Predictors of Disability Attributed to Symptoms of Increased Interrecti Distance in Women after Childbirth: An Observational Study

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Abstract

Objective. The purpose of this study was to investigate how various physical and psychological factors are linked to disability attributed to symptoms from increased interrecti distance (IRD) in women after childbirth.

Methods. In this cross-sectional observational study, 141 women with an IRD of at least 2 finger-widths and whose youngest child was between the ages of 1 and 8 years participated. A multiple linear regression model was performed, with disability as the outcome variable and fear-avoidance beliefs, emotional distress, body mass index, lumbopelvic pain, IRD, and physical activity level as predictor variables.

Results. The regression model accounted for 60% ($R^2 = 0.604$, adjusted $R^2 = 0.586$) of the variance in disability ($F_{6,132} = 33.5$). The 2 strongest predictors were lumbopelvic pain, with a regression coefficient of 1.4 (95% CI = 1.017 to 1.877), and fear avoidance, with a regression coefficient of 0.421 (95% CI = 0.287 to 0.555). The actual IRD, with a regression coefficient of −0.133 (95% CI = −1.154 to 0.888), did not contribute significantly to the variation in disability.

Conclusion. Disability attributed to symptoms from an increased IRD is explained primarily by the level of lumbopelvic pain but also by the degree of fear-avoidance beliefs and emotional distress.

Impact. This study highlights pain intensity and psychological factors as crucial factors for understanding disability attributed to increased IRD.

Keywords: Avoidance Behavior, Emotional Distress, Muscle Diastasis, Ultrasonography
Introduction
Pregnancy and childbirth are transforming events for women, both physically and psychologically. Physically, the female body adapts in a remarkable way during pregnancy. Among other things, the muscle bellies of musculus rectus abdominis are pushed apart when the belly grows, and the fascia structure, linea alba, is stretched and thinned, which leads to increased interrecti distance (IRD). For many women, the IRD remains increased after childbirth. It has been reported that 40% of women have an increased IRD 6 months after childbirth, but the exact prevalence is likely varying depending on the definition of an abnormal IRD and where on the belly the IRD is measured. Early postpartum, an increased IRD has been linked to negative body image and increased levels of abdominal pain, and at 1 year postpartum, it is associated with deficiencies in trunk muscle function. However, the consequences on physical disability, especially in a longer term, are largely unknown. One potential pathway is that increased IRD provokes pain in the lumbopelvic area, which in turn is linked to self-rated physical disability. However, the link between increased IRD and lumbopelvic pain is uncertain, with some studies showing an association between the two and others not.

Psychologically, childbirth is often followed by mood changes, that is, maternal distress. Although systematic reviews point out physical activity as an important factor to prevent mood changes, the levels of physical activity in mothers are low compared with women without children. Lack of time, child care, fatigue, and role conflicts are among the reported barriers. Fear-avoidance beliefs may also be a central factor that triggers physical inactivity as illustrated by the fear-avoidance model, which describes how individuals with catastrophic thinking and avoidance behavior may get stuck in a vicious circle maintaining disability, pain, and poor health. In line with the model, increased fear avoidance has repeatedly been linked to decreased physical activity levels and increased disability in chronic pain populations. However, fear-avoidance beliefs and physical activity levels in women with increased IRD after childbirth are not known.

Thus, there is a need to explore the consequences of an increased IRD, including physical as well as psychological perspectives. Therefore, the research question of this explorative study was how potentially important physical and psychological factors are linked to disability attributed to symptoms from an increased IRD in women after childbirth.

Methods
Design
This was a cross-sectional observational study.

Participants
Participants were recruited consecutively through articles in local newspapers, postings in primary care childcare centers in 3 regions in Sweden, the 3 regions’ Facebook pages, and a Swedish blog about women’s health. Inclusion criteria were that the women had to have an IRD of at least 2 finger-widths and at least 1 child. The youngest child had to be between 1 and 8 years old. Exclusion criteria were neurological, rheumatological, skeletal, or muscular disease or scoliosis. Participants received verbal and written information about the study and signed an informed consent prior to study participation.

Ethics Approval
Prior to participation, verbal and written information about the study was provided to the participants, and written consent was obtained. The study complied with the declaration of Helsinki and was approved by the Regional Ethics Review Board at Uppsala University, Sweden (No. 2017–316).

Data Collection
Data was collected between October 2017 and November 2018. Each participant attended a single visit, which, after general information and signing of the informed consent form, started with an online self-assessment questionnaire compiled in esmaker (Entergarten AB, Halmstad, Sweden). The participant was alone in the room while filling out the questionnaire, but an investigator was available in another room if the participant had any questions. After the questionnaire, an ultrasound examination was performed, and before leaving, the participant received an accelerometer and instructions in the management of the device.

