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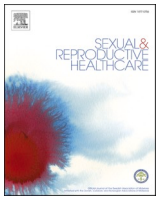

Full Length Article

Intrapartum fetal monitoring practices in Norway: A population-based study

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ABSTRACT

Objective: To describe intrapartum fetal monitoring methods used in all births in Norway in 2019–2020, assess adherence to national guidelines, investigate variation by women's risk status, and explore associations influencing monitoring practices.
Methods: A nationwide population-based study. We collected data about all pregnancies with a gestational age ≥ 22 weeks during 2019–2020 from the Medical Birth Registry of Norway. We used descriptive analyses, stratified for risk status, to examine fetal monitoring methods used in all deliveries. Univariable and multivariable logistic regression models were used to determine factors associated with monitoring with cardiotocography (CTG) in low-risk, straightforward births.
Results: In total, 14 285 (14%) deliveries were monitored with only intermittent auscultation (IA), 46 214 (46%) with only CTG, and 33 417 (34%) with IA and CTG combined. Four percent (2 067/50 533) of women with risk factors were monitored with IA only. Half (10 589/21 282) of the low-risk women with straightforward births were monitored with CTG. Maternal and fetal characteristics, size of the birth unit and regional practices influenced use of CTG monitoring in this group.
Conclusions: Most births are monitored with CTG only, or combined with IA. Half the women with low-risk pregnancies and straightforward births were monitored with CTG although national guidelines recommending IA.

Introduction

Background

The goal of intrapartum fetal monitoring is to detect potential fetal decompensation and enable timely and effective intervention to prevent damage or death [1,2]. There are two principles for fetal monitoring. One is intermittent monitoring, known as Intermittent Auscultation (IA), which is usually performed with a Pinard stethoscope or a hand-held Doppler ultrasound device. The other principle is electronic fetal monitoring with cardiotocography (CTG).

The current body of evidence suggests that using CTG is associated with increased risk of caesarean section and instrumental births and reduced risk for neonatal seizures but no reduction in the incidence of cerebral palsy or other adverse neonatal outcomes [2–6]. Both international and Norwegian guidelines recommend IA for fetal monitoring in healthy women with low risk for fetal compromise and CTG in women with high risk [1,7–11].

However, results from some studies indicate an overuse of CTG in low-risk births [12–15]. Norwegian studies describe how the labour admission test, a screening test consisting of an approximately 20-minute CTG and continuous CTG, is frequently used in women with low-risk despite evidence and guideline recommendations suggesting otherwise [14,16]. A Swedish study found that 29 % of all birth units

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used CTG routinely in all women during labour, whereas a study from Ireland showed 76 % of women classified as low-risk upon onset of labour were monitored with CTG [12,13].

The Healthcare Personnel Commission in Norway released a report in 2023 emphasizing the need to reduce overdiagnosis and overtreatment [17]. The report specifically praised the international "Choosing Wisely" campaign for raising awareness on reducing unnecessary examinations and treatments that may not benefit patients and could cause harm. The "Choosing Wisely" campaigns from Norway, UK, Italy, and Canada all recommend avoiding use of CTG during low-risk births, unless a change in risk status occurs and CTG becomes medically justified [18–21].

To reduce unnecessary use of CTG and secure that women receive appropriate intra-partum fetal monitoring, we need to know the proportion of women receiving out-of-guideline fetal monitoring.

The aims of the present study are: 1) to identify and describe the methods used for intrapartum fetal monitoring in all births in Norway during 2019–2020, 2) to determine how methods vary based on the pregnancy's risk status, and 3) to explore associations that may explain fetal monitoring practices.

Methods

Study population and design.

