Midwifery 118 (2023) 103572

Contents lists available at ScienceDirect

Midwifery

journal homepage: www.elsevier.com/locate/midw

Trends in perinatal outcomes of women with chronic medical conditions: A 10-year population-based study in the Netherlands

Ageeth N. Rosman[a,b,*], Hanneke W. Harmsen van der Vliet - Torij[a], Sander R. Hilberink[a]

[a] Rotterdam University of Applied Sciences, Research Center of Innovations in Care, P.O. Box 25035, 30001 HA Rotterdam, The Netherlands
[b] Perined, Mercatorlaan 1200, 3528 BL Utrecht, The Netherlands

ARTICLE INFO

Article history:
Received 22 June 2022
Revised 14 November 2022
Accepted 4 December 2022

Keywords:
Chronic medical condition
perinatal outcome
mode of birth

ABSTRACT

Objective: To gain insight into perinatal outcomes in women with chronic medical conditions, in order to contribute to the optimization of personalized perinatal care. We hypothesize that women with a chronic medical condition have poorer perinatal outcomes than women without a known chronic medical condition.
Design: Population-based study using data of the Netherlands Perinatal Registry between 2010-2019.
Setting: Nationwide study in the Netherlands.
Participants: Pregnancies of women who were diagnosed with chronic medical conditions by a medical specialist before pregnancy (n=36,835), divided into seven sub-groups and a reference group of pregnancies of women without known chronic medical conditions (n=1,084,623).
Measurements and findings: The primary outcome measure was mode of birth. Secondary outcomes measures were onset of labour, preterm birth, asphyxia, Neonatal Intensive Care Unit (NICU) admission, and perinatal mortality. Spontaneous birth ranged from 45.0% (orthopaedic conditions) to 71.3% (neurological conditions) to 82.6% in the reference group. Assisted vaginal birth, planned caesarean birth, and emergency caesarean birth occurred significantly more in all groups compared to the reference group ($p<0.001$). Preterm birth was significantly more likely in the studied groups as well as perinatal asphyxia and NICU admission (all $p<0.001$). Adjusting for mode of birth, parity, age and ethnicity did not change the outcomes for the group of women with chronic medical conditions. Perinatal mortality was seen in all groups but in none of the separate groups significantly more than in the reference group. Descriptive statistics, univariate and multivariable logistic regression analyses were applied.
Key conclusions: Women with chronic medical conditions are more likely to experience preterm birth, caesarean births and NICU admission of the new-born.
Implications for practice: Knowledge about perinatal outcomes of women with chronic medical conditions is a first step for obstetrics care providers in order to optimize personalized care.

Introduction

In the Netherlands, the percentage of women with chronic medical conditions (CMC) before pregnancy is increasing. According to Statistics Netherlands in 2019, 29.8% of all women between 20-40 years old had at least one chronic medical condition (Statline, 2019). Endocrine conditions, respiratory and cardiovascular diseases are the most prevalent among women with CMC (4.5%, 9.2% and 22.3% respectively) (Statline, 2019). Hence, midwifery and medical professionals will more often provide care to women with known CMC We hypothesize that women with CMC are at higher risks of adverse perinatal outcomes than women without a known CMC indicating a probably necessity to optimize or customize personalized perinatal care.

Research of perinatal outcomes mostly focuses on specific conditions, such as endocrine (diabetes) or cardiovascular (hypertension) diseases or on physical disabilities (Angras et al., 2021; Deierlein et al., 2021; Relph et al., 2021;). Diabetes or thyroid conditions are risks factors for perinatal complications such as perinatal mortality, perinatal asphyxia or impaired foetal growth and congenital malformations (Ornoy et al., 2021). In their study, which focused on women with various disabilities Clements et al. (2016) concluded that these women were more likely than women without disabilities to have poorer perina-

* Corresponding author at: Research Center Innovations in Care, Rotterdam University of Applied Sciences, 3015 EK Rotterdam, The Netherlands
E-mail address: a.n.rosman@hr.nl (A.N. Rosman).

https://doi.org/10.1016/j.midw.2022.103572

tal outcomes such as preterm birth (aOR 1.2 (95%CI 1.1-1.4) (Clements et al., 2016).

