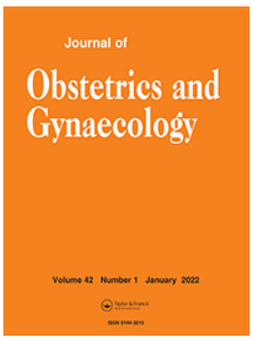

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ORIGINAL ARTICLE

Maternal and neonatal outcomes in the following delivery after previous preterm caesarean breech birth: a national cohort study

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ABSTRACT

The objective of this retrospective, nationwide Finnish population-based cohort study was to determine whether there is an association between preterm caesarean breech delivery in the first pregnancy and maternal and neonatal morbidity in the subsequent pregnancy and delivery. We identified all singleton preterm breech birth in Finland from 2000 to 2017 (n = 1259) and constructed a data set of the first two deliveries for these women. We compared outcomes of the following pregnancy and delivery among women with a previous preterm caesarean breech section with the outcomes of women with one previous vaginal preterm breech birth. *p* Value, odds ratio, and adjusted odds ratio were calculated. Neonates of women with a previous caesarean preterm breech delivery had an increased risk for arterial umbilical cord pH below seven (1.2% versus 0%; *p* value .024) and a higher rate of neonatal intensive care unit admission [22.9% versus 15% adjusted OR 1.57 (1.13–2.18); *p* value <.001]. The women with a previous caesarean section had a higher rate of uterine rupture (2.3% versus 0%; *p* value .001). They were also more likely in the subsequent pregnancy to have a planned caesarean section [19.9% versus 4% adjusted OR 8.55 (4.58–15.95), an emergency caesarean section [21.5% versus 9.7% adjusted OR 2.16 (1.28–2.18)], or an instrumental vaginal delivery [9.3% versus 3.8% adjusted OR 2.38 (1.08–5.23)].

IMPACT STATEMENT

- **What is already known on this subject?** Vaginal birth after caesarean section is generally known to be associated with a higher risk of maternal and neonatal morbidity.
- **What do the results of this study add?** The following birth after previous caesarean preterm breech section is associated with a higher rate of uterine rupture and with a higher rate neonatal admission to the neonatal intensive care unit and more often an arterial umbilical cord pH below seven regardless of the mode of the following delivery, compared to women with a subsequent delivery after a previous vaginal preterm breech birth.
- **What are the implications of these findings for clinical practice and/or further research?** Our results must be considered when counselling patients regarding their first preterm breech delivery, as the selected method of delivery also affects the outcomes of subsequent pregnancies and deliveries.

KEYWORDS

Preterm; breech delivery; caesarean section; uterine rupture; vaginal birth after caesarean; subsequent

Introduction

Caesarean section rates are increasing worldwide (Hehir et al. 2018), also in preterm pregnancies. Many studies have been carried out to access if a caesarean section has a benefit for neonates born preterm (Muhuri et al. 2006; Herbst and Kallen 2007; Robilio et al. 2007; Haque et al. 2008; Deutsch et al. 2011; Demirci et al. 2012; Alfirevic et al. 2013; Bergenhenegouwen et al. 2014; Azria et al. 2016). Nevertheless, the results of these studies remain controversial. The National Institute of Health and Care Excellence guideline recommends consideration of caesarean section for all women in preterm labour with a singleton breech foetus (National Collaborating Centre for Women's and Children's Health (UK) 2015). The reason for this is perhaps that several studies have suggested that preterm foetuses in breech presentation delivered by a primary caesarean section have a significantly lower risk of neonatal mortality compared with those delivered vaginally (Muhuri et al. 2006; Herbst and Kallen 2007; Robilio et al. 2007; Deutsch et al. 2011; Demirci et al. 2012; Bergenhenegouwen et al. 2014; Azria et al. 2016). Breech presentation is also in preterm pregnancies associated with obstetric risk factors, which are often an indication for a planned caesarean section (Toijonen et al. 2020). The Royal College of Obstetricians and Gynaecologists Breech Delivery Guideline from 2017 stated that the mode of birth in spontaneous singleton preterm breech deliveries should be decided individually based on the maternal and foetal factors

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(Impey et al. 2017). Also, the Cochrane review from 2013 did not recommend the mode of birth in preterm breech deliveries (Alfirevic et al. 2013).