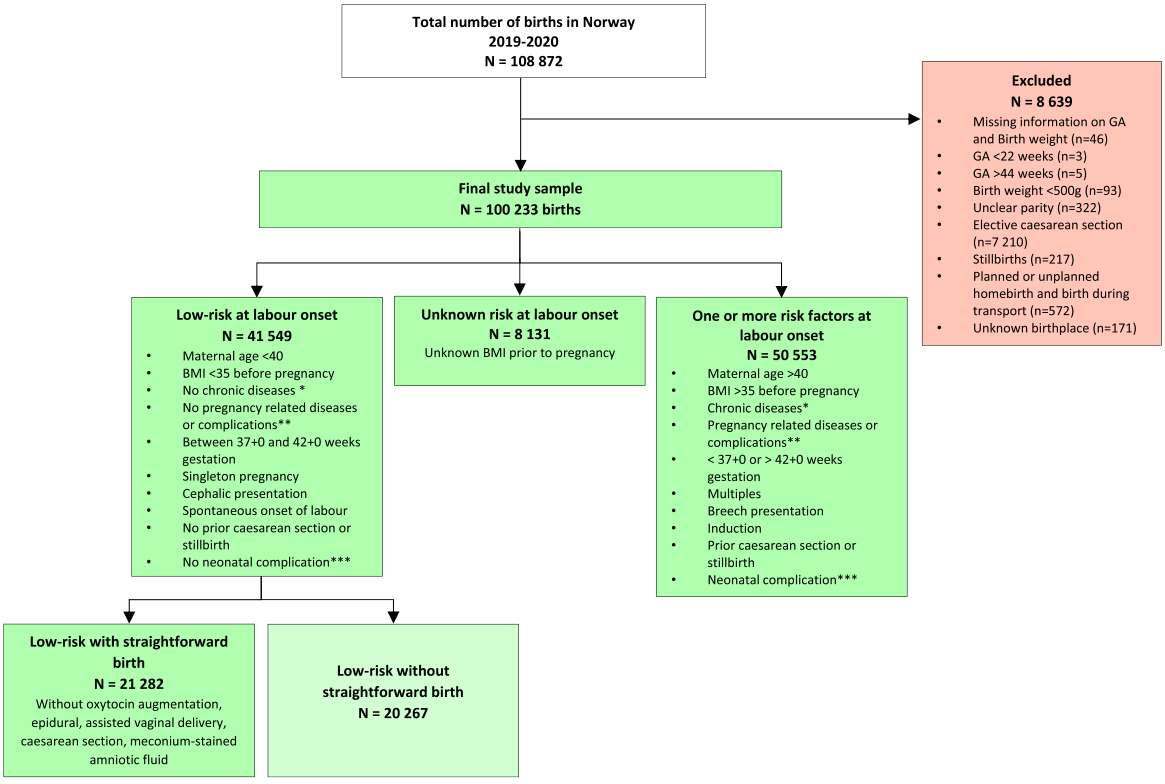
were obtained from the Medical Birth Registry of Norway (MBRN), a registry established in 1967 that covers details on all births in Norway. The MBRN data are obtained from antenatal health cards and birth medical records, which contain comprehensive personal and medical information. Registration in MBRN is mandatory by birth-attending midwives or doctors.

The study's population includes births that occurred in Norway during 2019 and 2020, with gestational ages (GA) ranging from ≥ 22 weeks (and 0 days) to ≤ 44 weeks (and 0 days). We excluded births with a birthweight < 500 g, missing information on birthweight, GA, or parity. Additionally, elective caesarean sections, stillbirths, planned and unplanned homebirths, and births with an unknown birthplace were excluded (Fig. 1).

The registration of fetal monitoring methods in MBRN commenced in 2017; however, due to significant data gaps from 2017 and 2018, these years were omitted from our study. The use of devices – such as Pinard Stethoscope, Doppler device, and CTG – are registered separately.

Setting

Intrapartum care in Norway is organized across three distinct levels: Level 1, highly specialized units with advanced obstetric, pediatric, and anaesthesiology services; Level 2, birth units in smaller hospitals with obstetric and anaesthesiology services; and Level 3, alongside and freestanding midwifery-led units caring for low-risk births only [22]. Specialist healthcare services are divided between four regional health authorities: the Northern, Central, Western, and South-Eastern Norway Regional Health Authorities. Antenatal and maternity care is provided free of cost and all birth units are publicly owned and financed. Midwives are present at all births, have an independent responsibility for low-risk women, and primarily perform fetal monitoring and interpret



* Chronic diseases; diabetes, hypertension, kidney diseases, epilepsy
**Pregnancy-related diseases or complications; diabetes, hypertension, pre-eclampsia, eclampsia, HELLP syndrome, bleeding during pregnancy, placenta previa, polyhydramnion, oligohydramnion, or PROM.
*** Neonatal complications; congenital heart defect or neural tube defect
GA: gestational age; BMI: body mass index; HELLP: hemolysis, elevated liver enzymes, and low platelet count syndrome; PROM: premature rupture of membranes.

