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Risk factors for constipation during pregnancy: a multicentre prospective cohort study

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Abstract

Background Constipation is frequently encountered in the population of pregnant women. Physical activity and nutritional factors are considered common causes of constipation; however, their impact on this population has not yet been evaluated precisely. This study aimed to assess the prevalence of constipation and its risk factors during pregnancy and postpartum.

Methods A prospective observational cohort study was conducted in 3 hospitals in Lithuania, including women with early viable pregnancies using questionnaires on demographic, obstetric, nutrition, behaviour, peri-anal disease, and birth data. All women with an early viable pregnancy (<12 weeks' gestation) aged 18 - 45 years who gave written informed consent were included. The Rome III criteria defined constipation. Independent risk factors were identified using multivariate analysis.

Results In all, 263 (55.9%) women developed constipation. Multivariate analysis identified haemorrhoidal disease during pregnancy (OR 8.25, 95% CI 4.41-15.4, $p < 0.001$), inadequate physical activity (OR 1.66, 95% CI 1.03-2.69, p=0.038), not participating in sports (OR 1.98, 95% CI 1.24-3.17, p=0.004), and monthly income 300-500 euros (OR 1.97, 95% CI 1.22-3.19, p=0.006) as significant predictors of constipation during pregnancy. Lower education was defined as a protective factor (retrospectively, secondary education by 2.2 times (OR 0.45, 95% CI 0.22-0.89, p=0.022) and unfinished secondary - by 1.84 times (OR 0.20, 95% CI 0.05-0.90, p=0.036) reduced the possibility of constipation development).

Conclusions In conclusion, haemorrhoidal disease during pregnancy, low physical activity, and low monthly income are independent risk factors for constipation during pregnancy. Lower education significantly reduces the incidence of this condition.

Keywords Pregnancy, Constipation, Risk factors

Introduction

Constipation is one of the most common health problems in the general population and has a high burden on the individual and the community [1]. The National Institute of Health (NIH) defines constipation as a condition in which bowel movements are difficult or painful less than 3 times per week with hard, dry, or lumpy stools or the feeling of incomplete emptying.

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Chronic constipation bothers 10–15.3% of the general population [2, 3]. The most important risk factors for constipation are poor diet (51%), stress (30%), and insufficient physical activity (19%) [4]. An epidemiologic studies report that constipation is more common in the elderly, especially those over 65 [5]. However, according to the data from the studies conducted in the last decade, younger people are more often affected [6–8]. Women, in general, complain more often of constipation [3, 5, 6, 8–11]. Chronic constipation is found in them 2 times more often [12], and its course is more severe [13]. A global systematic review of the literature reports an odds ratio of 2.22 for women to men for chronic constipation [14], and in epidemiological studies, it ranges from 1.0 to 4.8 [12, 15]. In addition, women are more likely to use laxatives and seek medical attention for symptoms of constipation [16]. Whites with lower socioeconomic status, and lower education were affected more frequently [11, 15–18]. The literature indicates the association of constipation with anxiety disorders, depression, insomnia [10, 11, 19], back and joint pain, circulatory, gynaecological, and urinary system disorders [11, 20], dyspepsia, gastroesophageal reflux [16], rectal cancer, diverticulitis, hemorrhoidal disease, fistulas, tears, rectal prolapse, anaemia, primary neurological diseases [11, 15, 21]. The influence of rectal cancer, Parkinson's disease, multiple sclerosis, metabolic disorders, hypertension, and angina pectoris on this disease has not been proven [22]. Individuals with rectal diseases and anamnesis of rectal surgery are 3.3–5.3 times more likely to be ill [22]. Increased risk of constipation in women who have undergone hysterectomy is reported [22]. The most important risk factors for constipation are depression and hemorrhoidal disease. In 2009 seven scientific studies confirmed a significant relationship between hemorrhoidal disease and constipation [12]. 15–29% of patients complaining of chronic constipation suffer from depression [23]. Scientific studies have proven the connection between constipation and used drugs. These drugs include opioid analgesics, antidepressants, antihistamines, antispasmodics, anticonvulsants, aluminium antacids, acetaminophen, aspirin, nonsteroidal anti-inflammatory drugs, digoxin, glyceryl trinitrate, atorvastatin, furosemide, levothyroxine [12, 15, 19]. Chronic constipation is more common in obese (20–37%) and overweight (17–40%) individuals [24], although epidemiological studies have not confirmed the relationship between body mass index and constipation [12, 14, 18]. Smokers or former smokers are more affected [7, 11, 22]. Researchers do not demonstrate a relationship between alcohol consumption and constipation [11].

Constipation bothers about a third of pregnant women and 17–52% of women after childbirth [23, 25]. There are some risk factors for constipation during pregnancy that have already been demonstrated and recognized in several prospective studies. The disease is more common in women older than 35 years, with higher education, with a prepregnancy BMI greater than 24 kg/m2, and who were bothered by constipation before pregnancy [25, 26]. The risk of getting sick increases with psychological factors, a certain profession, impending abortion, and constipation before pregnancy consumption of iron supplements [12, 26]. Constipation occurs more often in the first and third trimesters of pregnancy [23, 25, 27]. A literature review published by *Cattani* states that there is currently no scientific evidence for a relationship between childbirth and constipation due to the lack of standardized, validated assessment methods [28]. Other authors indicate that women with at least one birth are 3.58 times more likely to have the disease (95% CI 1.50–8.57) [29]. In the first days after childbirth, constipation bothers women more often during cesarean section than among women who give birth naturally (57 vs. 47%). The same trend persists in the first month after delivery (15% and 9%, respectively) [30].

