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What is the effect of physical activity on duration and mode of delivery? Secondary analysis from the Norwegian Fit for Delivery trial

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Conflict of interest notification

All authors declare that no conflict of interest exists.

Abstract

Introduction.

Beneficial effects of physical activity (PA) during pregnancy for the mother and offspring have been reported by several studies, but there are conflicting results concerning possible effect of PA on course of labor and risk of caesarean delivery. This study presents secondary analyses from the Norwegian Fit for Delivery randomized controlled trial, aiming at studying the effect of a lifestyle-intervention including group-exercise classes, as well as possible influence of PA-level in late pregnancy, on labour outcomes.

Material and Methods.

Healthy nulliparous women with singleton pregnancy were randomized to an intervention group, n=303 (dietary counseling and twice-weekly exercise-classes) or a control group, n=303 (standard care). The participants were analysed both by randomization, and as a cohort comparing women with lowest (quartile 1, 0 MET-hours moderate-to-vigorous PA/week) (n=140) vs. highest (quartile 4, ≥16 MET-hours moderate-to-vigorous PA/week) (n=131) PA-level in late pregnancy, assessed with IPAQ-questionnaire.

Results.

The intervention group had longer first stage of labor compared to the control group (293±202 vs. 257±181 minutes, p=0.030). No differences between the randomization-groups were seen for time spent in second stage of labor, prolonged labor or mode of delivery. In the total sample, women with the highest PA-level had lower odds of acute cesarean delivery (OR 0.33, CI;0.11-0.97, p=0.044), compared to those with the lowest PA-level.

Conclusion.

A significantly longer first stage of labor was observed in the intervention group compared to the control group. High PA-level in late pregnancy was associated with lower odds of acute cesarean delivery, compared to the low PA-level.

Key words (3-8) RCT, exercise, pregnancy, caesarean section, delivery outcomes, labor

Abbreviations

BMI body mass index

MET metabolic equivalent of task

MVPA moderate-to-vigorous physical activity

IPAQ International Physical Activity Questionnaire

PA physical activity

Key message

A combined lifestyle intervention in pregnancy resulted in a slightly longer first stage of labor. High physical activity level in late pregnancy was associated with reduced risk of acute caesarean section.

Introduction

Physical activity level tends to decline as the pregnancy progresses (1, 2). Beneficial effects of physical activity during pregnancy for both the mother and her baby have been reported in several studies (3, 4). Women with uncomplicated pregnancies are recommended to exercise at moderate intensity for a minimum of 150 minutes/week, with few restrictions, as this level of physical activity is considered without harm to the mother or the fetus (3). However, conflicting results concerning possible associations between physical activity level and duration of labor have previously been reported, both by exercise-intervention studies (4-6), by observational studies of recreational exercisers (7), and by observational studies of the general population (2, 8). Exercise during pregnancy may also play a role for mode of delivery, but the literature is inconsistent and presents no consensus as to whether physical activity influence cesarean delivery rate (2, 9-12). A recently published meta-analysis with individual participant data from 36 randomized controlled trials, including the Norwegian Fit for Delivery (NFFD) trial demonstrated, however, that physical activity and diet interventions during pregnancy lower the odds of cesarean delivery (13).

The NFFD trial was designed to evaluate whether an antenatal lifestyle intervention combining physical activity and dietary elements resulted in measurable health benefits for both mother and her baby (14). The trial demonstrated a significantly higher physical activity level in late pregnancy among the intervention group participants compared to the control group participants (15). No difference between groups of randomization was found for operative delivery or postpartum hemorrhage ≥500 ml, birth weight or length of gestation (16).

In this secondary analysis, we aimed to investigate the effect of the NFFD intervention on course of labor (induction of labor, use of analgesia, duration of labor), mode of delivery (vaginal vs. cesarean), postpartum hemorrhage >1000 ml, placental weight, and birth

outcomes (Apgar score, admission into neonatal intensive care unit (NICU) >48 hours). In addition, we also aimed to analyse the participants as a cohort and compare the same outcomes in participants with the lowest vs. the highest physical activity level in late pregnancy.

