CHAPTER 7. EFFECT OF A SECOND PREGNANCY

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**Introduction**

Biomechanical effects of pregnancy may continue after the postbirth period and therefore influence any subsequent pregnancies. Maintained postural changes postbirth have been reported (Bullock-Saxton 1991), and parity may also affect the postural changes during a subsequent pregnancy (Dumas et al 1995). Increased peripheral joint laxity may also be maintained after the first pregnancy (Ostgaard et al 1993). Many investigations of the effects of pregnancy, however, have used a mixture of primigravida and multiparous subjects (Jensen et al 1996a, Paul and Frings-Dresen 1994a) or do not report the parity of the subjects (Bullock-Saxton 1991, Ellis et al 1985, Paul et al 1996). Thus the continuing effects of a previous pregnancy may confound the results. In addition although longitudinal studies tend to have the first test session late in the first trimester it is possible that biomechanical adaptations may have already occurred (Dumas et al 1995).

In order to more fully understand the effects of pregnancy, a longitudinal data collection consisting of nulliparous, primiparous and multiparous data would be required. As part of the larger study reported in previous chapters, such data became available for a single subject. The aim of the study was to investigate the effect of first pregnancy and then a subsequent pregnancy on selected biomechanical variables.

**Methods**

One subject was initially tested twice as a control (Nulliparous) then learning she was pregnant, transferred to the maternal group where she completed five further test sessions (Maternal 9a). When the baby (Baby 1) was nine months old maternal subject 9 again became pregnant and volunteered to be retested (Maternal 9b and Baby 2). Maternal subject 9 was aged 39, 40 and 41 years for each respective series of test sessions.
maternal test session was at 13 weeks gestation for Maternal 9a and 17 weeks for Maternal 9b. Both babies were a vaginal delivery and the gestation time and baby mass were similar for each pregnancy. Baby 1 (3.03 kg) was delivered at 40 weeks gestation while Baby 2 (3.56 kg) was delivered at 41 weeks gestation. Anthropometric details for Nulliparous and Maternal 9b are listed in Table 7.1. A detailed anthropometrical profile for Maternal 9a is listed in Appendix 1, Tables A1vii-xiii.

Selected biomechanical variables were investigated reflecting areas of interest revealed in Chapters 4, 5 and 6 including:

i) Thoracolumbar spine sagittal plane postural alignment for sitting and standing.

ii) Thoracolumbar spine range of motion and the mediolateral width of the base of support for seated and standing forward flexion.

iii) Hip joint sagittal plane range of motion, duration of the pre-extension phase, peak left relative posterior GRF and thoracolumbar spine, thoracic and pelvic segment peak flexion for a free rise to stand from a chair.

The case study used a single system design (Domholdt 1993). Initial data processing and data reduction was as described previously for each variable in Chapters 3, 4, 5 and 6. Data for each variable was graphed including Maternal 9a and 9b and Nulliparous data points. The maternal group mean and the control group mean plus and minus twice the standard errors (2 SE) from Chapters 4, 5 and 6 were also included for comparative purposes as shown in Figure 7.1. Maternal sessions 1 to 4 were during the pregnancies and Session 5 was 8 weeks postbirth. Only two nulliparous test sessions were collected therefore the creation of celeration lines to allow quantitative analysis of a single system design (Domholdt 1993) was not thought to be valid. Further statistical analysis was therefore not performed and results are based on visual interpretation of the graphs.
Results

Prior to pregnancy Nulliparous (Table 7.1) was similar to the control group (Appendix 1, Tables A1ii-vi) for mass, height, circumferences of the thigh and trunk, and exercise habits and also reported no back pain. During the second pregnancy (Table 7.1), Maternal 9b had a similar increase to the first pregnancy (Appendix 1, Tables A1vii-xiii) in mass, Rectus abdominis diastasis and circumferences of the thigh and trunk. Maternal subject 9 also reported some intermittent back pain during both pregnancies although she exercised less during the second pregnancy. Postbirth mass, circumference of the thigh and trunk, and Rectus Abdomens diastasis were similar for both pregnancies.

