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**ORIGINAL PAPER**

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# Effects of an abdominal drawing-in manoeuvre on stabilometric and gait parameters in adults: a pilot study

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**ABSTRACT**

**Introduction.** To our knowledge, no studies have checked the effect of the abdominal drawing-in maneuver (ADIM) on gait and stabilometric parameters in lower back pain (LBP) and pain-free subjects

**Aim.** To assess the effect of sustained ADIM on a) gait pattern and b) stabilometric parameters with opened eyes and closed eyes in an adult population.

**Material and Methods.** A group of 20 adults were invited to participate in the study. The Oswestry Disability Index was used for assessing LBP. Gait analysis was performed on a treadmill ZEBRIS FDM-T. The static balance assessment was performed on a stabilometric platform ZEBRIS FDM-S.

**Results.** There were no significant differences in all tests conducted on the stabilometric platform. Results of gait analysis showed between-group differences in the main effect of group (Non-LBP vs. LBP) for the difference in maximal vertical ground reaction force during the terminal stance (GRFts). The mean GRFts value in the Non-LBP group was greater by 14.8 N (95% CI 9.55–20.1) compared with the LBP group (Table 3).

**Conclusions.** ADIM has no immediate effects on selected stabilometric and gait parameters in the study group. No effect was seen in subjects with and without pain during the examination.

**Keywords.** gait, stabilometric parameters

## Introduction

Previous studies have attempted to determine the role of the lateral abdominal muscles in lower back pain (LBP) or scoliosis conditions.[1–6] In these type of studies, the most common assessment variables are the resting thickness of the transversal abdominal muscle (TrA), abdominal oblique internal (OI) and external (OE) muscles or their change in thickness during an 'abdominal drawing-in maneuver' (ADIM), which is used to evaluate lateral abdominal muscle function.[2,7–9] The

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ADIM is also the basic exercise of a spine stabilization program, where the goal is to restore proper neuromuscular control by re-educating deep abdominal muscle function.[10,11] Biomechanically, the ADIM increases abdominal pressure, sacroiliac joint stability and thoracolumbar fascia tension, because the TrA and OI are voluntarily contracted. Some studies have demonstrated that the ADIM is effective in the treatment of LBP and should be implemented in scoliosis.[2,7,12]

However, the use of the ADIM has also received some criticism, because it may be considered as an artificial movement task with no reflection in activities of daily living.[8] This, in turn, may hypothetically create inappropriate effects on daily activities, such as walking or standing. Some rehabilitation protocols for deep abdominal muscles consist of the ADIM performed in different body positions and intervals.[13] Thus, it could also be possible to advise patients with LBP to sustain an ADIM for a longer time, while walking or standing.

To our knowledge, no studies have checked the effect of the ADIM on gait and stabilometric parameters in LBP and pain-free subjects. Hence, the aim of the study was to assess the effect of sustained ADIM on a) gait pattern and b) stabilometric test parameters with opened and closed eyes in an adult population.

## Material and Methods

*Setting and study design*

This was an experimental study conducted in the Department of Biomechatronics at the Technology University in Zabrze. The study was designed according to the Declaration of Helsinki. All participants received oral and written information about all procedures and gave their signed informed consent to participate.

***Study population***

A group of 20 adults were invited to participate in the study (mean age = 20.6 ± 0.8 years; mean body weight = 63.1 ± 13.4 kg; mean body height = 170.2 ± 9.2 cm) from randomly chosen laboratory groups at the University. Individuals who had had a surgical procedure on the thoracic cage, abdominal cavity, pelvic girdle and/or spine were excluded. All participants who have claimed to participate in stability training (or other physiotherapy program) 6 months prior to or during the study were also excluded.

***LBP assessment***

All participants completed an Oswestry Disability Index (ODI), which is used for assessing LBP. The ODI contains 10 questions, each one having six possible choices scored from 0 to 5, with higher values indicating a more severe condition. The sum of the scores for all questions gives a total score ranging between 0 and 50. To calculate the LBP disability level of the participants, expressed as a percentage, the total score is multiplied by 100 and divided by 50.[15] To clarify the LBP definition, it was defined for participants as a pain between the last rib and lower gluteal fold, which is severe enough to limit or change your daily routine or physical activity level for more than 1 day.

If the participants marked the minimum score for the first question of the ODI (I have no pain at the moment), they were treated as free from LBP (Non-LBP group) during the study procedures. However, if the participants reported anything other than the minimum value for the first question (the pain is mild, moderate, etc.), they were treated as the LBP group.

***Static balance assessment***

The static balance assessment was performed on a stabilometric platform ZEBRIS FDM-S (Zebris Medical GmbH, Germany), and the following parameters were analysed: general force distribution, ellipse area and path length. These parameters were assessed during the Romberg test (standing position with eyes closed and open for 30 seconds).

***Gait analysis***

Gait analysis was performed for 60 seconds on a treadmill ZEBRIS FDM-T (Zebris Medical GmbH, Germany). The treadmill was placed on a flat surface, the gait speed was 4.5 km/h and the slope was equal to 0 degrees. The following parameters were measured: GLL – difference in gait line length (|right-left|); GRFts – difference in maximal vertical ground reaction force during the terminal stance (|right-left|); GRFlr – difference in maximal vertical ground reaction force during the loading response (|right-left|).