Material and methods

The NFFD trial was a population-based prenatal combined lifestyle intervention consisting of dietary counseling and supervised exercise-classes, evaluated in a randomized controlled trial. Normal-weight, overweight and obese participants were recruited by midwifes from eight healthcare clinics in the southern part of Norway, encompassing both cities and rural areas, between September 2009 and February 2013. Eligible participants were healthy nulliparous women, ≥18 years old, literate in Norwegian or English, with singleton pregnancy ≤20 weeks of gestation and a pre-pregnancy body mass index (BMI) ≥19 kg/m^2.

Exclusion criteria were pre-existing diabetes, disabilities precluding participation in an exercise program, continued substance abuse or planned relocation outside of the study area before delivery. All participants planned to give birth at Sørlandet Hospital HF, which is a conglomeration of three hospitals located in the cities Kristiansand, Arendal and Flekkefjord. Most women delivered at Sørlandet Hospital HF Kristiansand, which is the regional maternity unit in southern Norway, delivering approximately 2000 babies a year. Approximately 1610 nulliparous women attended the participating healthcare clinics during the inclusion period and were thus potentially eligible for inclusion. After providing informed consent and completing initial blood tests and questionnaires, a total of 606 (37.6%) women were included in the study. Of these, 589 were included in the analysis, divided into the intervention group (n=295) and the control group (n=294). A Consort flow chart of the study population is presented in Figure 1. The study protocol has been previously published (14). The primary outcomes of the NFFD trial were gestational weight gain, weight retention postpartum, maternal hyperglycemia and the incidence of large for gestational age newborns (15-17); of these, intervention effect was only demonstrated for gestational weight gain (reduced by 1.3 kg, from pre-pregnancy weight to term) (16).

The Norwegian Regional Committee for Medical Research Ethics South-East-C approved the trial and modifications (REK reference 2009/429) and the trial was registered at

ClinicalTrials.gov (NCT01001689).

Intervention

From time of randomization (mean gestational week 17.6±2.6) until delivery (mean gestational week 39.9±1.8), the intervention group had access to a twice-weekly standardized exercise program. Classes were provided for groups at five different fitness centres, led by qualified instructors and consisted of ten minutes of warm up, 40 minutes of cardiovascular- and strength exercises at moderate intensity, with emphasis on core- and pelvic floor musculature, and finally ten minutes of stretching. Exercise intensity was measured by ratings of perceived exertion set to 12–14 (somewhat hard) on the 6–20 Borg´s rating scale (18). Additionally, the participants were encouraged to undertake at least 30 minutes of cardio exercises at moderate intensity at least three times a week, in accordance with current physical activity recommendations (19). The instructors recorded adherence to exercise classes, but no log was kept of self-imposed daily activity. The dietary component of the intervention consisted of ten dietary recommendations designed by the NFFD team (14). Women in the control group received standard prenatal care provided through alternating visits with midwives and doctors.

Physical activity assessment

The self-reported International Physical Activity Questionnaire Short-Form (IPAQ-SF) (20) was used to assess physical activity level. IPAQ-SF quantifies frequency and duration of vigorous intensity physical activity (VPA), moderate intensity physical activity (MPA), walking and sitting during the last seven days. Participants in both the intervention and the control group answered IPAQ-SF either electronically (>90%, in Norwegian) or in print (in English or Norwegian), at inclusion (mean gestational week 16.1±2.5) and at gestational week 36. Responses were scored according to established methods (www.ipaq.ki.se). For MPA and VPA, the reported frequency (days/week) was multiplied by reported average duration (minutes/day) and by the corresponding IPAQ algorithm (4.0 for MPA and 8.0 for VPA) to calculate the corresponding metabolic equivalent of task (MET) in hours/week. In the IPAQ-SF, no report of intensity is given with respect to walking (www.ipaq.ki.se). Hence, we decided not to include walking as a part of MPA and VPA levels in this study. One MET is equivalent to the energy expenditure at rest (1 MET=3.5 ml O_2 $kg^{-1} \cdot min^{-1}$). The intensity category moderate-to-vigorous physical activity (MVPA) was calculated by adding MPA and VPA.

