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Low back pain intensity among childbearing women and associated predictors. A cohort study

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ABSTRACT

Background: Low back pain is a common condition among childbearing women, causing physical disability and an increased risk of sick leave and obstetric complications.
Aims: To assess the prevalence and intensity of low back pain during pregnancy, to describe the physical disability and sick leave in relation to the severity of low back pain and to identify predictors of moderate to severe low back pain in socio-demographic, health and obstetric characteristics among childbearing women.
Methods: A cohort study was undertaken (n = 566) during August 2015 to March 2016. Questionnaires were used to obtain information about low back pain intensity, physical disability due to low back pain and sick leave at 20 and 32 weeks of gestation. Of the 654 eligible women, 87% completed the first questionnaire.
Findings: Three out of four reported any low back pain at 20 weeks of gestation, and nine out of ten women at 32 weeks. Of these women, one in three reported moderate to severe pain at 20 weeks, increasing to half of the women at 32 weeks. Both sick leave and physical disability increased with increasing low back pain scores. Pre-pregnancy low back pain, multiparity and lower level of education were all identified as predictors of moderate to severe low back pain.
Conclusions: Women with pre-pregnancy low back pain, multiparity and lower level of education, represent the group of women with the highest risk of moderate to severe low back pain during pregnancy and should be payed special attention.

Statement of significance

Problem or issue

There is a lack of updated knowledge concerning low back pain among childbearing women, using validated measurements to estimate the extent of the problem.

What is already known

Low back pain is a very common condition in childbearing women, with potential severe consequences on both a personal level as well as on a societal level.

What this paper adds

This study provides new and updated knowledge concerning low back pain among childbearing women, the development of low back pain over time and shows higher rates of low back pain than in previous studies, using validated measurements.

1. Background

Worldwide low back pain is a very common condition among childbearing women.[1–4] The prevalence of low back pain increases

Abbreviations: BMI, body mass index; OR, odds radio; CI, confidence interval; RMDQ, The Roland Morris Disability Questionnaire.

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during pregnancy with 20% reporting low back pain before pregnancy,[5–7] around 40% in the first trimester[6] and 44–70% in the third trimester.[1–4]

The condition is presumably caused by a variety of factors.[8,9] These include; hormonal changes,[10] increased mobility of the pelvis, joint laxity,[11] changes in the spinal curvature,[12] and muscle dysfunction.[13] However, not all underlying causes are yet known.[14] Low back pain during pregnancy is strongly associated with a history of low back pain,[1,15,16] and other known risk factors are higher pre-pregnancy body mass index (BMI),[1,16] young maternal age,[1,2,17] multiparity,[5,6] and heavy workload.[5,18] Depression and anxiety at 24 weeks of gestation were found to be associated with increased low back pain intensity in the third trimester.[1]

The consequences of low back pain in childbearing women are severe; on a personal level these women experience a decreased capacity for standing, walking and sitting, along with sleep problems, making daily activities challenging[4,8]; and they are more likely to report poor general health.[19] In interviews, women with pelvic girdle pain have described that they felt isolated from social life and dependent on their partner and others for help. They worried about being a burden to their colleagues and about their employers' reaction to their diminished work capacity.[20,21] Women with low back pain are at higher risk of longer duration of labor, operative vaginal delivery and emergency cesarean section.[22] On a societal level, low back pain has serious socio-economic consequences, as 21–50% of sick leave during pregnancy can be attributed to low back pain.[19,23–26] This poses a challenge in countries, such as Denmark, where 80% of all women of fertile age work outside the home.[27] Another challenge is the lack of strong evidence of an effective treatment, as concluded in a recent Cochrane review.[28] Some evidence exists that exercise and acupuncture may decrease low back pain intensity and physical disability among childbearing women.[28] However, other studies indicate that only few women are offered or seek treatment.[1,2]

Low back pain in pregnancy remains a highly relevant clinical problem and populations of childbearing women change over time, for example with regard to lifestyle factors such as exercise habits and pre-pregnancy BMI. It is therefore important to continue professional and scientific awareness about the development of low back pain during pregnancy and to identify vulnerable groups at risk of moderate to severe low back pain, as these women constitute the greatest clinical challenge.[3,15]

The aims of this study were: 1. To assess the prevalence and intensity of low back pain during pregnancy; 2. To describe the physical disability and sick leave in relation to the severity of low back pain; 3. To identify predictors of moderate to severe low back pain in socio-demographic, health and obstetric characteristics among childbearing women.

2. Methods

2.1. Study design and population

A cohort study was undertaken at the Zealand University Hospital, Roskilde, Denmark from August 2015 to March 2016. The hospital serves as primary facility with 2600 deliveries annually and covers a large geographic area of both urban and rural areas. All childbearing women of 18 years or more, who were able to read and understand Danish, were consecutively invited to participate in the study. The participants were approached by a secretary with no connection to the research project, at a routine ultrasound scan around 20 weeks of gestation, after having received written information. The scan is offered to all childbearing women at around 20 weeks of gestation with the purpose of screening for fetal malformations; more than 95% of all childbearing women in Denmark accept this offer.[29] If the woman was willing to participate in the study, two self-administered electronic questionnaires were sent. The first was sent directly after acceptance to participate around 20 weeks and the second at 32 weeks of gestation. The women were able to answer the questionnaires from their smartphone trough an emailed link. In Denmark, most people have wireless internet access though their phone company which covers 98% of the country.[30]

In the study period 786 women were scheduled for the 20 weeks ultrasound scan. Ninety-six childbearing women were excluded, due to lacking Danish language skills, and 36 women were not approached due to logistic failure. Of the 654 eligible women, 32 declined to participate, leaving 622 women, who agreed to participate and 566 (87%) completed the first questionnaire and comprised the study population. The second questionnaire was completed by 513 (78%) of the 566 participating women.

