

# AGE-RELATED DIFFERENCES IN THE RELATIVE TIMING OF LUMBAR AND PELVIC CONTRIBUTION TO THE TRUNK MOTION IN THE SAGITTAL PLANE

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## INTRODUCTION

Frequent trunk bending/return in the sagittal plane has been suggested as a risk factor for low back pain (LBP). The trunk motion in the sagittal plane is the result of flexion/extension of lumbar spine and rotation of pelvis. The relative pattern of lumbar and pelvic contributions to trunk motion has been studied under the so-called topic of lumbopelvic rhythm, which includes both magnitude and timing aspects of lumbar and pelvic contributions to trunk motion. We have previously shown that the magnitude of lumbar (pelvic) contribution to trunk motion is smaller (larger) in individuals older versus younger than 50 years old. But, there has not been any study yet to compare the timing aspect of lumbopelvic rhythm between the age groups. The mean absolute relative phase (MARP) between the thorax (i.e., sum of lumbar flexion/extension and pelvic rotation) and pelvis rotations was evaluated in this study to establish age-related differences in timing aspect of lumbopelvic rhythm among healthy individuals.

## METHODS

Seventy two individuals participated in the study after completing a consenting procedure approved by the University of Kentucky IRB. The participants were grouped in five age ranges (gender and sample size) of 22-28 (11 M and 8 F), 32-38 (8 M and 7 F), 42-48 (6 M and 6 F), 52-58 (6 M and 7 F) and 62-70 (6 M and 7 F) years old with respective mean (SD) stature (cm) of 172 (8), 171 (7), 173 (9), 171 (12) and 171 (10), and respective mean (SD) body mass (kg) of 69 (10), 73 (13), 79 (15), 78 (12) and 72 (16). Each participant attended two data collection sessions wherein they completed three repetitions of slow and three repetitions of fast trunk flexion-extension tasks. The participants started each task from the standing posture and bent forward to reach their maximum comfortable trunk flexion, and then returned to the

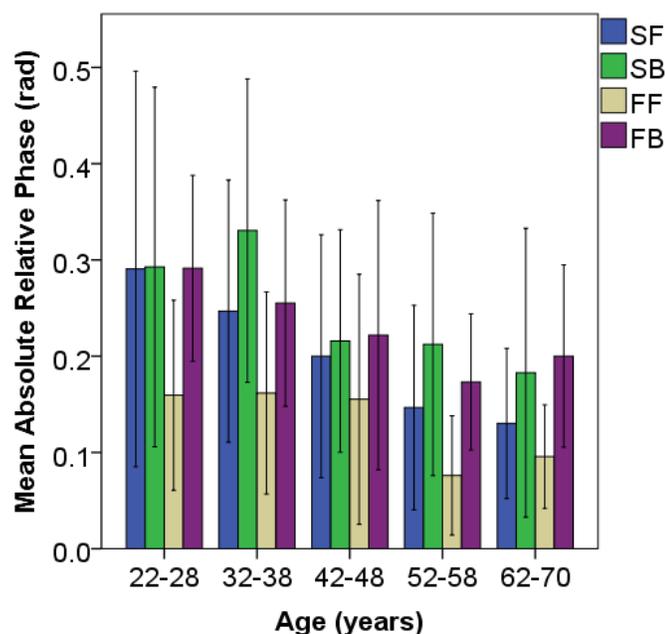
upright posture. The paces of trunk flexion for the fast and slow motions were self-selected and participants were instructed to remain in full flexion posture for 5 s during the slow tasks. The thoracic and pelvic rotations relative to the upright standing posture were measured using two inertial-magnetic sensors (Xsens Technologies, Enschede, Netherlands) attached to the subject's back at the levels of T10 and S1. Kinematic 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. For each task, the continuous relative phase between thorax and pelvic rotations was calculated using the approach suggested by Lamb and Stöckl [1]. The MARP was then calculated for bending and return phases of each task separately as suggested by Stergiou et al. [2]. A four-way repeated measures analysis of variance (ANOVA) was performed on the log transformed MARP values using SPSS 22.0 (SPSS Inc., Chicago IL, USA) to determine the effects of age and gender as between-subject factors, as well as flexion pace and direction (i.e., bending or return) as within subject factors. Tukey post-hoc test was used to determine differences between the age groups when appropriate.

## RESULTS AND DISCUSSION

The older (52-58 and 62-70) versus younger (22-28 and 32-38) age groups had a significantly smaller mean MARP ( $p < 0.001$ ). Since there was no pace\*age ( $p = 0.490$ ), direction\*age ( $p = 0.678$ ), and pace\*direction\*age ( $p = 0.659$ ) interaction, the main effect of age holds for both directions and paces of trunk motion (Figure 1).

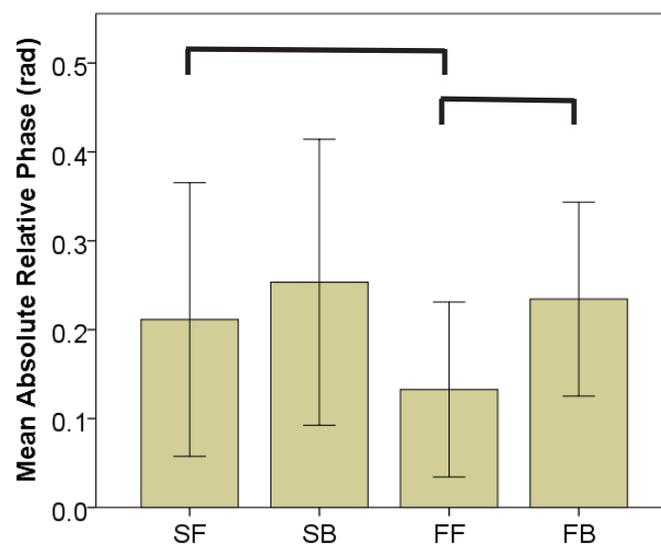
The older versus younger individuals demonstrated a more in-phase thorax-pelvis motion which could be due to their stiffer lumbar spine. Compared to asymptomatic individuals, the LBP patients have a more in-phase trunk motion [3]. More in-phase

motion of LBP patients has been suggested to be an active neuromuscular strategy for protection of the lumbar spine. Thus, more in-phase trunk motion in older versus younger individuals, as observed here, may also be an indication of active neuromuscular strategy to protect the lumbar spine from possible injuries caused by the bending/return tasks.



**Figure 1:** Age-related differences in mean absolute relative phase during the tests. The 1<sup>st</sup> letter code is S (slow) or F (fast), and the 2<sup>nd</sup> is F (forward bending) or B (backward return).

There was no difference in MARP between male and female participants. Because of the observed significant effects of pace ( $p=0.011$ ) and direction ( $p<0.001$ ) as well as the pace\*direction interaction ( $p<0.001$ ), separate repeated measures ANOVA were conducted for each level of pace and direction. The fast versus slow motion was associated with a smaller mean MARP only in the bending, and the bending versus return was associated with a smaller mean MARP only in the fast motion (Figure 2). These results suggest that individuals adopt a more in-phase trunk motion under the fast motion which may be again an active protective strategy under a motion pace that is associated with substantially higher spinal loads [4]



**Figure 2:** The effects of pace and direction on mean absolute relative phase. Significant difference between the tests are shown by bars above.

## CONCLUSIONS

Lumbopelvic rhythm is often evaluated by clinicians for detection of mechanical abnormalities in the lower back. Our results related to MARP between thoracic and pelvic rotations may help distinguishing potential age-related versus disorder-related abnormalities in timing aspect of lumbopelvic rhythm.

## ACKNOWLEDGMENT

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