Measurements

Labor and delivery data were recorded in partographs by midwifes assisting during birth who were blinded to randomization. A research assistant not involved in the study and blinded to randomization, recorded labor outcomes after delivery from electronic hospital records. The active first stage of labor was defined as the time from regular contractions and cervix effaced and dilated four cm to complete dilation (10 cm) (21). The second stage of labor was defined as time from fully dilated cervix to delivery, and the active second stage was defined as the time of active pushing (21). Active labor was defined as active first and second stage of labor together (21). Prolonged labor was used to describe "abnormal labor" and was defined as active labor exceeding 12 hours (21). Prolonged active second stage was defined as active pushing over 60 minutes (22). Cesarean delivery was defined as acute or pre-labor. Instrumental vaginal deliveries included both vacuum and forceps deliveries. Vaginal delivery was defined as spontaneous vaginal and instrumental vaginal deliveries together. Episiotomies were performed by lateral technique (23). Perineal tears affecting the external and internal sphincter are referred to as obstetric anal sphincter injuries. The attending midwife or obstetrician estimated blood loss, and postpartum hemorrhage ≥1000 ml was registered. Pre-pregnancy BMI was calculated from self-reported pre-pregnancy weight and height. Gestational length at birth was calculated based on mid-trimester ultrasound scan (eSnurra). Sociodemographic data were obtained from a questionnaire answered at inclusion and citizenship was obtained from hospital records.

Statistical analyses

Analyses followed the intention-to-treat principle. When analysing the sample as a cohort, participants reporting the lowest and the highest MVPA-level at gestational week 36 were included; giving the low active group, n=140 (quartile 1, with 0 MET-hours of MVPA/week) versus the high active group, n=131 (quartile 4, with ≥16 MET-hours of MVPA/week).

Descriptive statistics are presented as mean with standard deviation (SD), median with IQR or proportions with n (%), as appropriate. For group comparisons, categorical variables were analysed using Pearson´s chi-squared test, and continuous variables were analysed using the independent sample t-test or the Mann-Whitney U test. For comparisons of proportions between groups, MedCalc for Windows, version 12.7.7.0 (MedCalc Software, Ostend, Belgium) was used.

Multivariable analyses were performed for duration of labor and delivery outcomes, for both randomization analyses and cohort analyses. Analyses in the final model included all variables with a *p*-value <0.20 in the bivariate analyses. The Hosmer´s step down procedure (24) was performed and repeated until all factors were significant at a level $p<0.05$. Linear regression analyses were performed investigating duration of labor given as β with 95% confidence interval (CI). Logistic regression analyses were performed for delivery outcomes reporting odds ratio (OR), adjusted OR and 95% CI. Randomization or physical activity category (depending on which analyses were performed), and age were always retained in the regression analyses. For both linear regression and logistic regression analyses, the following explanatory variables were included: maternal age, pre-pregnancy BMI, education </≥ 4 years of college/university, income </≥ 400,000 NOK/year, smoking (no/yes), induction of labor (no/yes), epidural analgesia (no/yes), gestational age at birth and birth weight. The statistical analyses were performed using SPSS for IBM statistical software package version 23.0 (IBM Corporation, Armonk, NY, USA). Level of significance was set to $p \leq 0.05$.

Results

Baseline characteristics were similar both when comparing groups based on randomization and groups based on physical activity level, except for a higher proportion of overweight/obese women in the low active group (35.0%) compared to the high active group (22.9%) ($p=0.029$) (Table 1).

Analyses based on randomization groups

At gestational week 36, the intervention group reported a median of 8 (2,19) MET-hours of MVPA/week, while the control group reported a median of 4 (0,12) MET-hours of MVPA/week ($p<0.001$).