2.2. Ethics approval and consent to participate

All the women who participated in the present study gave freely written informed consent before filling out the questionnaire. The study was approved by the Danish Data Protection Agency, Region Zealand (REG-120-2014, approval was given on December 30th 2014) According to Danish law, the study is exempt from the requirement of approval by the Danish Research Ethics Committee.

2.3. Data

The first questionnaire consisted of 50 items providing information about low back pain intensity, physical disability and sick leave due to low back pain and also socio-demographic characteristics (age, pre-pregnancy weight and height, cohabiting, level of education and occupation), obstetric history (parity and mode of conception), medical history (chronic and mental disorders), lifestyle factors (smoking status at conception and pre-pregnancy exercise with yes/no answers). The second questionnaire consisted of 31 items covering low back pain intensity, physical disability and sick leave due to low back pain.

Low back pain was defined according to the European guidelines[8] as pain between the 12th rib and the gluteal fold. The questionnaires included a drawing of a woman where the definition was illustrated. For the measure of low back pain intensity the Low Back Pain Rating scale[31] was used. It consisted of three 11-point numeric box scales from 0 to 10 points (pain now, worst pain in the past two weeks and average pain in the past two weeks), where 0 indicated no pain and 10 maximum pain. The three scores were added up and an average was calculated for each woman. The group of interest was women who experienced the most radical effect on daily life, identified in previously studies as women with a pain score >3 (moderate to severe pain).[32,33] In order to identify predictors for moderate to severe low back pain, the pain scores were categorized according to severity – mild (0.1–3), moderate (3.1–6) and severe pain (6.1–10) – in accordance with International standards,[32] and further dichotomized (no pain/mild pain (0.1–3) and moderate to severe pain (3.1–10) to present the predictors as odds ratios (OR). For the illustrations (Figs. 1–4) the pain scores were categorized as follows; $(0.1-1=1)$, $(1.1-2=2)$, $(2.1-3=3)$, $(3.1-4=4)$, $(4.1-5=5)$, $(5.1-6=6)$, $(6.1-7=7)$, $(7.1-8=8)$, $(8.1-9=9)$, $(9.1-10=10)$. Women who indicated a pain score of ≥ 1 in the question 'pain now' were asked to respond to additional questions regarding physical disabilities due to low back pain, using The Roland Morris Disability Questionnaire (RMDQ).[34] The Danish version[35] consists of 23 questions with yes/no answers and provides a score from 0 (no disability) to 23 (maximum disability). Sick leave due to low back pain before 20 weeks and from 20 to 32 weeks was assessed with a yes/no

answer. The history of low back pain was established by two questions: experiences of low back pain before the present pregnancy (yes/no) and frequency (daily, weekly, monthly, occasionally and rarely). The answers were categorized into often (daily, weekly) and rarely (monthly, occasionally and rarely). We categorized the following outcome variables: maternal age, parity, pre-pregnancy BMI, cohabiting, mode of conception, disorders, educational level, occupation, smoking status and pre-pregnancy exercise, as shown in Table 1.

2.4. Statistical analysis

We used descriptive statistics to calculate the prevalence and intensity of low back pain, presented in relation to maternal characteristics. To investigate the differences between the categorical variables we used the chi-square test. The Kruskal–Wallis test was used for non-normally distributed data. Spearman's correlation coefficients were used to assess the correlation between low back pain and physical disability. To investigate

Table 1
Socio-demographic, health, obstetric characteristics, and low back pain scores.