Table 7.1. Anthropometrical profile for Nulliparous and Maternal subject 9b

<table>
<thead>
<tr>
<th></th>
<th>Nulliparous</th>
<th></th>
<th>Maternal 9b</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Postbirth</th>
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<tbody>
<tr>
<td></td>
<td>Session 1</td>
<td>Session 2</td>
<td>Session 1</td>
<td>Session 2</td>
<td>Session 3</td>
<td>Session 4</td>
<td>Session 5</td>
<td></td>
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<tr>
<td>Mass (kg)</td>
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<td>66</td>
<td>63</td>
<td>69</td>
<td>72.6</td>
<td>77</td>
<td>69</td>
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<tr>
<td>Exercise +</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>*</td>
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<tr>
<td>Backpain #</td>
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<td>0</td>
<td>0</td>
<td>intermittent</td>
<td>intermittent</td>
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<tr>
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<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>Knee</td>
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<tr>
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<td>55.0</td>
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<td>Hip</td>
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<td>96.0</td>
<td>101.0</td>
<td>74.0</td>
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<td>Chest</td>
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<td>85.0</td>
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<td>96.0</td>
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<td>Above umbilicus</td>
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<td>*</td>
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<td>4.0</td>
<td>4.0</td>
<td>1.5</td>
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<tr>
<td>At umbilicus</td>
<td>*</td>
<td>*</td>
<td>2.5</td>
<td>2.8</td>
<td>4.0</td>
<td>4.0</td>
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</tr>
<tr>
<td>Below umbilicus</td>
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<td>*</td>
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<td>1.0</td>
<td>2.5</td>
<td>4.0</td>
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* missing data
+ Average number of weekly exercise sessions for the month prior to the test session
# Occurrence of backpain
Postural alignment in the sagittal plane

For upright sitting prior to pregnancy (Nulliparous), the thoracolumbar postural alignment in the sagittal plane was similar to the control group (Figure 7.1). Throughout the first pregnancy, (Maternal 9a), the thoracolumbar spine showed a neutral posture which was similar to the control group (Figure 7.1). Early in the second pregnancy, (Maternal 9b) the thoracolumbar spine posture was similar to the nulliparous posture and the first postbirth period. In late second pregnancy and in the second postbirth period the thoracolumbar spine alignment became more extended (Figure 7.1). The more extended posture was in contrast to the maternal group, which tended to become slightly more flexed in late pregnancy.

![Figure 7.1. Thoracolumbar spine sagittal plane postural alignment in upright sitting for Maternal subject 9a and 9b and Nulliparous. Negative values indicate spine extension.](image-url)
For quiet standing prior to pregnancy (Nulliparous), the thoracolumbar postural alignment in the sagittal plane was similar to the control group (Figure 7.2). Maternal 9a showed small changes in posture throughout the pregnancy first increasing then decreasing the curvature (Figure 7.2). Early in the second pregnancy, the thoracolumbar spine sagittal plane alignment was similar to that of the first pregnancy, however, as the pregnancy progressed the extension increased which continued postbirth (Figure 7.2).

![Figure 7.2. Thoracolumbar spine sagittal plane postural alignment in quiet standing for Maternal subject 9a and 9b and Nulliparous. Negative values indicate spine extension.](image-url)
Seated and standing forward flexion

Prior to pregnancy (Nulliparous) the thoracolumbar spine range of motion during seated (Figure 7.3) and standing (Figure 7.4) forward trunk flexion was similar to the control group. During both pregnancies (Maternal 9a and 9b) the range of motion tended to decrease for both seated (Figure 7.3) and standing (Figure 7.4) forward flexion similar to the maternal group although there was variation from session to session. Generally postbirth (Session 5) the range of motion increased back to early pregnancy levels. During the second postbirth period for seated forward flexion, however, the range of motion remained reduced (Figure 7.3).

![Figure 7.3. Thoracolumbar spine seated forward flexion range of motion for Maternal subject 9a and 9b and Nulliparous.](image)
Prior to pregnancy (Nulliparous) the mediolateral width of the base of support during seated forward flexion was similar to the control group (Figure 7.5). During both pregnancies the width increased similar to the maternal group. Postbirth (Session 5) the width decreased back to early pregnancy levels. A similar result was seen for mediolateral width of the base of support during standing.

Figure 7.4. Thoracolumbar spine standing forward flexion range of motion for Maternal subject 9a and 9b and Nulliparous.

Figure 7.5. Mediolateral width of the base of support during seated forward flexion for Maternal subject 9a and 9b and Nulliparous.
Rising to stand from a chair

The hip joint range of motion was generally greater than the control group for Nulliparous and Maternal 9b (Figure 7.6). The range of motion was variable from session to session for Maternal 9a. For Maternal 9b, the range of motion tended to decrease in late pregnancy and decrease further postbirth.

![Graph of hip joint range of motion in the sagittal plane for Maternal subject 9a and 9b and Nulliparous.](graph)

*Figure 7.6. Hip joint range of motion in the sagittal plane for Maternal subject 9a and 9b and Nulliparous.*

The duration of the pre-extension phase generally showed an inconsistent pattern during both Nulliparous and Maternal 9a series of test sessions. Maternal 9b, however, showed a similar pattern over the test series to the maternal group (Figure 7.7). For both pregnancies, the pre-extension phase duration was similar in early pregnancy and postbirth (Figure 7.7). From mid to late pregnancy there was a decrease in pre-extension phase duration similar to the maternal group.
Nulliparous left peak posterior relGRF was similar to the control group (Figure 7.8). The peak posterior relGRF for Maternal 9a tended to decrease as pregnancy progressed similar to the maternal group (Figure 7.8). For Maternal 9a, however, the left posterior relGRF increased as pregnancy progressed. Both postbirth values returned to early pregnancy values (Figure 7.8).