First stage of labor was longer in the intervention group (293±202 minutes) compared to the control group (257±181 minutes) ($p=0.030$), resulting in longer mean duration of active labor in total (323±167 vs. 278±164 minutes, respectively ($p=0.027$) (Table 2). Time spent in second stage or active second stage of labor did not differ between the intervention and the control group, neither did prolonged labor (>12 hours) or prolonged active second stage of labor (>60 minutes) (Table 2). Differences in duration of labor remained unchanged when

women with cesarean delivery were excluded from the analyses. The strongest contributors to duration of labor were use of epidural (β=0.29, CI;93.76-166.72, p<0.001), birthweight (β=0.15, CI;0.26-0.09, p<0.001) and induction of labor (β=0.17, CI;41.07-116.21, p<0.001), explaining 14% of the variation. There were no significant differences in other obstetrical or birth outcomes comparing the intervention group and the control group (Table 2, Table 3).

Analyses based on physical activity level groups

Among the high active group participants, median MVPA level was 22 MET-hours/week at gestational week 36 (min-max values: 16 - 88 MET-hours/week), and of these, 71.8% reported VPA (min-max values: 1.3 - 40 MET-hours/week).

In the low active group, 65.0% of the participants originally belonged to the control group and 35.0% to the intervention group, while the corresponding numbers for the high active group were 33.6% to the control group and 66.4% to the intervention group.

There were no differences in duration of labor between low vs. high active group (p=0.076) in the unadjusted analyses (Table 2). In the adjusted analyses, total duration of labor was 58 minutes longer in the high active group compared to the low active group (β=0.16, CI;13.62-103.31, p=0.011). The strongest contributors to duration of labor were use of epidural (β=0.32, CI;88.84-194.84, p<0.001), birthweight (β=0.16, CI;0.15-0.102, p=0.008) and induction of labor (β=0.16, CI;19.37-128.33, p=0.008), explaining 14% of the variation. When the stages of labor were examined individually (first stage, second stage, active second stage) there were no significant differences in duration between low and high active groups in the adjusted analyses. The low active group was more likely to use epidural analgesia during labor than the high active group (OR 1.88, CI;1.04-3.41, p=0.036). In adjusted analyses, being in the high active group was associated with higher odds of a vaginal delivery (OR 2.69, CI;1.02-7.09, p=0.046), as well as lower odds of an acute cesarean delivery (OR 0.33, CI;0.11-0.97, p=0.044) compared to women in the low active group (Table 4, Figure 2). Failure to progress in labor was the most common reported indication for acute cesarean delivery, accounting for 70.6% of the cases in the low active group and 50.0% in the high active group (p=0.001). Total cesarean delivery rate was 15.0% in the low active group compared to 6.9% in the high active group (p=0.033). Pre-labor cesarean delivery was similar between the low and high active groups; 2.9% vs. 2.3% respectively (p=0.77). Other

obstetrical and birth outcomes were, overall, similar between women in the low versus the high active group (Table 2, Table 4).

Discussion

The main findings of the present study were that the intervention group participants experienced a longer first stage of labor. No group differences were observed with regard to second stage of labor, prolonged labor, or birth outcomes. Analysing the total group as a cohort, women with high MVPA level in late pregnancy had lower odds for acute cesarean delivery compared to women with low MVPA levels. Epidural analgesia was more common among women in the low active group compared to women in the high active group.

Nulliparous women are at greater risk of experiencing both longer labor and eventually prolonged labor compared to multiparous women (25). Furthermore, prolonged labor is in turn associated with higher risk of operative vaginal and cesarean delivery (22), obstetric anal sphincter injury (22) and postpartum hemorrhage (22). In the present study, rates of prolonged labor were similar between randomization groups, which is in line with another exercise-intervention study from Norway including 855 participants (5). However, the intervention group, in the present study, experienced 44 minutes longer total duration of labor than the control group, mainly due to 36 minutes longer first stage of labor. Mean active labor in nulliparous women has been reported to be six hours (26). As both randomization groups in the present study experienced a total duration of active labor less than six hours (5.4 hours and 4.6 hours), the small difference found in duration is most likely of little clinical importance. Our data provides no explanation for the difference in duration of labor observed between randomization groups. However, adjusted analyses of the physical activity cohort analyses showed a significantly longer total duration of labor in the high active group compared to the low active group suggesting that physical activity level may play a role. Studies involving supervised exercise interventions reporting on duration of labor are few, with inconsistent results; from a shorter first stage of labor of 2.1 hours (4) to a longer active second stage of six and 19 minutes in the intervention groups (5, 9) compared to their corresponding control groups, to no difference at all in duration of labor between groups of randomization (6). However, several of the trials reported findings for both nulliparous and multiparous women, and the trials used different definitions of duration of labour, or failed to provide a definition, making comparison of outcomes such as duration of labor deceptive.