Characteristics	n	20 weeks of gestation (n = 566)				32 weeks of gestation (n = 513)			
		Low back pain (yes) n (%)	p Value[a]	Pain score median (min-max)[b]	p Value[c]	Low back pain (yes) n (%)	p Value[a]	Pain score median (min–max)[b]	p Value[c]
Total respondents	566	429 (76)		2.7 (0–10)		460 (90)		4.0 (1–10)	
Age (years)			0.002		<0.001		<0.001		<0.001
<25	55	43 (78)		3.3 (0–9.3)		42 (93)		5.0 (0–10)	
25–29	184	157 (85)		3.3 (0–8.3)		162 (95)		4.3 (0–9.3)	
30–34	205	147 (72)		2.3 (0–8.7)		169 (91)		3.3 (0–9)	
35–39	100	69 (69)		2.2 (0–10)		72 (77)		2.7 (0–8.7)	
≥40	22	13 (59)		1.2 (0–8)		15 (79)		2.7 (0–7.7)	
Parity			0.91		0.39		0.56		0.14
Nulliparous	223	168 (76)		2.5 (0–9.3)		184 (91)		3.7 (0–10)	
Multiparous	343	261 (76)		3.0 (0–10)		276 (89)		4.3 (0–9.3)	
Pre-pregnancy BMI[d]			0.75		0.06		0.39		0.03
<18.5	19	15 (79)		4.0 (0–8.7)		12 (80)		6.0 (0–9)	
18.5–24.9	302	224(74)		2.3 (0–9.3)		242 (89)		3.3 (0–10)	
25–29.9	134	105 (78)		3.3 (0–10)		114 (93)		4.7 (0–9)	
≥30	64	50 (78)		2.7 (0–8.3)		52 (90)		4.3 (0–9.3)	
Missing data	47								
Disorders			0.11		0.02		0.25		0.10
Chronic	89	74 (83)		3.7 (0–8.7)		74 (93)		4.3 (0–9.3)	
Mental	15	13 (88)		3.0 (0–7)		15 (100)		6.0 (1–7.7)	
No disorders	462	342 (74)		2.7 (0–10)		371 (89)		3.8 (0–10)	
Pre-pregnancy Low back pain			<0.001		<0.001		0.004		<0.001
No pain	390	260 (67)		1.6 (0–10)		309 (87)		3.0 (0–10)	
Rarely	67	60 (90)		3.3 (0–10)		60 (94)		4.7 (0–7.8)	
Often	109	108 (99)		5.0 (0–8.8)		90 (98)		6.0 (0–10)	
Cohabitant with partner			0.86		0.67		0.13		0.65
Yes	526	398 (76)		2.7 (0–10)		432 (90)		4.0 (0–10)	
No	40	30 (77)		3.0 (0–8)		27 (82)		4.0 (0–9)	
Education			0.20		<0.001		0.46		<0.001
Advanced degree	129	86 (67)		1.7 (0–9.3)		110 (88)		3.0 (0–10)	
1–4 years higher education	334	264 (79)		3.0 (0–10)		266 (89)		4.3 (0–10)	
Skilled worker[e]	53	42 (82)		3.7 (0–8)		43 (94)		4.8 (0–9)	
Compulsory education	50	35 (70)		4.2 (0k8)		39 (95)		5.7 (0–9)	
Occupation			0.36		0.11		0.78		0.38
Employed	509	383 (75)		2.7 (0–10)		420 (90)		4.0 (0–10)	
Unemployed	57	46 (81)		3.3 (0–8)		40 (91)		4.2 (0–9)	
Smoking (at conception)			0.46		0.13		0.56		0.92
Non-smoker	476	358 (75)		2.7 (0–10)		396 (90)		4.0 (0–10)	
Smoker	90	71 (79)		3.3 (0–8.3)		64 (88)		4.0 (0–10)	
Pre-pregnancy exercise									
Exercise	406	308 (76)	0.95	2.3 (0–10)	0.17	N/A		N/A	
No exercise	160	121 (76)		3.3 (0–9.3)		N/A		N/A	

[a] Chi Square test.
[b] Low back pain was measured by the Low Back Pain Rating Scale which consist of 3 numeric box scales from 0 to 10 points (pain now, worst pain and average pain in the past two weeks).
[c] Kruskal–Wallis test.
[d] Missing data for pre-pregnancy BMI (body Mass Index kg/m^2) n = 47.
[e] A practical and theoretical education of 2–4 years with a final examination. Eg. a hairdresser, a carpenter, a cook.

potential predictors of moderate to severe low back pain *a priori* covariates were defined as: maternal age, parity, pre-pregnancy BMI, mode of conception, level of education, occupation, pre-pregnancy low back pain, disorders, smoking, partner status, pre-pregnancy exercise and univariate logistic regression analysis was performed. Subsequently a multivariate logistic regression model was performed with mutual adjustment for the potential predictors and the results are presented as adjusted OR with 95% confidence intervals (CI). A multivariate linear regression analysis was performed to explore the changes in low back pain score from 20 to 32 weeks of gestation. The analysis was mutually adjusted for all maternal characteristics and for the low back pain score at 20 weeks. Taking missing data (non-responders at 32 weeks of gestation) into account, ad hoc analyses were performed based on last observation carried forward. We also performed a best case scenario (all missing outcomes = 0 no/mild low back pain) and worst case scenario (all missing outcomes = 1 moderate to severe low back pain). This did not change the results. Statistical significance was considered at p-value <0.05 two-sided. Data were analyzed using SPSS version 22(IBM).

3. Results

Table 1 presents the prevalence of low back pain and the low back pain intensity distributed in categories of the socio-demographic, health and obstetric characteristics in the study population (n = 566). The non-responders at 32 weeks of gestation (n = 53) had a significantly lower level of education, were more often smokers at conception, unemployed, had more often experienced pre-pregnancy low back pain and reported higher low back pain intensity at 20 weeks of gestation compared to responders.

3.1. Prevalence of low back pain

The overall prevalence of low back pain was 76% at 20 weeks and 90% at 32 weeks of gestation (Table 1). In 20 weeks of gestation 39% reported mild pain, 20% moderate and 17% reported severe pain. In 32 weeks of gestation 38% reported mild pain, 23% moderate and 29% reported severe pain. The prevalence of low back pain differed significantly with age and according to pre-pregnancy low back pain, at both 20 and 32 weeks of gestation. The overall low back pain score was 2.7 (min–max 0–10) at 20 weeks and 4.0 (min–max 1–10) at 32 weeks of gestation. Sixty-five percent reported an increase in low back pain score, 23% a decrease, four percent reported unchanged low back pain from 20 to 32 weeks of gestation while 8% experienced no low back at any time pain during pregnancy. Low back pain intensity differed significantly among age groups, among women with and without pre-pregnancy low back pain and according to education levels at 20 and 32 weeks of gestation. A significant difference was also found between the pre-pregnancy BMI groups ($p < 0.03$) at 32 weeks of gestation, as women with a pre-pregnancy BMI under 18.5 reported the highest pain score (Table 1). Distribution of low back pain scores among childbearing women at 20 and at 32 weeks of gestation are shown in Fig. 1.