In the Netherlands, extensive research has been undertaken on pregnancies complicated by chronic endocrine conditions (GlucoMOMS study; Voormolen et al., 2018) or cardiovascular diseases (Amsterdam Born Children Development (ABCD) study; Beer et al., 2010). Among others these studies showed that different methods of monitoring of glucose levels during pregnancy did not improve perinatal outcomes of mothers with pre-gestational diabetes. The ABCD-study researched maternal pre-existent hypertension and infant growth. Children of mothers with pre-existent hypertension showed almost twice as much (OR 1.89; 95% CI 1.21–2.97)often catch-up grow in the first 14 months after birth than of children of women without pre-existent hypertension (Beer et al., 2010).

Recently, a systematic review by Heideveld-Gerritsen et al. (2021) concluded that women with physical disabilities experience more barriers when accessing perinatal care. They also concluded that there was a lack of knowledge among healthcare professionals regarding perinatal outcomes of women with physical disabilities This resulted in a lack of awareness of the special needs of women with disabilities, which if addressed could improve clinical practice.

Although some of the consequences of specific chronic conditions on general health are known, a comprehensive oversight of what is known relating to perinatal outcomes of pregnancies of women with CMC is lacking. Therefore, the aim of this study was to describe perinatal outcomes of women with CMC, diagnosed before pregnancy, and to compare these outcomes with a reference group of women without known CMC.

Methods

Study design

A nationwide population-based study was performed using data from the Netherlands Perinatal Registry (Perined) from 01 January 2010 to 31 December 2019.

Setting

The Netherlands Perinatal Registry links data from primary care midwives with data from obstetricians, clinical midwives, and paediatricians in secondary and tertiary care hospitals by a validated linking procedure, which are collated in the form of an annual report (Perined, 2021). Collectively, this results in a nationwide database containing data on 96% of all pregnancies and births in the Netherlands, which is made available for research. Firstly we identified women with a chronic medical condition (yes/no) framework, then filtered the results relating to the type of chronic medical condition. This resulted in seven groups of CMC. We used diagnosis codes contained within the perinatal registry to identify pregnancies of women with CMC (Supplementary file S1). As women could appear more than once in the database, for example, if they have had more than one pregnancy in the study period this meant that the numbers mentioned in the study population do not always correspond one -to-one with the number of women actually with a CMC.

Study population

Pregnancies of women who were diagnosed with CMC by a medical specialist before pregnancy were firstly grouped as a total and secondly divided into seven sub-groups having a neurological, respiratory, cardiovascular, endocrine, internal, mental health condition, or an orthopaedic condition. The reference group consisted of pregnancies of women without known CMC.

Data collection

Data collection was done at the level of the mother.

Outcome measures

The primary outcome measure of this study was mode of birth (spontaneous, assisted vaginal birth, planned, or emergency caesarean birth). Secondary outcome measures were preterm birth, divided into early preterm birth (24+0 weeks - 31+6 weeks gestation) and late preterm birth (32+0 weeks - 36+6 weeks gestation), and onset of labour (spontaneous, induction). Neonatal outcomes were birthweight (grammes), perinatal asphyxia defined as Apgar score <7 at five minutes after birth, neonatal intensive care unit (NICU) admission for at least 24 hours, and perinatal mortality. We also collected the baseline characteristics of age, parity and ethnicity to test comparability to the reference group.

Statistical analysis

We used two different processes of statistical analysis to ascertain statistically significant differences between cohorts. Firstly, we compared perinatal outcomes of all women with CMC (total group CMC) to the reference group. Secondly, perinatal outcomes of the seven sub-groups of women with CMC were compared with the reference group by univariate and multivariate logistic regression analyses.