**Figure 7.7.** Pre-extension phase duration as a proportion of total movement time for Maternal subject 9a and 9b and Nulliparous.

**Figure 7.8.** Left peak relative posterior GRF for Maternal subject 9a and 9b and Nulliparous.
Peak thoracolumbar spine flexion for Nulliparous was less than the control group (Figure 7.9). For Nulliparous the thoracic and pelvic segment peak flexion was similar to the control group (Figures 7.10 and 7.11 respectively). As pregnancy progressed the peak thoracolumbar spine flexion slightly decreased for both pregnancies in contrast to the maternal group where no change was evident (Figure 7.9). The thoracic segment peak flexion decreased in contrast to the maternal group where an increased flexion was seen (Figure 7.10). The pelvic segment peak flexion showed no consistent pattern of change similar to the maternal group (Figure 7.11).

![Graph showing peak flexion angles for Maternal subject 9a and 9b and Nulliparous.](image)

*Figure 7.9. Thoracolumbar spine peak flexion angle for Maternal subject 9a and 9b and Nulliparous.*

At maternal Session 2 for both pregnancies the interaction between the thoracic and pelvic segment motion proposed in Chapter 6 was evident (Figures 7.10 and 7.11). A relatively decreased thoracic segment peak flexion in Maternal 9a was seen with an increase for the pelvic segment. For Maternal 9b a relatively increased thoracic segment peak flexion was seen in conjunction with a decrease for the pelvic segment.
Figure 7.10. Thoracic segment peak flexion angle for Maternal subject 9a and 9b and Nulliparous.

Figure 7.11. Pelvic segment peak flexion angle for Maternal subject 9a and 9b and Nulliparous.
**Discussion**

Parity has been proposed to affect biomechanical adaptations to pregnancy. As part of a larger study nulliparous, primiparous and multiparous longitudinal data became available for a single subject. The aim of the case study was to investigate the effect of a first pregnancy and a subsequent pregnancy on selected biomechanical variables.

Prior to pregnancy the subject was similar to the control group for her anthropometric profile. For each subsequent pregnancy, similar anthropometric changes were seen as pregnancy progressed and during the postbirth period. Ostgaard et al (1993) suggested that there is an earlier increase in abdominal circumference in multiparous women. Trunk circumference, at the level of umbilicus, was greater for the second pregnancy at Session 1. The greater second pregnancy circumference, however, was likely to have been due to the difference in the gestation time at first test. An abdominal circumference measure at 13 weeks would be expected to be less than a measure at 17 weeks. Subsequent abdominal circumference measures, which were taken at the same gestation dates for each pregnancy were similar or slightly less for the second pregnancy in contrast to Ostgaard et al (1993).

**Posture in standing and sitting**

Dumas et al (1995) suggested that parity might affect the postural alignment in the sagittal plane during standing in late pregnancy, which was also seen in the present study. An increased curvature in late second pregnancy in contrast to little change for the first pregnancy was also seen for upright sitting.

The cause of the increased curvature in late second pregnancy is unclear. Although Ostgaard et al (1993) proposed that increased peripheral joint laxity is maintained after the first pregnancy, Dumas et al (1995) reported no difference in joint laxity between first and
subsequent pregnancies. It is also possible that the differences between the first and second pregnancy and also the differences between Maternal subject 9 and the maternal group as a whole reflect the individual nature of adaptations to pregnancy. Moore et al (1990) and Bullock-Saxton (1991) also reported that individual subjects showed different postural behaviours with some increasing and some decreasing their lumbar lordosis. Postural adaptations may therefore be individual in nature for each pregnancy.

The individual nature of the adaptations to pregnancy was also seen postbirth. For the first pregnancy, the thoracolumbar curvature in standing decreased postbirth in contrast to Dumas et al (1995) first pregnancy results, although similar to overall maternal results reported in previous chapters where parity was not controlled. For the second pregnancy the curvature continued to increase postbirth in contrast to Dumas et al (1995) second pregnancy results, although similar to Bullock-Saxton (1991 and Moore et al (1990) where parity was not controlled. The differences between studies may have been due to the different time after birth used for testing (Dumas et al 1995). The results of the present study suggest that parity may also affect the postural alignment postbirth. It is also possible that the response is individual and therefore an assumption of persistent changes postbirth may be not true for all women.