***Protocol***

At the beginning, all participants performed an analysis of body balance under both conditions (open and closed eyes) as well as gait analysis while walking on the treadmill. Immediately after, all participants were instructed on how to perform the ADIM according to the procedures described by Hides et al.[14] and with the use of ultrasound imaging as a biofeedback tool (detailed information about the application of ultrasound imaging was explained elsewhere[15–18]). A total of six contraction attempts, each with a 10-second hold, were performed in supine and standing positions. After the training, participants underwent body balance assessment and gait analysis while holding the ADIM (Figure 1).

***Statistical analysis***

Differences in demographic data between the Non-LBP and LBP groups were examined using an independent-samples *t*-test. Stabilometric and gait data were analysed using analysis of variance (ANOVA) for repeated measurements with the between-subjects factor being group (Non-LBP vs. LBP) and the within-subjects factor being abdominal muscle condition (rest vs. ADIM). The results are presented as mean difference and 95% confidence interval (CI). For all analyses, results were considered significant at $p < 0.05$.

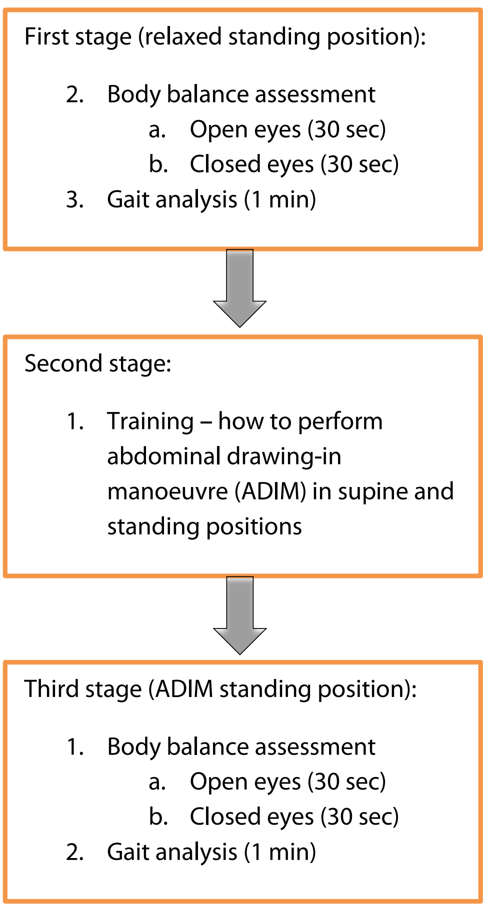


**Figure 1.** Study protocol

## Results

### *Participants*

Out of 20 participants, 18 were included in the final analysis. Two participants did not fulfil the protocol (they were unable to perform the ADIM correctly). Out of 18 participants, 9 of them marked the minimum score for the first question on the ODI (I have no pain at the moment), and they were treated as free from LBP (Non-LBP group). The remaining nine participants reported a value greater than the minimum for the first question (the pain is mild, moderate, etc.); they were treated as the LBP group. The complete characteristics of the study population, divided into groups, are presented in Table 1. The subjects from Non-LBP group were heavier, taller and had lower ODI scores than the group who had pain during the study.

### *Static balance assessment*

There were no significant differences in all tests conducted on the stabilometric platform. The mean values and corresponding *P* values from ANOVA are presented in Table 2.

### *Gait analysis*

Results from the treadmill only showed between-group differences in the main effect of group (Non-LBP vs. LBP) for the GRFts parameter. The mean GRFts value in the Non-LBP group was greater by 14.8 N (95% CI 9.55–20.1) compared with the LBP group (table 3).

## Discussion

In this report, the effects of the ADIM on gait and stabilometric parameters in young adults are presented. This is also the first report to evaluate the effects of the ADIM in LBP and pain-free subjects. In the study population, compared to the relaxed condition, static balance test results during the ADIM were not statistically different, indicating that the ADIM did not affect the stabilometric parameters during the Romberg test (closed eyes and open eyes). Additionally, no significant difference was shown in LBP incidence during the examination (Non-LBP vs. LBP). Regarding gait analysis, only the Non-LBP group had higher GRFts values by almost 15 N compared with the LBP group, and there were no differences in gait parameters between the relaxed and contracted (ADIM) conditions.