Fig. 1. Flowchart of included (green boxes) and excluded (red box) births registered in MBRN in 2019–2020 and risk status at labour onset. * Chronic diseases; diabetes, hypertension, kidney diseases, epilepsy**Pregnancy-related diseases or complications; diabetes, hypertension, pre-eclampsia, eclampsia, HELLP syndrome, bleeding during pregnancy, placenta previa, polyhydramnion, oligohydramnion, or PROM. *** Neonatal complications; congenital heart defect or neural tube defect GA: gestational age; BMI: body mass index; HELLP: hemolysis, elevated liver enzymes, and low platelet count syndrome; PROM: premature rupture of membranes. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

the fetal heartrate during labour. According to a national quality requirement, women shall receive one-to-one care from a midwife during active labour. Obstetricians are involved in all high-risk births and abnormal fetal heart registrations.

Risk status

Risk status at labour onset was defined using the Norwegian intrapartum fetal monitoring guidelines [7], in conjunction with the Norwegian quality requirement guidelines applicable during the study period [22]. "Low-risk at labour onset" was defined as births between GA 37 + 0 and 42 + 0 weeks, with a singleton pregnancy, cephalic presentation, spontaneous onset of labour, and no prior caesarean section or stillbirth. Additionally, criteria included maternal age < 40 years, Body Mass Index (BMI) < 35 kg/m^2 prior to pregnancy, no chronic diseases (diabetes, hypertension, kidney disease, or epilepsy), and no pregnancy-related diseases or complications (such as gestational diabetes, pregnancy-induced hypertension, pre-eclampsia, eclampsia, hemolysis, elevated liver enzymes, low platelet count syndrome, large bleeding during pregnancy, placenta previa, polyhydramnios, oligohydramnios or pre-labour rupture of membranes. Neonatal complications, such as congenital heart defect or neural tube defect, were also excluded. "One or more risk factors present at labour onset" was the criterion used to define pregnancies with one or more risk factors (Fig. 1).

The Norwegian intrapartum fetal monitoring guidelines recommend IA in women with low-risk, which aligns with our defined "Low-risk at labour onset" group and recommend CTG in situations where risk factors are present [7]. However, complications and risk factors may arise during labour, necessitating a change from IA to CTG. To further refine our classifications, we subdivided the "Low-risk at labour onset" group into a "Straightforward birth" category. This term has previously been defined as a vaginal birth without any procedures or interventions [23]. In our study, we defined "Straightforward birth" as a birth that does not involve oxytocin augmentation, epidural analgesia, assisted vaginal birth, caesarean section, or the presence of meconium-stained amniotic fluid (Fig. 1).

Other variables

The Maternal Origin variable was classified into three distinct categories based on the Global Burden of Disease (GBD) super-regions [24]. Women born in Norway were grouped into the "High-Income" category, which also encompasses Western Europe, Southern Latin America, North America, Asia Pacific, and Australasia. The remaining super-regions – Central and Eastern Europe, Central Asia; North Africa and the Middle East; sub-Saharan Africa; South Asia; Southeast Asia, East Asia, and Oceania; and Latin America and the Caribbean – were amalgamated into the "Other" category.

Missing data

For 8 131 (8 %) births in the final study sample, no risk factors were present at labour onset; however, information regarding BMI prior to pregnancy was missing. Subsequently they were categorized into "Unknown risk at labour onset" (Fig. 1).

The fetal monitoring method was not recorded in 6 % of the births. It is unknown if these omissions were due to the absence of a monitoring method or a failure to record the utilized method. Consequently, these cases are categorized as "No method registered".

Information on smoking prior to pregnancy was missing for 9 176 (9 %) of the births. These cases were categorized as non-smokers, in line with other studies conducted with MBRN data [25,26]. The regression analysis only encountered missing data for maternal origin (n = 238), which was coded as "No data" and treated as a distinct category in the analysis.

Statistical analysis

Descriptive analysis was used to present continuous variables as mean values with standard deviations. For categorical variables, frequencies and percentages are reported. Stratification was performed based on the types of fetal monitoring methods used during birth. The four categories used were as follows: "IA only", where only a Pinard stethoscope and/or Doppler device was used; "CTG only", which employed only CTG; "IA and CTG", where at least one device out of CTG and IA was used; and "No method registered", where no fetal monitoring method was registered during birth.

The target outcome variable, CTG, was categorized as yes or no. The covariates included in the study were factors that may have influenced the method used to monitor the fetus during labour. All covariates were categorized as categorical variables. Factors involved in the analysis were maternal age, parity, maternal origin, marital status, smoking prior to pregnancy, BMI prior to pregnancy, GA, birthweight, size of birth unit (number of births per year), and Regional Health Authority area. Univariable and multivariable logistic regression analyses were performed to assess which factors affected whether or not women with low-risk at labour onset, who also had a straightforward birth, were monitored with CTG. Odds ratios (ORs) and the corresponding 95 % confidence intervals (95 % CIs) were calculated.

