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Leisure time physical activity among pregnant women and its associations with maternal characteristics and pregnancy outcomes

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ABSTRACT

Background: Physical activity during pregnancy is generally considered safe and beneficial for both the pregnant woman and her fetus. The overall aim was to investigate pregnant women's pre-pregnancy and early pregnancy physical activity and its associations with maternal characteristics and pregnancy outcomes.
Methods: This cross-sectional study combined data from the Maternal Health Care Register in Västerbotten (MHCR-VB) and the Salut Programme Register (Salut-R). Data were collected from 3,868 pregnant women living in northern Sweden between 2011 and 2012.
Results: Almost half of the participants (47.1%) achieved the recommended level of physical activity. Compared to the women who did not achieve the recommended level of exercise, these women had lower BMI, very good or good self-rated health, and a higher educational level. No significant associations could be established between physical activity levels and GDM, birth weight, or mode of delivery.
Conclusions: Positively, a considerably high proportion of Swedish pregnant women achieved the recommended level of physical activity. Factors associated with recommended physical activity level were BMI ≤30 kg/m^2, very good or good self-rated health, and higher educational level. Our findings emphasize the need for health care professionals to early detect and promote fertile and pregnant women towards health-enhancing physical activity, especially those with low levels of physical activity and overweight/obesity, to improve overall health in this population.

Background

Physical activity during pregnancy

Globally, physical inactivity is the fourth leading risk factor for mortality and is considered a major threat to public health [1–3]. Physical activity during pregnancy is generally safe and beneficial for both the pregnant woman and her foetus and does not increase the risk of adverse pregnancy outcomes [4]. Physical exercise during pregnancy can maintain or improve fitness and may further improve pregnancy outcomes [4–6]. For obese pregnant women, physical activity reduces the risk of pre-eclampsia [6], decreases pelvic pain and back pain [7], reduces gestational weight gain during pregnancy [8], and increases well-being [9]. There is, however, insufficient evidence to conclude that physical exercise prevents pregnancy glucose intolerance or gestational diabetes mellitus (GDM) [10]. Although health care providers advise pregnant women to maintain or increase their physical activity, pregnant women tend to lower their physical activity [11].

Guidelines regarding physical activity

Considering physical activity as a preventive factor, national guidelines in many countries recommend specified levels of physical activity during pregnancy [12,13]. For the ages 18–64 years, the World Health Organization (WHO) recommends levels of physical activity to be at least 150 minutes (performed in bouts of at least 10 minutes) of moderate-intensity aerobic physical activity per week or 75 minutes of vigorous-intensity aerobic physical activity per week, or a combination of these. Pregnant women should seek advice before striving to achieve these recommendations [14]. These recommendations are endorsed by the Swedish Professional Associations for Physical Activity and are also applicable for pregnant women [4]. These recommendations are also in line with

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guidelines on health promotion developed by the Swedish National Board of Health and Welfare (NBHW) [15] .

Rationale of the study

Few studies have been investigating the prevalence of self-reported physical activity during pregnancy in Sweden in relation to the national recommendations and their associations with pregnancy outcomes. Furthermore, the literature is limited regarding the associations between maternal background characteristics and level of physical activity during pregnancy.

Aims

The overall aim was to investigate pregnant women's pre-pregnancy and early pregnancy physical activity and its associations with maternal characteristics and pregnancy outcomes.

The specific objectives were to 1) investigate prevalence of self-reported physical activity during leisure-time in early pregnancy, 2) investigate associations between pre-pregnancy and early pregnancy physical activity during leisure time and to investigate maternal background characteristics, mode of delivery, birth weight, prevalence of gestational diabetes mellitus, and self-rated health.

Methods

This population-based, cross-sectional study combined data from the Swedish Maternal Health Care Register (MHCR) and the Salut Programme Register (Salut-R) for 2011 to 2012.