This study aimed to identify the most important risk factors for the development of constipation in pregnant and postpartum women and to discuss whether preventive measures should be implemented for risk factors.

Materials and methods

Study design

We performed a prospective multicenter cohort study in three different clinical centers (Vilnius University Hospital Santaros Klinikos; Vilnius City Clinical Hospital and Vilnius Maternity Hospital). Participants were women in early (less than 12 weeks gestation) viable pregnancy, aged 18 to 45 years, who presented to one of the study centers. The study recruitment period took 4 years between 1 July 2015 and 1 July 2019. Women were informed about the study, and those who showed interest in participating were screened for eligibility. The study was approved by the Vilnius Regional Bioethics Committee, Vilnius, Lithuania, under registration numbers 158200-7-059-13 and 158200-16-843-357. All participants provided written informed consent and were able to quit the study at any time.

Inclusion and exclusion criteria

The inclusion criteria were women with an early viable pregnancy (less than 12 weeks gestation) between the ages of 18 and 45 years who gave written informed consent and agreed to participate in the study and were included. The exclusion criteria were not meeting the inclusion criterion, refusal to participate in the study, or missing data in medical records.

Study visits and data collection

During the first visit (the first trimester of pregnancy (< 12 weeks of gestation)), two gynaecologists interviewed all women who met the inclusion criteria.

Each participant was questioned and examined three times: in the first and second trimesters and during the first two months after childbirth.

During the first visit, a detailed questionnaire was completed that included socioeconomic factors, physical activity, dietary and anthropometric data, obstetric history, peri-anal symptoms during previous pregnancies, and the presence of chronic health conditions (Questionnaire 1). Sufficient (adequate) physical activity was assessed as daily 30–60 min. moderate physical activity (e.g., brisk walking, jogging, stair climbing) at least 3 times a week (according to physical activity guidelines approved by the World Health Organization). All participants were asked about doing any moderate-intensity sports, fitness, or recreational (leisure) activities for at least 10 minutes continuously and surveyed about possible types of activities (swimming, dancing, walking/running, biking, going up the stairs, jumping rope, gymnastics, skating, skiing, playing tennis/football/basketball). They had to choose the intensity level of each activity, which was defined as low, medium, or high. They also had to answer questions about the frequency of doing sport (how many days per week) and duration of the exercises (per day). This evaluation was based on the Global Physical Activity Questionnaire (GPAQ) assessment. Pregnancy outcome and neonatal data were obtained from medical records at the third visit.

The proctology questionnaire was completed, and a physical examination was performed at each visit. a physical examination was performed. A gynecologist was prepared by a colorectal surgeon to recognize and diagnose the perianal pathology using a standardized methodology before the study began. If any peri-anal symptoms (pain, rectal bleeding, discomfort) or peri-anal disease (hemorrhoidal disease, tears, or peri-anal tissue protrusion) occurred during the study period, a colorectal surgeon investigated the patient immediately (performed inspection and anoscopy). The proctology questionnaire evaluated the most common symptoms of peri-anal complaints (pain, bleeding from the anus, lumps in the anus, constipation, and its type, fecal and gas incontinence) and the most common peri-anal diseases and conditions — hemorrhoidal disease, tearing, and constipation (Questionnaire 2). Constipation was evaluated according to the criteria of Rome III. The frequency of these risk factors in patients with constipation (constipation group) was compared with that in patients who did not have this condition (control group). The constipation group was made up of patients with constipation who reported at least one visit. This study aimed to assess the prevalence of constipation and risk factors for this condition in pregnant and postpartum women.

Sample size calculation

We considered the relationships between variables to be statistically significant if the p-value was less than 0.05 ($p < 0.05$) and the statistical power of the 1-ß test was equal to 0.95 (1-ß = 0.95). If these conditions are met and the effect size w=0.25 and the number of degrees of freedom Df=1–4 (the number of variables studied simultaneously is 2–5) are chosen, the total sample size is 188–254.

Statistical analysis

Statistical data analysis was performed with the software package R statistical V 4.2.2 (2022-10-31) (© The R Foundation for Statistical Computing), RStudio 2022.07.2 Build 576 © 2009–2022 RStudio, PBC, IBM SPSS Statistics V.23, G*Power V. 3.1.9.4 University of Duesseldorf, Germany).

In describing the subjects' characteristics, quantitative variables were reported as the mean with standard deviation (SD), median, and quartiles (Q). Qualitative variables were reported in absolute numbers and percentages.

Categorical data between the groups were compared by Fisher's exact test, Pearson chi-square, and Shapiro–Wilk test.

Continuous characters were compared by the Mann–Whitney U test for data that did not meet the normality conditions for comparisons between two independent groups and the Kruskal–Wallis test to compare three or more independent groups. We used the Welch parametric F test and the Bayes factor as an additional measure of hypothesis validity for comparisons of three or more independent groups when the variables met the conditions of normality.

When comparing two groups of variables, we used the rank biserial correlation coefficient (rpb) to estimate the effect size (ES) between interval (discrete) quantitative variables that did not meet the conditions of normality. We considered the effect size to be small if rpb < 0.05, very small if 0.05 ≤ rpb < 0.20, small if 0.20 ≤ rpb < 0.30, moderate if 0.30 ≤ rpb < 0.40, and large if rpb > 0.41.