We executed the multivariable logistic model incorporating the ten covariates described above to identify factors associated with the use of CTG. The discriminative capacity of the chosen model was evaluated using the area under the receiver operating characteristic curve (AUC).

Statistical analyses were performed using Stata version 17.0. P < 0.05 was considered statistically significant.

Results

Study population and fetal monitoring methods used

A total of 100,233 births were included in the study. Of these, 41,549 (41 %) were classified as "Low-risk at labour onset", 8 131 (8 %) as "Unknown risk at labour onset", while 50 553 (51 %) had "One or more risk factors present at labour onset" (Fig. 1).

The Doppler device for fetal monitoring was used in 47 % of the births and the Pinard stethoscope in 4 %. Regardless of risk status, 80 % of women underwent CTG monitoring at some point during birth. The proportion of women monitored with IA only was 14 %, while 46 % were monitored with CTG only. In 34 % of the births, the combination of IA and CTG was used. 6 % of the births were registered without use of any fetal monitoring method (Table 1). Maternal characteristics stratified by methods used for fetal monitoring are presented in Table 1.

In terms of monitoring methods used in births with "Low-risk at labour onset", 26 % were monitored with IA only, 27 % with CTG only, 42 % with both IA and CTG, and no method was registered for 5 %. In women with "One or more risk factors present at labour onset", 4 % were monitored with IA only, 62 % CTG only, 27 % both IA and CTG, and 7 % had no methods registered. In women with "Low-risk at labour onset and straightforward birth", 45 % were monitored with IA only, 19 % with CTG only, 31 % with both IA and CTG, and no method was registered in 5 % (Table 2).

Among the 2 067 women for whom risk factors were present but only IA was registered, 70 % (n = 1 450) were multiparous and 30 % (n = 617) were nulliparous. The types of risk factors in these births included high maternal age ≥ 40 (n = 274; 13 %), diabetes (n = 189; 9 %), prelabour rupture of membranes (n = 845; 40 %), and induction of labour (n = 296; 14 %).

CTG monitoring in low-risk, straightforward births

A total of 21 282 women were low-risk at the onset of labour and also had a straightforward birth. Of these, 45 % were monitored with IA only,

Table 1
Clinical characteristics of the total study cohort, stratified by methods used for fetal monitoring, n = 100 233.

Characteristics	Methods used for fetal monitoring				
	Total	IA only	CTG only	IA and CTG	No method registered
Total number of births, n (%)	**100 233 (100)**	**14 285 (14)**	**46 214 (46)**	**33 417 (34)**	**6 317 (6)**
Parity					
Nulliparous	45 595 (45)	3 441 (24)	21 956 (48)	17 573 (53)	2 625 (41)
Multiparous	54 638 (55)	10 844 (76)	24 258 (52)	15 844 (47)	3 692 (59)
Maternal age, when giving birth					
Mean (SD)	30.71 (SD 5)	30.9 (SD 4)	30.96 (SD 5)	30.1 (SD 5)	31.5 (SD 5)
<20 years	599 (1)	51 (0.4)	292 (1)	231 (1)	25 (0.4)
20–29 years	40 425 (40)	5 249 (37)	17 879 (39)	15 116 (45)	2 181 (35)
30–39 years	55 505 (55)	8 677 (61)	25 808 (55)	17 259 (52)	3 761 (60)
≥40 years	3 704 (4)	308 (2)	2 235 (5)	811 (2)	350 (5)
Maternal morbidity					
Diabetes*	6 163 (6)	199 (1)	4 026 (9)	1 495 (5)	443 (7)
Hypertensive disorders**	4 189 (4)	89 (1)	2 844 (6)	942 (3)	314 (5)
Previous CS (1 or more)	7 124 (7)	135 (1)	4 719 (10)	1 607 (5)	663 (11)
Bleeding during pregnancy	8 84 (1)	84 (1)	487 (1)	252 (1)	61 (1)
BMI Prior to pregnancy* ***(kg/m^2)***					
Mean (SD)	24.6 (SD 5)	23.4 (SD 4)	25.3 (SD 5)	24.2 (SD 4)	24.7 (SD 5)
<18.4 (underweight)	3 348 (3)	530 (4)	1 468 (3)	1 144 (3)	206 (3)
18.5–24.9 (normal weight)	55 238 (56)	8 920 (62)	23 407 (51)	19 598 (59)	3 313 (53)
25.0–29.9 (overweight)	21 195 (21)	2 658 (19)	10 042 (22)	7 206 (22)	1 289 (20)
30–34,9 (obesity)	8 403 (8)	632 (4)	4 691 (10)	2 547 (8)	533 (8)
>35 (obesity)	3 918 (4)	111 (1)	2 710 (6)	848 (2)	249 (4)
Missing	8 132 (8)	1 434 (10)	3 897 (8)	2 074 (6)	727 (12)
Smoking	5 994 (6)	497 (4)	3 214 (7)	1 835 (6)	448 (7)
Multiple births	2 404 (2)	30 (0.2)	1818 (4)	297 (1)	259 (4)
Gestational age at birth, in weeks					
22–36	5 245 (5)	145 (1)	3 441 (8)	992 (3)	667 (11)
37–41	90 692 (91)	14 041 (98)	39 894 (86)	31 310 (94)	5 447 (86)
42–44	4 296 (4)	99 (1)	2 879 (6)	1 115 (3)	203 (3)
Onset of labour					
Spontaneous	71 298 (71)	13 972 (98)	25 366 (55)	27 690 (83)	4 270 (68)
Induced	28 935 (29)	313 (2)	20 848 (45)	5 727 (17)	2 047 (32)

