7 km/h, and . BW: Body Weight; H: Height; ROM: Range Of Motion.

	Variable	Walk at 5 km/h			Run at 7 km/h		
		YR	ER	SE	YR	ER	SE
MAX	Ankle Angle (°)	11±4	10±2	12±3	21±3	21±3	22±3
	Knee Angle (°)	65±3	67±6	65±5	75±5	79±8	72±7
	Hip Angle (°)	36±5	46±6	41±8	40±4	48±6	42±6
MIN	Ankle Angle (°)	-16±4	-14±4	-16±5	-20±4	-12±5	-14±5
	Knee Angle (°)	-1±3	2±5	-2±5	6±4	13±4	8±3
	Hip Angle (°)	-5±4	0±6	-3±5	0±3	7±5	3±6
ROM	Ankle Angle (°)	28±3	24±4	28±5	41±5	33±4	36±6
	Knee Angle (°)	66±4	65±5	67±6	69±6	66±9	64±8
	Hip Angle (°)	42±4	46±5	44±4	40±4	40±3	39±5
MAX	Ankle Moment (%BWxH)	10.1±2.2	9.2±3.0	9.5±1.6	10.5±4.7	13.2±6.1	8.3±2.6
	Knee Moment (%BWxH)	3.4±1.3	5.8±3.3	3.2±2.4	15.3±7.8	13.3±5.4	11.8±2.8
	Hip Moment (%BWxH)	5.7±1.2	5.6±1.1	6.0±1.6	4.8±1.4	6.5±1.1	5.2±0.2
MIN	Ankle Moment (%BWxH)	-0.8±0.5	-1.1±1.0	-0.9±0.7	-0.6±0.3	-0.6±0.7	-1.3±1.1
	Knee Moment (%BWxH)	-3.4±1.2	-3.0±0.9	-3.8±1.7	-2.5±0.3	-2.5±0.6	-2.8±0.4
	Hip Moment (%BWxH)	-2.3±0.6	-3.6±1.3	-2.6±1.2	-3.4±0.9	-3.8±0.7	-3.7±0.5
	Stride Length (%H)	83.2±3.6	81.8±5.4	83.5±2.8	87.4±5.0	83.1±3.3	84.2±3.1
	Toe-out Angle (°)	28±1	29±2	27±1	50±3	50±3	49±2
	Knee Adduction Moment Peak (%BWxH)	4.9±1.0	4.3±1.1	3.5±0.6	4.9±2.8	5.8±2.6	3.0±1.6
	Peak of Impact Force (%BW/s)	2506±565	3141±1018	2719±1155	5958±1746	7184±1956	6502±1582