The study sample

In MHCR (2011–2012), we identified a sub-set of participants from the county of Västerbotten (MHCR-VB), located in northern Sweden, who also participated in the Salut-R from 2011 to 2012. All pregnancies, irrespective of single birth or multiple births, were included in the study sample. The final dataset consisted of 3,868 pregnant women. If cases were not identified in both registers, they were excluded (n = 979). The following variables retrieved from the MHCR-VB were included in the dataset: country of origin, maternal age, parity, maternal height, maternal weight, body mass index at first visit to ANC, smoking, level of education, self-rated health, GDM, oral glucose tolerance test (OGTT), gestational age, mode of delivery, and birth weight. The variables extracted from the Salut-R were self-reported data on pre-pregnancy and early pregnancy physical activity during leisure time.

Information on physical activity levels was available from the Salut-R, and all other variables of background characteristics and pregnancy outcomes were retrieved from the MHCR. The sample size was estimated for different outcomes under study. With the power of 90% at a significant level of 5%, it would be possible to detect a difference of 0.5 in BMI (SD = 4.5) between two groups with a sample size of 1800 in each group. Achieving the power of 90% at a significant level of 5%, it would be possible to detect a difference in proportion of 0.03 between two groups with a sample size of 1500 in each group for self-rated health: "very good" and "good" and "neither good nor poor" or "very poor".

The Maternal Health Care Register

The Nordic countries have a unique opportunity to perform register-based research due to their population-based national registers [16]. The Swedish Maternal Health Care Register (MHCR), a national health quality register, is characterized by a satisfying internal validity for the majority of the variables that have been collected since 1999 by midwives in antenatal care (ANC) [17]. The coverage in the MHCR is to be considered high. In 2011, 2012 and 2013 the MHCR monitored around 81%, 85%, and 89% of all pregnant women in Sweden, respectively [18]. MHCR data are collected on two occasions: first during the pregnant woman's first visit to an ANC and then during a visit within the first 16 weeks postpartum.

The Salut Programme and its register

The Salut Child-Health Promoting Intervention Programme (Salut Programme) is headed by the County Council of Västerbotten [19]. The Salut Programme Register (Salut-R) includes data collected through a questionnaire from early pregnancy (around gestational week 10) from the woman and her partner at their first visit to an ANC. The pregnancy questionnaire contains information on obstetric and medical history, living conditions, and lifestyle habits.

Ethical approval

Ethical approval from the Ethical Review Board in Umeå was granted for The Salut-R (Dno 2010-63-31) and MHCR and MHCR-VB (Dno 2012-407-31M and 2014-152-32M).

Definitions and categorizations of variables

Some variables acted both as independent and dependent variables. See the descriptions below.

Independent variables

Maternal age was defined as age (years) at delivery. *Parity* was defined as the total number of children born (including the index pregnancy in the MHCR). *Maternal height* (cm) and *maternal weight* in early pregnancy (kg) were self-reported. *Gestational age* was divided into pre-term, term, and post-term. *Early pregnancy body mass index (BMI)* was calculated with the formula BMI kg/m^2. The different BMI groups were defined according to the WHO's definition of BMI: underweight: <18.5 kg/m^2; normal range: 18.5–24.99 kg/m^2; overweight: 25–29.99 kg/m^2; obesity class 1: 30–34.99 kg/m^2; obesity class 2: 35–39.99 kg/m^2; and obesity class 3: ≥40 kg/m^2 [20]. *Smoking* at three months before pregnancy and at the first antenatal visit was self-reported. *Level of education* was defined as elementary school, high school, and university. *Country of origin* was categorized into Sweden, other Nordic countries, and other countries. *Employment status* was categorized into employed, student, parental leave, unemployed, sickness leave, and other status. *Pre-pregnancy and early pregnancy self-reported physical activity during leisure time* (LTPA) (included as a dependent variable) was based on the following question: "How often do you perform any kind of physical activity during leisure-time? Please have the last 12 months in mind when responding to the question". There were three groups of physical activity levels: low (not breathless or sweaty), moderate (warm, possible to have a conversation), and vigorous (high pulse, breathless, and sweaty). The respondent assessed the number of days they were physically active on each level. To calculate activity minutes, the reported number of days in the second group (moderate) was multiplied by 30 minutes and the third group (vigorous) was multiplied by 60 minutes. Group one (low) was defined as <150 activity minutes. Finally, the variable was dichotomized as <150 physical activity minutes (i.e., not achieving the recommended level) and ≥150 physical activity minutes (i.e., achieving the recommended level) during leisure time.