CTG: cardiotocography; IA: intermittent auscultation; BMI: body mass index; CS: caesarean section; SD: standard deviation.
* Including pregestational (Type 1, Type 2, others) and Gestational Diabetes.
** Including Chronic hypertension, Gestational hypertension, Pre-eclampsia, HELLP or Eclampsia.
*** Categories according to the World Health Organization classification of BMI (31).

19 % with CTG only, 31 % with both IA and CTG, and no method was registered in 5 % (Table 2). Women >=30 years were less likely to be monitored with CTG (OR 0.88, 95 % CI; 0.83–0.93) compared to women in the < 30 years reference group. In terms of parity, nulliparous women were monitored with CTG more often compared to the reference group of multipara women (OR 1.58, 95 % CI; 1.49–1.69).

Table 2
Fetal monitoring method used, stratified by risk status.

	IA only n = 14 285	CTG only n = 46 214	IA and CTG n = 33 417	No method registered n = 6 317
Risk status at labour onset				
N = 100 233				
Low-risk*, n (%)	10 784 (26)	11 049 (27)	17 620 (42)	2 096 (5)
N = 41 549				
Unknown risk status**, n (%)	1 434 (18)	3 896 (48)	2 074 (25)	727 (9)
N = 8 131				
One or more risk factors present, n (%)	2 067 (4)	31 269 (62)	13 723 (27)	3 494 (7)
N = 50 553				
Low-risk at labour onset and straightforward birth*, n (%)**				
N = 21 282				
	9 481 (45)	3 997 (19)	6 592 (31)	1 212 (5)

CTG: cardiotocography; IA: intermittent auscultation.
* At term with a single fetus, cephalic presentation, with spontaneous onset of labour, maternal age < 40, Body mass index (kg/m2) < 35 prior to pregnancy, no previous caesarean deliveries or stillbirth, no chronic or pregnancy-related diseases or complications.
** Unknown due to missing data on BMI prior to pregnancy.
*** Births without oxytocin augmentation, epidural, assisted vaginal delivery, caesarean section, and meconium-stained amniotic fluid.

Compared to women born in "High-income countries", women born in "Other countries" (see Methods) were more likely monitored with CTG (OR 1.51, 95 % CI; 1.40–1.62).

Women who smoked prior to pregnancy were monitored with CTG more often than non-smoking women (OR 1.49, 95 % CI; 1.29–1.71). Further, underweight women (pre-pregnancy BMI < 18.5 kg/m^2) were more likely to be monitored with CTG (OR 1.14, 95 % CI; 1.00–1.31) compared to women with a normal BMI (18.50–24.99 kg/m^2). Similarly, overweight and obese women (BMI 25–34.99 kg/m^2) were more likely monitored with CTG (OR 1.31, 95 % CI; 1.23–1.4) compared to women with a normal BMI.