When comparing two or more groups of nominal variables, we used Cramer's V to estimate the effect size.

Results

The flow diagram of the study is presented in Figure 1. In total 848 women were screened for eligibility. The analysis of risk factors related to constipation included 470 (33.2%) women after excluding 378 women with missing information on relevant variables. Of the total cohort,

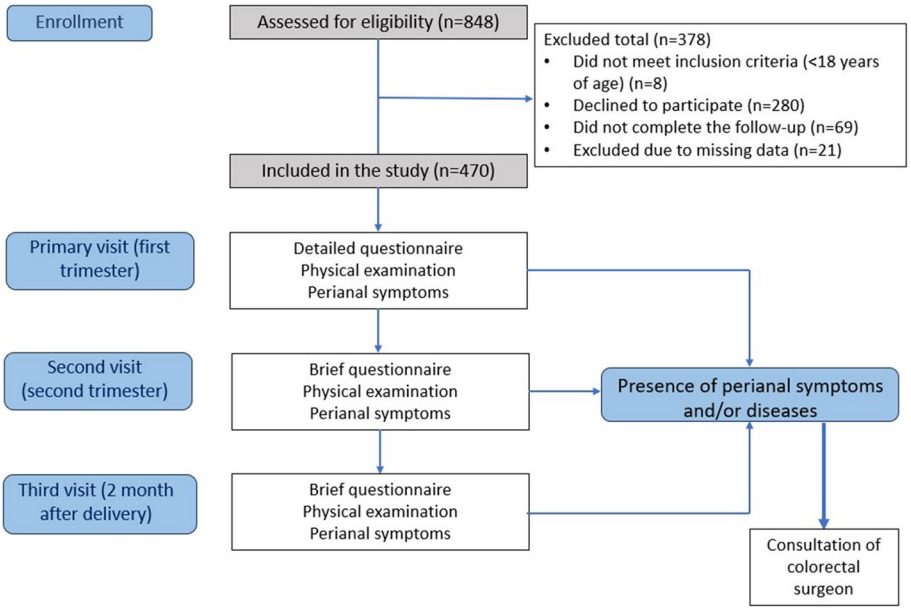

Fig. 1 Flowchart of the study

263 (55.9%) were diagnosed with constipation during pregnancy or the postpartum period.

The mean age of the subjects was 29.5 years (18 – 45 years). Most women were married (355, 75.5%), fewer lived in a partnership (60 (12.7%)), were divorced (37 (7.87%)) or single (38 (8.09%)). The mean body mass index was 22.9 (15.4–43.8 kg/m^2).

In total, there were 470 deliveries. Of them, 296 (62.97%) women gave birth vaginally, 88 (18.72%) had a cesarean section, 6 (1.28%) had vacuum extraction, 6 (1.28%) had forceps extraction and 4 (0.85%) had vaginal delivery after previous cesarean section. The mean duration of the second labour period was 25.2 minutes (3–50 minutes). Of all women, 74 (15.74%) experienced perineal tears, and 131 (27.87%) underwent episiotomy. During the study, 16 (3.4%) women experienced preterm birth. The analysis showed no significant associations between the number of deliveries and constipation (p = 0.349) or between gravidity and constipation (p = 0.590). However, there were statistically significant differences between the groups in terms of parity and gravidity, as shown in Table 1. There were no statistically significant differences between the groups comparing the mode of delivery (shown in Table 1).

Table 1 Pregnancy characteristics by groups according to the presence of constipation

Group n	Non-constipation n 216 (% from women)	Constipation n 284 (% from women)	*p*-Value
Parity = 1	107 (49.6%)	109 (38.6%)	0.042
Parity = 2	59 (27.4%)	143 (50.2%)	<0.001
Parity >= 3	50 (23.0%)	32 (11.2%)	0.003
Gravidity = 1	107 (49.6%)	111 (39.1%)	0.052
Gravidity = 2	60 (27.4%)	142 (49.7%)	<0.001
Gravidity >= 3	49 (23.0%)	32 (11.2%)	0.003
Spontaneous vaginal delivery	158 (73.3%)	196 (69.1%)	0.404
Instrumental delivery	7 (3.0%)	14 (4.7%)	0.428
- Forceps	5 (2.3%)	7 (2.3%)	0.945
- Vacuum	2 (0.7%)	7 (2.3%)	0.488
Extraction			0.428
Cesarean delivery	51 (23.7%)	74 (26.2%)	0.606

The median height of the newborn was 53 cm (42–60 cm), the median weight was 3542.5 g (2100–5340 g), and the median head circumference was 35 cm (31–42 cm). Women gave birth to boys less frequently (209, 44.47%) than girls.

After analyzing the medical history of our subjects, we categorized the diseases into the following groups: cardiovascular diseases, respiratory diseases, digestive system disorders, neurological diseases, endocrine system disorders, gynecological diseases, anemia, and varicose veins. Women with a history of respiratory or neurological diseases experienced constipation less frequently ($p < 0.001$). However, the limited number of participants with a history of these conditions raises concerns about the reliability of these findings. Due to the small sample size, we did not analyze specific diseases within these categories.