In order to explore the changes in low back pain score from 20 to 32 weeks of gestation in relation to maternal characteristics we performed a multivariate linear regression analysis where we mutually adjusted for all maternal characteristics (as shown in Table 1) and for the low back pain score at 20 weeks. This showed that multiparous women, women with pre-pregnancy low back pain often and compulsory education had an increased low back pain score while women aged 35 years and older had a decreased pain score from 20 to 32 weeks of gestation (Table 2).

3.2. Physical disability and sick leave

Figs. 2 and 3 illustrate a positive association between the low back pain score and the physical disability score at both 20 (Spearman's Rho 0.74, $p < 0.001$) and 32 weeks of gestation (Spearman's Rho 0.71, $p < 0.001$).

The proportion of women who reported sick leave due to low back pain increased with rising low back pain score at both 20 and 32 weeks of gestation (Fig. 4). At 20 weeks of gestation, only few women with scores from 0.1 to 3 (mild pain) reported sick leave, one in six women with scores from 3.1 to 6 (moderate pain) reported sick leave and more than half of women with scores from 6.1 to 10 (severe pain) reported sick leave. At 32 weeks few women with mild pain reported sick leave, from one in five till half of the women with moderate pain reported sick leave and up till three out of four women with severe pain reported sick leave (Fig. 4).

3.3. Predictors of moderate to severe low back pain

Moderate to severe low back pain was reported by 37% (n = 207) at 20 weeks and by 52% (n = 266) at 32 weeks of gestation. Table 3 shows the results of the multivariate logistic regression analysis. Women who often experienced pre-pregnancy low back pain at 20 weeks of gestation had an OR 7.5 (CI 4.3–13) and OR was also

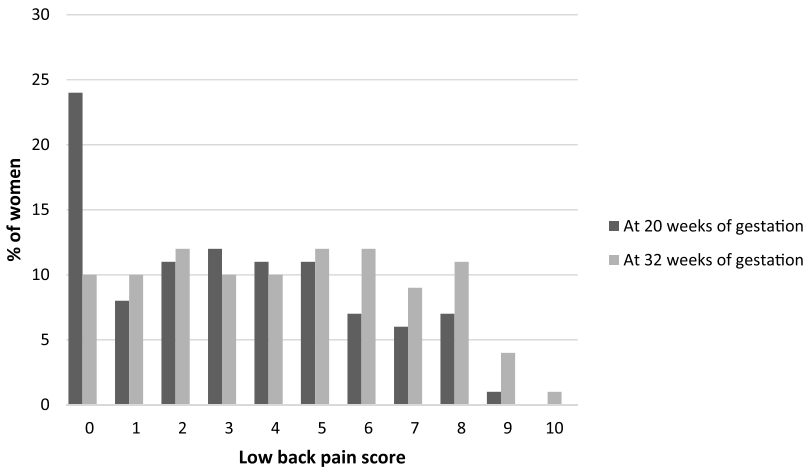

Fig. 1. Shows the distribution of low back pain scores among pregnant women at 20 (n = 566) and 32 weeks of gestation (n = 513). The score is an average of three scores measured on numeric box scales (pain now, worst and average pain during the past two weeks).

Table 2
Changes of the low back pain score from 20 to 32 weeks of gestation (n = 513).

Characteristics	Mean change	Crude difference	Adjusted[a] difference	95% CI
Age (years)				
<25	1.36	0.37	0.42	−0.29 to 1.14
25–29	1.0	Ref	Ref	Ref
30–34	1.25	0.26	−0.17	−0.63 to 0.28
35–39	0.86	−0.13	−0.82	−1.38 to −0.26
≥40	0.77	−0.23	−1.18	−2.21 to −0.16
Parity				
Nulliparous	0.95	Ref	Ref	Ref
Multiparous	1.18	0.23	0.52	0.11–0.92
Pre-pregnancy BMI				
<18.5	1.04	0.5	0.13	−0.98 to 1.24
18.5–24.9	0.96	Ref	Ref	Ref
25–29.9	1.15	0.16	0.33	−0.12 to 0.78
≥30	1.49	0.5	0.52	−0.07 to 1.12
Disorders				
None	1.12	Ref	Ref	Ref
Chronic	0.95	−0.17	0.22	−0.29 to 0.73
Mental	1.11	−0.01	0.25	−0.86 to 1.37
Pre-pregnancy low back pain				
No pain	1.15	Ref	Ref	Ref
Rarely	1.15	0.01	0.47	−0.1 to 1.04
Often	0.85	−0.29	0.82	0.29–1.35
Cohabitant with partner				
Yes	1.09	Ref	Ref	Ref
No	1.0	−0.1	−0.01	−0.78 to 0.76
Education				
Advanced degree	1.06	Ref	Ref	Ref
1–4 years higher education	0.98	−0.07	0.18	−0.27 to 0.63
Skilled worker	1.28	0.22	0.53	−0.2 to 1.25
Compulsory education	1.75	0.69	1.05	0.24–1.85
Occupation				
Employed	1.10	Ref	Ref	Ref
Unemployed	0.98	−0.12	−0.18	−0.86 to 0.49
Smoking at conception				
Non-smoker	1.11	Ref	Ref	Ref
Smoker	0.97	−0.14	−0.41	−0.95 to 0.14
Pre-pregnancy exercise				
Exercise	1.13	Ref	Ref	Ref
No exercise	0.97	0.16	0.22	−0.19 to 0.64

