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DO FEMALE ELITE ATHLETES EXPERIENCE MORE COMPLICATED CHILDBIRTH THAN NON-ATHLETES?
A case-control study

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ABSTRACT

Objective. Previous studies have suggested that female athletes might be at higher risk of experiencing complications such as caesarean sections and perineal tears during labour than non-athletes. Our aims were to study delivery outcomes, including emergency caesarean section rates, length of 1st and 2nd stage of labour and severe perineal tears, in first-time pregnant elite athletes compared to non-athletes.

Methods. Retrospective case-control study comparing birth outcomes of primiparous female elite athletes engaging in high and low impact sports compared to non-athletic controls. The athletes had prior to birth competed at national team level or equivalent.

Participant characteristics and frequency of training for at least three years before a first pregnancy were collected via self-administered questionnaire. Information of delivery outcome was retrieved from the Icelandic Medical Birth Registry.

Results. In all 248 participated, 118 controls, 41 low- and 89 high impact elite athletes. No significant differences were found between the groups regarding incidence of emergency caesarean section or length of 1st and 2nd stage of labour. The incidence of 3rd-4th degree perineal tears was significantly higher (23.7%) among low impact athletes than in the high impact group (5.1%, p=0.01), but no significant differences were seen when the athletes were compared to controls (12%, p=0.09 for low impact and p=0.12 for high impact athletes).

Conclusion.

Participation in competitive sports at elite level was not related to adverse delivery outcome including length of labour, the need for caesarean section during delivery and severe perineal tears.

KEY WORDS

Elite athletes, childbirth, pelvic floor, pregnancy, sport, impact, exercise, perineal tears.

ABBREVIATIONS

PFMT, Pelvic floor muscle training; PFM, Pelvic floor muscles; CS, caesarean section; IOC, International Olympic Committee; OR, Odds ratio; CI, Confidence interval; SD, Standard deviation; BMI, Body mass index.

INTRODUCTION

Current guidelines encourage pregnant women to participate in aerobic and other strengthening exercises as well as to practice specific strength-training of the pelvic floor muscles (PFMT).[1 2 3] Previous studies have suggested that participation in high impact, high intensity sports might lead to hypertrophy of the pelvic floor muscles (PFM) to the extent of causing obstruction for the passing fetus and thus prolonging the 2nd stage of labour [4 5]. Based on this it can been hypothesized that hypertrophied PFMs could be associated with adverse outcomes in labour, such as severe perineal tears (3rd-4th degree) and failure to progress in labour resulting in higher rates of emergency caesarean sections (CS). However, the International Olympic Committee (IOC) expert group has revealed a significant lack of high quality evidence specific to pregnant elite athletes and the impact of strenuous exercise during pregnancy on labour and childbirth.[6]

Sports activities are usually divided into those involving *high impact*, defined as activities where both feet are above the floor (running and jumping) such as in ball games, running or gymnastics, or *low impact* (one or both feet are on the ground all the time) such as golf, cross-country skiing, weight lifting or swimming (with minimal gravitational influence).[7] Participation in high and low impact sports could thus have a different influence on labour and birth outcomes. In an IOC review article, Bø *et al* specifically highlighted the need for research on the prevalence of, and risk factors for, maternal and perinatal outcomes in elite athletes and how these compare with estimates for the general population. Prolonged labour, emergency CS and severe perineal tears (3rd-4th degree) were specifically mentioned as important variables for assessing this claim.[8]

The aims of the present study were to compare the incidence of emergency CS, 3rd- 4th degree perineal tears and length of the 1st and 2nd stage of labour between elite athletes who participated in either high or low impact sports using as a control group women who were only physically active at a recreational level. Furthermore, we aimed to study the association between delivery outcome and exercise training frequency before and during the first pregnancy in elite athletes.

METHODS

Design

This was a retrospective case-control study comparing data from before and during first pregnancy and childbirth of two groups of female elite athletes and one female non-athletic group.

Participants and data collection

Data were collected over one-year period from November 2015 to 2016. We identified elite athletes through Icelandic sports federations and public/social media. The athletes accepting to participate helped in recruiting more eligible athletes and women to form the non-athletic control group. Requests for participants were also mediated through social media. The elite athletes were grouped by low and high impact sports.[7]

All the athletes had competed in the highest division possible or were professional athletes (like ballroom dancers) in their sport or at national team level (58% in national teams) for at least three years before their first pregnancy. With regard to CrossFit, which is not included as an Olympic sport,[9] most of the participants had competed in international tournaments. Participants in the non-athletic group did not compete in sports and had only been physically active at a recreational level before and during their first pregnancy.

Inclusion criteria for the study were a healthy mother, singleton first pregnancy, able to understand Icelandic or English, while all women with high risk pregnancy, such as gestational hypertension, pre-eclampsia or multiple pregnancy were excluded.