Dependent variables

Self-rated health (SRH) was reported by the woman during early pregnancy and divided into five categories: "very good", "good", "neither good nor poor", "poor", and "very poor" health. The

following variables in MHCR were collected from pregnant women's medical records. *Gestational diabetes mellitus (GDM)* was defined as any degree of glucose intolerance with onset or first recognition during pregnancy and was not considered as manifest diabetes mellitus type 2. GDM was diagnosed with a 75-g oral glucose tolerance test (OGTT) followed by a capillary two-hour blood glucose value of ≥10 mmol/L. *Delivery mode* was reported as vaginal delivery, non-instrumental vaginal delivery, instrumental vaginal delivery, elective caesarean section, or emergency caesarean section. *Birth weight* was reported in gram. When calculating birth weight, the birth weight of single births was included as well as the birth weight of the first child of duplex or triplex pregnancy. *Body mass index (BMI)* was calculated and categorized as described in the section above.

Statistical analysis

Two-independent samples t-test was used to test the difference of parametric data, and Pearson's Chi-Squared test was used to test the difference of proportions for categorical variables. Univariate and multivariate logistic regression analyses were performed and presented with odds ratios (OR) and their 95% confidence intervals (CI). Statistical analysis was done using SPSS version 22.

Results

Study sample in relation to the source population

In an earlier study [21], we had access to a total dataset from MHCR including all pregnant women from 2011 to 2012. This dataset included 184,183 women, and was used in the present study to evaluate the representativeness of the sample. The coverage of the variables in the study sample was generally higher than in the total MHCR. There were small but statistically significant differences between the study sample and MHCR-VB. In the study sample, maternal height was higher (166.6 cm vs. 166.3 cm), parity was lower (1.79 vs. 1.80), BMI was lower (24.5 kg/m^{2}vs. 24.8 kg/m^2), educational level was higher, employment proportion was higher (77.8% vs. 73.7%), and non-Nordic origin proportion was lower (9.4% vs. 11.7%). Table 1 presents the characteristics of the study sample.

Pre-pregnancy and early pregnancy physical activity levels and their associations with maternal characteristics

Table 2 presents physical activity during leisure time and its associations with maternal background characteristics. Almost half of the pregnant women (47.1%) reported that they achieved the recommended level of physical activity, and a significantly higher proportion of women reported their health as very good or good. Distribution of self-rated health is presented in Fig. 1, which shows that it was less common with very good health when the leisure time physical activity (LTPA) was low. In addition, the presented proportion of the pregnant women who reported their health as "very poor" or "poor" were very few (1.3%) (Table 1). Pregnant women who did not achieve the recommended level of LTPA had significantly higher weight and BMI and lower educational level, and more were of a non-Nordic origin and were smokers before pregnancy compared to pregnant women who achieved the recommended level of LTPA (≥150 activity minutes/week) (Table 2).

Maternal and fetal outcomes and their associations with leisure time physical activity

The recommended level for LTPA was found to be protective for having a BMI of ≥30 kg/m^2. However, there were no statistically significant associations between the two groups of PA levels and GDM or mode of delivery. Women who achieved the recommended level

Table 1
Characteristics of the study sample (N = 3868).

