

# Spinal Column and Abdominal Muscles Loading in Pregnant Women Dependent on Working Postures

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## ABSTRACT

**Introduction:** Diastasis recti abdominis is consequence of mechanical forces that, proportionally to uterus and fetus augmentation, make pressure on anterior abdominal wall. Muscle tonus in pregnancy is significantly impaired. Stress relaxation of connective tissues and modified statics often cause back and leg pain. **Aim:** To evaluate whether pregnancy augment the spinal column and abdominal muscles loading and to what extent, based on anthropometric measurements and software analysis.

**Methods:** Twenty women participated in the study, having similar anthropometric measurements. Average height was 170 cm (mean), and weight 68.0 kg (mean). Three working postures were analyzed: upright (working posture 1), semi-bent (working posture 2) and bent (working posture 3) working postures by both non-pregnant and pregnant women. Simulation was made in software package CATIA. **Results:** Analysis was done for working postures at workplace in pre-pregnancy period (height 170 cm, weight 68 kg) and during pregnancy (height 170 cm, weight 80 kg). From analysis of posture 2 and posture 3 in pregnant woman, conclusion can be drawn that despite of the fact that our examinees did not carry any external/additional loads, in these two working postures the abdominal muscles suffered overloading. **Conclusion:** It is crucial to strengthen the entire musculature for women who wish to get pregnant. The pre-pregnancy exercises might improve the posture, tonus and boost chances for safe labor and delivery. Strong abdominal muscles are needed to unload the spine. It is highly recommended to prepare their musculature for pregnancy through various pre-pregnancy exercises.

**Keywords:** biomechanics, software, muscles, pregnancy.

## 1. INTRODUCTION

Abdomen in late pregnancy period causes shift of the body's center of gravity where at the spinal column suffers tremendous load (1-5). This can sometimes be accompanied by low back pain. When augmented uterus in the third trimester starts pressing on ischiatic nerve protruding from the spine and passing through pelvis minor, pain in low back arises, while numbness down the leg may be felt (1).

There may occur an instant loss of control over the leg muscles when walking (sciatica is unilateral in most of the cases) (4, 6).

Muscle tonus in pregnancy is significantly impaired. Abdominal muscles could be burdened (pressured), while their role is to provide main support to the spine. Stress relaxation of connective tissues and mod-

ified statics often cause back and leg pain (1, 6).

Diastasis recti abdominis is defined as a separation of the two muscle bellies of rectus abdominis and is consequence of mechanical forces that, proportionally to uterus and fetus augmentation, make pressure on anterior abdominal wall (1). Diastasis, however, may be caused by umbilical hernia, due to incapability of abdominal muscles to transfer the force toward the spinal column. This is why pain arises in abdomen and pelvis.

## 2. AIM

To evaluate whether pregnancy augment the spinal column and abdominal muscles loading and to what extent, based on anthropometric measurements and software analysis.

