Original Article

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Quick Response Code:

Website: www.herniasurgeryjournal.org
DOI: 10.4103/ijawhs.ijawhs_21_25

Risk for ventral hernia related to parity: A population-based register study

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Abstract

INTRODUCTION: The association between pregnancy and the risk of developing ventral hernias is unclear. This study aimed to assess the risk of developing a primary ventral hernia requiring repair and whether increasing parity is associated with a greater risk of developing a ventral hernia.

MATERIALS AND METHODS: This nationwide cohort study included women born between 1950 and 1980 who were registered in the Swedish Medical Birth Register (MBR). Data on pregnancies and vaginal or cesarean sections were retrieved from the birth register. The cohort was cross-matched with the National Patient Register (NPR) to identify subsequent primary hernia repairs.

RESULTS: This study included 1,630,754 women born between 1950 and 1980. Among these, 1,588,609 (97.4%) were registered in the MBR. The incidence rates for umbilical hernia repair (UHR) and epigastric hernia repair (EHR) were 13.2/100,000 person-years and 5.4 per 100,000 person-years, respectively. When compared with women registered for one delivery, the incidence rate ratio for UHR was higher among those with two deliveries (1.18, 95% CI:1.12-1.24) and among those registered with ≥3 deliveries (1.48 95% CI: 1.41-1.56). The incidence rate ratios were 1.29 (95% CI: 1.20–1.39) and 1.34 (95% CI: 1.24–1.45) for EHR among women with two and ≥3 registered deliveries, respectively.

CONCLUSION: A history of more than one pregnancy is associated with an increased incidence of umbilical and epigastric hernias.

Keywords:

Epigastric hernia, linea alba, parity, pregnancy, umbilical hernia, ventral hernia

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Submitted: 02-Mar-2025
Accepted: 08-Apr-2025
Published: 23-Jun-2025

Background

Hernia of the linea alba (ventral hernia) is a common surgical condition that affects both men and women. Surgery is the only curative treatment available for ventral hernia.[1] Although very common in women of reproductive age, there is no consensus regarding the optimal timing for surgical repair in women anticipating future pregnancy. Studies addressing the recurrence rate of repaired ventral hernias following subsequent pregnancies are limited. In a recent study that included 35,874 primary hernia repairs, a higher prevalence of epigastric hernia was observed in women (57.6%) than in men (42.4%).[2] While the influence of hormonal changes and abdominal distension on the abdominal wall during pregnancy is well-known, there is a lack of comprehensive evidence regarding the specific impact of pregnancy on the anatomy of linea alba.[3,4] Inherent tension in the tissues due to hormonal fluctuations and mechanical forces during pregnancy may compromise the integrity of supporting muscles and connective tissues, potentially leading to rectus abdominis diastasis (RAD) and primary ventral hernias such as umbilical and epigastric hernias.[5]

How to cite this article: Katawazai A, Järnbert-Pettersson H, Wallin G, Sandblom G. Risk for ventral hernia related to parity: A population-based register study. Int J Abdom Wall Hernia Surg 2025;8:101-6.

Although an increase in the inter-rectus space (widening of the linea alba) is considered a normal and harmless process during pregnancy, the persistent postpartum RAD rate has been reported to be 33% 12 months postpartum.[6,7] Although ventral hernias are typically considered rare in nulliparous women, the impact of multiple pregnancies on hernia development—and whether distension and potential weakening affect healing after hernia repair—remains poorly understood. Moreover, distension of the linea alba may predispose women to incisional hernia development after abdominal surgery. A recent large register-based study reported that reoperation rates following primary ventral hernia repair were significantly higher in women regardless of the repair method.[2] This study aimed to assess the risk of primary ventral hernia requiring repair in relation to the number of previous pregnancies.

Materials and Methods

Study design

The study was based on the Swedish Medical Birth Register (MBR)[8] and the Swedish National Patient Register (NPR).[9,10]

The Swedish MBR was founded in 1973 and includes data on all deliveries in Sweden. It is compulsory for every healthcare provider to report births to the register, and information is collected from the prenatal, delivery, and neonatal care medical records. Data on the Swedish population were retrieved from Statistics Sweden.