[a] Adjusted multivariate linear regression analysis for age, parity, pre-pregnancy BMI (Body Mass Index kg/m^2), disorders, pre-pregnancy low back pain, cohabitant with partner, education, occupation, smoking, pre-pregnancy and low back pain score at 20 weeks of gestation.

significantly increased for those who were skilled workers or had a compulsory education. Multiparous women also had significantly higher OR of moderate to severe low back pain. Significantly lower OR for moderate to severe low back pain were found for older women, as women aged 35–39 years had an OR 0.4 (CI: 0.2–0.7) and women aged 40 years and older had OR 0.1 (CI: 0.03–0.4) at 20 weeks of gestation. Similar results were found at 32 weeks of gestation.

Taking missing data (non-responders at 32 weeks of gestation) into account, three ad hoc analyzes were performed and identical results found (data not shown). Due to missing data in the pre-pregnancy BMI variable (8%) we also performed the multivariate regression analysis without pre-pregnancy BMI at both 20 and 32 weeks of gestation and found similar results.

4. Discussion

Of the 566 participating childbearing women three out of four reported any low back pain at 20 weeks of gestation, and the proportion increased to nine out of ten women at 32 weeks. Of these women, one in three reported moderate to severe pain at 20 weeks, increasing to half of the women at 32 weeks. Two out of three reported an increase in the low back pain score; one in four reported a decrease, while four percent reported an unchanged low back pain score from 20 to 32 weeks of gestation. The highest low back pain scores were reported by young, underweight women and in women reporting pre-pregnancy low back pain. The women who reported the lowest pain score were among those with an advanced degree education. Both sick leave and physical disability increased with increasing low back pain scores. Pre-pregnancy low back pain, multiparity and lower level of education were all identified as predictors of moderate to severe low back pain.

This study provides new and updated knowledge concerning low back pain among childbearing women, the development of low back pain over time and shows higher rates of low back pain than in previous studies.

The prevalence reported at 20 weeks of gestation in the present study was in line with other prospective studies.[3,6] However the

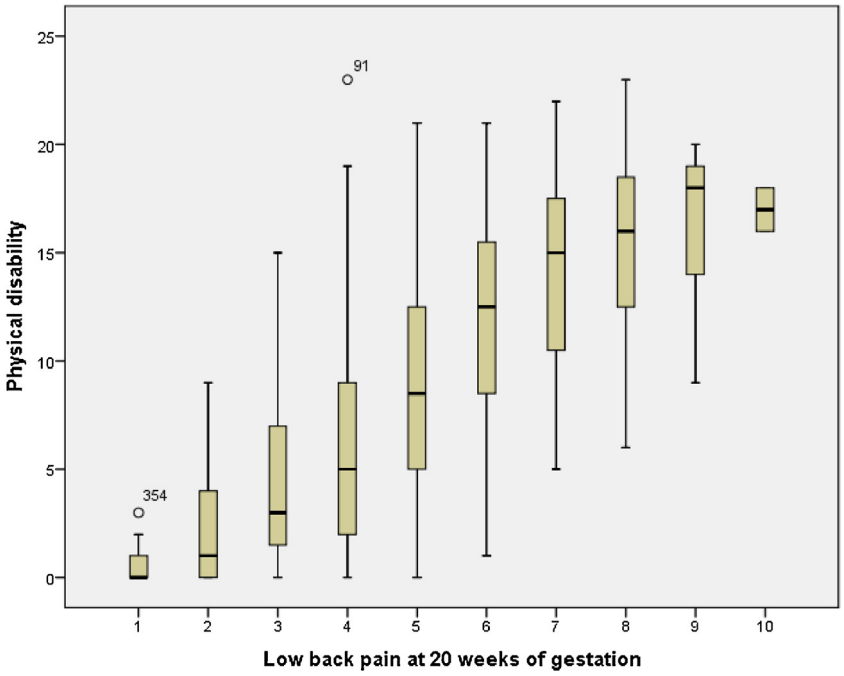

Fig. 2. Shows the association between the low back pain score, at 20 weeks of gestation (An average of scores measured on three numeric box scales; pain now, worst and average pain during the past two weeks) and the physical disability score measured by Roland Morris Disability Questionnaire (Spearman's Rho = 0.74 $p < 0.001$) (n = 349).