The most important statistically significant differences between groups are shown in Table 2. We found a statistically significant small association between monthly income and the relevance of constipation during pregnancy. Women who earned 300 – 500 euros per month (per person) (65.0% vs. 43.0%) were more likely to get this condition ($p<0.001$). More of them were overweight (24.0% vs. 12.0%) or obese (8.0% vs. 6.0%) ($p<0.001$), consumed alcohol before pregnancy more often (77.0% vs.

Table 2 Statistically significant baseline characteristics by group with constipation during pregnancy or after childbirth

	Control group	Constipation group	*p*-value*	ES[a] (95% CI)
BMI evaluation (before pregnancy) [n (%)]	*N*=216	*N*=284	<0.001	0.17 (0.06, 1.00)
Too low	23 (11.0%)	14 (5.0%)		
Normal	155 (72.0%)	178 (63.0%)		
Overweight	26 (12.0%)	69 (24.0%)		
Obese	12 (6.0%)	23 (8.0%)		
Education [n (%)]	*N*=216	*N*=284	0.05	0.10 (0.00, 1.00)
Secondary	30 (14.0%)	25 (9.0%)		
Unfinished secondary	9 (4.0%)	3 (1.0%)		
Special secondary	22 (10.0%)	38 (13.0%)		
Unfinished higher	34 (16.0%)	49 (17.0%)		
Higher	121 (56.0%)	169 (60.0%)		
Monthly income [n (%)]	*N*=216	*N*=284	<0.001	0.21 (0.13, 1.00)
<300 euro	23 (11.0%)	19 (7.0%)		
300–500 euro	92 (43.0%)	184 (65.0%)		
>500 euro	101 (47.0%)	81 (29.0%)		
Physical activity [n (%)]	*N*=216	*N*=284	<0.001	0.22 (0.14, 1.0)
Too little	124 (57.0%)	224 (79.0%)		
Adequate	89 (41.0%)	59 (21.0%)		
Too big	3 (1%)	1 (0.4%)		
Sports [n (%)]	*N*=216	*N*=284	<0.001	0.19 (0.00, 1.00)
No	102 (47.0%)	189 (67.0%)		
Yes	114 (53.0%)	95 (33.0%)		
Alcohol consumption	*N*=146	*N*=133	<0.001	0.17 (0.06, 1.00)
No	59 (40.0%)	31 (23.0%)		
Yes	87 (60.0%)	102 (77.0%)		
Previous perineal tear [n (%)]	*N*=124	*N*=75	<0.001	0.29 (0.16, 1.00)
No	99 (80.0%)	50 (53.0%)		
I grade	17 (14.0%)	7 (7.0%)		
II or higher grade	8 (6.0%)	18 (25.0%)		
Haemorrhoidal disease during pregnancy [n (%)]	*N*=207	*N*=263	<0.001	0.37 (0.30, 1.00)
No	193 (93.0%)	159 (60.0%)		
Yes	14 (7.0%)	104 (40.0%)		

* Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test

[a] Cramer's V effect size; rank biserial correlation coefficient (ES – effect size)

60.0%) (p<0.001), or have had a perineal tear less often but and its grade was bigger during previous deliveries (respectively, 53.0% vs. 80.0% and 25.0% vs. 6.0%) (p<0.001). The small effect between physical activity and constipation between groups was reported. In the constipation group, fewer participants reported their physical activity as adequate (21.0% vs. 41.0%) (p<0.001) or stated doing sports less often (33.0% vs. 53.0%) (p<0.001). We found a statistically significant moderate effect of haemorrhoidal disease during pregnancy and constipation. Women in the constipation group were much more likely to develop this condition than in the control group (40.0% vs. 7.0%) (p<0.001).

During the study, 190 (40.42%) women developed peri-anal symptoms. The prevalence of these symptoms in women who fully completed the study is shown in Table 3. The most common self-reported symptoms were peri-anal pain (69.47%) (especially dull pain (40.0%)), and peri-anal discomfort (65.26%).

We found statistically significant differences between groups comparing personal anamnesis of constipation and perianal diseases (haemorrhoidal disease and/or fissure). Women in the constipation group more often had suffered from constipation before pregnancy (52% vs. 48%) (p<0.001) and had a personal history of perianal disease (76% vs. 24%) (p<0.001). The comparison of personal histories of perianal or abdominal surgeries did not reveal statistically significant differences.

Of the 263 women, 104 (40.0%) developed haemorrhoidal disease diagnosed by the researcher. Of them, 66 (34.74%) were diagnosed with thrombosed haemorrhoidal disease, and 7 (3.68%) with haemorrhoidal disease and anal fissure. Peri-anal diseases mostly developed during the period after childbirth 119 (89.47%). Of all subjects, 2 (1.5%) developed hemorrhoids during the first trimester, 2 (1.5%) during the second trimester, and 82 (61.65%) during the third trimester of pregnancy. The remaining 18 (17.3%) women developed haemorrhoidal disease during any trimester of pregnancy and postpartum period.

Statistical analysis of risk factors for developing constipation during pregnancy is shown in Table 4. Univariate analysis revealed suspected risk factors for constipation. We identified that haemorrhoidal disease during pregnancy (p<0.001), too little physical activity (p<0.001), not doing sports (p<0.001), being overweight compared to normal weight (p=0.003), and monthly income of 300–500 euros (p<0.001), were significantly associated with constipation during pregnancy and after childbirth. Lower education (unfinished secondary education) was the only protective factor that decreased the risk of constipation 4 times (p=0.042).