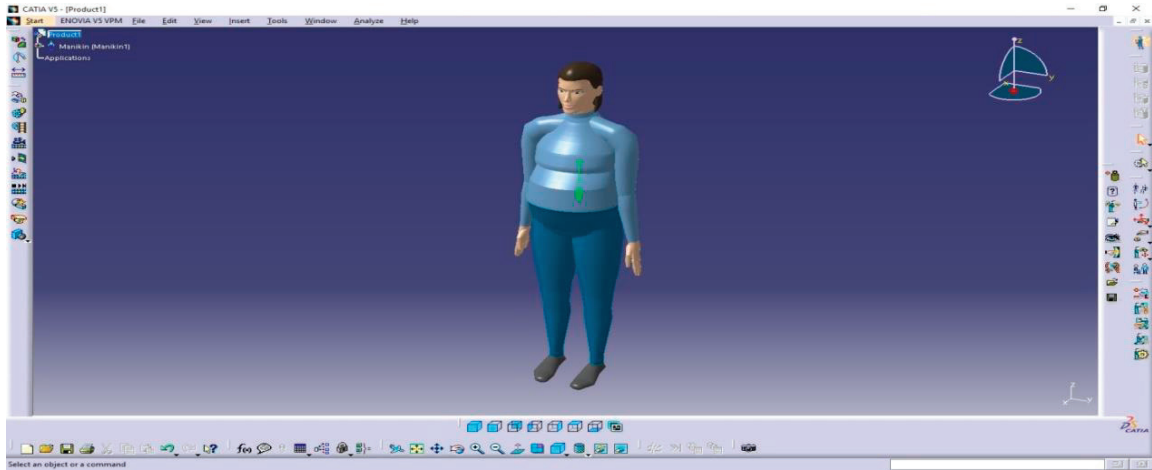


Figure 1. Working posture 1

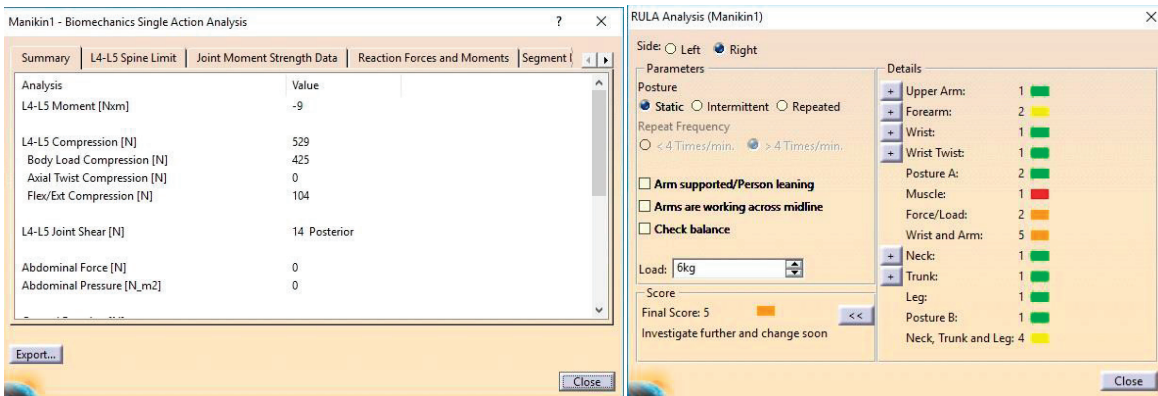


Figure 2. Biomechanical analysis of posture 1, Rula analysis of posture 1



Figure 3. Working posture 2

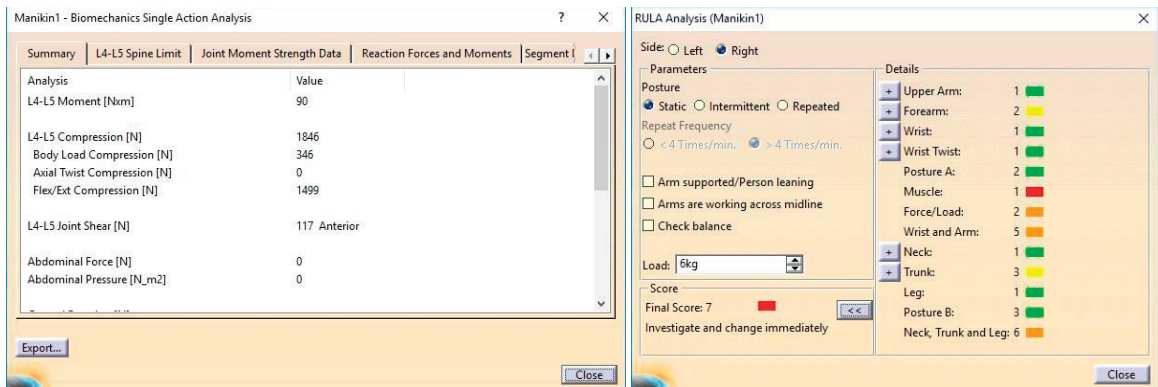


Figure 4. Biomechanical analysis of posture. Rula analysis of posture 2



Figure 5. Working posture 3

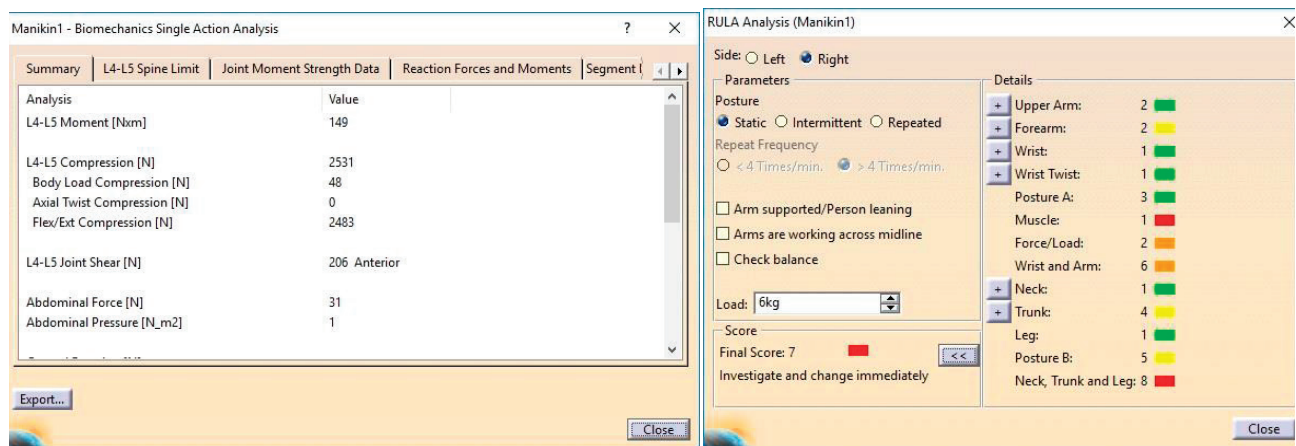


Figure 6. Biomechanical analysis of posture. Rula analysis of posture 3

### 3. METHODS

An experiment was conducted at one of the gynecological institutions where pregnant women are delivering their babies. Twenty women participated in the study, having similar anthropometric measurements. Average height was 170 cm (mean), and weight 68.0 kg (mean).

Their condition was under gynecological monitoring from conception until labor and delivery. During the experiment, our examinees complained about the pain in abdominal muscles and partially spinal column. Moreover, for a healthy pregnancy and a healthy baby, it is recommendable that woman with normal body mass gains between 12 to 16 kg before pregnancy. Simulation was made in software package CATIA (powered by Dassault Systèmes' 3DEXPERIENCE platform).

### 4. RESULTS

#### 4.1 Analysis of working postures at workplace in period before pregnancy

The examinees anthropometric values were: a) height h=170 cm and b) weight Q= 68.0 kg.

Based on the above analysis of posture 1, conclusion may be reached that biomechanical spinal column loading is within allowed limits of 300 N/3400N, as well as the entire body's posture of 1/7 (in yellow) also being within allowed limits.

Based on the above analysis of posture 2, conclu-

| Month | Woman's weight in (kg). | Weight gained in course of nine months in (kg). |
|-------|-------------------------|---|
| 0     | 68.0                    | 0.0   |
| 1     | 68.5                    | 0.5   |
| 2     | 69.0                    | 0.5   |
| 3     | 69.5                    | 0.5   |
| 4     | 70.5                    | 1.0   |
| 5     | 72.0                    | 1.5   |
| 6     | 74.0                    | 2.0   |
| 7     | 76.0                    | 2.0   |
| 8     | 78.0                    | 2.0   |
| 9     | 80.0                    | 2.0   |

Table 1. With weight values per months of pregnancy

sion may be reached that biomechanical spinal column loading is within allowed limits of 1297 N/3400N, as well as the entire body's posture of 4/7 (in yellow) also being within allowed limits.

Based on the above analysis of posture 3, conclusion may be reached that biomechanical spinal column loading is within allowed limits of 2328 N/3400N, as well as the entire body's posture of 5/7 (in orange) also being within allowed limits.