On the contrary, caesarean section in planned term deliveries is associated with an increased maternal short-term morbidity (Hofmeyr et al. 2015). Having had a planned term caesarean birth compared with planned vaginal birth might also cause in subsequent pregnancies adverse outcomes. Women with at least one previous caesarean section are more likely to have another caesarean (Uddin and Simon 2013). Several studies also indicate that women with a previous caesarean section are more often in need of a blood transfusion. They have an increased risk of endometritis, uterine rupture, hysterectomy, and death (Royal College of Obstetricians and Gynaecologists 2015). Women with a history of caesarean section suffer more often from placenta previa (Jauniaux et al. 2019), and abnormally invasive placentation like placenta accrete (Silver et al. 2006). A history of planned caesarean birth at term increases the risk of stillbirth and neonatal morbidity during subsequent pregnancy (O'neill et al. 2013). For caesarean sections in preterm pregnancies, the risks named above might be even higher, as during a caesarean section, often, an enlarged uterotomy is necessary to deliver the foetus safely. These enlarged incisions are more traumatic compared to the usual lower segment incisions, as the uterus is quite often opened up to the fundus (Figure 1). However, women with a history of preterm caesarean have high rates of successful trial of labour in a subsequent term pregnancy (Rietveld et al. 2019).

We hypothesised that the subsequent delivery after a primary preterm caesarean breech section is associated with adverse outcomes in the following birth, regardless of the mode of the next birth. These outcomes are essential to know, and the information should be integrated into the counselling of women with a preterm foetus in breech presentation, especially concerning women that are thinking about having a large family.

Methods

Population

We conducted a retrospective, nationwide Finnish population-based case–control study using data from the Finnish national medical birth register and the hospital discharge register, maintained by the Finnish Institute for Health and Welfare. All Finnish maternity hospitals are contributing clinical data to the record, and reporting to the national registries is obligatory. The register has shown good validity and coverage (Gissler 2004). In Finland, all new-born infants are examined by a paediatrician. Personal identification numbers given at birth can be used to trace the child in the case of death or subsequent hospitalisation. The hospital discharge register contains information on procedures and diagnoses (International Statistical Classification of Diseases and Related Health Problems 10th Revision, ICD-10) in the public sector. We included all women undergoing a second delivery with a history of a singleton preterm breech delivery during their first delivery regardless of the mode of birth. We constructed a data set in which we connected the first two deliveries of these women. All women were nulliparous at the time of the first delivery. We compared the outcomes of the second birth of women with one previous caesarean preterm breech section, versus the outcomes of the following birth of women with one previous vaginal preterm breech delivery. In Finland, pregnant women with one previous lower-segment caesarean section have the opportunity to attempt vaginal labour during a subsequent pregnancy. In Finland, are specific, selecting and managing criteria for a trial of vaginal term breech labour in use. For vaginal preterm delivery are no recommendations regarding the mode and the handling of the delivery. Authorisation to use the data was obtained from the Finnish Institute for Health and Welfare as required by the national data protection law in Finland (reference number THL/652/5.05.00/2017).

We compared the labour outcomes of the subsequent delivery of women with a history of preterm breech caesarean section with the labour outcomes of women with a history of vaginal preterm breech delivery. Independent variables were vaginal breech delivery and caesarean breech delivery at the first delivery. The outcomes and variables for the analysis were selected based on previous literature on the subject (Tables 1–3). The data was extracted from the Hospital Discharge Register using information from basic variables and ICD-10 codes. As variables for the maternal outcome, we selected maternal mortality, maternal need for blood transfusion, uterus rupture, mode of subsequent delivery planned caesarean, mode of subsequent delivery emergency caesarean section, mode of subsequent delivery instrumental vaginal delivery, mode of subsequent delivery spontaneous vaginal delivery and mode of subsequent delivery spontaneous vaginal breech delivery (Table 2). As neonatal outcomes, we chose stillbirths during pregnancy, neonatal deaths during delivery, arterial umbilical pH $<$ 7, 5 min APGAR $<$ 4, 5 min APGAR $<$ 7, neonatal intensive unit admission (NICU) admission, neonatal intubation (Table 3).