Outcome Measures
Outcome Variable
Disability was measured with a modified version of the Pain Disability Index (PDI). The PDI measures pain-related activity limitation within 7 domains: family/home responsibilities, recreation, social activity, occupation, sexual behavior, self-care, and life-support activities. In the present study, we were interested in activity and participation restrictions that the participants attributed to their symptoms of increased IRD. Therefore, the word “pain” was omitted from the questionnaire and the introductory text. Instead, the participant was instructed to rate her activity limitation due to any symptoms attributed to the increased IRD. Another modification of the questionnaire was a change from an 11-grade scale (0–10) to a 10-grade scale (0–9) due to an error in the online questionnaire. Thus, a sum score was calculated ranging from 0 to a maximum of 63 instead of a maximum of 70 as in the original scale.

Predictor Variables
Fear-avoidance beliefs was measured with the Tampa Scale of Kinesiophobia (TSK-17). The TSK consists of 17 statements intending to capture beliefs about the relation between activity, pain, and harm, for example, “I am afraid I might injure myself if I exercise” and “It is really not safe for a person with a condition like mine to be physically active.” The participant rated agreement with each statement on a 4-point scale (1 = strongly disagree to 4 = strongly agree). The Swedish version has shown acceptable reliability and validity.

Emotional distress was measured with the Hospital Anxiety and Depression Scale (HADS). The HADS consists of 14 items. Seven items concern common symptoms of depression, for example, “I still enjoy the things I used to enjoy” and “I feel cheerful,” and 7 items illustrate anxiety symptoms, for example, “I feel tense or wound up” and “I get sudden feelings of panic.” However, its use in the present study was based on recent findings suggesting that the total score can be used as a valid measure of the single construct emotional distress. The participants rated the 14 items on a 4-point scale.

Average pain from the lumbopelvic region over the last week was rated as a single rating on an 11-point numerical
Non-wear periods were defined as 60 minutes of consecutive activity, data were downloaded and stored in 60-second epochs. When the accelerometer was returned from the participants, the data collection period, the participants sent the device back in a padded envelope with pre-paid postage.

Body mass index (BMI) was calculated by dividing the body mass in kilograms with the square of the body height in meters.

The IRD was measured through ultrasound (Logiq e R7, General Electric Company, Boston, MA, USA) with a linear probe (47 mm wide) at 12 MHz. The participant lay relaxed in a supine position with both knees bent to 90°. Three B-mode images were taken across the midline of the abdomen 4.5 cm above the center of the umbilicus at the end of a normal expiration. If the IRD distance was such that it was difficult to identify the medial delimitation of the musculus rectus abdominis muscle bellies within the image frame, the images were taken with a panoramic view function. This means that the probe was moved across the midline during image collection, and multiple images were collected and merged by the software, providing an image with extended field of view. Both single images and panoramic view are valid measurements of IRD.

Physical activity was measured with an accelerometer (wGT3X-BT, Actigraphcorp, Pensacola, FL, USA) worn by the participants on their right hip. The participants were asked to live their lives as normal and keep the accelerometer on all waking hours for 7 consecutive days, except for water activities (e.g., when taking showers, swimming, etc). The sampling rate was set to 30 Hz, and data collection started the morning after the participant’s visit. At the end of the collection period, the participants sent the device back in a padded envelope with pre-paid postage.

Data Analysis
The ultrasound images were saved on an external hard drive and analyzed offline with a custom written script in commercial software (Matlab R2019a, Mathworks, Natick, MA, USA). The IRD was defined as the shortest horizontal path between the medial delimitations of the left and right musculus rectus abdominis muscle bellies. The mean path length of the 3 obtained images was calculated and used in the analysis. Analysis of the accelerometer data was performed in commercial software (Actilife 6, Actigraphcorp, Pensacola, FL, USA). When the accelerometer was returned from the participant, data were downloaded and stored in 60-second epochs. Non-wear periods were defined as 60 minutes of consecutive zero counts with the allowance of 2 minutes of <100 counts/min. The participant had to have valid data for at least 4 days, with at least 1 weekend day, to be included in the analysis. Uni-axial counts per minute had the highest correlation with disability of all physical activity measures and was used as a measure of general physical activity level in the analysis. A multiple linear regression analysis was performed in SPSS 25 (IBM Corporation, Armonk, NY, USA) with forced entry of predictors. Disability (modified PDI) was used as the outcome variable and BMI, fear-avoidance beliefs (TSK-17), emotional distress (HADS), lumbopelvic pain (numerical rating scale), IRD (ultrasound), and physical activity (accelerometer) as predictors. Model diagnostics were conducted that showed no undue influence of individual cases on the model (Cook’s distance all <1, no collinearity issues (all Variance Inflation Factor [VIF] < 1.35), independence of errors (Durbin-Watson = 2.4), and normally distributed errors as indicated by a histogram. A tendency towards heteroscedasticity was identified by eyeballing a scatterplot of studentized residuals by standardized predicted values. As a sensitivity analysis, the regression model was conducted with the square root of the outcome variable. This improved the heteroscedasticity, but there was no difference in the main outcomes. Thus, for ease of interpretation the original model is reported.

Role of the Funding Source
The funders played no role in the design, conduct, or reporting of this study.