Compared to women giving birth at 39^{+0}–40^{+6} weeks, those at 37^{+0}–38^{+6} weeks were more likely monitored with CTG (OR 1.12, 95 % CI; 1.03–1.22). Likewise, those birthing at 41^{+0}–42^{+0} weeks were more often monitored with CTG (OR 1.22, 95 % CI; 1.14–1.31).

Units with 1–499 annual births were more likely to be monitored with CTG (OR 2.78, 95 % CI; 2.51–3.08) compared to deliveries in units with 3 000 or more births. Similarly, units with 500–1 499 and 1 500–2 999 annual births were also more likely to be monitored with CTG (OR 2.13, 95 % CI; 1.96–2.31 and OR 1.56, 95 % CI; 1.44–1.69) compared to those with 3 000 or more births.

Women giving birth in Western Norway (OR 0.80, 95 % CI; 0.74–0.86), Central Norway (OR 0.82, 95 % CI; 0.74–0.90), and Northern Norway (OR 0.30 95 % CI; 0.27–0.34) were less likely to be monitored with CTG compared to those giving birth in South-Eastern Norway (Table 3).

Discussion

Main findings

Most women in our 2019–20 cohort (80 %) were monitored with

Table 3
CTG monitoring in low-risk straightforward births, n = 21 282. Univariable, and multivariable adjusted odds ratios (OR) and 95 % confidence intervals (CI).

	CTG YES (n)	CTG NO (n)	Univariable analysis OR (95 % CI)	Multivariable analysis* OR (95 % CI)
Maternal age (years)				
<30	4 716	4 057	**Reference**	
>=30	5 873	6 636	**0.76 (0.72–0.80)**	**0.88 (0.83–0.93)**
Parity				
Nulliparous	3 253	2 414	**1.52 (1.43–1.62)**	**1.58 (1.49–1.69)**
Multiparous	7 336	8 279	**Reference**	
Maternal Origin (GBD) **				
Norway and other high-income countries***	8 052	8 745	**Reference**	
Other****	2 391	1 856	**1.4 (1.31–1.5)**	**1.51 (1.40–1.62)**
No data	146	92	**1.72 (1.33–2.24)**	**1.65 (1.26–2.17)**
Marital status				
Married/Partner	10 109	10 297	**Reference**	
Single	480	396	**1.23 (1.08–1.41)**	1.08 (0.94–1.24)
Smoking prior to pregnancy				
Yes	546	354	**1.59 (1.39–1.82)**	**1.49 (1.29–1.71)**
No	10 043	10 339	**Reference**	
Body mass index (kg/m^2)				
<18.5	531	476	**1.22 (1.08–1.39)**	**1.14 (1.00–1.31)**
18.50–24.99	6 930	7 598	**Reference**	
25.00–34.99	3 128	2 619	**1.31 (1.23–1.39)**	**1.31 (1.23–1.4)**
Weeks (+days) of Gestation				
37 + 0–38 + 6	1 689	1 560	**1.17 (1.08–1.26)**	**1.12 (1.03–1.22)**
39 + 0–40 + 6	6 628	7 154	**Reference**	
41 + 0–42 + 0	2 272	1979	**1.24 (1.16–1.33)**	**1.22 (1.14–1.31)**
Birthweight, g				
<3000	874	782	**1.15 (1.04–1.27)**	1.02 (0.92–1.14)
3000–3999	7 859	8 072	**Reference**	
>4000	1 856	1 839	1.04 (0.96–1.11)	1.08 (0.99–1.16)
Size of birth unit (number of births per year)				
1–499	1 652	1 252	**1.84 (1.69–2.00)**	**2.78 (2.51–3.08)**
500–1499	2 260	1 807	**1.74 (1.62–1.88)**	**2.13 (1.96–2.31)**
1500–2999	2 780	2 206	**1.76 (1.64–1.88)**	**1.56 (1.44–1.69)**
3000+	3 897	5 428	**Reference**	
Reginal Health Authority				
South-Eastern Norway	6 243	5 313	**Reference**	
Western Norway	2 348	3 018	**0.66 (0.62–0.71)**	**0.80 (0.74–0.86)**
Central Norway	1 260	1 194	**0.9 (0.82–0.98)**	**0.82 (0.74–0.90)**
Northern Norway	738	1 168	**0.54 (0.49–0.59)**	**0.30 (0.27–0.34)**

CTG: cardiotocography.

* Adjusted for Maternal age, Parity, Maternal Origin, Marital status, Smoking prior to pregnancy, Body mass index, Weeks of Gestation, Birthweight, Size of birth unit and Health region. The model's performance was evaluated using the Area Under the Receiver Operating Characteristic (ROC) curve (AUC). The AUC value was 0.64.