Variables[a]	Subjects MHCR-VB[b] and Salut-R
	2011–2012
	n (%)
Maternal age[c]	3868 (100.0)
Mean; SD	29.7; 4.9
Min–max	16–46
Maternal age[c]	
≤19	45 (1.2)
20–24	553 (14.3)
25–29	1304 (33.8)
30–34	1292 (33.5)
35–39	578 (15.0)
≥40	90 (2.3)
Parity	3862 (99.8)
Mean; SD	1.79; 0.85
Min–max	1–9
Parity	
1	1929 (44.0)
2	1599 (38.3)
3	548 (13.0)
≥4	205 (4.6)
Gest age	3814 (98.6)
Mean; SD	281.6; 6.7
Min–max	166–303
Gest age[d,e]	
Preterm	177 (4.7)
Term	3196 (85.5)
Post-term	369 (9.8)
Weight (kg)	3838 (99.2)
Mean; SD	68.2; 13.3
Min–max	39–156
Height (cm)	3856 (99.7)
Mean; SD	166.6; 6.2
Min–max	141–186
BMI (kg/m^2)[f]	3830 (99.7)
Mean; SD	24.5; 4.6
Min–max	15.1–51.0
BMI early pregnancy	
<18.5	87 (2.3)
18.5–24.99	2406 (62.8)
25–29.99	886 (23.1)
30–34.99	303 (7.9)
35–39.99	119 (3.1)
≥40	29 (0.8)
Educational level	3741 (96.7)
Elementary school	167 (4.5)
High school	1528 (40.8)
University	2046 (54.7)
Employment status	3841 (99.3)
Employed	2988 (77.8)
Student	400 (10.4)
Parental leave	184 (4.8)
Unemployed	174 (4.5)
Sickness leave	58 (1.5)
Other status	37 (1.0)
Country of origin	3868 (100.0)
Sweden	3447 (89.9)
Nordic countries[g]	28 (0.7)
All other countries	363 (9.4)
SRH[h]	3472 (89.8)
Very good	1206 (34.7)
Good	1933 (55.7)
Neither good/poor	288 (8.3)
Poor	37 (1.1)
Very poor	8 (0.2)
Smoking 3 months[i]	3868 (100.0)
No smoking	3593 (92,9)
Smoking	272 (7.0)
Smoking first visit	3868 (100.0)
No smoking	3793 (98.1)
Smoking	74 (1.9)

[a] For each specified variable, n and % are presented.
[b] Västerbotten county is in northern Sweden.
[c] Maternal age in years.
[d] Gestational age calculated using WHO guidelines.
[e] Pre-term = 22 + 0–36 + 6, Term = 37 + 0–41 + 6, post-term = 42 + 0–43 + 6 (weeks).
[f] Body mass index (BMI) (kg/m^2) early pregnancy.
[g] Norway, Denmark, Finland, and Iceland.
[h] Self-rated health (SRH).
[i] Smoking three months before pregnancy.

Table 2
Leisure time physical activity levels in relation to maternal background characteristics (N = 3868) and test of difference of specified categories.