Further, comparison of studies is challenged by different exercise-intervention designs, varying designs for the control groups, as well as different trimesters for start-up of interventions (4-6, 9). In line with previous trials, we found no differences between the randomization groups regarding number of inductions (27) or use of epidural (5), factors that might influence duration of labor (28).

In the present study we found no difference in cesarean delivery rate between groups of randomization. This finding is supported by previous trials involving an exercise program (5, 29). However, two meta-analysis concluded that structured aerobic and resistance exercise during pregnancy (16 studies, n=3037) (10) and exercise of low-to-moderate intensity during the second and third trimesters (5 studies, no data of n) (11) decrease the risk of cesarean delivery among healthy pregnant women. The NFFD trial was not powered to adequately assess mode of delivery, but a recently published meta-analysis including 36 combined lifestyle interventions (n=12,526), there among the NFFD trial (13), reported lower odds of cesarean delivery in the intervention group participants compared to standard care controls (OR=0.91). Another possible explanation for the lack of effect of the NFFD intervention on mode of delivery might be that the exercise workload was inadequate, with only two exercise sessions per week and focus on strength- and low impact exercises, including pelvic floor muscle training. In addition, the intervention started late in the first half of pregnancy, perhaps too late to influence obstetrical outcomes.

When analysing the sample as a cohort based on physical activity level in late pregnancy, we found that women in the high active group had lower odds of an acute cesarean delivery compared to the low active group. Given that vaginal delivery for the firstborn is of significant importance not only on the individual level, but also for subsequent maternal and neonatal risks (30), these findings might be of clinical importance. The high active group in the cohort analyses reported a median physical activity level ≥four hours of MVPA/week, while the intervention group reported a median physical activity level of two hours of MVPA/week at gestational week 36. Correspondingly, the low active group reported no MVPA/week, while the control group reported one hour of MVPA/week at gestational week 36. This difference in MVPA-level might partly explain why an association between physical activity level and acute caesarean delivery rate was found in the cohort analyses, but no effect on mode of delivery was found when randomization groups were compared. Comparable to our findings in the cohort analyses, a recently published large Norwegian cohort study

(n=30,364) showed that exercising frequently and performing high-impact exercises at gestational week 30 were associated with reduced risk of acute caesarean delivery, compared to not exercising (12). Improved maternal cardiovascular function, greater physical strength and endurance to sustain the effort required during childbirth might partly explain why highly active women experience a lower acute cesarean delivery rate than their less physically active counterparts (11), and hence longer total duration of labor as seen in the adjusted analyses. Walking is a common mode of exercise in pregnancy (31, 32). However, in the present study MVPA level is reported without time spent walking as IPAQ-SF excludes walking from the moderate intensity category and gives no information on the intensity of walking (www.ipaq.ki.se). At gestational week 36, the intervention group reported more time spent walking than the control group (8 (3,15) vs. 7 (2,15) MET-hours/week, p=0.04) (33), as did the high active group compared to the low active group (12 (4,23) vs. 5 (0.1,11) MET-hours/week, p<0.001) (data not shown). It is likely that participants performed part of the time spent walking at moderate intensity. Hence, the differences in MVPA level between the groups might have been even larger if walking had been included. This in turn might have resulted in stronger effects or associations between physical activity level and various outcomes than observed in our analysis.