Participants

The study cohort comprised women born between 1950 and 1980 in Sweden. Data on pregnancies and vaginal or cesarean sections were retrieved from the MBR and matched with the first ventral hernia intervention codes. The cohort was cross-matched with the NPR to identify the subsequent primary hernia repair cases. All intervention codes beginning with JAE-JAF were used to identify women who underwent ventral hernia repair [Figure 1].

This approval also confirmed that informed consent was not necessary for the present study because the retrieved data did not include any information that could be linked to the participating women.

Statistics

To estimate the incidence rates, the numerator was the number of women with umbilical or epigastric hernia repairs (EHRs) each year, and the denominator was the total number of person-years at risk among women in the cohort.

We calculated the numerator as the sum of the number of women in the MBR and NPR groups who underwent umbilical or EHR each year. The denominator (person-years) was calculated using the following categories:

a) The sum of person-years for women in the MBR with hernia repair according to NPR.
b) The sum of person-years for women not in the MBR but with hernia repair according to the NPR.

Person-years were calculated as the time from the year of birth to the year when the hernia was first operated on (each patient was counted once) or to the end of the follow-up period in 2021, whichever occurred first. The entire cohort was divided into three groups: one pregnancy (parity 1, reference group), two pregnancies (parity 2), and three or more pregnancies (parity 3+). A separate comparison was performed between vaginal and cesarean deliveries.

Statistical analyses were performed using SPSS version 28 and R version 4.3.1. Confidence intervals for the rate ratios were calculated using OpenEpi software.

Data availability statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

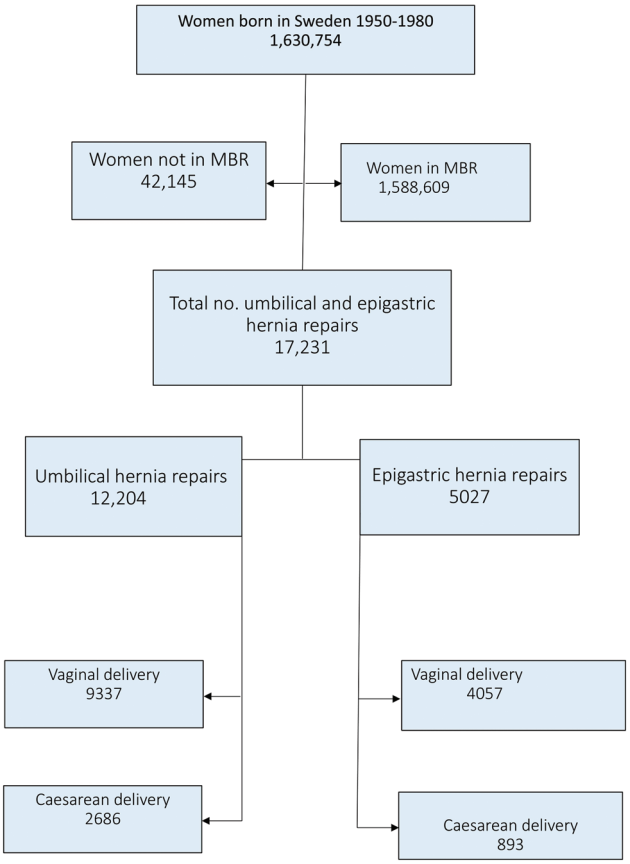

Figure 1: Parity and ventral hernia, flowchart

Inclusion criteria

Only women born in Sweden between 1950 and 1980 and registered in MBR were included in the study. No exclusion criteria were applied [Figure 2].

The primary endpoint was umbilical and EHR.

Results

A total of 1,630,754 women born in Sweden between 1950 and 1980 were included in this study [Figure 2]. Of these, 1,588,609 (97.4%) were registered in MBR. A total of 12,204 (70.8%) umbilical and 5027 (29.2%) EHR procedures were performed. The estimated incidence rates of umbilical hernia repair (UHR) and EHR were 13.2/100,000 person-years [Table 1] and 5.4/100,000 person-years [Table 2], respectively. An association between the number of pregnancies and increased incidence rate ratios of both UHR and EHR was observed.