Variables[a]	All	<150 PA min[b]	≥150 PA min[b]	p-value[c]
	n (%)	n (%)	n (%)	
Maternal age[d]	3762 (97.3)	1989	1773	
Mean; SD		30.0; 5.0	29.4; 4.8	<0.001
Min–max		19–44	16–46	
Maternal age[d]				
≤19		26 (1.3)	16 (0.9)	<0.001
20–24		256 (12.9)	280 (15.8)	
25–29		638 (32.1)	637 (35.9)	
30–34		689 (34.6)	570 (32.1)	
35–39		325 (16.3)	239 (13.5)	
≥40		55 (2.8)	31 (1.7)	
Parity	3762 (97.3)	1992	1770	0.005
Mean; SD		1.80; 0.81	1.79; 0.79	
Min–max		1–9	1–6	
Parity				
1		754 (37.9)	904 (51.1)	<0.001
2		860 (43.2)	592 (33.4)	
3		272 (13.7)	212 (12.0)	
≥4		106 (5.3)	62 (3.5)	
Gest age	3715 (96.0)	1962	1753	0.343
Mean; SD		281.4; 6.4	281.5; 6.5	
Min–max				
Gest age[e,f]				
Preterm		100 (5.1)	73 (4.2)	0.250
Term		1680 (85.6)	1499 (85.5)	
Post-term		182 (9.3)	181 (10.3)	
Weight (kg)	3739 (96.7)	1976	1763	
Mean; SD		71.1; 14.0	68.5; 14.0	0.034
Min–max		48–113	39–156	
Height (cm)	3756 (97.1)	1984	1772	
Mean; SD		165.1; 6.5	166.4; 6.3	0.007
Min–max		150–183	141–186	
BMI (kg/m²)[g]	3731 (96.5)	1969	1762	
Mean; SD		24.8; 4.8	24.3; 4.2	0.001
Min–max		18.4–42.0	15.1–50.9	
BMI early pregnancy[g]		1969	1762	
<18.5		54 (2.7)	31 (1.8)	<0.001
18.5–24.99		1180 (59.9)	1180 (67.0)	
25–29.99		476 (24.2)	377 (21.4)	
30–34.99		166 (8.4)	126 (7.2)	
35–39.99		76 (3.9)	37 (2.1)	
≥40		17 (0.9)	11 (0.6)	
Educational level	3653 (94.4)	1922	1731	
Elementary school		94 (4.9)	57 (3.3)	0.002
High school		809 (42.1)	669 (38.6)	
University		1019 (53.0)	1005 (58.1)	
Employment status	3742 (96.7)	1983	1759	
Employed		1546 (78.0)	1384 (78.7)	0.025
Student		187 (9.4)	202 (11.5)	
Parental leave		104 (5.2)	71 (4.0)	
Unemployed		101 (5.1)	65 (3.7)	
Sickness leave		25 (1.3)	26 (1.5)	
Other status		20 (1.0)	11 (0.6)	
Country of origin	3766 (97.4)	1995	1773	
Sweden		1784 (89.4)	1627 (91.8)	0.043
Nordic countries[h]		14 (0.7)	12 (0.7)	
Other countries		197 (9.9)	134 (7.6)	
SRH[i]	3390 (87.6)	1782	1608	
Very good		495 (27.8)	685 (42.6)	<0.001
Good		1070 (60.0)	818 (50.9)	
Neither good/poor		191 (10.7)	87 (5.4)	
Poor		23 (1.3)	13 (0.8)	
Very poor		3 (0.2)	5 (0.3)	
Smoking 3 months[j]	3768 (97.4)	1995	1773	0.017
No smoking		1841 (92.3)	1663 (93.8)	
Smoking		152 (6.6)	109 (2.9)	

[a] For each specified variable, n and % are presented.
[b] <150 physical activity minutes at leisure time (52.9%) and ≥150 physical activity minutes at leisure time (47.1%).
[c] Test of difference, t-test for continuous variables and chi-squared test for categorical variables.
[d] Maternal age in years.
[e] Gestational age calculated using WHO guidelines.
[f] Pre-term = 22 + 0–36 + 6, term = 37 + 0–41 + 6, post-term = 42 + 0–43 + 6 (weeks).
[g] Body mass index (BMI).
[h] Norway, Denmark, Finland, and Iceland.
[i] Self-rated health (SRH).
[j] Smoking three months before pregnancy.

of PA were half as likely to report poor or very poor self-rated health compared to the women who did not (Table 3). When adjusting for age, parity, body mass index, educational level, employment status, country of origin, self-rated health and smoking, the odds ratios were almost unchanged (Table 3). The probability of reaching the recommended level of PA during leisure time was related to the level of education, and these odds increased if the pregnant woman had reached a university level education compared to an educational level below university (OR = 1.44, 95% CI 1.22–2.03).

Discussion

Almost half of the pregnant women reported that they achieved the recommended level of LTPA in early pregnancy, and these participants were characterized by significantly lower weight and BMI, and higher educational level, and were more likely to be non-smokers compared to those who did not achieve the recommended levels of physical activity. However, our new findings – i.e., almost half of pregnant women achieved the recommended level of physical activity – are not consistent with earlier studies. Previous studies report corresponding figures ranging between 3 and 25% [22–25]. The differences in these results are most likely explained by the different ways (i.e., time points) these studies estimated physical activity during pregnancy. For example, two previous studies do not report any gestational week at all as the measure point for physical activity [22,23] and two studies report 10–24 weeks of gestation [24] and 17–22 and 27–30 weeks of gestation [25]. These differences clearly affect the prevalence due to the decreasing levels of physical activity during pregnancy. In our study, there was only one measure point, around 10 weeks of gestation, and the participants were asked to have the last 12 months in mind when responding to the question. Thus, in our study pre-pregnancy and early pregnancy physical activity was estimated. In addition, a prevalence of 38% was found in a Danish study investigating the prevalence of pregnant women in early pregnancy (i.e. 10 weeks of gestation) reaching the recommended levels of physical activity [26]. In a study investigating the prevalence of pre-pregnancy physical inactivity, 60.8% of the women achieved the recommended level of physical activity 3 months prior to pregnancy [27]. In addition, the guidelines used for recommended levels of physical activity differ and should be taken into account when comparing results. Women who report light or sedentary physical activity one year prior to pregnancy are more likely to be young, obese, smokers, or have a lower educational level, in relation to women reporting competitive physical activity or moderate/heavy physical activity [28].