All statistically significant univariate risk factors were included in multiple logistic regression analyses to identify independent risk factors for constipation.

Multivariate logistic regression analysis revealed independent risk factors for the development of constipation during pregnancy: $\chi^2(13) = 123.24$, p = 0.00 p <0.001, pseudo-R^2 (Cragg-Uhler) = 0.31, pseudo-R^2 (McFadden) = 0.19, sensitivity = 75% CI (70, 80), specificity = 65% CI (58, 72), positive prognostic value = 73% CI (68,79), negative prognostic value = 68% CI (61,74), and prevalence = 56% CI (51,61) (Figure 2 and Figure 3).

We found that haemorrhoidal disease during pregnancy (OR 8.25, 95% CI 4.41–15.4, p < 0.001), inadequate physical activity (OR 1.66, 95% CI 1.03–2.69, p=0.038), not participating in sports (OR 1.98, 95% CI 1.24–3.17, p=0.004), and a monthly income of 300–500 euros (OR 1.97, 95% CI 1.22–3.19, p=0.006) are independent risk factors for developing constipation during pregnancy. Lower education was a protective factor (retrospectively, secondary education by 2.2 times (OR 0.45, 95% CI 0.22–0.89, p=0.022) and unfinished secondary education by 1.84 times (OR 0.20, 95% CI 0.05–0.90, p=0.036)) which reduced the possibility to develop constipation.

Table 3 Prevalence of peri-anal symptoms during pregnancy

Peri-anal symptom	Frequency n (% from 190 symptomatic women)
Peri-anal pain	132 (69.47%)
Dull pain	76 (40%)
Sharp pain	12 (6.32%)
Peri-anal discomfort	124 (65.26%)
Itching	99 (52.11%)
Painful protrusion at the anus	98 (51.57%)
Burning	102 (53.68%)
Mucous discharge	91 (47.89%)
Bleeding	86 (45.26%)

Discussion

Main findings

Our study identified an incidence of constipation during pregnancy of 55.9%. During the study, 40.4% of women developed peri-anal symptoms. The most diagnosed peri-anal symptom was dull peri-anal pain, and the most common pathology was haemorrhoidal disease. The third trimester of pregnancy and the postpartum period were critical for the development of peri-anal diseases. Multivariate analysis revealed that haemorrhoidal disease during pregnancy, low physical activity, and low monthly income are independent risk factors for constipation during pregnancy. Lower education decreased the possibility of this condition. Those results emphasize the

Table 4 Statistical analysis of risk factors for developing constipation during pregnancy

Variable	Value	Constipation during pregnancy		OR* (univariable)	OR* (multivariable)	OR* (final)
		Control group, *N* = 207	Constipation group, *N* = 263			
Hemorrhoidal disease during pregnancy	no	193 (93.2%)	159 (60.5%)			
	yes	14 (6.8%)	104 (39.5%)	9.02 (4.97–16.37, ***p*<0.001**)	8.16 (4.30–15.47, ***p*<0.001**)	8.25 (4.41–15.44, ***p*<0.001**)
Physical activity	adequate	89 (43%)	58 (22.1%)			
	too big	3 (1.4%)	1 (0.4%)	0.51 (0.05–5.04, *p*=0.566)	0.51 (0.04–5.99, *p*=0.592)	0.55 (0.05–5.98, *p*=0.627)
	too little	115 (55.6%)	204 (77.6%)	2.72 (1.82–4.07, ***p*<0.001**)	1.60 (0.98–2.62, *p*=0.061)	1.66 (1.03–2.69, ***p*=0.038**)
Sport	yes	113 (54.6%)	92 (35%)			
	no	94 (45.4%)	171 (65%)	2.23 (1.54–3.24, ***p*<0.001**)	1.98 (1.23–3.17, ***p*=0.005**)	1.98 (1.24–3.17, ***p*=0.004**)
Education	higher	116 (56%)	154 (58.6%)			
	secondary	30 (14.5%)	25 (9.5%)	0.63 (0.35–1.12, *p*=0.117)	0.44 (0.22–0.89, ***p*=0.023**)	0.45 (0.22–0.89, ***p*=0.022**)
	special secondary	22 (10.6%)	37 (14.1%)	1.27 (0.71–2.26, *p*=0.424)	1.23 (0.61–2.47, *p*=0.563)	1.28 (0.64–2.56, *p*=0.491)
	unfinished higher	30 (14.5%)	44 (16.7%)	1.10 (0.65–1.86, *p*=0.709)	0.85 (0.46–1.58, *p*=0.600)	0.83 (0.45–1.53, *p*=0.543)
	unfinished secondary	9 (4.3%)	3 (1.1%)	0.25 (0.07–0.95, ***p*=0.042**)	0.22 (0.05–0.98, ***p*=0.047**)	0.20 (0.05–0.90, ***p*=0.036**)
BMI value	normal weight	150 (72.5%)	168 (63.9%)			
	obesity	12 (5.8%)	21 (8%)	1.56 (0.74–3.28, *p*=0.239)	0.74 (0.31–1.80, *p*=0.507)	
	overweight	24 (11.6%)	60 (22.8%)	**2.23 (1.32–3.76, *p*=0.003)**	1.44 (0.79–2.63, *p*=0.238)	
	underweight	21 (10.1%)	14 (5.3%)	0.60 (0.29–1.21, *p*=0.153)	0.65 (0.28–1.51, *p*=0.319)	
Monthly income	>500 eur	101 (48.8%)	78 (29.7%)			
	<300 eur	23 (11.1%)	19 (7.2%)	1.07 (0.54–2.10, *p*=0.845)	1.01 (0.41–2.48, *p*=0.985)	1.00 (0.41–2.43, *p*=0.996)
	300 - 500 eur	83 (40.1%)	166 (63.1%)	2.59 (1.74–3.85, ***p*<0.001**)	2.00 (1.23–3.23, ***p*=0.005**)	1.97 (1.22–3.19, ***p*=0.006**)