Participants were initially contacted by telephone and subsequently sent information about the study through e-mail. Ethical approval was obtained from Icelandic National Bioethics Committee (Ref: VSN-13-189), and the Data Protection Authority granted permission as well (Ref: 2014030475TS/--). The study was conducted in accordance with the Helsinki declaration on human experimentation.

Questionnaire

All participants answered an electronic questionnaire regarding background and type of sport if any, frequency of training (hours/week), both specific sports training and/or other regular training classified as strength, endurance and/or flexibility training, number of years in the highest division possible and/or in the national team before and during their first pregnancy.

Outcome assessment

Information on pregnancy outcomes were extracted from the Icelandic Medical Birth Registry. Participants´ maternity record details were retrieved electronically and included maternal age in years, height in cm, weight in kg and body mass index as kg/m^2 (BMI) at the first antenatal visit, mode of delivery, duration of 1st and 2nd stages of labour in minutes, degree of perineal tears, use of episiotomy, anaesthesia/epidural, birthweight in g, length and newborn head circumference in cm. In some cases (n=11) the athletes had delivered their child while living abroad. In those cases, the women scanned and e-mailed their original medical birth records. Emergency CS in Iceland is defined as a decision for CS taken within eight hours of the delivery time.

Statistics

Statistical analysis was performed using SAS, R and Stata software. Characteristics of study participants were described by frequencies and percentages for dichotomous outcomes. The median with 10th -90th percentiles was used to describe skewed continuous variables while the means and standard deviations (SD) were used to describe normally distributed variables.

Chi-squared test was used to compare delivery outcome for emergency caesarean section, 3^{rd}-4^{th} degree perineal tears and Kruskal-Wallis for length of 1^{st} and 2^{nd} stages of labour for the three groups. Penalized multiple logistic regression analysis with the Firth small-sample bias-reduction method[10,11] was applied to estimate the association with predictor variables and impact groups. Odds ratio (OR) with 95% confidence interval (95%CI) were calculated for 3^{rd}-4^{th} degree perinal tears. Results from three models were presented: 1. Unadjusted, 2. Adjusted for maternal age, BMI and training frequency, 3. Model 2 with additional adjustment for birthweight. P-values <0.05 were considered significant.

RESULTS

Background information

In all, 248 of the 293 women invited filled in and returned the questionnaire (84%) (Figure 1) Table 1 shows the characteristics of study participants. All groups were significantly different from each other regarding frequency of training (hours/week) before their first pregnancy, where the low impact group exercised more than the high impact group, - the non-athletic control group being least active. Training frequency and months of training during pregnancy were not different between the athletic groups, but lower in the non-athletic group. The non-athletic women had significantly higher BMI than women in both athletic groups. Birthweight was significantly higher in the low impact group compared to the non-athletes. The low impact group had significantly longer time from childbirth to recruitment than both other groups.

Table 1. Characteristics and past exercise habits (specific sports women engage in and additional training) at recruitment of study participants, presented for each period separately (means and SD).

	Non-athletics (n=118)	Low impact (n=41)	High impact (n=89)	p-value
Maternal				
Age at delivery (years)	26.0 (4.0)	26.7 (4.2)	27.2 (3.6)	0.21
Pre-pregnancy BMI (kg/m^2)	25.5 (5.7)	23.6 (3.0)	22.7 (2.8)	<0.001
Height (cm)	168.8 (6.5)	170.0 (6.6)	169.9 (6.1)	0.40
Neonatal				
Birthweight (kg)	3.5 (0.6)	3.7 (0.4)	3.6 (0.5)	0.02
Head circumference (cm)	35.1 (2.1)	36.0 (1.3)	35.6 (1.3)	0.009
Training				
Time from delivery to replies (years)	3.4 (15.0)	5.4 (16.7)	3.3 (15.7)	0.008
Training for ≥3 years prior to pregnancy (hours/week)	1.6 (3.2)	20.3 (10.7)	14.3 (4.3)	<0.0001
Training during pregnancy (hours/week)	0.2 (1.2)	10.2 (12.7)	8.5 (7.4)	<0.0001
Gestational month training stopped	0.2 (1.2)	3.8 (3.9)	4.4 (3.8)	<0.0001
Years in highest division	0 (0)	8.7 (5.5)	8.4 (4.7)	<0.0001

Table 2 shows details of group composition. The non-athletic control group consisted of 118, the low impact group 41 and the high impact group 89 women.

Table 2. Classification of participants by type of sport prior to pregnancy.