Baseline characteristics and perinatal outcomes were compared with the reference group by using the Chi-squared test and student T-tests. Mode of birth was adjusted for age, parity and onset of labour. Preterm birth, onset of labour and planned Caesarean births were adjusted for age, parity and ethnicity. Neonatal outcomes were adjusted for parity, age, ethnicity and mode of birth. The statistical analyses were performed using SPSS statistical software, version 27.0 (IBM SPSS Statistics Faculty Pack 27 for Windows). Unless stated otherwise, all results are given in absolute numbers and percentages, Odds Ratios, and adjusted Odds Ratios (aORs).

Results

During the study period (Jan 1st 2010- Dec 31rd 2019), 36,835 pregnancies of women with a chronic medical condition were identified and presented as total group of women with CMC. This group of women were divided into seven sub-groups: neurological condition (N=3,191), respiratory condition (N=1,491), cardiovascular condition (N=10,733), endocrine condition (N=13,106), internal condition (N=3,666), mental health condition (N=4,335), and orthopaedic condition (N=313). Also, a reference group of 1,084,623 women without a known chronic medical condition of the same period was composed. Over the years the percentage of women with a known chronic medical condition varied between 2.7% in 2010 to 4.0% in 2013, 2015 and 2016 and decreased to 3.3% in 2019. In the whole study period the average percentage of women with CMC among all pregnant registered in the perinatal registry, was 3.6% corresponding with absolute numbers of a minimum of 2,753 women in 2019 and a maximum number of 4,349 in 2012 (Please note: this data is not included in table 1).

Women with CMC were significantly older than the reference group ($p<0.001$) for all CMC groups except for the orthopedic group which had a p-value of 0.003. There were no significant difference in parity ($p=0.130$) or ethnicity ($p=0.073$) and the reference group. Except for the endocrine sub-group ($p=0.688$), multiparity was significant lower among women with a neurological, respiratory, internal, mental health disease and orthopedic condition (p-value varied between <0.001 – 0.009). Ethnicity var-

Table 1
Demographics study population and reference group over the years 2010-2019.

	Age (mean, SD)	p-value	Parity (N; % multiparous)	p-value	Etnicity (N; % Western)	p-value
Total group (n=36,741)	31.9 (4.9)	<0.001	21,092 (57.4)	0.130	33,559 (91.3)	0.073
Neurological group (n=3,185)	31.2 (4.7)	<0.001	1,672 (52.5)	<0.001	3,029 (95.1)	<0.001
Respiratory group (n=1,489)	31.2 (5.3)	<0.001	827 (55.5)	0.009	1,339 (89.9)	0.121
Cardiovascular group (n=10,703)	32.4 (4.9)	<0.001	6,625 (61.9)	<0.001	9,832 (91.9)	0.004
Endocrine group (n=13,065)	32.0 (4.9)	<0.001	7,486 (57.3)	0.688	11,642 (89.1)	<0.001
Internal group (n=3,659)	31.2 (4.5)	<0.001	1,963 (53.6)	<0.001	3,487 (95.3)	<0.001
Mental health group (n=4,237)	31.6 (5.6)	<0.001	2,366 (54.7)	0.001	3,938 (91.0)	0.809
Orthopedic group (n=313)	31.5 (4.9)	0.003	153 (48.9)	0.003	292 (93.3)	0.169
Reference group (n= 1,084,623)	30.6 (4.8)		620,473 (57.2)		987,717 (91.1)	

ied in the sub-groups: There were more women with a western ethnicity in the neurological sub-group (p<0.001), cardiovascular group (p=0.004) and the internal sub-group (p<0.001). Significantly less western women were present in the endocrine subgroup (p<0.001). Details are presented in table 1.