#### 4.2 Analysis of working postures at workplace during pregnancy

The examinees anthropometric values were: height h=170 cm and weight Q= 74+6=80.0kg.

Based on the above analysis of posture 1 (pregnant woman), conclusion may be reached that biomechanical spinal column loading is within allowed limits of 525N/3400N, as well as the entire body's posture of 1/7 (in yellow) also being within allowed limits.

Based on the above analysis of posture 2 (pregnant woman), conclusion may be reached that biomechanical spinal column loading is within allowed limits of 1846N/3400N, and that the entire body's posture of 7/7 (in red) requires redesign of this working posture from aspect of overly loaded muscles in order to prevent health issues.

Based on the above analysis of posture 3 (pregnant woman), conclusion may be reached that biomechanical spinal column loading is within allowed limits of 2531N/3400N, and that the entire body's posture of 7/7 (in red) requires redesign of this working posture from aspect of overly loaded muscles, neck vertebra and legs in order to prevent health issues.

## 5. DISCUSSION

After the analysis, it is clear that spinal column loading regarding all three working postures is within allowed limits, while the musculature of subjects, especially if they are not prepared for such posture, is in an alarming condition.

From analysis of posture 2 and posture 3 in pregnant woman, conclusion can be drawn that despite of the fact that our examinees did not carry any external/additional loads, in these two working postures the abdominal muscles suffered overloading. Also, the Rula-analysis suggested that those postures must be avoided.

## 6. CONCLUSION

It is crucial to strengthen the entire musculature for women who wish to get pregnant. The pre-pregnancy exercises might improve the posture, tonus and boost chances for safe labor and delivery. Strong abdominal muscles are needed to unload the spine. Moreover, if the

muscles are shortened or weak, they cause or aggravate the back pain.

For women wishing to get pregnant, it is highly recommended to prepare their musculature for pregnancy through various pre-pregnancy exercises.

- \* Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms.
- \* Author's contribution: Each author gave substantial contribution to the conception or design of the work and in the acquisition, analysis and interpretation of data for the work. Each author had role in drafting the work and revising it critically for important intellectual content. Each author gave final approval of the version to be published and they agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.
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