Umbilical hernia repair

We found 12,204 UHR, 12,023 in the MBR group, and 181 in the non-MBR group. In the MBR group, of the total 12,023 UHR, 9337 (77.6%) were women who had vaginal deliveries, and 2686 (22.4%) had a cesarean section. The mean incidence rate of UHR per 100,000 person-years was 13.2. The incidence rate for women who had undergone vaginal delivery was 11.7 per 100,000 person-years (reference group) and 21.5 per 100,000 person-years (IRR: 1.83, 95% CI: 1.76–1.92) after cesarean section. The incidence rate was nearly twice as high in the cesarean section group as in the vaginal delivery group.

Using the group of women with one registered delivery as reference (incidence rate 11.98 per 100,000 person-years), the incidence rate ratio for UHR was 1.18 (95% CI: 1.12–1.24, $P < 0.001$) among women with two deliveries and 1.48 (95% CI: 1.41–1.56, $P < 0.001$) among those with ≥3 deliveries [Table 1].

Epigastric hernia repair

The EHR group comprised 5027 repairs. Among these, 4950 and 77 were found in the MBR and non-MBR groups, respectively. Of the 4950 repairs in the MBR group, 4057 had a vaginal delivery, and 893 had a cesarean section. The mean incidence of EHR per 100,000 person-years was 5.44. The incidence rate in the cesarean delivery group was higher (7.14 per 100,000 person-years) than that in the vaginal delivery group (5.08 per 100,000 person-years). The incidence rate ratio for cesarean section was 1.41 (95% CI: 1.31–1.51) compared to vaginal delivery.

Compared to women registered with one delivery, who had the lowest incidence rate of 4.48 (per 100,000 person-years), the incidence rate ratio for EHR was 1.29 (95% CI: 1.20–1.39, $P < 0.001$) among those registered with two deliveries and 1.34 (95% CI: 1.24–1.45, $P < 0.001$) among women registered with ≥3 deliveries [Table 2].

Discussion

Key results

In this nationwide cohort study, we found an incidence rate of 13.2 per 100,000 person-years for UHR, demonstrating a uniform distribution among women born between