**Table 1.** The mean ± SD of groups and the mean (95% CI) differences between groups and the t-test result for independent samples

| Characteristic | Groups | | Difference between groups | |
|---|---|---|---|---|
| | Non-LBP (n = 9) | LBP (n = 9) | Non-LBP minus LBP | test t |
| Age (*yr*) | 20.5 ± 0.5 | 20.7 ± 1.09 | -0.22 (-1.07 to 0.63) | -0.59 |
| Weight (*kg*) | 69.1 ± 14.6 | 54.8 ± 6.22 | 14.3 (-3.10 to 25.6) | 2.71* |
| Height (*cm*) | 175.1 ± 10.7 | 165.4 ± 5.13 | 9.66 (1.27 to 18.1) | 2.44* |
| ODI (%) | 2.42 ± 5.02 | 10.7 ± 7.81 | -8.32 (-14.9 to -1.75) | -2.69* |

* Significant difference ($p < 0.05$)

**Table 2.** Mean ± SD values of stability parameters at rest and during ADIM in Non-LBP and LBP groups

| | Non-LBP group | | LBP group | | P value from ANOVA | | |
|---|---|---|---|---|---|---|---|
| | | | | | Main effect | | |
| | Rest | ADIM | Rest | ADIM | Group | Condition | Interaction |
| Static balance assessment (open eyes) | | | | | | | |
| Elipse area (mm2)) | 58.1 ± 73.3 | 65.4 ± 56.3 | 29.1 ± 16.5 | 42.5 ± 31.6 | 0.27 | 0.07 | 0.57 |
| Path length (mm) | 412 ± 84 | 409 ± 71 | 389 ± 74 | 433 ± 74 | 0.99 | 0.37 | 0.29 |
| Force[a] (%) | 5.88 ± 3.98 | 6.95 ± 4.89 | 8.31 ± 4.51 | 8.22 ± 4.86 | 0.33 | 0.68 | 0.62 |
| Static balance assessment (closed eyes) | | | | | | | |
| Elipse area (mm2)) | 40.4 ± 24.2 | 57.9 ± 38.9 | 34.5 ± 20.6 | 41.8 ± 32.7 | 0.38 | 0.10 | 0.49 |
| Path length (mm) | 489 ± 109 | 444 ± 71 | 423 ± 69 | 463 ± 104 | 0.46 | 0.94 | 0.15 |
| Force[a] (%) | 5.64 ± 3.38 | 6.15 ± 5.28 | 7.55 ± 3.39 | 9.73 ± 5.56 | 0.13 | 0.36 | 0.57 |

[a] force distribution = |ride side-left side|;

**Table 3.** Mean ± SD values of stabilometric parameters at rest and during ADIM in Non-LBP and LBP groups

| | Non-LBP group | | LBP group | | P value from ANOVA | | |
|---|---|---|---|---|---|---|---|
| | | | | | Main effect | | |
| | Rest | ADIM | Rest | ADIM | Group | Condition | Interaction |
| Gait analysis | | | | | | | |
| GLL (mm) | 9±14 | 7±13 | 5±5 | 6±4 | 0.55 | 0.60 | 0.11 |
| GRFts (N) | 20.7±7.32 | 20.7±70.9 | 6.25±5.73 | 5.47±2.57 | >0.001* | 0.88 | 0.86 |
| GRFlr (N) | 20.7±7.33 | 25.4±26.1 | 6.25±5.73 | 18.4± 6.9 | 0.09 | 0.10 | 0.46 |

GLL – differences in gait line length (|right-left|); GRFts – difference in maximal vertical ground reaction force during the terminal stance (|right-left|); GRFlr – difference in maximal vertical ground reaction force during the loading response (|right-left|); *significant difference

Considering that ADIM is effective in LBP rehabilitation, the above-mentioned results are a cause for optimism, because it can be stated that a sustained (no longer than 1 minute) ADIM has no side-effects on stabilometric and gait parameters during normal standing and walking.[7,12] There were also no significant differences between the Non-LBP and LBP groups. Thus, it can be said that in a short period of time, ADIM had no effect on parameters such as ellipse area, path length, general force distribution, GLL, GRFts and GRFlr.

The ADIM engages TrA and OI muscle activity (increases the thicknesses of those muscles) relative to the OE. Some studies revealed that an increase in deep abdominal muscle thickness (TrA and OI) is correlated with lumbo-pelvic neutral posture in erect standing and that improper posture diminished stabilographic variables.[19,20] Studies have also confirmed that core stability exercises (focusing on the trunk muscles) improve balance ability.[21,22] Thus, from the results of our study and others, it could be suggested that balance ability and gait pattern are not related to deep abdominal muscle thickness. In our study, participants in the ADIM condition supposedly had significantly thicker TrA and OI muscles compared with those in the relaxed state. Most studies have confirmed this observation.[23–25] However, such a condition (supposedly higher muscle thickness during ADIM) had no effect on stabilometric and gait parameters. This means that factors other than deep abdominal muscle thickness are important for changing stabilometric and gait parameters.

The study has also limitations, which advise careful interpretation of the results. The most important is the lack of control in the lateral abdominal muscle in the ADIM condition during the examination. It was impossible to control muscle thickness by ultrasound imaging without disturbing the participants. In future studies, it could be worthwhile to use a belt to fix a transducer to the body.[26] The second limitation is the relatively small sample size and the criteria for inclusion in the Non-

LBP group (pain-free on the day of the examination), which may have included some participants who had occasional lower-back problems. Additionally, some of the standard deviation (SD) values presented in the Table 2 and 3 are relatively big comparing to their mean values, this may indicate high variability and abnormal statistical distribution of these parameters.

## Conclusions

ADIM has no immediate effects on selected stabilometric and gait parameters in the study group. No effect was seen in subjects with and without pain during the examination.

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