We evaluated potential confounders, which could affect the maternal and neonatal outcomes during the second delivery. We reviewed the following factors: maternal age below 25 and over 35 years, smoking, body mass index (BMI) $\geq$ 30 and $\geq$ 35, hypo- or hyperthyroidism, gestational diabetes and pre-existing type 1 diabetes mellitus, preeclampsia, placenta praevia, placental abruption, premature rupture of membranes (PROM), oligohydramnios, congenital foetal

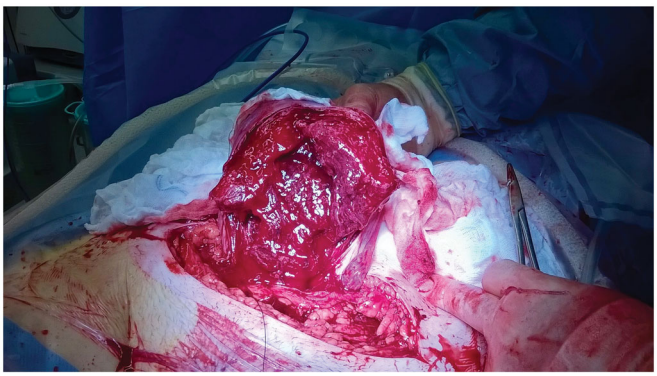

Figure 1. J-incision in a preterm breech caesarean section in pregnancy week 24.

Table 1. Demographics and potential confounders.

	Previous caesarean N = 838		Previous vaginal N = 421			
	n	%	n	%	*p* Value	OR 95% CI
Maternal age < 25	99	11.8 %	64	15.2 %	0.091	0.75 (0.53–1.05)
Maternal age ≥ 35	185	22.1 %	90	21.4 %	0.777	1.04 (0.78–1.38)
Smoking	82	9.8 %	47	11.2 %	0.447	0.86 (0.59–1.26)
Maternal BMI ≥ 35	28	3.3 %	13	3.1 %	0.811	1.08 (0.56–2.12)
Maternal hypothyroidism	14	1.7 %	4	1.0 %	0.310	1.77 (0.58–5.41)
Maternal hyperthyroidism	0	0.0 %	0	0.0 %		
Pre-gestational insulin treated diabetes	28	3.3 %	4	1.0 %	0.011	3.60 (1.26–10.34)
Gestational diabetes	83	9.9 %	53	12.6 %	0.148	0.76 (0.53–1.10)
Preeclampsia / hypertonia	72	8.6 %	15	3.6 %	0.001	2.54 (1.44–4.49)
Placenta previa	3	0.4 %	1	0.2 %	0.720	1.51 (0.16–14.55)
Placenta ablation	9	1.1 %	0	0.0 %	0.033	
PROM	51	6.1 %	26	6.2 %	0.950	0.98 (0.60–1.60)
Oligohydramnios	8	1.0 %	5	1.2 %	0.700	0.80 (0.26–2.47)
Congenital anomalies	48	5.7 %	31	7.4 %	0.259	0.76 (0.48–1.22)
Neonatal female gender	408	48.7 %	218	51.8 %	0.300	0.88 (0.70–1.12)
Small for gestational age	33	3.9 %	9	2.1 %	0.093	1.88 (0.89–3.96)
Previous delivery age 23 + 0–27 + 6	76	9.1 %	63	15.0 %	0.005	0.57 (0.40–0.81)
Previous delivery age 28 + 0–31 + 6	124	14.8 %	52	12.4 %		1.23 (0.87–1.74)
Previous delivery age 32 + 0–36 + 6	638	76.1 %	306	72.7 %		1.20 (0.92–1.57)

Table 2. Maternal outcomes.

	Previous caesarean N = 838		Previous vaginal N = 421				
	n	%	n	%	*p* Value	OR 95% CI	Adjusted OR 95% CI
Subsequent delivery planned caesarean section	167	19.9 %	17	4.0 %	<.001	5.91 (3.54–9.89)	8.55 (4.58–15.95)
Subsequent delivery emergency caesarean section	180	21.5 %	41	9.7 %	<.001	2.54 (1.77–3.64)	2.16 (1.28–3.65)
Subsequent delivery spontaneous vaginal	404	48.2 %	323	76.7 %	<.001	0.28 (0.22–0.37)	0.26 (0.17–0.39)
Subsequent delivery vacuum extraction	78	9.3 %	16	3.8 %	<.001	2.60 (1.50–4.51)	2.38 (1.08–5.23)
Subsequent delivery vaginal breech delivery	9	1.1 %	24	5.7 %	<.001	0.18 (0.08–0.39)	0.10 (0.01–0.77)
Maternal blood transfusion	23	2.7 %	13	3.1 %	.730	0.89 (0.44–1.77)	0.90 (0.30–2.74)
Maternal mortality	0	0.0 %	0	0.0 %			
Uterus rupture	19	2.3 %	0	0.0 %	.002		