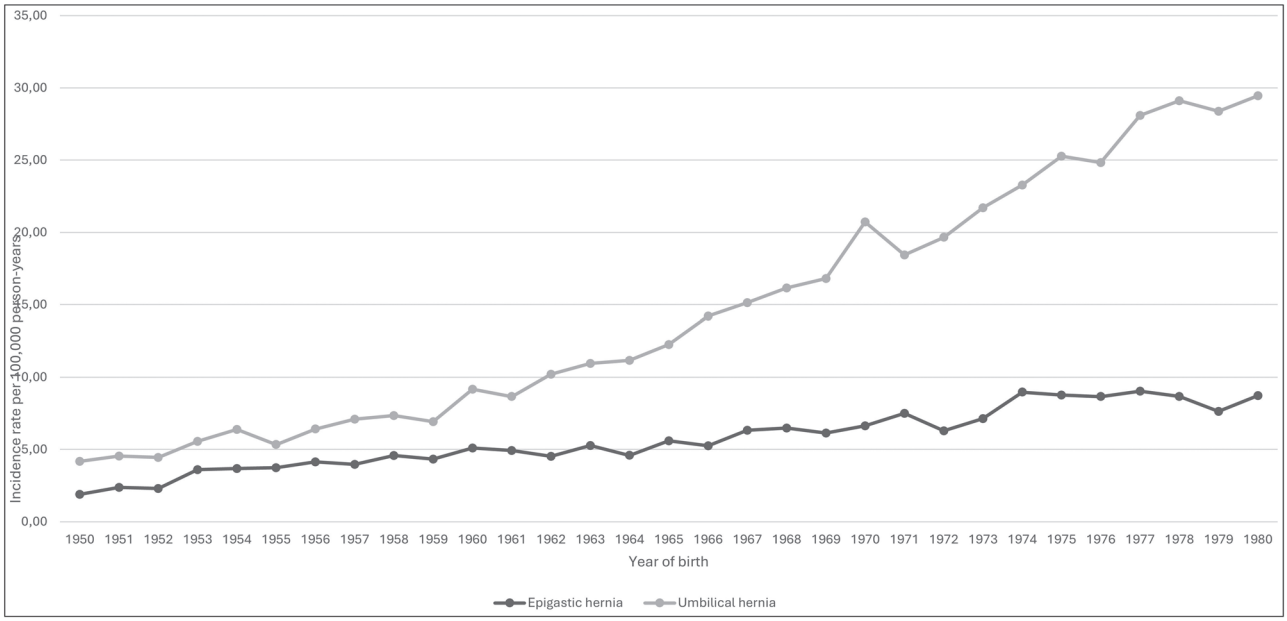

Figure 2: The incidence rates of ventral hernia repair in relation to parity

Table 1: Incidence rate ratios of umbilical hernia repair according to mode of delivery and parity

Variable	Number of umbilical hernia repairs	Person-years	Incidence rate per 100,000 person-years	Incident rate ratio (95% CI)	*P* value
Mode of delivery					
Vaginal delivery	9337	76,446,957	11.69	Reference	
Cesarean delivery	2686	12,379,206	21.50	1.83 (1.76–1.92)	0.0001
Parity					
Parity 1	2278	20,651,796	10.98	Reference	
Parity 2	5646	43,223,784	12.99	1.18 (1.12–1.24)	0.0001
Parity ≥ 3	4099	24,950,583	16.31	1.48 (1.41–1.56)	0.0001

Table 2: Incidence rate ratio of epigastric hernia repairs according to mode of delivery and parity

Variable	Number of epigastric hernia repairs	Person-years	Incidence rate per 100,000 person-years	Incidence rate ratio (95% CI)	*P* value
Mode of delivery					
Vaginal delivery	4057	79,915,421	5.08	Reference	
Cesarean delivery	893	12,513,506	7.14	1.41 (1.31–1.51)	<0.0001
Parity					
Parity 1	929	20,714,580	4.48	Reference	
Parity 2	2510	43,382,544	5.77	1.29 (1.20–1.39)	<0.0001
Parity ≥ 3	1511	25,102,721	6.00	1.34 (1.24–1.45)	<0.0001

1950 and 1980. A positive association between higher parity and higher UHR incidence rate was observed. Additionally, the incidence rate of UHR was higher in women who underwent cesarean delivery than in those who underwent vaginal delivery. Women who had one or more cesarean deliveries were categorized into the cesarean delivery group and compared to those who had no cesarean deliveries. Similarly, the incidence rate of EHR was 5.4/100,000 person-years, with a similar association between higher parity and increased EHR incidence rate. Consistent with the UHR findings, women who underwent cesarean section had a higher EHR incidence rate than those who underwent vaginal delivery.

Limitations of the study

The register data available lacked information on migration and death, and women who immigrated to Sweden and those who died were, thus, included in the denominator when estimating the incidence rates but not in the numerator. This contributed to the underestimation of the incidence rate. Between 1950 and 1980, there was a net increase in immigration, resulting in a higher person-year numerator, which may have led to an overestimation of the absolute incidence rates of umbilical and EHRs. Although it is mandatory for all healthcare providers to report births to the register and information is gathered from medical records covering prenatal, delivery, and neonatal care, there is still a 2%–5% gap in recorded births, as indicated by the individual overseeing the MBR and NPR. Additionally, the absence of delivery data for women before immigration could affect the incidence rate ratios related to parity and mode of delivery. Altogether, different sources of error affect the incidence and incidence rate ratio in different directions, and it is difficult to determine whether this is more likely to result in underestimation or overestimation. Different sources of error affect the absolute incidence, and these estimates are not as reliable as the relative incidence rate ratios that are equally affected by the uncertainty in absolute incidence (e.g., vaginal versus cesarean). While recognizing the observed increase in the risk for umbilical and epigastric hernias with parity, particularly from the first birth, the study was limited by the lack of data regarding nulliparity. To address this, we established a reference category based on the history of single deliveries. However, it is important to note that this approach may lead to an underestimation of the incidence rate ratio because ventral hernias are rare in nulliparous women. Furthermore, this study did not consider factors that could influence the outcomes. Variables such as body mass index, smoking habits, family history, socioeconomic status, and education level, which may be linked to both parity and the occurrence of hernia, as well as the need for repair, were not adjusted for in our analysis. These potential confounding factors should be considered when interpreting our results, as they could have an impact on the observed associations.