**Seated and standing forward flexion**

During both pregnancies the thoracolumbar range of motion for seated and standing forward flexion varied from session to session. Overall the range of motion decreased similar to the maternal group results and Dumas et al (1998b). As seen for the maternal group the width between the feet also increased. Therefore similar strategies were seen for both pregnancies to minimise obstruction from apposition between the anterior abdomen and the thighs.
Generally postbirth the range of motion increased back to early pregnancy levels as seen for the maternal group and Dumas et al (1998b). During the second postbirth period for seated forward flexion, however, the range of motion remained reduced. Dumas et al (1998b) also found a different range of motion for standing forward flexion at postbirth six and postbirth 16 weeks testing. Dumas et al (1998b) suggested that the different range of motion was due to increased flexibility as a result of continuing hormonal effects. It is likely, however, that the differences seen postbirth by Dumas and colleagues and also by the present study may be an effect of variability associated with retesting.

**Rising to Stand from a Chair**

The maternal subjects, reported in Chapter 6, were able to flex the upper body forward, raise the total body mass up and maintain stability during rising to stand from a chair as pregnancy progressed. Some biomechanical adaptations to pregnancy, however, varied with the rise to stand condition and it was also possible that the adaptations may have varied with parity as has been reported for postural alignment in standing (Dumas et al 1995). The effect of parity on selected biomechanical variables during rising to stand from a chair has not been previously investigated.

The generally increased hip joint range of motion for Maternal subject 9 in comparison to both the control and maternal groups highlighted the individual response to the rise to stand task. The variable hip joint sagittal plane range of motion and pre-extension duration seen during Nulliparous and the first pregnancy may also reflect the inherent variations in some kinematic and temporal aspects of rising to stand.

There also appeared to be an effect of parity. For Nulliparous and the first pregnancy the range of motion and the duration of the pre-extension phase was variable from session to session, while for the second pregnancy the pattern of change was more consistent over the
series of sessions. The reason for a more consistent pattern to be used in the second pregnancy was unclear. It was possible that the differences between pregnancies were due to intra subject variation rather than an effect of parity. As this study was based on a single subject, caution must be used in interpretation of the results.

The left peak posterior relative GRF, however, showed consistent patterns of change throughout both pregnancies although the pattern itself was different for each pregnancy. During the first pregnancy the posterior GRF tended to decrease as pregnancy progressed similar to the maternal group, however, for the second pregnancy an increase was seen. Previously (Chapter 6) it was proposed that a decrease in the anteriorly directed (propulsive) GRF proportionally more than the increased mass may be related to maintaining terminal balance control by limiting the horizontal linear momentum. The maternal group decreased propulsion GRF was seen with no significant decrease in hip joint range of motion as was also seen for the first pregnancy. The second pregnancy however showed a decreasing range of motion of the hip joint as pregnancy progressed with an increase in the proportional propulsion GRF. It is possible that the horizontal momentum of the centre of mass may be limited by either reducing the range of motion of the hip joint as seen in the second pregnancy or reducing the acceleration of the mass as seen in the first pregnancy. Either strategy would be successful in maintaining terminal balance control.

For both pregnancies a similar pattern of change was seen for the trunk segments’ peak motions therefore the effect of pregnancy was similar. In contrast to the maternal group, however, the thoracic segment peak flexion decreased as pregnancy progressed for Maternal subject 9. The trunk is a major contributor to the horizontal linear momentum of the whole body during rising to stand from a chair (Pai and Rogers 1990). Therefore a
reduction in trunk motion as seen for the second pregnancy with reduced hip joint flexion would require an increased propulsive force as was seen. For the first pregnancy, however, the reduced thoracic segment motion with little change in the hip joint flexion was combined with a reduced propulsive force. It is possible that for the first pregnancy a combination of some reduction in the forward motion of the trunk segment and a reduced propulsive force was used to control forward momentum while in the second pregnancy, the minimisation of the forward motion of the trunk as pregnancy progressed required increased propulsion so that the minimum requirement of horizontal moment could be maintained.

Conclusions

No effect of parity was seen the thoracolumbar spine range of motion and the mediolateral width of the base of support for seated and standing forward flexion. A possible effect of parity was seen for thoracolumbar spine postural alignment in the sagittal plane for upright sitting and quiet standing and the duration of the pre-extension phase and sagittal plane hip joint range of motion during free rising to stand from a chair. Where effects of parity were seen it was also possible that the pattern of change attributed to parity was due to intersubject differences and an individual response to the constraints of pregnancy on each occasion. Although the pregnancies were very similar in mass increase, gestation and birth weight of the baby and therefore the effect of the pregnancy could be assumed to be similar on each occasion, the variation in the selected biomechanical variables may be related to the many possible varying combinations of kinematic and kinetic variables which result in a similar outcome. The possible carry over effect from previous pregnancy may be less important than the differences in adaptations by an individual and the effect of these movements and postural adaptations on the musculoskeletal system.