Total duration of labor was significantly longer in the high active group compared to the low active group in the adjusted analyses. However, no difference in duration of first and second stage of labor was found between the two physical activity groups in the cohort analyses. This is in contrast to an observational study comprising 40 nulliparous women reporting that an increase in aerobic fitness was associated with a decrease in total duration of labor (8). However, the two studies may not be directly comparable, as the other study investigated physical fitness instead of physical activity level, and in addition defined start of labor at three cm cervical dilatation, not four cm as we used in our study. A longer total duration of labor in the high active group corresponds well with our finding that the high active group (93%) was more likely to deliver vaginally than the low active group (85%), which in turn might reflect the greater physical ability women in the high active group possessed to sustain the course of labor, compared to women in the low active group. Although a significant larger proportion of women were overweight/obese in the low active group (35%) compared to the high active group (23%) in our study, it did not seem to influence duration of labor, in contrast to findings in a Swedish observational study (n=63,829), where obesity was associated with a longer first stage and a shorter second stage of labor (34).

Strengths and limitations

The main strength of the study is the prospective randomized controlled trial design. In addition, the NFFD trial is among the largest trials published involving a supervised exercise program as part of a combined lifestyle intervention. Another strength is recruitment of participants through antenatal visits at their healthcare clinics, rather than a potentially more selected population recruited through advertisement. Further, we used definitions of start and duration of labor in accordance with the World Health Organization´s recommendations (21). Finally, we explored possible differences in delivery outcome between women with the highest physical activity level vs. the lowest physical activity level in late pregnancy, which can contribute to elucidate possible positive and negative association between physical activity level and labor outcomes.

The first limitation of our study is that physical activity level is self-reported. We have previously demonstrated that physically active pregnant women tend to under-report, while physically inactive pregnant women tend to over-report physical activity level (20). A second limitation is the fact that the NFFD trial was not powered for the outcomes analysed in the present study. Third, our study lacks data on augmentation of labor, which may influence duration of labor and cesarean delivery rate.

Conclusion

The NFFD lifestyle intervention, including twice-weekly supervised exercise classes, demonstrated a slightly longer first stage of labor in the intervention group compared to the control group. High physical activity level in late pregnancy was associated with lower odds of an acute cesarean delivery, compared to low physical activity level. The results of the present study confirm that exercise in late pregnancy does not seem to influence obstetrical outcome negatively.

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Table 1. Baseline characteristics of participants divided by randomization and divided by low versus high physical activity level.

	Randomization groups			**Cohort analyses**		
	Intervention group (n = 295)	**Control group (n = 294)**		**Low active (n = 140)**	**High active (n = 131)**	
Variable	**Mean (SD) / Median (IQR)**					
			***p*-value**			***p*-value**
Age at inclusion (years)	27.9 (4.2)		0.50	27.9 (4.3)	28.2 (4.2)	0.49
Gestational week at inclusion	16.1 (2.5)	16.1 (2.4)	0.75	16.1 (2.5)	15.9 (2.5)	0.45
Pre-pregnancy weight (kg)	65 (59 – 74)	64 (59 – 73)	0.53	64 (59 - 78)	64 (58 - 70)	0.16
Pre-pregnancy BMI (kg/m^2)	22.7 (21.0 – 25.7)	22.7 (20.9 – 25.0)	0.42	23.0 (20.9 - 26.6)	22.5 (21.0 - 24.5)	0.24
			n (%)			
Overweight/obese (BMI ≥25 kg/m^2)	92 (31.2)	74 (25.2)	0.11	49 (35.0)	30 (22.9)	**0.029**
Obese (BMI ≥30 kg/m^2)	23 (7.8)	20 (6.8)	0.64	12 (8.6)	11 (8.4)	0.95
Educational level < 4 years college/university ≥4 years college/university	104 (35.4) 96 (32.5)	88 (29.9) 113 (38.4)	0.19	42 (30.2) 45 (32.4)	45 (34.4) 49 (37.4)	0.16
Occupation Employed outside home Long-term sick leave	240 (81.4) 6 (2.0)	256 (87.1) 5 (1.7)	0.06	115 (82.1) 3 (2.1)	112 (85.5) 2 (1.5)	0.93
Household income (NOK) ≤ 400,000 401,000 – 700,00 > 700,000 Don´t want to answer	95 (32.2) 82 (27.8) 101 (34.2) 17 (5.8)	88 (30.1) 81 (27.7) 101 (34.6) 22 (7.5)	0.98	43 (31.2) 45 (32.6) 39 (28.3) 11 (8.0)	40 (30.5) 36 (27.5) 50 (38.2) 5 (3.8)	0.48
Daily smokers	8 (2.8)	15 (5.0)	0.40	7 (5.0)	8 (6.1)	0.57