These findings were confirmed by the present study. A study of well-being during pregnancy reports that higher educational level and physical activity increase well-being [29], and the present study confirms these associations that statistically significantly more pregnant women who reach the recommended level of LTPA reported their health as very good/good and had a higher educational level. Furthermore, studies indicate that physical activity before and during pregnancy increases well-being and decreases depression [9,30]. In the present study there were also statistically significantly more women with non-Nordic origin in the category with lower level of LTPA, and this can be considered as a public health concern. A prospective cohort study reports that women with low physical activity levels during pregnancy are more likely to have a caesarean section (CS) or an instrumental delivery compared to pregnant women with higher physical activity levels [31]. However, the study sample was fairly small and maternal BMI was not included in the regression model; only maternal age, parity, and LGA were included as confounders [31]. Furthermore, a previous meta-analysis of 16 different randomized control studies including a total of 3,359 pregnant women concluded that women who benefit from a structured

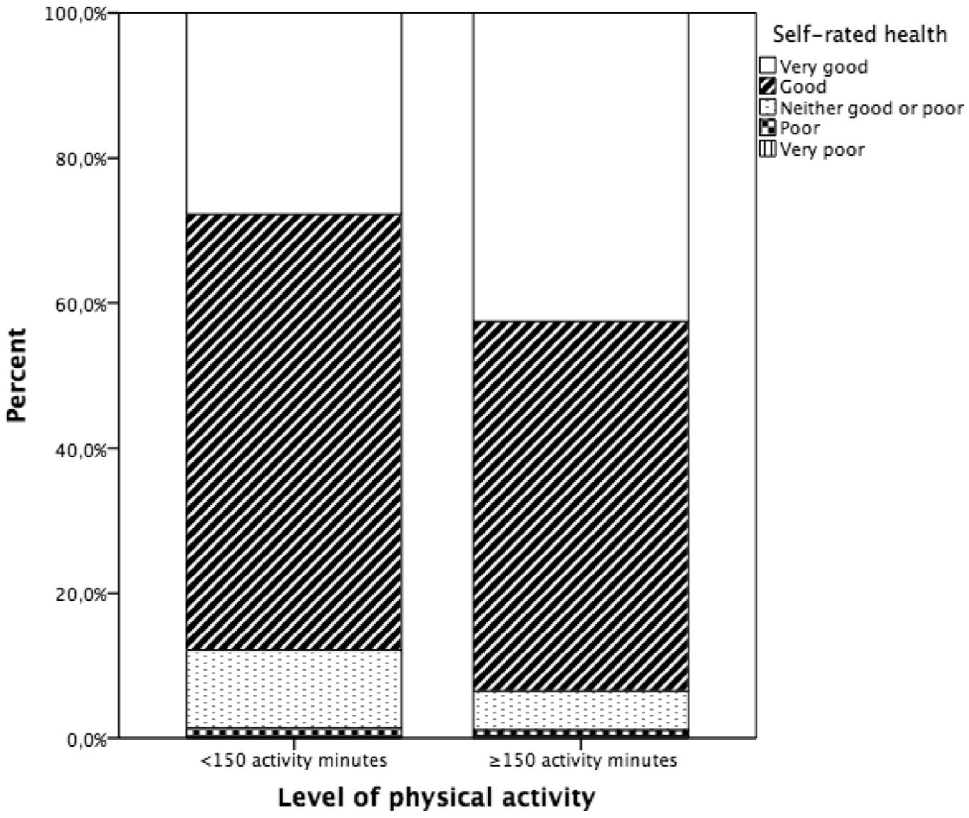

Fig. 1. Distribution of self-rated health in relation to two different levels of physical activity.

