THE LUMBOPELVIC RATIO DURING TRUNK FLEXION: THE EFFECTS OF AGE, GENDER AND MOTION PACE

[1]Milad Vazirian, [1]Iman Shojaei, [1]Anuj Agarwal and [1]Babak Bazrgari

[1] University of Kentucky, Lexington, KY, USA
email: milad.vazirian@uky.edu

INTRODUCTION

The prevalence of low back pain (LBP) increases with aging. Given the projected increase in the number of older individuals at workplace, management of occupational LBP will require an understanding of the reason(s) behind such increase in risk of LBP with aging [1]. A recent study by Tafazzol et al. [2] has shown that a reduction of lumbar contribution to a given angle of trunk flexion, as reflected in a reduction of lumbopelvic ratio (LPR), was associated with an increase in spinal loads. The objective of this study was to quantify age-related changes in LPR under fast and slow trunk flexion motions. On the basis of the suggested relationship between the LPR and spinal loads, it was hypothesized that, for a given task, the LPR of older versus younger individuals and faster versus slower motion paces will be smaller.

METHODS

Sixty individuals participated in the study after completing a consenting procedure approved by the University of Kentucky IRB. Participants were grouped in five age ranges of 22-28 (11 male and 7 female), 32-38 (7 male and 7 female), 42-48 (3 male and 6 female), 52-58 (4 male and 6 female) and 62+ (4 male 5 and female) years old with respective mean (SD) stature (cm) of 172 (1.9), 171 (1.8), 170 (2.3), 173 (4.2) and 171 (2.7) , and respective mean (SD) body mass (kg) of 69 (2.5), 72 (3.4), 77 (5.2), 81 (3.7) and 71 (4.2). Each participant attended two data collection sessions during which they completed three repetitions of slow and three repetitions of fast trunk flexion-extension tasks. Participants started each task from the standing posture and bent forward to reach their maximum comfortable trunk flexion, and then returned to the upright posture. The paces of trunk flexion for fast and slow motions were self-selected and participants were instructed to remain in full flexion posture for 5 s during the slow tasks. The thoracic and pelvic relative rotations from the upright standing posture were measured using two inertial-magnetic sensors (Xsens Technologies, Enschede, Netherlands) attached to the subject's back at the levels of T12 and S1. Lumbar flexion during each task was estimated as the difference between the measured thoracic and pelvic rotations. Finally, the LPR, was calculated as the ratio of lumbar flexion to pelvic rotation at the instant of full trunk flexion. Kinematics data were collected by a sampling rate of 50 Hz and were low-pass filtered using a fourth-order, bidirectional, Butterworth filter with cutoff frequency of 6 Hz. Repeated measures analysis of variance (ANOVA) was conducted to determine the effects of age and gender (i.e., between-subject factors) as well as flexion pace (i.e., within subject factor) on the maximum values of thoracic and pelvic rotations along with corresponding lumbar flexion and the LPR.

RESULTS AND DISCUSSION

The maximum thoracic rotation did not change with age ($p=0.433$) or gender ($p=0.395$), but was larger ($p<0.001$) during the fast vs. slow flexion tasks (Table 1).

Table 1: Mean maximum thoracic rotations along with 95% confidence interval for the slow and fast tasks (all values are in degrees)

Pace	Mean	95% Confidence Interval	
		Lower Bound	Upper Bound
Slow	82.9	79.4	86.4
Fast	95.8	92.4	99.1

The pelvic rotations increased with age ($p<0.001$), pace of task ($p<0.001$) and was larger ($p<0.001$) in females vs. males. (Table 2).

In contrast to the pelvic rotation, the lumbar flexion decreased generally with age (p=0.003). However, it was larger in the males than females (p=0.017), and similar to the thoracic and pelvic rotations, was found to increase with pace of task motion (p<0.001). (Table 3).

Table 2: Mean maximum pelvic rotation along with 95% confidence interval for each age group, gender and pace (all values are in degrees)

Age	Mean	95% Confidence Interval	
		Lower Bound	Upper Bound
22-28	24.0	20.0	28.1
32-38	26.4	21.9	30.9
42-48	29.3	23.4	35.3
52-58	35.3	29.9	40.7
62+	40.4	34.3	46.6
Male	26.7	23.1	30.9
Female	35.5	32.5	38.6
Slow	26.5	24.3	28.7
Fast	35.6	33.1	38.0

Table 3: Mean lumbar flexion along with 95% confidence interval for each age group, gender and pace (all values are in degrees)

Age	Mean	95% Confidence Interval	
		Lower Bound	Upper Bound
22-28	60.4	56.0	64.9
32-38	65.2	60.4	70.1
42-48	59.5	53.1	66.0
52-58	51.9	46.0	57.8
62+	52.0	45.9	58.1
Male	60.9	57.1	64.6
Female	54.7	51.4	58.0
Slow	55.9	53.3	58.5
Fast	59.7	57.1	62.2

The main effects of age, gender and pace on the LPR were all significant (P<0.001). Specifically, the LPR was smaller under fast versus slow trunk motions, older (>40 years old) versus younger (< 40 years old), and female versus male participants. There was an interaction between the pace and age, however, the slow motion was associated with a higher LPR in all age groups, although with highly different values.

Our results concur with earlier findings of reduction in lumbar range of flexion with aging [4]. Furthermore, on the basis of the suggested relationship between the LPR and spinal loads [2], our results suggest that older versus younger individuals and females versus males may experience larger spinal loads when doing the same flexion-extension task. Given the important role of mechanical loading in development of LBP, it is likely that the adopted lumbopelvic motion by older individuals to perform physical activity put them at higher risk of lower back injury as compared to younger individuals. It is also important to mention that LBP patients demonstrate a smaller LPR during trunk flexion as compared to asymptomatic individuals [4]. Future investigation of whether such differences in LPR, and potentially in the lower back biomechanics, between people with and without LBP is a cause or consequence of LBP can further enhance our understanding related to etiology of LBP among older individuals.

Table 4: Mean LPR along with 95% confidence interval for each age group, gender and pace

Age	Mean	95% Confidence Interval	
		Lower Bound	Upper Bound
22-28	2.998	2.538	3.458
32-38	3.038	2.529	3.546
42-48	2.273	1.600	2.946
52-58	1.733	1.118	2.347
62+	1.368	.729	2.006
Male	2.754	2.361	3.147
Female	1.809	1.465	2.154
Slow	2.620	2.280	2.959
Fast	1.944	1.740	2.148

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