** Global Burden of Disease (GBD) regional classification system and Norway (27).

*** High income countries; West Europe, Southern Latin America, North America, Asia Pacific and Australasia.

**** Central Europe, Eastern Europe, and Central Asia, Sub-Saharan Africa, North Africa and the Middle East, Southern Asia, Southeast Asia, East Asia and Oceania, Latin America and the Caribbean.

CTG. Only 14 % were monitored exclusively with IA, while 46 % with CTG only. IA and CTG were combined in 34 % of births, with no method registered in 6 %. A Doppler device was used in 47 % of births and the Pinard stethoscope in 4 %.

In low-risk women, with straightforward births, 45 % were monitored with IA only and 50 % with CTG. In women with risk factors present, 89 % were monitored with CTG, 4 % were monitored with IA only, and 7 % had no methods registered.

Interpretation

While all Norwegian birth units reported access to the Pinard stethoscope in 2019 [16], it was only used in 4 % of the births in our study. This may indicate that the Doppler device is preferred for IA monitoring. An Irish study reported that midwives found the Pinard stethoscope impractical because the birthing woman had to change position for auscultation, and parents couldn't hear the fetal heart sound [27]. In contrast, a Norwegian study highlighted its utility in following the cardinal movements of the fetus, offering an alternative to some of the vaginal exams [28].

The results imply an overuse of CTG in situations where IA might have been adequate. While the data obtained in this study can reveal trends, it cannot provide a comprehensive understanding of the impacting factors. Our analysis indicates potential factors influencing CTG monitoring in low-risk and straightforward births; however, the AUC value of 0.64 suggests that random factors, such as local chance occurrences, could influence the outcome. Furthermore, individual midwives' attitudes and experiences with fetal monitoring might play a role [29].

Patients and users are permitted under law [30] to participate in decisions regarding treatment and care and give informed consent. In our experience, the method of fetal monitoring is usually not presented as a choice, and women are not asked to give consent. This practice may change in the future, as user's organisations put pressure on maternity wards to comply with the Patient and User Rights act [31]. However, it is unlikely that women's preferences of mode of fetal monitoring have influenced the results in the present study.

Previous research shows that in busy periods, when it is not possible to perform one-to-one midwifery care, CTG can be used as "a babysitter" and without medical indication [32]. While busy periods may contribute to the overuse of CTG, this alone does not account for the fact that half of all low-risk women with straightforward births were monitored with CTG. And it cannot explain why units with less than 500 births annually use CTG more than larger units. Sub-group analysis revealed that most of these smaller units are Level 2 units that are spread across Norway. Level 2 units do not include neonatal intensive care units [22], which may have affected midwives' choice in fetal monitoring method.

A study from Statistics Norway [33] found that primiparous women admitted on busy days received less intra-partum interventions, and their babies had better Apgar scores than women admitted on less busy days. The author concluded that there is overtreatment in Norwegian maternity wards during slow periods and introduced a hypothesis that midwives and doctors perform more interventions when there is spare capacity. If this is true, it could contribute to explain our findings of smaller and less busy units use more CTG in low-risk women than bigger units.

Sub-group analysis shows four of five units with 3 000 + births are Level 1 units with "alongside midwifery-led units," likely influencing the results and causing discrepancies.

In South-Eastern Norway, which encompasses most of the Level 1 and 2 units, low-risk births are more likely to be monitored with CTG than in the other three regions. In contrast, in Northern Norway, low-

risk births were much less likely to be monitored with CTG. About half of births in Northern Norway occurred in two different Level 1 units, which notably have the lowest percentage of CTG use in low-risk births among Level 1 units. We lack data on staffing levels in the different birth units. According to national quality requirement guidelines [22], which all units were expected to follow, the staffing must be adequate to ensure appropriate monitoring and treatment as well as complying with one-to-one midwifery care for women in active labour. Due to our experience, it is usually busier in bigger units than in smaller, and there are situations where there is shortage of staff. There is a need to investigate the differences in use of modes of fetal monitoring between the health regions in more detail and explore whether different cultures for fetal monitoring may play a role.