A relatively small number of women (42,145) was not included in the MBR. The number of ventral hernia repairs in the non-MBR group was 258 of 17,231 (1.50%). One of the limitations of this study is that, unfortunately,

we had no data on whether these women had been pregnant one or more times in the past. These women were excluded from this study.

Interpretation

Previous studies have demonstrated an association between pregnancy and hernial recurrences. A similar study in a Danish population that assessed pregnancy as a risk factor for ventral hernia found a high rate of reoperation for recurrence after primary ventral hernia repair, with a 10-year cumulative incidence of 14.1%. This study found that pregnancy following hernia repair was associated with a 1.6-fold increased risk of recurrence after reoperation. Delaying elective hernia repair until after pregnancy is recommended to reduce recurrence risk in these women.[11] Another study published in 2016 found that this association was statistically significant (adjusted odds ratio, 1.73; 95% confidence interval: 1.40–2.14). Further analysis revealed that no specific variable exerted an excessive influence on the overall study results.[12]

This comprehensive, nationwide study investigated the incidence of umbilical and epigastric hernias in women. We identified a positive association between parity (number of pregnancies per woman) and the rates of UHR and EHR. Specifically, our findings showed that women with higher parity had a higher incidence of EHR and UHR, suggesting a link between parity and susceptibility to ventral hernias.

The magnitude of this association is likely underestimated because we used surgical repair as a surrogate for ventral hernia, thereby capturing only hernias that required surgery. Additionally, our results showed a significant association between UHR, EHR incidence, and cesarean section. Women who underwent cesarean section had a higher incidence of UHR, indicating a potential link between this mode of delivery and an increased risk of hernia development. This observation suggests that the cumulative effect of multiple pregnancies and cesarean sections may contribute to an increased risk of ventral hernias. Furthermore, we noted an increased incidence of ventral hernias during the study period. This increase could be attributed to several factors. Increased accessibility to healthcare facilities in the general population may have contributed to the increase in hernia diagnosis. Moreover, the digitalization of healthcare systems, coupled with improved health-related information and support mechanisms, may have increased awareness and prompted more individuals to seek medical attention for hernia-related problems.

Generalizability

This study provides valuable information on umbilical and EHR in Swedish women, based on a substantial dataset of 1,630,754 individuals. The large cohort size enhanced the robustness of our findings, allowing for a meaningful comparison with other systems. This study provides insight into these common surgical procedures and is broadly applicable to similar healthcare systems. This study provides valuable information on the incidence of ventral hernia in women, hopefully encouraging healthcare professionals in other countries to contribute to ongoing discussions on ventral hernia in postpartum women.

Conclusion

Our findings show an association between pregnancy and the risk of developing ventral hernia, which increases with increasing parity.

Author contributions

AK led the project from concept development, formal analyses, funding acquisition, investigation, project administration, and resource management to validation, visualization, writing the original draft, and reviewing and editing the manuscript. HJ-P contributed to brainstorming, statistical analysis, and evaluation. He was also involved in manuscript review and editing. GW contributed to the conceptualization of the study, manuscript review, and editing and provided supervision throughout the project. GS contributed to the conceptualization, data collection, and investigation phases, provided supervision throughout the project, assisted with validation and data visualization, and played a key role in drafting the original manuscript, as well as reviewing and editing the final version.

Ethical policy and institutional review board statement

This study was approved (Dnr.2022-03159-01) by the Swedish Board of Ethics (Etikprövningsmyndigheten). Date of approval 2022-06-27. This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Given its retrospective design and use of anonymized data from national registers, individual informed consent was waived by the appropriate ethics review board. All procedures were carried out in compliance with relevant institutional guidelines and ethical standards.

Data availability statement

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Financial support and sponsorship

Funding was provided by the Swedish Government (Avtal om Läkarutbildning och Forskning (ALF) Agreement). The funder was not involved in the study

design, data collection, data analysis, manuscript preparation, publication, or any other decisions.

Conflicts of interest

There are no conflicts of interest.

Acknowledgment

Not applicable.

Abbreviations

MBR Medical Birth Register
NPR National Patient Register

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