Adjusted for: maternal age ≥ 35, maternal BMI ≥ 30, maternal BMI ≥ 35, pre-gestational diabetes treated with insulin; preeclampsia/hypertonia; PPROM; oligohydramnios; delivery age 23 + 0–27 + 6; delivery age 28 + 0–31 + 6; delivery age 32 + 0–36 + 6.

Table 3. Neonatal outcomes.

	Previous caesarean N = 838		Previous vaginal N = 421		*p* Value	OR 95% CI	Adjusted OR 95% CI
	n	%	n	%			
Neonatal deaths	4	0.5 %	3	0.7 %	.596	0.67 (0.15–3.00)	0.59 (0.13–2.77)
Arterial umbilical pH < 7	10	1.2 %	0	0.0 %	.024		
5 min APGAR < 4	5	0.6 %	3	0.7 %	.807	0.84 (0.20–3.52)	0.92 (0.22–3.93)
5 min APGAR < 7	12	1.4 %	3	0.7 %	.267	2.02 (0.57–7.21)	2.03 (0.56–7.34)
Neonatal NIUT admission	192	22.9 %	63	15.0 %	.001	1.69 (1.24–2.31)	1.57 (1.13–2.18)
Neonatal intubation	10	1.2 %	6	1.4 %	.729	0.84 (0.30–2.31)	0.80 (0.28–2.30)
Stillbirths during pregnancy	4	0.5 %	2	0.5 %	.996	1.00 (0.18–5.51)	1.12 (0.20–6.23)
Preterm delivery	163	19.5 %	87	20.7 %	.610	0.93 (0.69–1.24)	0.83 (0.61–1.13)
Delivery 23 + 0–27 + 6	6	0,7 %	5	1,2 %	.396	0.60 (0.18–1.98)	0.63 (0.18–2.14)
Delivery 28 + 0–31 + 6	11	1,3 %	11	2,6 %	.097	0.50 (0.21–1.15)	0.53 (0.22–1.28)
Delivery 32 + 0–36 + 6	146	17,4 %	71	16,9 %	.805	1.04 (0.76–1.42)	0.92 (0.66–1.28)

Adjusted for: Maternal age ≥ 35; maternal BMI ≥ 30; maternal BMI ≥ 35; pre-gestational diabetes treated with insulin; preeclampsia/hypertonia; PPROM; oligohydramnios; subsequent delivery planned caesarean section; subsequent delivery emergency caesarean section; [5]ubsequent delivery vacuum extraction; subsequent delivery vaginal breech delivery; delivery age 23 + 0–27 + 6; delivery age 28 + 0–31 + 6; delivery age 32 + 0–36 + 6.

anomalies, infant sex and small-for-gestational-age (SGA) according to Finnish standards (Gissler 2004).

Statistical analysis

The calculations were performed using SPSS 19. Statistical differences in categorical variables were evaluated with the Chi-squared test or Fisher's exact test when appropriate. We calculated odds ratios (ORs) with corresponding 95% confidence intervals using binary logistic regression. A stepwise logistic regression model was done to assess the adjustments. Differences were deemed to be statistically significant, with a *p* value ≤.05.

Results

We identified 1259 women who had a second delivery after a previous singleton preterm breech birth, among them 838

(67%) had a previous preterm breech caesarean section and 421 (33%) women a previous vaginal preterm breech delivery. From the 838 women with a previous caesarean section 75 women (9.1%) had a previous extremely preterm birth, with a gestational age of 24 + 0 to 27 + 6, 124 women (14.8%) had a previous very preterm delivery of the gestational age of 28 + 0 to 31 + 6 weeks and 638 (76.1%) a previous moderate to late preterm delivery (32 + 0 to 36 + 6 weeks of gestation). From the 421 women with a previous vaginal preterm breech delivery 63 women (15%) had a previous extremely preterm birth, 52 women (12.4%) had a previous very preterm delivery, and 306 (72.7%) had a previous moderate to late preterm delivery. Women with previous caesarean section had less often a previous extremely preterm birth (gestational age of 24 + 0 to 27 + 6), compared to women with an earlier vaginal preterm breech delivery [odds ratio (OR) 0.57, 95% confidence interval (CI) (0.40–0.81)], $p = .005$.