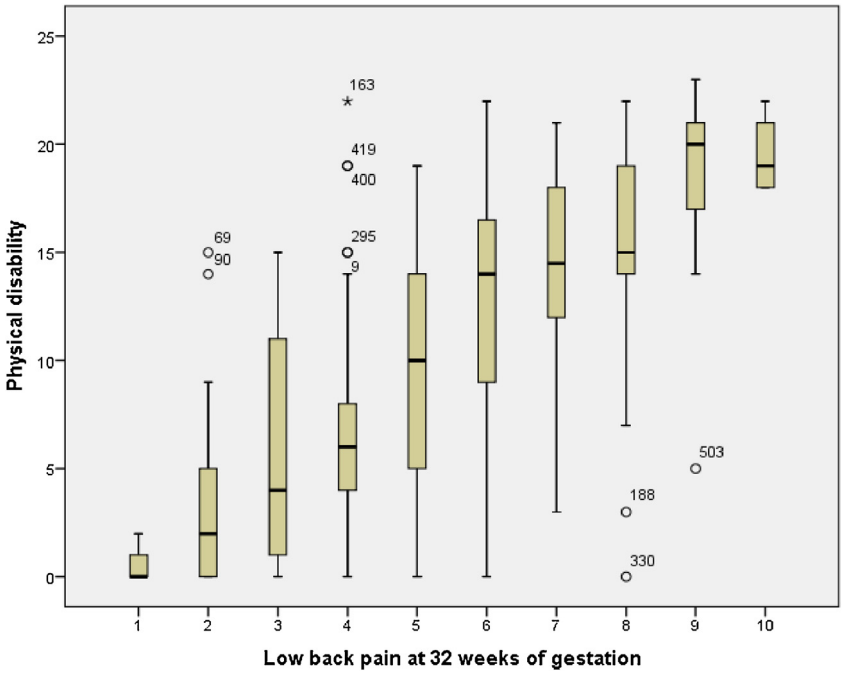

Fig. 3. Shows the association between the low back pain score (An average of scores measured on three numeric box scales; pain now, worst and average pain during the past two weeks) and the physical disability score measured by Roland Morris Disability Questionnaire, at 32 weeks of gestation (Spearman's correlation $\rho = 0.71$ $p < 0.001$) (n = 376).

prevalence of 90% at 32 weeks of gestation was higher than in other studies.[1,3,6] An explanation may be that we used three questions (pain now, average pain and worst pain in the past two weeks) to measure pain, and two of the questions were an assessment of pain over a two-week period; this may cover more aspects of the pain experience, which may have led to the higher prevalence found in this study. In contrast to our measurement of pain, Gutke et al. used a single question (pain now) to assess pain measurement and they found a prevalence of 63%, considerably lower than in our study. Even though we found a higher prevalence the overall pain score of 4.0 (min–max. 1–10) at 32 weeks of gestation was in line with two other studies,[2,6] which used a measurement of pain similar to that used in the present study. Furthermore, the proportion of women reporting moderate to severe low back pain was similar to that in other studies.[2,15,36] There were some inconsistencies between the definitions of low back pain, which may also explain the variation

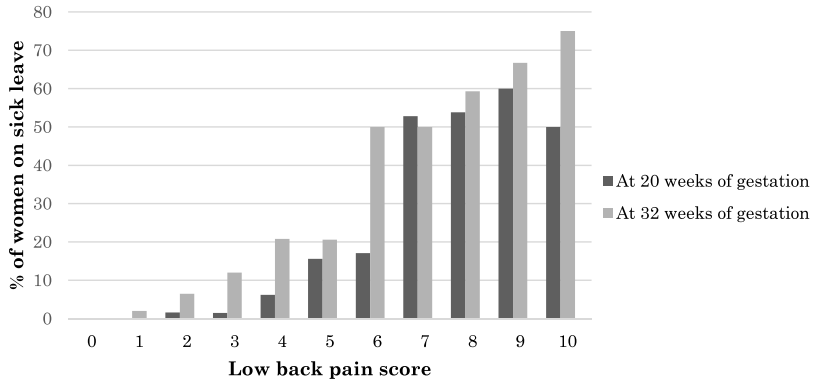

Fig. 4. Shows the percentage of women on sick leave due to low back pain at 20 (n = 566) and 32 (n = 513) weeks of gestation distributed according to the low back pain score measured on three numeric box scales (pain now, worst and average pain during the past two weeks).

in the prevalence across studies.[14] The highest median pain scores are reported among younger and underweight women. Higher pain scores among younger women have been found in previous studies,[4,6] We have not found a physical explanation for these results and there is therefore reason to consider that a part of the explanation of the higher pain score reported by younger women could be related to other aspects such as the psychological aspect of pain. Opposite to other studies[1,2,17] we found that women with the lowest pre-pregnancy BMI reported the highest median pain score, which is surprising as a higher BMI is associated with an increased risk of low back pain in non-childbearing individuals.[37] This might be due to the fact that we found a non-statistically trend toward a lower age, lower educational level class and more unemployment among women with a pre-pregnancy BMI below 18.5 (data not given).

We demonstrated that with increasing pain scores the reported physical disability increased proportionally, as well as the rates of sick leave due to low back pain. Interestingly we found that the proportion of women reporting sick leave due to low back pain increased sharply at a pain score between 6–7 in 20 weeks and 5–6 in 32 weeks of gestation. This indicates that the majority of childbearing women do not report sick leave until the pain is severe and that they to a high extent continue their work obligations despite pain. Earlier studies have not described the association between low back pain score and the proportion of sick leave.[3] Furthermore our results demonstrate that women with moderate to severe pain face the largest burden of disability in everyday life and at work, which is also supported by interview studies of women with low back pain.[20,21] Still, the Danish national guidelines for antenatal care[38] only provide limited recommendations for the diagnosis and treatment of women with moderate to severe low back pain.