Table 2 shows results related to the primary outcome measure 'mode of birth. Spontaneous birth occurred in two thirds of all women with CMC but less often than in the reference group (66.0% versus 82.6%). For women with CMC (total and sub-groups) significantly more women had assisted vaginal births (p<0.001), planned caesarean birth (p<0.001), and emergency caesarean birth (p<0.001) than in the reference group. After adjusting for age, parity, ethnicity, and onset of labour the significant differences disappeared for planned Caesarean births for women with a respiratory condition, mental health condition, and orthopaedic conditions. Rates of induction of labour were more than double among women with CMC than in women without CMC (25.8% versus 10.1%; p<0.001) (supplementary file S2, onset of labour).

Preterm birth occurred more frequently in all CMC groups than in the reference group (5.9% to 11.3% versus 4.9%) (Table 3). After adjusting for age, ethnicity and parity, preterm birth occurred significantly more often in women with a cardiovascular (aOR 1.656), endocrine (aOR 2.346), internal (aOR 1.576), and mental health condition (aOR 1.484). In the total group of women with CMC, early preterm birth occurred significantly more often than in the reference group (p<0.001). A significant difference remained after adjusting for age, parity, and ethnicity for women with a cardiovascular, endocrine, and internal condition. Late preterm birth was more likely to occur in the total group of women with CMC when compared to the reference group (p<0.001). More specifically, late preterm birth occurred significantly more often in women with a cardiovascular, endocrine, internal, mental health, and orthopaedic conditions after adjustment for age, parity, and ethnicity (p<0.001).

Neonatal outcomes (birthweight, perinatal asphyxia, NICU admission, perinatal mortality) are shown in Table 4. Neonates of women with CMC had significantly lower birthweights (range 3,275-3,427 grammes) than in the reference group (range 2,882-4,016grammes)(p=0.031). Perinatal asphyxia was also significantly more present in all sub-groups of women with CMC (aOR 1.124 – 3.039). Adjusted Odds ratios on NICU admission showed that this was significantly higher in all CMC groups than in the reference group (aOR 1.463 – 3.828). When compared with the reference group, perinatal mortality occurred significantly more often in the total group of women with CMC (p=0.018). However, within the sub-groups, perinatal mortality was not significantly higher than in the reference group.

Discussion

This study showed that women with CMC have elevated risks for adverse perinatal outcomes when compared to a reference group. The majority of women gave birth spontaneously except for women with orthopaedic conditions who had significantly more caesarean births. Women with endocrine conditions were most at risk for preterm birth. Early preterm birth was significantly more present in women with cardiovascular, endocrine, or internal conditions. Lower birthweight, perinatal asphyxia and NICU admission occurred significantly more often in all groups with CMC. Perinatal mortality occurred in all groups of women with CMC but not significantly more than in the reference group.

Comparison to literature

A study of Mitra et al. (2015) found that approximately 7% of the women who gave birth to a child had a disability. This number exceeds the number of women with CMC we found. We identified an average percentage of women with CMC in the Netherlands of 3.6% over the years 2010-2019.

We cannot be certain on the difference in percentages (7% in the study of Mitra and 3.6% in the database of Statline, the Netherlands which is another database than the Perined database) however, there are a number of possible explanations, including women with CMC are less likely to experience a pregnancy (Horner-Johnson, 2017) or a poor registration of CMC in the Netherlands Perinatal Registry. The latter can be due to an extensive menu options of the registry including non-obligatory items or prioritizing reasons for secondary or tertiary care (Perined, 2020).Tarasoff et al. (2020) published a systematic review and meta-analysis about maternal disability and risk for pregnancy and postpartum complications. Results showed that women with disabilities (physical, sensory, intellectual and developmental) had increased risks for caesarean births (OR 1.29 (95%CI 1.02-1.63) however, there was a lack of homogenesis in the studies compared and some studies were of low evidence or there was no control for confounding variables (Tarasoff et al., 2020). Our study also showed increased risks for caesarean births in general (aOR 1.091 (95%CI 1.047-1.137) and more specifically, emergency caesarean births for all CMC (aOR 2.717 (95%CI 2.624-2816) . We also found significantly more instrumental vaginal births in women with CMC (aOR1.677 (95% CI 1.611-1.746).