Citizenship			0.19		0.40
Norwegian	262	252		126	121
European	14	21		11	10
Non-European	4	5		2	0
Missing	15	16		1	0

SD standard deviation
IQR interquartile range
Kg kilo grams
M meters
BMI body mass index
NOK Norwegian kroners

Table 2. Obstetrical and neonatal outcomes for the intervention group, control group, low active group and high active group

	Randomization groups					**Cohort analyses**				
	Intervention group, n=295		**Control group, n=294**			**Low active n=140**		**High active n=131**		
Outcome	**n**	**%**	**n**	**%**	***p*-value**	**n**	**%**	**n**	**%**	***p*-value**
Gestational age, days[ab]	279 (12.4)		279 (13.9)		0.89	282.3 (9.3)		281.6 (8.5)		0.53
Gestational age ≤37 weeks	17 (5.8)		17 (5.8)		0.83	1 (0.7)		1 (0.8)		0.98
Duration of active labor, minutes[a]	322.7 (166.8)		278.3 (164.4)		**0.027**	291.4 (151.6)		328.5 (172.6)		0.076
Duration of 1st stage of labor, minutes[a]	293.4 (201.8)		257.1 (181.4)		**0.030**	257.8 (184.2)		269.6 (166.8)		0.60
Duration of 2nd stage of labor, minutes[a]	69.5 (43.4)		66.0 (41.9)		0.49	68.8 (42.6)		72.4 (43.1)		0.62
Duration active 2nd stage of labor[a]	40.3 (25.0)		41.5 (24.9)		0.58	39.9 (21.3)		42.3 (25.1)		0.42
Epidural analgesia	56/280	20.0	76/287	26.5	0.068	38/137	27.7	22/130	16.9	**0.034**
Fentanyl analgesia	169/276	61.2	168/282	59.6	0.69	86/137	62.8	84/127	66.1	0.57
Induced labor delivered by caesarean	11/62	17.4	8/61	13.1	0.48	6/38	15.8	1/27	3.7	0.12
Episiotomy	104/271	38.4	90/273	33.0	0.19	51/131	38.9	58/125	46.4	0.23
OASI	9/266	3.4	9/267	3.4	0.99	4/128	3.1	4/124	3.2	0.96
Baby weight[a]	3410.6 (486.2)		3449.7 (539.3)		0.36	3528.6 (417.1)		3450.5 (429.7)		0.13

Baby length[a]	50.0 (2.1)		49.9 (2.7)		0.88	50.4 (1.9)/137		50.2 (1.7)/127		0.22
Apgar 1[a]	8.8 (1.1)		8.7 (1.3)		0.35	8.7 (1.3)		8.8 (1.1)		0.82
Apgar 5[a]	9.6 (0.7)		9.4 (1.1)		0.079	9.5 (1.1)		9.5 (0.7)		0.64
Apgar 10[a]	9.8 (0.5)		9.7 (0.9)		0.30	9.7 (1.0)		9.8 (0.5)		0.57
5-minute Apgar below 7	1 (0.3)		6 (2.0)		0.057	3 (2.1)		1 (0.8)		0.35
NICU ≥ 48 h	23 (7.8)		27 (9.2)		0.55	6 (4.3)		6 (4.6)		0.91
Placental weight, gram[a]	656.4 (140.8)		667.0 (138.6)		0.36	669.6 (129.7)		656.3 (146.9)		0.23
Preeclampsia (serious preeclampsia/HEELP)[c]	15 (7)/289	5.2	10 (8)/292	3.4	0.50 (0.44)	6 (3)/140	4.3	3 (1)/131	2.3	0.60 (0.35)