* *OR* odds ratio

importance of adequate physical activity during pregnancy and the prevention of haemorrhoidal disease. Those risk factors could be easily modified and help to prevent constipation during pregnancy and the postpartum period.

Interpretation

Maternal peri-anal diseases and constipation are prevalent during pregnancy and after childbirth. They have a significant effect on maternal health and quality of life. Although there are several studies on the incidence of constipation in women during pregnancy [23, 25–27, 29, 30], the sample sizes are not large, and some of the studies did not include preterm births, were retrospective [26], and reported relevance of constipation according to the trimester of pregnancy. Our results are like those observed by *Kuronen* (40.0% during pregnancy and 52.0% after childbirth) [30]. *Vazquez* reported that constipation occurs in 11.0% to 38.0% of pregnant women [31]. Other studies mostly concentrated on specific times in pregnancy – trimesters of pregnancy – but not the association of constipation with peri-anal diseases and symptoms. *Ponce* study results showed that the prevalence of self-reported constipation in three pregnancy trimesters was 45.4%, 37.1%, 39.4%, and 41.8% postpartum, respectively. Prevalence defined by the Rome II criteria for the same periods was 29.6%, 19.0%, 21.8%, and 24.7%. *Ferdinande* found that 68.0% of pregnant women developed peri-anal symptoms [32]. The most common diagnoses were haemorrhoidal thrombosis, haemorrhoidal prolapse, and anal

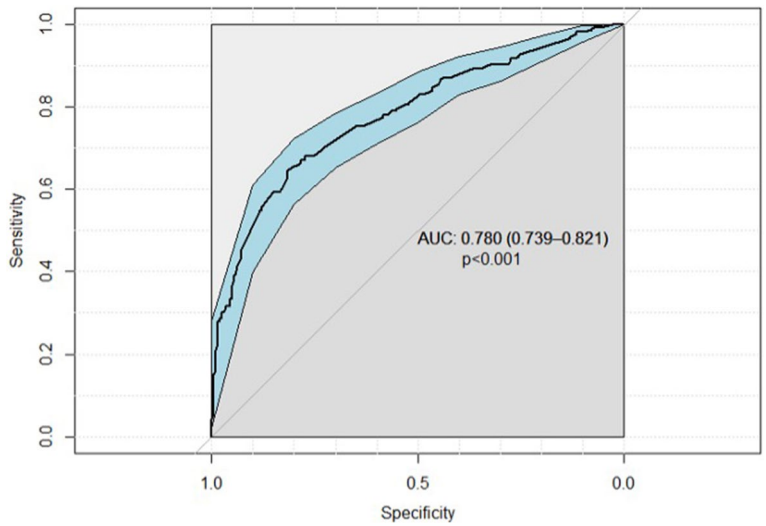

Fig. 2 Multivariate logistic regression analysis for the development of constipation during pregnancy

fissure. The two independent risk factors for anal symptoms were constipation and a history of anal problems [32]. The prevalence of peri-anal symptoms found during our study was lower (40.42%). However, 40.0% of them were diagnosed with haemorrhoidal disease. Our results are like *Unadkat*, who reported the rate of symptoms of peri-anal disease to be 27.0% [33]. The most often those symptoms occurred during the third (31 patients (43.0%)) and second (16 (23.0%)) trimesters and most rarely during the first trimester (12 patients (16.0%)). In our study, 2 patients (1.5%) developed hemorrhoidal disease during the first trimester, 2 (1.5%) during the second trimester, and 82 (61.65%) during the third trimester of pregnancy.

This observational cohort demonstrated that haemorrhoidal disease during pregnancy, too little physical activity, not doing sports, and a monthly income of 300–500 euros are independent risk factors for constipation during pregnancy. Lower education decreased the possibility of this condition.

According to *Nellesen*, chronic constipation is more common in obese (20–37%) and overweight (17–40%) individuals [24]. Our study results were similar. We found that there were more overweight (24.0% vs. 12.0%) or obese (8.0% vs. 6.0%) patient in constipation group.

Constipation has been linked to low physical activity. *Derbyshire* observed that non-constipated subjects participated in higher levels of vigorous, moderate, and light activity in the first two trimesters of pregnancy. In the third trimester of gestation and after birth, constipated subjects participated in higher levels of vigorous and moderate activity; however, these findings were not statistically significant [25]. This study is one of a few studies in which physical activity's impact on constipation in pregnant women population is evaluated. The results of our study proved that inadequate maternal physical activity (not participating in sports during pregnancy, involving moderate physical activity) is independently associated with constipation during pregnancy. Those physical activity changes can be easily recommended to pregnant and postpartum women to reduce the risk of maternal constipation without causing any complications or negative outcomes to the mother or foetus.