exercise programme during pregnancy have a significantly lower risk of CS in relation to those who do not participate in such a programme [32]. In contrast, we did not find a higher prevalence of CS or instrumental delivery among women who did not achieve the recommended LTPA.

A previous study shows no significant associations between pre-pregnancy and the first half of pregnancy physical activity level and low birth weight or GDM [33]. In a study of 79,692 single pregnancies that compared pregnancy outcomes in exercising and non-exercising pregnant women, no significant association was found

Table 3
Maternal and fetal outcomes in relation to specified physical activity level. Univariate and multivariate logistic regression, OR, and their 95% confidence intervals.

Dependent variables	All	<150 PA min[a]	≥150 PA min[a]	Crude OR (95% CI)	Adjusted[b] OR (95% CI)
	n (%)	n (%)	n (%)		
BMI early pregnancy[c]	3731 (96.5)				
<30		1710 (86.6)	1588 (90.1)	Ref.	Ref.
≥30		259 (13.2)	174 (9.9)	0.72 (0.59–0.88)	0.74 (0.61–0.91)
SRH[d]	3390 (87.6)				
Very good/good		1565 (87.8)	1503 (93.5)	Ref.	Ref.
Neither good/poor or poor/very poor		217 (12.2)	105 (6.5)	0.50 (0.40–0.64)	0.52 (0.48–0.71)
GDM[e]	3735 (96.9)				
Yes		23 (1.2)	13 (0.7)	0.63 (0.32–1.26)	
No		1956 (98.8)	1743 (99.3)	Ref.	
Mode of delivery	3767 (97.4)				
Vag. non instr.		1588 (79.6)	1418 (80.0)	Ref.	
Vag. instr.[f]/CS[g]		406 (20.4)	355 (20.0)	0.98 (0.84–1.15)	
Birth weight[h]	3757 (97.1)				
Mean; SD		3555.8; 534.9	3551.5; 518.3		
Min–max		803–5524	521–5340		

[a] < 150 physical activity minutes at leisure time (52.9%) and ≥150 physical activity minutes at leisure time (47.1%).
[b] Adjusted for age, parity, body mass index, educational level, employment status, country of origin, self-rated health and smoking.
[c] Body mass index (BMI) (kg/m^2).
[d] Self-rated health (SRH).
[e] Gestational diabetes mellitus (GDM).
[f] Vacuum extraction or forceps.
[g] Caesarean section (CS).
[h] Birth weight of the child.

regarding birth weight [34]. Our study is in line with this finding, as we found no significant associations with GDM or birth weight between women who did and women who did not reach the recommended levels of LTPA. A Cochrane review has concluded that the evidence is insufficient regarding the impact of physical activity on the risk of GDM [10]. Our study was primarily dimensioned for investigating the associations between specified maternal characteristics and pre-pregnancy and early pregnancy physical activity. Our study may have failed in demonstrating associations between different physical activity levels and GDM or birth weight due to insufficient sample size.

Methodological considerations

The strengths of this study are as follows: the variables included in the MHCR have recently been investigated and demonstrate good internal validity [17]. The data in the study sample probably represent the population of pregnant women in Sweden, as the coverage in the MHCR is high (81% and 85% for 2011 and 2012, respectively). The Medical Birth Register (MBR), which is a health register characterized by mandatory participation, covers almost all births in Sweden [35] and maternal background characteristics in MHCR such as maternal age and BMI are consistent with data in the MBR. Another strength of our study, related to representativeness of the study sample, was the fact that we could compare key maternal background characteristics with the sub-sample of MHCR-VB (i.e., the source population). The statistically significant differences between MHCR-VB and the study sample (Table 1) regarding parity, maternal height, BMI, educational level, employment status, and country of origin were small, so they were considered to have exerted no major influence.