Women with a previous caesarean breech delivery suffered during the subsequent pregnancy more often from pre-gestational treated diabetes 3.3% compared to women with an earlier vaginal preterm breech labour 1.0% [OR 3.60, 95% CI (1.26–10.34)], $p = .011$. The mothers with a history of caesarean section had also more often preeclampsia or high blood pressure 8.6% than mothers with a history of vaginal delivery 3.6% [OR 2.54, 95% CI (1.44–4.49)], $p = .001$ during subsequent pregnancy. The maternal characteristics of the studied women are listed in Table 1.

Maternal outcomes

There were no maternal deaths. Women with a history of preterm caesarean breech delivery had in 2.3% of all deliveries a uterus rupture during the subsequent delivery compared with none uterus rupture in women with a previous vaginal preterm breech delivery, $p = .002$. The risk of having a planned caesarean section during the sequent delivery was with 19.9% significantly elevated among women with an earlier preterm caesarean breech delivery [adjusted odds ratio (aOR) 8.55, 95% CI (4.58–15.95)], compared to 4% in women with a history of vaginal preterm breech delivery, $p < .001$. The rate of having an emergency caesarean section was 21.5% in women with previous caesarean section in contrast to a rate of 9.7% in women with a previous vaginal birth [aOR 2.16, 95% CI (1.28–3.65)], $p < .001$. Also, the rate of instrumental vaginal deliveries (vacuum extraction) was with 9.3% elevated in contrast to 3.8% in mothers with a history of vaginal preterm breech delivery [aOR 2.38, 95% CI (1.08–5.23)], $p < .001$. Women with an earlier preterm caesarean breech delivery were less likely to have a spontaneous vaginal delivery (48.2% versus 76.7%) [aOR 0.26, 95% CI (0.17–0.39)], $p < .001$, or a vaginal breech delivery (1.1% versus 3.1%) [aOR 0.10, 95% CI (0.01–0.77)], $p < .001$. The maternal outcomes are listed in Table 2.

Neonatal outcomes

The neonatal mortality rate and the rate of stillbirths during pregnancy did not differ among women without a previous vaginal delivery planning vaginal birth (0.7%) compared with caesarean birth (0.5%) [aOR 0.59, 95% CI (0.13–2.77)], $p = .596$. The percentage of neonates that had an umbilical arterial pH below seven was 1.2% among neonates from women with a previous caesarean preterm breech birth compared to none among women with an earlier vaginal preterm breech delivery, $p = .024$.

The risk of admission to a NICU was significantly elevated among neonates born by women with a history of a preterm caesarean breech section (22.9%), compared to those whose mothers had a previous vaginal preterm breech delivery (15%) [aOR 1.69, 95% CI (1.24–2.18)], $p = .001$. There were no statistical differences for the other neonatal outcomes among both groups. Neonatal outcomes are listed in Table 3.

Discussion

A subsequent delivery after a previous preterm caesarean section with the child in a breech presentation is associated with a significantly increased maternal and neonatal morbidity. However, our study shows that the rate of adverse outcomes is low.

Only women with a history of preterm caesarean breech section had a uterus rupture during subsequent birth. In the group of women who had a previous preterm vaginal breech birth were no uterus ruptures noticed. Women with a history preterm caesarean breech section had a lower possibility of a spontaneous vaginal delivery. Instead, they had more often an abdominal or instrumental delivery. The risk of neonatal admission to the NICU was significantly elevated among new-borns among women who had not had a previous vaginal delivery. These neonates had also more often an umbilical arterial pH below seven.