The strongest predictor of moderate to severe low back pain was pre-pregnancy low back pain in line with previous studies.[1,15,16,39] Women who reported pre-pregnancy low back pain often had a sevenfold increase in the odds of reporting moderate to severe low back pain during pregnancy. This suggests that it might be useful to implement a potential preventive effort in pre-pregnancy counseling.

Further we identified younger age and lower level of education as groups who reported high pain scores. Although younger age has previously been reported as a predictor in other studies,[1,2,17] we have not found an explanation for these results. We therefore further tested if more co-morbidity among the younger women or the distribution of unemployed women, could explain this result, but found no statistically significant differences among age groups, nor in the distribution of unemployed women (Data not shown). We therefore suggest that low back pain in pregnancy should be understood in a broader context as it is in patients with chronic pain. The prevailing pain theory assumes that the pain experience is influenced by cognitive, emotional, physiological and behavioral factors.[40] The interventions targeting these aspects have shown to reduce pain intensity and to increase the level of daily physical functions in patients with chronic low back pain.[41] In future studies it would be interesting to address low back pain treatment among childbearing women as described among non-pregnant individuals, especially among younger women, women with lower level of education and women with pre-pregnancy low back pain. Another explanation of higher risk of low back pain among women with a lower education could be related to work conditions, which is seen in some studies but not in others.[42] Data on work conditions were not available in the present study.

We did not find pre-pregnancy exercise to decrease the risk of moderate to severe low back pain, unlike other studies with larger sample sizes (n = 3500 and 5200, respectively).[42,43] We found an adjusted OR of 0.8, (CI; 0.5–1.3) at 20 weeks of gestation, the same OR as seen in the larger studies,[43] however our study might not be sufficiently powered in order to detect differences in risks and a type 2 error might have occurred.

4.1. Strengths and limitations

The risk of selection bias in the present study is a possibility as women experiencing low back pain might have been more willing to participate than women who do not, however information about non-participants was not available. Our response rate of 87% at 20 weeks and 78% at 32 weeks of gestation was high and selection bias would therefore only have limited impact. We excluded non-Danish speaking women (n = 96) and the results are therefore only applicable to the Danish-speaking part of the general population.

Information on pre-pregnancy lifestyle factors (smoking and exercise), pre-pregnancy low back pain and sick leave from the time of conception was collected retrospectively at 20 weeks of gestation, which might have resulted in recall bias. However, in the present analysis we only used yes/no answers for smoking, exercise and sick leave, which presumably would make the information more accurate than if a specific number of days or hours were to be stated, and we therefore believe that the results have not been significantly affected.

We collected data on low back pain and physical disability prospectively, and this was considered a strength. Furthermore, we used validated instruments for the measurement of both the low back pain intensity (Low Back Rating scale) and the physical disability (Roland Morris Disability Questionnaire), which strengthen the internal validity. Even though, the instruments have not been validated in a population of childbearing women we

Table 3
Predictors of moderate to severe low back pain at 20 and 32 weeks of gestation.

Characteristics	20 weeks of gestation (n = 566)			32 weeks of gestation (n = 513)		
	No/mild n (%)	Moderate/severe n (%)	Adjusted OR (95% CI)[a]	No/mild n (%)	Moderate/severe n (%)	Adjusted OR (95% CI)[a]
Total respondents	359 (63)	207 (37)		247 (48)	266 (52)	
Age						
<25	30 (55)	25 (45)	0.8 (0.4–1.7)	14 (31)	31 (69)	1.8 (0.8–4.4)
25–29	102 (55)	82 (45)	1.0	74 (43)	97 (57)	1.0
30–34	138 (67)	67 (33)	0.6 (0.3–0.9)	94 (51)	91 (49)	0.6 (0.4–1.1)
35–39	70 (70)	30 (30)	0.4 (0.2–0.7)	52 (56)	41 (44)	0.4 (0.2–0.7)
≥40	19 (86)	3 (14)	0.1 (0.03–0.4)	13 (68)	6 (32)	0.2 (0.1–0.8)
Parity						
Nulliparous	145 (65)	77 (35)	1.0	105 (52)	98 (48)	1.0
Multiparous	213 (62)	130 (38)	1.7 (1.04–2.6)	142 (46)	168 (54)	1.9 (1.2–3.0)
Pre-pregnancy BMI						
<18.5	8 (42)	11 (58)	2.3 (0.7–7.5)	6 (40)	9 (60)	1.6 (0.4–6.0)
18.5–24.9	198 (66)	104 (34)	1.0.	149 (55)	124 (45)	1.0
25–29.9	75 (56)	59 (44)	1.1 (0.7–1.8)	45 (37)	78 (63)	1.9 (1.2–3.1)
≥30	44 (69)	20 (31)	0.6 (0.3–1.3)	24 (41)	34 (59)	1.5 (0.8–2.8)
Cohabitant with partner						
Yes	334 (63.5)	192 (36.5)	1.0	232 (48)	247 (52)	1.0
No	24 (61.5)	15 (38.5)	1.2 (0.5–2.7)	15 (46)	18 54)	0.9 (0.3–2.4)
Education						
Advanced degree	100 (77.5)	29 (22.5)	1.0	77 (62)	48 (38)	1.0
1–4 years higher education	205 (61)	129 (39)	1.8 (1.03–3.1)	136 (46)	163 (54)	1.4 (0.9–2.3)
Skilled worker	28 (55)	23 (45)	2.9 (1.2–6.6)	19 (41)	27 (59)	2.4 (1.0–5.4)
Compulsory education	24 (48)	26 (52)	3.9 (1.6–9.2)	14 (34)	27 (66)	2.8 (1.1–7.1)
Occupation						
Employed	327 (64)	182 (56)	1.0	227 (48)	242 (52)	1.0
Unemployed	32 (56)	25 (44)	0.9 (0.4–1.8)	20 (46)	24 (56)	0.9 (0.4–1.9)
Low back pain						
No pain	284 (73)	105 (27)	1.0	210 (59)	146 (41)	1.0
Rarely	44 (66)	23(34)	1.7 (0.9–3.1)	20 (31)	44 (69)	3.6 (1.9–6.8)
Often	30 (27.5)	79 (72.5)	7.5 (4.3–13)	16 (17)	76 (83)	6.7 (3.5–13)
Disorders						
None	305 (66)	157 (34)	1.0	209 (50)	209 (50)	1.0
Chronic	45 (51)	44 (49)	1.9 (01.1–3.3)	32 (40)	48 (60)	1.3 (0.7–2.3)
Mental	9 (60)	6 (40)	1.3 (0.4–5.0)	6 (40)	9 (60)	1.8 (0.5–6.6)
Smoking at conception						
Non-smokers	307 (64.5)	169 (35.5)	1.0	211 (48)	229 (52)	1.0
Smokers	52 (58)	38 (42)	0.8 (0.4–1.4)	36 (49)	37 (51)	0.5 (0.3–1.0)
Pre-pregnancy exercise						
Exercise	268 (66)	138 (34)	0.8 (0.5–1.3)	181 (48)	192 (52)	1.2 (0.8–1.9)
No exercise	91 (57)	69 (43)	1.0	66 (47)	74 (53)	1.0