Poskus reported that a personal history of peri-anal disease and constipation are independent risk factors for hemorrhoidal disease [34]. The results of our study prove the association between this disease and constipation. The association between constipation and hemorrhoidal disease was analyzed by many authors. In the 1970s, *Burkitt* and co-authors identified a low-fiber diet and constipation as one of the causes of hemorrhoidal disease [35]. Constipation and long stools lead to an increase in intra-abdominal pressure, which results in obstruction of venous blood outflow [36]. Defecation of hard faecal material increases the shearing force on the anal cushions [37] and causes them to slide down [38]. In case of constipation, even after prolonged straining, it is not always possible to have an efficient bowel movement. This may further increase the return of venous blood to the anal cushions [39]. Individuals suffering from constipation are 2.5–4.32 times more likely to develop hemorrhoidal disease [30, 40–43]. Constipation, straining, and hard stools of at least 25% total voiding time are significantly associated with a higher risk of disease (OR 1.43; 95% CI 1.11, 1.86) [44]. Hemorrhoidal disease and constipation have different epidemiological features (age, sex, ethnic origin), so some researchers doubt whether they can be

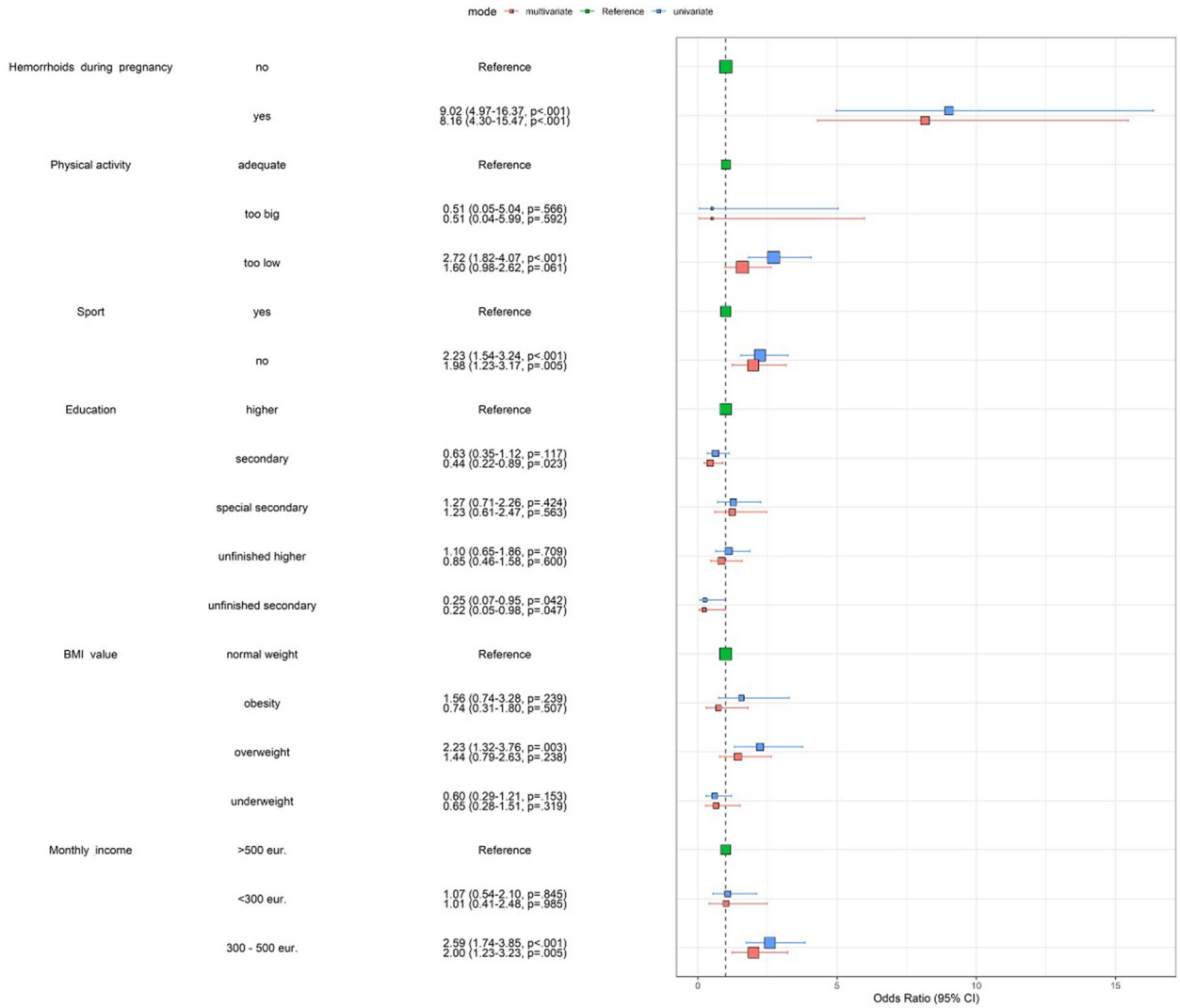

Fig. 3 Graphic visualization of logistic regression

classified as hemorrhoidal disease risk factors. *Kalkdijk* literature review reported in 2022 stated that although no significant difference in the prevalence of hemorrhoidal disease was found between patients with constipation (OR 2.37; 95% CI, 0.67–8.44), the incidence of constipation was significantly higher in patients with hemorrhoidal disease than in patients with constipation in healthy subjects (SD 2.09; 95% CI, 1.27–3.44). The authors identified constipation and dyssynergic bowel movement as the main risk factors for hemorrhoidal disease [45].