We question whether midwives and doctors see CTG use without specific indication as a problem. Prior studies have demonstrated that professionals feel unsecure when using IA, viewing CTG as a hard copy "proof" of an uncompromised baby, using CTG as a "babysitter" during busy periods, and that organisational cultures drive the use of CTG, [29,32,34]. Moreover, the perception of risk by midwives and doctors influences individual decisions regarding choice of fetal monitoring method [29]. These perceptions of risk, likely influenced by past experiences, not only affect individual decisions but also shape the norms in the birth unit. Our regression analysis results suggest a pattern of reduced CTG usage in categories that align closely with what is considered normal or low-risk parameters, such as normal BMI (18.50–24.99 kg/m^2), and near-term GA (39^{+0}–40^{+6}). This suggests a preference for CTG monitoring even in borderline low-risk births, aligning with previous research on overestimating risk in low-risk births [35]. The infrequent use of IA suggests limited opportunities for midwives and doctors to practice and get comfortable with the technique, thereby reducing its future use.

Our study suggests maternal factors like age and parity may influence CTG use in low-risk births. Even though risk of complications during childbirth is known to increase with age, with no clear cut-off point [36], our findings show that women over 30 years of age have less chance of CTG monitoring compared to those under 30. Nulliparous women were more likely monitored with CTG. This could be attributed to the typically longer duration of labour and the increased incidence of complications during births involving nulliparous women [37].

Norwegian quality requirement guidelines state that women from certain countries have a higher risk of birth complications and recommend tailored care during birth [22,38,39]. Studies have confirmed that migrant women in high-income countries, have an increased risk of fetus being small for the gestational age (SGA) [40]. Our findings corroborate this notion by revealing women with maternal origins outside Norway or other high-income regions had higher chance of CTG monitoring. Although speculative, language barriers may influence midwives' choice of fetal monitoring method.

In women with risk factors at labour onset, 89 % underwent CTG monitoring, indicating guideline adherence [7]. In seven percent, no method was registered. Rapid labour could explain some of these cases, it is also plausible that CTG was used but not properly registered. These potential inaccuracies should be accounted for while interpreting our findings.

Four percent of women with risk factors for fetal compromise were monitored with IA only, despite guideline recommendations. As the proportion of women with risk factors who received out-of-guideline fetal monitoring was small, and existing evidence has not proven that CTG monitoring improves neonatal outcomes [2,6] the clinical impacts are probably small.

Strengths and limitations

To our knowledge, this is the first study to investigate fetal monitoring method practices using a population-based registry. The main strength of this study is the large, population-based nationwide sample. Since MBRN is a registry that includes all births in Norway, there was no selection bias in the sample population. Missing value rates were overall low and validation studies on the MBRN have confirmed data reliability [41].

A limitation of this study is the absence of data on duration and timing of the fetal monitoring methods used. Consequently, it remains unclear whether a woman was monitored solely with admission CTG or continuously with CTG throughout the birth. Additionally, we lack clinical information about abnormal IA findings and maternal infections.

Conclusion

Our study found that CTG monitoring was used in 80 % of births regardless of risk status, while IA was exclusively used in just 14 % of births. CTG was used in half of all low-risk, straightforward births, suggesting an overuse of CTG according to guideline recommendations. We observed a tendency for CTG monitoring in low-risk births with borderline risk factors, supporting previous research suggesting that midwives may overestimate the risk of complications. To understand the reasons for the deviation from fetal monitoring guidelines, and its clinical consequences, further research is necessary. There is a need to take action to reduce unnecessary use of CTG in Norwegian maternity wards.

Ethics statement

MBRN released an anonymized study file without personal data for this study. The need for informed consent for the participating women in the MBRN was waived as all data received were unidentified. The Regional Committee for Medical and Health Research Ethics of Northern Norway (REK) approved the use of data from the NMBR (approval number 280390. September 2021).

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Author contribution

K.J.A, E.B, A.D.P and A.K contributed to the conceptualization and the design of the study. K.J.A analysed the data, wrote the original draft, and is responsible for review and editing. A.H.P supported data analysis and management. R.D, A.D.P, A.C.S, and A.K contributed by providing critical comments to the analyses, performing data interpretation, and reviewing and writing of the article. All authors have approved the final manuscript.

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CRediT authorship contribution statement

Kristin Jerve Aanstad: Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Are Hugo Pripp:** Writing – review & editing, Formal analysis, Data curation. **Rebecka Dalbye:** Writing – review & editing, Supervision, Methodology, Formal analysis. **Aase Devold Pay:** Writing – review & editing, Supervision, Conceptualization. **Anne Cathrine Staff:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Anne Kaasen:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Ellen Blix:** Writing – review & editing, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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