Results
Flow of Participants Through the Study
A total of 141 women participated in the study. Two did not return the accelerometer and were excluded from the analysis. Demographic characteristics are shown in Table 1.

Regression Analysis
The mean (SD) of all variables in the regression model are shown in Table 2 together with the zero order correlation between the predictors and between the predictors and the outcome variable. Disability due to symptoms from the increased IRD was significantly correlated with distress, lumbopelvic pain, fear-avoidance beliefs, and BMI.

The 6 predictor linear regression model accounted for 60% ($R^2 = 0.60$, adjusted $R^2 = 0.59$) of the variance in disability $F(6, 132) = 33.5, \text{P} < .001$. For the regression coefficients and beta weights of each predictor, please see Table 3. In order of the size of their contribution, lumbopelvic pain, fear-avoidance beliefs, and distress added significantly to the explanation of the variance in disability.

Discussion
This study sheds light on physical and psychological factors associated with disability due to symptoms from an increased IRD in women after childbirth and points at pain intensity as a key for understanding disability. Lumbopelvic pain was the strongest predictor of disability despite the fact that the women were instructed to consider all symptoms from the increased IRD and not pain specifically. This compares well with the results from a previous study, where the level of pain was determinant for disability in women with persistent pregnancy-related lumbopelvic pain.

The level of disability due to IRD symptoms in our sample indicates that an increased IRD may cause difficulties with daily activities. To the authors’ knowledge, there are no norm values for PDI in the general population, but the mean disability in our study (8.9) is slightly lower than in 2 fairly highly functional samples of primary care pain populations.

| Characteristic | Value |
|----------------|-------|
| Sex (M, F) | M: 109, F: 32 |
| Mean age (SD), y | 37 (4.9) |
| No. of children (range) | 2.3 (1–6) |
| Mean age of youngest child (range), y | 3.2 (1–8) |
| Mean age of oldest child (range), y | 7.3 (1–26) |
| Twin births (%) | 9 |
| Caesarian (%) | 38 |

a Twin births: percentage of women with at least 1 twin pregnancy.

b Caesarian: percentage of women with at least 1 caesarian procedure.
However, it should be noted that, besides the modified instructions, the range of the scale differed from the original scale. Yet, the women in the current study mostly rated on the lower half of the scale, which indicates that an additional scale-step in the upper end of the scale unlikely would have changed the results.

The level of fear-avoidance beliefs in our study (33.0) was similar to that in a general Finnish female population (TSK mean 32.9) but lower than reported in musculoskeletal pain populations (eg, TSK mean 39.4), suggesting that the level in the present study is equivalent to a healthy population. Still, the association between fear-avoidance beliefs and disability due to symptoms from the IRD expands on previous results from pain populations and underline the importance of considering psychological factors in understanding the effect of increased IRD on women after childbirth. To further stress this importance, emotional distress was the third-most important predictor of disability. This held true even though the total HADS score (10.4) was similar to those in a general female population (8.53 in women 30–59 years of age and 9.5 in girls between 16 and 23 years).

From a physical point of view, quite noteworthy, there was no association between the IRD and disability, and the IRD was not a significant predictor in the regression model, which means that the IRD per se is not a major contributor to the disability the women perceive from the increased IRD. However, there was a positive correlation between IRD and fear-avoidance beliefs, which indicates that women with greater IRD are more likely to hold stronger fear-avoidance beliefs. Possibly, fear avoidance may act as a mediator between the physical condition and disability, although this still needs empirical support in this population.

Interestingly, general physical activity level did not contribute to the regression model and did not show any relation to fear avoidance, which is in contrast to some previous studies but in line with others. In the current context, it is possible that the women were fearful about certain activities that engage the abdominal muscles more specifically, such as lifting. Yet, the avoidance of that kind of activity is not necessarily visible in the physical activity measurement with accelerometers. Furthermore, although previous research identifies an inverse relationship between BMI and physical activity level, there was no such relationship in the present study. One reason for this could be the lack of obese women in the present study, as earlier research has shown that the relationship is weak in non-obese women.

Limitations

This study has some obvious shortcomings. Women volunteered for participation, which potentially introduces a selection bias, that is, women with severe disability would be more likely to participate than women with less disability. However, the mean level of disability was fairly low, indicating that this was not the case. Regarding the disability measure, it should be noted that our adapted version of the PDI (answering relative to IRD symptoms not pain) has not been validated, which potentially may have influenced the results. Last but not least, it needs to be taken into consideration that cross-sectional data naturally limit which conclusions can be drawn; longitudinal studies are needed to understand the direction of the proposed links.

Disability attributed to symptoms from an increased IRD is mostly explained by the level of lumbopelvic pain but also by the degree of fear-avoidance beliefs and emotional distress. The IRD, that is, the actual distance between the rectus abdominis muscle bellies, did not explain any significant proportion of the variance in disability. Instead, pain intensity and psychological factors seem to be crucial for understanding disability attributed to increased IRD symptoms.
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