Studies conducted in the general population have revealed that constipation is more common in people with lower education [8, 39, 46]. Such an association with chronic constipation was found in Canada, Iran, Brazil, and Australia, and with any type of constipation in the United Kingdom, Germany, Brazil, Colombia, and China [12, 18] Those with no education or secondary education are more likely to be ill [8, 12, 46, 47]. The association between chronic constipation and low education was confirmed by researchers in China, the United States, Croatia, and Iran [11, 12, 18, 47], and for any type of constipation by researchers in the United Kingdom, France, Germany, Italy, and South Korea [18]. This indigestion is more common among the unemployed (18.3%) [18], divorced, and widowed [11, 18]. Our results in the pregnant women population were the opposite. While our analysis suggests that education could influence the prevalence of constipation in pregnant women, we found that this effect is more pronounced when evaluated in conjunction with other variables, such as BMI and physical activity. However, the small number of participants with secondary or unfinished secondary education (25 participants (9.5%) and 3 participants (1.1%) in the constipation group) limits the ability to draw robust conclusions

about education as an independent risk factor. Additionally, while lower education is generally associated with a higher prevalence of constipation in the general population, some studies with pregnant women have observed a similar trend [26].

Income is another socioeconomic factor that may be associated with constipation in the community. The relationship between income level and constipation in the general population has been widely discussed, with results varying across different countries. Nevertheless, there is a general trend suggesting that lower income is associated with a higher prevalence of constipation [12]. This association has been confirmed in studies conducted in the United Kingdom, Germany, Brazil, Colombia, China, and North America [12, 21]. However, this factor remains variable and may differ depending on the context. Our findings align with this trend, suggesting that lower income may contribute to poorer dietary habits and reduced physical activity, both of which could predispose individuals to constipation. It is important to note that our results only indicate a trend, and the association should be further evaluated in conjunction with other variables.

The most common risk factors of constipation are mostly discussed in general population studies. Still, there is a lack of studies in which those factors were evaluated in the pregnant women population. Moreover, constipation prophylaxis recommendations are for the general population and are based on expert opinion. This study adds better knowledge about constipation and its risk factors during pregnancy. We identified physical activity and hemorrhoidal disease as important independent factors contributing to the development of constipation during pregnancy and postpartum. These findings highlight the need for attention to these factors during routine pregnancy monitoring. Maternal counselling on adequate physical activity, along with an emphasis on the benefits of regular exercise, could serve as preventive measures. Additionally, timely diagnosis and prophylaxis of hemorrhoidal disease are critical to reducing the incidence of constipation.

Strengths and limitations

This was a prospective cohort study conducted in three healthcare institutions. Pregnant women were followed by two gynaecologists and peri-anal diseases, and their symptoms were evaluated by a coloproctologist.

The main limitation of this study was the number of patients lost to follow-up and exclusion due to missing data. In total 378 women were excluded: 8 did not meet the inclusion criteria (were minors), 280 declined to participate, 69 did not complete the follow-up and 21 were excluded due to the missing data. This may reflect the sensitivity of the population of pregnant women: working age and the condition considered by some to be a sensitive subject. Moreover, we did not perform an anoscopy throughout the study subject; however, the main aim of this study was to evaluate constipation, not peri-anal diseases, during pregnancy. Additionally, all women who were suspected to have peri-anal pathology were examined by a highly qualified surgeon.

Conclusions

In conclusion, haemorrhoidal disease during pregnancy, too little physical activity, and a monthly income of 300–500 euros are independent risk factors for constipation during pregnancy. Lower education significantly reduces the incidence of this condition.

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

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Authors' contributions

Conceptualization and design, ZSB, TP, GD, DB; methodology, TP, ZSB, DB, GD; software, ZSB; validation, TP, ZSB, DB, GD; formal analysis, EJ; investigation, ZSB, DB, TP, ZSB, EJ, DR; resources, ZSB, DB, TP, GD; data curation, ZSB, DB; writing—original draft preparation, ZSB, AO; writing—review and editing, TP, ZSB, DB, DR, JZ; visualization, EJ, ZSB; supervision TP, ZSB, DB, DR, GD; project administration, TP, ZSB, DB, DR, GD; funding acquisition, N/A. All the authors have read and approved the final manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request. All data relevant to the study are included in the article or uploaded as supplemental online information. Unidentified data underlying the findings reported in this article will be released to third parties upon written request to the corresponding author describing the intent of the data use and the full affiliation of the requesting organization. A data access agreement must be signed to gain access to the data.

Declarations

Ethics approval and informed consent

Ethical approval for this study was obtained from the Vilnius Regional Bioethics Committee, Vilnius, Lithuania, on June 10, 2009, and May 10, 2016, under registration numbers 158200-7-059-13 and 158200-16-843-357. Registration site URL: https://www.mf.vu.lt/mokslas/vilniaus-regioninis-biomedicininiu-tyrimu-etikos-komitetas#isduoti-vrbtek-leidimai by the principles of the

Declaration of Helsinki and in compliance with national guidelines. All participants provided informed consent before participation.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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