Moderate to severe low back pain defined as a pain score of >3 on 3 numeric box scales from 0 to 10 points (pain now, worst pain and average pain in the past two weeks). Adjusted OR, adjusted for age, parity, pre-pregnancy BMI (Body Mass Index kg/m^2), low back pain (pre-pregnancy), disorders, smoking status (at conception) and pre-pregnancy exercise.

[a] Confidence intervals.

showed (Figs. 2 and 3) that there is a strong correlation between the low back pain score and the physical disability score indicating suitability of the instruments in the present population. We used the wide definition of low back pain which includes pelvic girdle pain to obtain a full picture of pain among childbearing women[8] but this definition does not differentiate low back pain from pelvic girdle pain, which may be considered a limitation. The use of self-administrated questionnaires captures the low back pain intensity, but does not provide information for an exact diagnosis. Furthermore we used a single question to obtain information about pre-pregnancy low back pain and this does not provide detailed information about any condition acute or chronic that the participants might have and may be considered a limitation. We adjusted for a priori co-variates, but we are aware of the limited number included in the analysis and that we did not address all important co-variates.

4.2. Clinical implications

So far, previous studies do not seem to have influenced the prevalence of low back pain in pregnancy. In order to reduce the prevalence of low back pain during pregnancy future antenatal counseling should include evidence based and tailored strategies. Such intervention strategies should focus on low back pain in a broader context including both treatment of the physical symptoms (physical exercise, acupuncture and pelvic belts) and pain coping strategies with cognitive, emotional and behavioral aspects similar to the management of chronic back pain among the

general population.[41] These strategies may reduce low back pain intensity and increase physical capacity and quality of life in childbearing women especially among those with daily or weekly pre-pregnancy low back pain. However there is a lack of such evidence and it calls for research that specifically aims to demonstrate effective tailored intervention strategies.

Pre-pregnancy low back pain is a strong predictor of moderate to severe low back pain and this group would seem an obvious target for pre-pregnancy counseling in order to diminish the consequences of low back pain. Obtaining knowledge in the antenatal care of low back pain history from women in the early stages of pregnancy will provide an opportunity to identify and support these women throughout the pregnancy. A future intervention study should target women with pre-pregnancy low back pain.

5. Conclusion

The prevalence of low back pain increased from 76% at 20 weeks of gestation to 90% at 32 weeks of gestation. Sixty-five percent reported an increase in the low back pain score and half of the women experienced moderate to severe low back pain at 32 weeks of gestation. Physical disability and sick leave increased with the intensity of low back pain. Predictors of moderate to severe low back pain were pre-pregnancy low back pain, multiparity and lower level of education. Future research should focus on childbearing women with pre-pregnancy low back pain as they represent the most vulnerable group with the highest risk of moderate to severe low back pain during pregnancy. Such research should include elements of treating physical symptoms as well as cognitive, emotional and behavioral aspects.

Authors' contribution

All the authors participated in the design of the study and development of the questionnaire. MGB collected the data. MGB, JB and HKH performed the analysis of the data. All authors took part in the interpretation of the study results and in the drafting of the article. All authors read and approved the final manuscript.

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Availability of data and material

The datasets during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflict of interests

The authors declare that they have no competing interests.

Ethical statement

This study was approved by the Danish Data Protection Agency, Region Zealand (With approval number: REG-120-2014, approval was given on December 30th 2014) According to Danish law, the study is exempt from the requirement of approval by the Danish Research Ethics Committee. The author is in possession of documentation from the Ethics Committee, Region Zealand, which confirm the above described conditions.

All the women who participated in the present study gave freely written informed consent before they were included in the study.

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