A BIOMECHANICAL INVESTIGATION OF THE EFFECTS OF PREGNANCY ON SPINAL MOTION AND RISING TO STAND FROM A CHAIR

A thesis submitted in fulfilment of the requirements of the award of the degree

Doctor of Philosophy

from

School of Physiotherapy, Faculty of Health Science, The University of Sydney

by

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2001.

Statement of Declaration

The work presented in this thesis is the original work of the author except where as acknowledged in the text. I hereby declare that I have not submitted this material either in whole or in part for any degree at this or any other institution.

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Wendy Lynne Gilleard

Supervisor's Certificate

This is to certify that this thesis entitled "A biomechanical investigation of the effects of pregnancy on spinal motion and rising to stand from a chair", submitted by Wendy L Gilleard in fulfilment of the degree of Doctor of Philosophy, is ready for examination.

_____ Date _____

Associate Professor Jack Crosbie

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Abstract

During pregnancy the female body must accommodate the enlarging gravid uterus and increased mass. Therefore the maternal musculoskeletal system is required to adapt in both morphology and functional workload. After childbirth there is a rapid change in both mass and dimensions, requiring further adaptations. The objectives of the study were to investigate seated and standing upper body posture, the kinematics of seated and standing trunk motion, and the three dimensional kinematics and kinetics during rising to stand from a chair, as pregnancy progressed and in the early post-birth period.

Nine maternal subjects (aged 28 to 40 years) were tested at less than 16 weeks, 24 weeks, 30 weeks, 38 weeks gestation and at 8 weeks postbirth. The subjects, fitted with 37 retroreflective markers, were filmed during upright sitting, quiet standing, and four trials each of maximum seated and standing trunk forward flexion, side to side flexion and during maximum seated axial rotation. Three trials each of constrained and free rising to stand from a height adjustable stool and with each foot placed on a forceplate were also recorded. An eight-camera motion analysis system was used to record movements of the body segments and synchronised force plate variables in three dimensions. Motion of the ankle, knee and hip joints, pelvic, thoracic and head segments and the thoracolumbar and cervicothoracic spines and shoulder joints were investigated. Twelve nulliparous subjects (aged 21 to 35 years) were used as controls to provide standard descriptive data and to investigate the consistency of the selected biomechanical variables with repeated testing. A repeated measures ANOVA was used to investigate the possibility of linear and quadratic trends showing systematic changes within the maternal group, over the four test sessions during pregnancy for each variable. Two tailed Student t-tests were used to compare the maternal postbirth variable results with the control group.

There was no significant effect of pregnancy on the upper body posture during upright sitting and quiet standing. Postbirth, the pelvic segment had a smaller anterior orientation and the thoracolumbar spine was less extended, indicating a flatter spinal curve.

The maternal subjects were similar to the control subjects in early pregnancy and postbirth for trunk segment motions during seated and standing forward flexion and side to side flexion and seated axial rotation. Strategies, such as increasing the width of the base of support and reducing obstruction to movements from other body parts, were used in late pregnancy in attempts to minimise the effects of increased trunk mass and circumference. For seated and standing side to side flexion, the strategies were successful and no significant decreases in range of motion were seen. For seated and standing forward flexion and seated axial rotation, motion of the thoracic segment and the thoracolumbar spine were significantly reduced, although movement of the pelvis was less affected.

In early pregnancy and postbirth the kinematics and kinetics of the lower limbs and upper body segment kinematics during constrained and free rising were generally similar to the control subjects. As pregnancy progressed there were increases in mass and dimensions of body segments. The effect of increased mass was seen in increased ground reaction forces and sagittal plane lower limb joint external moments. An increased base of support width was found in association with an increased lateral ground reaction force and ankle inversion moment from each foot, which would move the body centre of mass medially. There was little change in the three dimensional kinematics of the thoracolumbar and cervicothoracic spine, although the contribution of the upper body segments differed for each rise condition. There were also few significant changes in the displacement of the ankle, knee and hip, and the angular velocity of ankle and knee joints. The maternal subjects were thus able to flex the upper body forward, raise the body and maintain stability as pregnancy progressed, regardless of whether the rise to stand was performed in a natural manner or under constrained conditions. The overall results show that, contrary to expectations as pregnancy progressed, maternal subjects minimised propulsion rather than increasing it to overcome the increased mass and possibly limited trunk flexion. A fear of postural instability may have made the subjects more cautious and as they were able to adequately flex the trunk forward, propulsion was minimised in favour of maintaining upright terminal balance.

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