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Full Length Article

What factors can affect lumbopelvic flexion-extension motion in the sagittal plane?: A literature review

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ABSTRACT

Clinicians use forward bending and backward return in routine clinical examinations for evaluating spine mobility. The magnitude and timing of lumbar spine and pelvic contributions have been described in the literature as lumbopelvic rhythm. There is still limited knowledge about the factors which can determinate lumbar and hip mobility and coordination in the sagittal plane. The aim of this study is to demonstrate those factors contributing to the lumbopelvic rhythm and to explain the differences observed between subjects. The studies included in the review present possible explanations of observed lumbar-pelvic motion and/or coordination. They measure movement of the lumbar spine, the pelvis and/or the hip in the sagittal plane. The search was conducted in August 2017. Two databases (PubMed and Web of Science) were searched. The search identified 126 potentially relevant articles (53 in PubMed, 73 in Web of Science). Initial screening based on titles and abstracts retrieved 35 articles. The second stage of selection involved reading the full texts of articles. Twenty-four papers were selected in this stage. After careful bibliographic study, seven papers were added for this review, resulting in a total of 31. This literature review demonstrates those factors contributing to lumbopelvic motion. Age and gender, hamstring muscle tightness, feet position, muscle fatigue, movement speed and external loading as well phase of motion can affect various aspects of lumbopelvic rhythm.

1. Introduction

Trunk motion in the sagittal plane results from the motions of the spine and pelvis (Esola, McClure, Fitzgerald, & Siegler, 1996; Granata & Sanford, 2000). Clinicians use forward bending and backward return in routine clinical examinations for evaluating spine mobility (Esola et al., 1996; Shojaei, Vazirian, Salt, Van Dillen, & Bazrgari, 2017). The magnitude and timing of lumbar spine and pelvic contributions to trunk motion have been described in the rehabilitation, ergonomic and sport literature as lumbopelvic rhythm (LPR) (Laird, Gilbert, Kent, & Keating, 2014; Vazirian, Dillen, & Bazrgari, 2016; Zhou, Ning, Hu, & Dai, 2016). LPR is an organised pattern characterised by coordination of the lumbar spine and hip connected to the pelvis, especially during flexion and extension in the sagittal plane (Kim et al., 2013; Pries, Dreischarf, Bashkuev, Putzier, & Schmidt, 2015; Vazirian et al., 2016). In previous studies,

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Table 1
Summary of study characteristics of articles included in review (chronological by the year of publication).

Author (year)	Sample size	Sex (Females/ Males)	Characteristics of participants	Measurement tool	Aim of investigation
Nelson et al. (1995)	30	30/0	Healthy	3D Space tracker system, an electromagnetic tracking device	Lumbar and pelvic motion as subjects lifted and lowered a 9.5 kg box with knees extended
Li et al. (1996)	39	22/17	Healthy	3D electromechanical digitiser	Effects of stretching on hamstring muscle length, standing lumbar lordosis, standing pelvic inclination, and the relative amount of lumbar and hip motion during trunk forward bending
Esola et al. (1996)	41	14/27	Healthy and LBP participants	3D optoelectric motion analysis system	Amount and velocity of lumbar spine and hip motion during forward bending; passive leg raising and active knee extension tests
McClure et al. (1997)	24	Lack of information	Healthy and LBP participants	3D optoelectric motion analysis system	Amount and pattern of lumbar spine and hip motion when rising from forward flexed position; determine if hamstrings length is related to the pattern of motion
Granata and Sanford (2000)	18	5/13	Healthy	Electromagnetic sensors and eigenvector model analyses	Influence of load and lifting velocity on LPR.
Larivière et al. (2000)	33	0/33	Healthy and LBP participants	Motion analysis system	Modification of the lumbar-pelvic rhythm in chronic low-back pain patients during lifting
Pal et al. (2007)	20	0/20	Healthy	3D motion analysis system	Describe and compare the initiation patterns, the relative contribution and peak angular displacement of the lumbar spine and hip region during flexion and return
Maduri et al. (2008)	11	4/7	Healthy	Electromagnetic motion analysis system	The range of lumbar curvature rotation examined at four torso inclination angles during lifting tasks
Kasahara et al. (2008)	12	0/12	Healthy	Flexible electrogoniometer (egm) system	Relationship of movement direction (in the 'forward bending' and 'rising from a forward flexed position' phases) on the lumbar spine and the pelvis in regard to lumbopelvic coordination in the sitting position
Sorensen et al. (2011)	12	0/12	Heathy	Lumbar motion monitor, sEMG	Sagittally symmetric lifting and lowering task (10 kg load) under three stance width conditions: narrow (feet together), moderate (feet shoulder width) and wide (feet 150% of shoulder width)
Kang et al. (2013)	16	0/16	Healthy	3D motion-capture system	Effects of hamstring-stretching exercises on the kinematics of the lumbar spine and hip during stoop lifting
Tafazzol et al. (2014)	8	0/8	Healthy	Inertial tracking device	Measure three-dimensional angular rotations of the pelvis and lumbar spine, measure sagittal coordination during forward flexion and backward extension
Song and Qu (2014a)	23	13/10	Healthy	Optoelectronic motion capture system and force plates	Examine age-related biomechanical differences during asymmetric lifting.
Hasebe et al. (2014)	18	0/18	Healthy	Spinal mouse, three-dimensional system	Existence of a specific LPR during forward bending in relation to tight hamstrings
Iwasaki et al. (2014)	26	10/16	Healthy	Two flexible electrogoniometers and sEMG	Relationship between physical characteristics and the lumbar pelvic rhythm during stoop lifting. Changes of the lifting strategy caused by physical characteristics and variations in load.
Kienbacher et al. (2015)	49	25/24	Healthy	3D accelerometers	The sex and age related differences in the neuromuscular activation profiles of the lumbar extensors and the related spine and hip kinematics during trunk flexion–extension task
Pries et al. (2015)	309	175/134	Healthy	Bending sensor segments and acceleration sensors	Effects of age and gender on lordosis, sacrum orientation and LPR
Jandre Reis and Macedo (2015)	67	26/41	Healthy and LBP participants	Goniometer	Association of hamstring tightness and range of motion in anterior pelvic tilt, lumbar motion and trunk flexion during forward bending
Hu and Ning (2015a)	13	0/13	Healthy	3D magnetic field based motion tracking system, semg	Lifting and lowering of a 20-lb box both before and after lumbar extensor muscle fatigue, generated through a static weight holding task
Hu and Ning (2015b)	15	0/15	Healthy	3D magnetic field based motion tracking system, semg	Performing five repetitions of weightlifting tasks both before and after a lumbar extensor muscle fatiguing protocol

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