	N	%
Non-athletic women	**118**	**47.5**
Low impact athletes	**41**	**16.5**
Swimming	16	6.5
Golf	10	4.0
Riding/jockey	5	2.0
Weight lifting	5	2.0
Ballroom dancing	3	1.2
Motocross	1	0.4
Pole fitness	1	0.4
High impact athletes	**89**	**35.9**
Track and field	24	9.7
Football (soccer)	19	7.7
Basketball	13	5.2
CrossFit	10	4.0
Team gymnastics	9	3.6
Handball	8	3.2
Racket sports (tennis, badminton)	4	1.6
Self-defence sports (judo, karate)	2	0.8

Impact groups and delivery outcome

There were three elective CS, one in each group. In the high impact group the indication was transverse lie and fibromyoma, in the low impact group fear of childbirth and in the control group breech presentation. For inter-group comparisons of delivery outcomes these women were omitted.

Table 3 shows delivery outcome. The number of emergency CS was not statistically different between groups; 9, 2 and 10 for the non-athletes, low and high impact groups respectively (p=0.51). The length of 1st and 2nd stages of labour was not significantly different between groups either (p=71 and p=0.22 respectively). There were 98 missing values for 1st and 28 missing values for 2nd stage of labour in the birth registry and this information could not be added when searched for in the actual maternity records.

The incidence of 3rd-4th degree perineal tears was significantly higher (23.7%) among low impact athletes than the high impact group (5.1%, p=0.01) but when each athletic group was compared to controls (12%), neither group reached significance, i.e. p=0.09 for low impact and p=0.12 for high impact athletes. Figure 2 shows the proportion of women with 3rd-4th degree tears by impact group. After adjusting for maternal age, BMI and training frequency high impact athletes still had lower risk of 3rd-4th degree tears compared to controls [OR (95%CI) 0.6; (0.1-2.5)], and the risk observed for low impact athletes was higher [OR (95%CI) 3.6 (0.8-17.1)] (Table 3). However, neither athletic group reached statistical significance when compared to controls. Adjustment for birthweight did not have an effect on the results. Penalized multiple logistic regression showed that frequency of exercise before and during pregnancy, maternal age and BMI had no significant association with any delivery outcome.

Table 3. Caesarean sections, length of labour stages and perineal tears by exercise/impact group and associations between impact group in women with vaginal delivery.

	Non-athletic	Low impact	High impact	p-value+
Caesarean sections	**n=10**	**n=3**	**n=11**	
Elective (n)	1	1	1	0.51
Emergency (n)	9	2	10	
Vaginal delivery	**n=108**	**n=38**	**n=78**	
Length of labour stages				
1st stage of labour (min)+,#	603 (231-1069)	613 (331-1017)	600 (296-1386)	0.71
2nd stage of labour (min)+,##	57 (17-116)	56 (32-106)	65 (23-153)	0.22
Degree perineal tears				
0-2nd, n (%)	95 (88%)	29 (76.3%)	74 (94.9%)	0.01
3rd-4th, n (%)	13 (12%)	9 (23.7%)	4 (5.1%)	
Unadjusted OR (95%CI)	1.00	2.3 (0.9, 5.8)	0.4 (0.1, 1.3)	0.01
Adjusted OR (95%CI)*	1.00	3.6 (0.8, 17.1)	0.6 (0.1, 2.5)	0.01
Adjusted OR (95%CI)**	1.00	2.4 (0.5, 12.8)	0.4 (0.1, 1.7)	0.01

+Testing the null hypothesis that all three groups are equal. Chi-squared test was used in all cases. except for length of 2nd stage labour where Kruskal-Wallis test was used.
*Adjusted for maternal age, BMI and training frequency.

** Adjusted for maternal age, BMI, training frequency and birthweight.
#For the 1^{st} stage of labour there were 50, 14 and 34 missing values for the non-athletic, low and high impact women, respectively (median, 10^{th} -90^{th} percentile).
##For the 2^{nd} stage of labour there were 8, 10 and 10 missing values for the non-athletic, low and high impact women, respectively (median, 10^{th} -90^{th} percentile).

DISCUSSION

We found no association between the length of 1^{st} and 2^{nd} stages of labour or a higher incidence of emergency CS and participation in high or low impact sports. Interestingly the high impact elite athletes had a lower incidence of 3^{rd}-4^{th} degree perineal tears than the low impact group. Participation in high impact sports seemed not to influence the incidence of severe perineal tears in a negative way. Frequency of exercise training itself before and during first pregnancy did not show relation to any subsequent delivery outcome. Regular, more frequent and high impact exercise during pregnancy has, however, been shown to reduce the need for emergency caesarean delivery in women having their first baby.[12]

Our results regarding the length of 1^{st} and 2^{nd} stages of labour are in line with the analysis by the IOC expert committee. There is moderate evidence supporting that physical activity does not increase the length of labour and in our study this also applied to elite athletes.[6] It was unfortunate that many values were missing in registration on the length of labour, particularly for the 1^{st} stage of labour in our case, but these missing data were quite evenly distributed among the three groups.