[a]Mean ±SD
[b]Gestational age data missing from 26 in the intervention group and 28 in the control group
[c]Preeclampsia data missing from 6 in the intervention group and 2 in the control group
HEELP; HEELP syndrome; haemolysis, elevated liver enzymes, low platelets
OASI; Obstetric anal sphincter injury
NICU: newborn intensive care unit

Table 3. Odds ratio for delivery outcomes among intervention group and control group participants

Outcome	**Intervention group, n=295**	**Control group, n=294**	**Unadjusted OR**	**95% CI**	***p*-value**
	n (%)	**n (%)**			
Induction of labor	62 (21.3)	61 (21.2)	0.97	0.65-1.44	0.87 ¶
Prolonged active labor > 12 hours	10 (3.4)	5 (1.7)	2.02	0.68-6.01	0.20 ¶
Prolonged active second stage > 60 minutes	55 (21.7)	57 (22.4)	0.95	0.63-1.45	0.81 ¶
Vaginal delivery (normal + instrumental)	257 (87.1)	258 (87.8)	0.94	0.58-1.54	0.82 ¶
Instrumental vaginal delivery	47 (15.9)	46 (15.6)	1.02	0.66-1.59	0.92 ¶
Cesarean delivery, pre labor	8 (2.7)	7 (2.4)	1.14	0.41-3.19	0.80 ¶
Cesarean delivery, acute	30 (10.2)	29 (9.9)	1.03	0.60-1.77	0.90 ¶
Postpartum haemorrhage ≥1000 mL	15 (5.1)	16 (5.4)	0.93	0.45-1.93	0.85 ¶

OR; odds ratio
CI; confidence interval
OAS; obstetric anal injury
NICU; neonatal intensive care unit
¶: Results remained unchanged in adjusted analyses

Table 4. Odds ratio for delivery outcomes among participants in low and high active group

Outcome	Low active (n=140)	High active (n=131)	Unadjusted OR*	95% CI	p-value	Adjusted OR	95% CI	p-value
	n (%)	n (%)						
Induction of labor	38 (27.3)	27 (20.6)	1.45	0.82-2.55	0.20			¶
Prolonged active labor > 12 hours	1 (0.7)	4 (3.1)	4.00	0.44-36.32	0.22			¶
Prolonged active 2nd stage > 60 minutes	23 (19.3)	35 (28.7)	1.68	0.92-3.06	0.091			¶
Vaginal delivery (normal + instrumental)	119 (85.0)	122 (93.1)	2.39	1.05-5.44	0.037	2.69$^{\Omega}$	1.02-7.09	0.046
Instrumental vaginal delivery (ventouse + forceps)	22 (15.7)	32 (24.4)	1.73	0.95-3.18	0.075			¶
Cesarean delivery, pre labor	4 (2.9)	3 (2.3)	0.80	0.18-3.63	0.77			σ
Cesarean delivery, acute	17 (12.1)	6 (4.6)	0.35	0.13-0.91	0.031	0.33$^{\alpha}$	0.11-0.97	0.044
Postpartum haemorrhage ≥1000 mL	10 (7.1)	6 (4.6)	0.62	0.22-1.77	0.38			¶

OR; odds ratio
CI; confidence interval
OAS; obstetric anal injury
NICU; neonatal intensive care unit
$^{\Omega}$Significant contributors were maternal age, epidural and smoking
$^{\alpha}$Significant contributors were epidural and smoking
¶: Results remained unchanged in adjusted analyses
σ: Adjusted analyses not performed due to few cases

Figure 1. Consort flow chart of study population

Figure 2. Delivery outcomes in the control group vs. the intervention group and the physically low active group vs. the physically high active group.
CS acute; acute cesarean delivery. Vaginal instrumental; forceps and vacuum vaginal delivery. Vaginal total; instrumental + spontaneous vaginal delivery. OR; odds ratio (unadjusted). CI; confidence interval.

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