The rate of uterine rupture in our study group was 2.3%, which is relatively high compared to earlier studies that reported rates of 0.7% for low transverse incisions and 2.0% for low vertical incisions (Landon et al. 2004). In trials of vaginal birth after previous term caesarean breech delivery, the percentage of uterus rupture is 2.0% (Macharey et al. 2020). For T-shaped or classical incision, the risk of uterine rupture during a subsequent pregnancy or birth much higher and ranges from 4% to 9% (ACOG 2010). The higher rate of uterine ruptures in our study might be caused by the possible need for U- or J-shaped incisions during the preterm caesarean breech section in the first pregnancy (Figure 1), as this kind of incisions might be associated with a higher risk of uterine rupture (ACOG 2019).

The results from our study confirm that vaginal birth after caesarean section is often associated with a subsequent planned caesarean section (Solheim et al. 2011) and with an increased risk of emergency caesarean sections, vacuum extractions, and failure of vaginal delivery during the following birth. A review of 963 papers by Eden et al. (2010) has shown the same results and found that women with a trial of vaginal birth after caesarean section have more often an abnormal delivery through a prolonged labour, a higher rate of abnormal foetal heart rates under birth, and fear of childbirth.

From the children of women with a previous caesarean preterm breech section had 1.2% an umbilical arterial pH

below seven compared to none among the children from women with a history of vaginal preterm breech delivery. This rate was actually higher compared to the results of an earlier study that reviewed the outcome of children among women with a previous term caesarean breech section, among these children had 0.6% an umbilical arterial pH below seven (Macharey et al. 2020). The neonates from our study among women with a previous caesarean preterm breech section were more often administrated to the NICU. The higher neonatal morbidity in the study group is explainable with the fact that we compare women with a previous vaginal delivery with women with their first trial of vaginal delivery (Smith 2001; Smith et al. 2002). Additionally, a trial of vaginal birth after caesarean section is due to the uterus scare associated with a higher risk of neonatal mortality (O'neill et al. 2017).

There were some differences between the two study groups. During the first pregnancy, women with an extremely preterm breech birth had significantly fewer caesarean sections than vaginal births. A possible explanation for this might be that the delivery started in many cases spontaneously and the cervix dilatated unexpectedly fast so that a caesarean section wasn't an option anymore. Another difference between the two groups was an increased rate of preeclampsia and high blood pressure in the women with a prior preterm caesarean section. Preeclampsia is a condition with an increased risk of recurrence, and it might have been already during the first pregnancy, the reason for the caesarean section (Kim et al. 2010). Also, during the second pregnancy, it increases the risk to have another caesarean section (Kim et al. 2010). Preeclampsia and high blood pressure are also risk factors for foetal growth restriction and adverse neonatal outcome (Van Der Tuuk et al. 2015). Pre-gestational insulin-treated diabetes is also a risk factor for adverse neonatal outcome and is associated with a higher need of an instrumental delivery, like caesarean section (Sibai et al. 2000). For this reason, we adjusted the maternal and neonatal outcomes for preeclampsia, high blood, and pre-gestational insulin-treated diabetes with those variables.

Up to our knowledge is our study, the first that reviews adverse outcomes in subsequent labour in women with a history of preterm caesarean breech labour. The analysis of our research is based on an extensive nationwide population database that allowed us to follow up successive pregnancies and births to the same woman and had access to a linked pregnancy database. We have a large sample size for a rare event like a preterm caesarean breech section, and our research has a robust adjustment for possible confounders. Our findings are limited by the retrospective design in which we rely on the coding protocols used by health-records staff, which in turn depend on diagnoses charted by caregivers who may not use consistent standards for differentiating, for example, a uterine rupture from dehiscence.

Conclusion

Our results show that a subsequent delivery after caesarean preterm breech delivery is associated with an increased maternal and infant morbidity, regardless of the mode of the following birth. These results must be considered when counselling patients regarding their first preterm breech delivery, as the selected method of delivery affects subsequent pregnancies and deliveries. The decision-making regarding the planned mode of the following delivery after a previous caesarean birth is complex. In consideration of safety, a repeat caesarean birth might be reasonable, but absolute differences in mortality and morbidity between planned vaginal delivery compared with planned caesarean birth remain small.

Ethical approval

Authorisation to use the data was obtained from the National Institute for Health and Welfare as required by the national data protection legislation law in Finland (reference number THL/652/5.05.00/2017).

Disclosure statement

The authors state explicitly that there are no conflicts of interest in connection with this article. All authors declare independence from any funding agency for this work.

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