In this study we found no significant differences in emergency CS rates among the groups. The incidence was relatively low ranging from five to eleven percent of the total number of participants in the groups. It may therefore be assumed that participating in sports at elite level does not increase the risk for emergency CS. The IOC expert committee found that results from multiple studies regarding caesarean section rates and exercise were inconsistent and no studies on elite athletes were found.[6] That the section rates in general are lowered when women exercise was recently shown in a large Norwegian study[12] and our results support that participating in sports at elite level does not increase the risk for emergency CS. Because the low impact group was smaller than the other two, comparisons become less precise regarding results for that group. This could explain the high incidence of 3rd-4th degree perineal tears (23.7%). In comparison the incidence among primiparas in Iceland for the years 2012-2016 was 6.6-7.2%.[13] This smaller group of women requires further study, including 5 weightlifters and 5 horseback riders, sports that are of interest regarding their impact on the pelvic floor. Considering the sample size, our results must be interpreted with caution. Although most of the childbirths took place less than five years before the study, the time of first childbirth for some of the participants went back to the year 2000. Therefore, we had a risk of recall bias regarding exercise training. Exercise training frequency was self-reported and not measured and this may make the data subject to overestimation.[14] However, life of the elite athlete revolves around sport and competition and therefore it is not unlikely that most remember quite well how they exercised even many years back. Exercise training was only documented as frequency (hours/week) and we had no information on intensity. We do not know how fast the athletes ran or swam or how much weight they lifted. Despite this, the athletes were among the best in their sports in Iceland or even internationally and therefore we can infer that it is likely that they did exercise intensively.

Limited information is available on this subject from other studies. Kruger *et al*[5] concluded that participation in high impact sports might influence the properties of the pelvic floor to the extent to cause obstruction for the passing fetus without having actual delivery information from athletes. They hypothesized that repetitive jumping and landing could possibly increase the pelvic floor muscle mass. Our results did not confirm this hypothesis neither for the length of 2nd stage of labour or rate of severe perineal tears, both of which could be influenced by the pelvic floor strength. The high impact athletes in our study seemed to have more favourable delivery outcomes regarding their pelvic floor than the control group, even though this did not reach statistical significance. In later article from 2007, Kruger *et al* proposed, however, that emphasis would be placed on further studies on the properties of the PFM in elite athletes.[4] A recent study of PFM strength in elite female athletes, almost entirely high impact compared to non-athletes, showed no significant difference in strength between the groups.[15] In a small comparison study of female handball, volleyball, basketball payers and controls, it was found that volleyball and basketball players had significantly weaker PFM than the controls.[16] It is not possible to infer that increased strength or volume of the PFM is associated with delivery outcome or that female athletes have stronger PFM than other women. According to Du *et al* PFMT during pregnancy was not found to have a negative influence on labour, - on the contrary specific PFMT reduced the length of the 1st and 2nd stages of labour.[17] Similarly, Bø *et al* found that women who exercised regularly during pregnancy had a wider levator hiatus at 37 gestational weeks, which in turn may lead to easier birth.[18] In the IOC review article no specific studies among elite athletes on the length of labour or regarding perienal tears were identified.[6] The few studies on elite athletes have used cross-sectional and retrospective designs[6] resulting in low to moderate levels of evidence. Our results must also be interpreted with that in mind.

Strengths and limitations

Strengths of the present study are the inclusion of a high number of elite athletes, the high response rate and use of a control group. Limitations were the retrospective design with a risk of recall bias and the differing number of participants between groups. Lack of significant results may also be due to the study being underpowered (type II error). Prospective studies on elite athletes are difficult to perform due to an infrequency of pregnancy in athletes competing at the national or international level at any given time and the geographic challenges of enrolling these women in prospective studies.

CONCLUSION

Participation in sports at elite level is not associated with higher rates of emergency caesarean section, prolonged 2nd stage of labour or 3rd-4th perineal tears.

Prospective studies on elite female athletes regarding birth outcome would be desirable, but meanwhile summative evidence from retrospective design may add to our knowledge and guide further research.

Figure 1. Flow chart of participants.

Figure 2. Proportion of vaginal births with 3rd and 4th degree perineal ruptures by groups, probability with 95% CI.

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CONFLICTS OF INTEREST

None declared.

What are the new findings?

Frequency and type of exercise is not associated with complications in childbirth.
Athletes participating in high impact sports do not experience more severe obstetric perineal tears than non-athletic women.
Emergency caesarean section rates and length of 1st and 2nd stages of labour is not influenced by sports impact.

How might it impact on clinical practice in the near future?

Health care providers and coaches may explain to high impact athletes that childbirth is not likely to have more effect on their pelvic floor than other women.
Caregivers and coaches around female athletes should encourage them to exercise their pelvic floor muscles during and after pregnancy.

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