The variable used for estimating physical activity during pregnancy was self-reported and retrieved from the Salut-R. We cannot disregard that an underestimation or an overestimation of "physical activity during leisure time" may bias the results in our study. This limitation has to be considered when interpreting our results. However, the question was based on a similar questionnaire that previously had been validated [36]. The study concludes that the questions should be close-ended and preferably categorical or at least in the form of a table with close-ended alternatives [36]. The variable has been recommended by the Swedish National Board of Health and Welfare to be used in questionnaires estimating self-reported physical activity level [36]. In addition, the variables in the MHCR-VB are mostly collected from medical records, which could be seen as a strength. A limitation of our study is that it does not include information about dietary habits. Several studies investigating physical activity during pregnancy consider this variable important when interpreting the results of pregnancy outcomes. Furthermore, the protective effect of physical activity may differ regarding the physical status of each pregnant woman, the trimester when physical activity occurs, and the intake of calories [5].

The present study included information on pre-pregnancy and early pregnancy physical activity. Thus, there was no later measure point in pregnancy, and that may be considered a limitation. It is well known that pregnant women usually lower their physical activity when they become pregnant [11]. Furthermore, there is an association between the level of physical activity before pregnancy and early pregnancy, and there is a decrease in physical activity later and throughout the pregnancy. Based on this, the results of the present study are probably to be considered representative.

Furthermore, a careful validation of the different instruments used for measuring physical activity in pregnancy should be considered. Considerable difficulties arise when interpreting the results of different studies regarding the measurement of physical activity during pregnancy due to the major variety of measure points, scales, and instruments. A review of self-reported physical activity as a measurement concludes that the target should be to collect data not only on the level of physical activity (amount of time engaged in sustained activity) but also on intensity, duration, and frequency of physical activity [37].

Ethical considerations

All quality national registers in Sweden, including MHCR and Salut-R, comply with the rules and procedures stated by The NBHW in Sweden. Collection and management of patient data in health systems and health registers are regulated through the Swedish Patient Data Law. The participation in MHCR is voluntary, and midwives in antenatal care are obliged to inform pregnant women of the aims and consequences of participation in the MHCR. The eligible participants were provided oral and written information about the register, and information was provided through advertisement at the local antenatal clinic. Furthermore, eligible participants in the MHCR were informed that all data are aggregated, so no individual woman can be identified. The Salut-R has ethical clearance for their data collection (Dno 2010-63-31). Information provided to the pregnant woman included the purpose of the visit, the aim of the Salut-R, and that participation in the register was voluntary.

Conclusions

Almost half of pregnant women achieved the recommended physical activity level, and these pregnant women were characterized by normal weight or overweight, very good or good self-rated health, and a higher educational level. No significant associations could be established between physical activity levels and GDM, birth weight, or mode of delivery. There were significantly more pregnant women with immigrant background in the category with lower physical activity.

Implications for practice and future research

Being overweight or obese during pregnancy are strongly associated with adverse pregnancy outcomes. Physical activity is significantly associated with a BMI <30 kg/m^2 and should be seen as beneficial due to the decreased risk of adverse pregnancy outcomes. Health care professionals have an opportunity to promote physical activity when counselling fertile and pregnant women. This counselling may help improve the health in this population, leading to good or very good self-rated health among these women. In addition, there is a need for efforts to promote physical activity to strengthen health among pregnant women with immigrant background. In addition, future randomized studies should investigate the impact of different physical activity levels on GDM.

Conflict of interest

The authors declare that they have no competing interests.

Authors' contributions

AI is principal investigator of the Salut Programme and its register (Salut-R) with author EE as close collaborator. Third author, ML, is responsible for data handling within both registers. Authors IM, ML, ML , EE, AI, and MP designed the study. First author ML performed the statistical analyses with assistance from IM and the third author ML and drafted the manuscript in collaboration with IM. EE, MP, AI, and the third author ML contributed to the manuscript during the work process. All authors have read and approved the final manuscript.

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