Induction of labour was higher in all CMC groups than in the reference group (aOR 3.650 (95%CI 3.544-3.759), supplementary file S2). Our perinatal registry lacks information about indications for induction of labour, so we were not able to analyse the real indications for induction of labour. However, we assume that most inductions are guideline-or evidence-based, especially for women with endocrine, cardiovascular, or respiratory conditions (Voormolen et al., 2018; Sonnaville et al., 2020; Xu et al., 2022). Induction of labour is often considered when the risks of staying pregnant no longer outweigh the risks of an early delivery. A review of Papalia, D'Souza and Hobson (2022) studied recent evidence for the most common indications for induction of labour such as gestational diabetes, hypertensive disorders, liver diseases

Table 2
Mode of birth.

	Spontaneous birth	Instrumental, vaginal birth				Planned Cesarean birth				Emergency Cesarean birth				Unknown
	N(%)	N(%)	p-value	OR (95%CI)	aOR (95%CI)	N(%)	p-value	OR (95%CI)	aOR (95%CI)	N(%)	p-value	OR (95%CI)	aOR (95%CI)	N (%)
Total group chronic conditions (n=36,348)	24,001 (66.0)	3,091 (8.5)	<0.001	1.927 (1.855-2.000)	1.677 (1.611-1.746)	4,277 (11.8)	<0.001	2.687 (2.610-2.765)	1.091 (1.047-1.137)	4,159 (11.4)	<0.001	2.557 (2.484-2.633)	2.717 (2.624-2.816)	820 (2.3)
Neurological disease (n=3,153)	2,251 (71.3)	300 (9.5)	<0.001	1.946 (1.730-2.188)	1.628 (1.438-1.843)	269 (8.5)	<0.001	1.806 (1.612-2.023)	0.918 (0.960-0.976)	278 (8.8)	<0.001	1.826 (1.634-2.041)	1.824 (1.605-2.072)	56 (1.8)
Respiratory disease (n=1,471)	1,029 (70.0)	132 (9.0)	<0.001	1.879 (1.577-2.242)	1.686 (1.399-2.033)	109 (7.4)	<0.001	1.625 (1.359-1.942)	0.811 (0.657-1.002)	167 (11.4)	<0.001	2.318 (2.014-2.669)	2.524 (2.133-2.985)	34 (2.3)
Cardiovascular disease (n=10,584)	7,285 (68.8)	811 (7.7)	<0.001	1.610 (1.501-1.730)	1.404 (1.301-1.516)	1,143 (10.8)	<0.001	2.318 (2.195-2.448)	1.105 (1.029-1.185)	1,113 (10.5)	<0.001	2.215 (2.096-2.340)	2.338 (2.189-2.496)	232 (2.2)
Endocrine disease (n=12,936)	7,933 (61.3)	1,235 (9.5)	<0.001	2.145 (2.016-2.277)	1.861 (1.744-1.986)	1,726 (13.3)	<0.001	3.094 (2.962-3.231)	1.209 (1.133-1.291)	1,822 (14.1)	<0.001	3.167 (3.036-3.303)	3.506 (3.324-3.699)	313 (2.4)
Internal disease (n=3,622)	2,386 (65.9)	305 (8.4)	<0.001	1.926 (1.718-2.159)	1.667 (1.476-1.881)	582 (16.1)	<0.001	3.353 (3.116-3.607)	0.911 (0.963-0.980)	265 (7.3)	<0.001	1.666 (1.486-1.868)	1.676 (1.472-1.908)	84 (2.3)
Mental disease (n=4,280)	2,981 (69.6)	380 (8.9)	<0.001	1.831 (1.651-2.032)	1.550 (1.386-1.732)	345 (8.1)	<0.001	1.758 (1.591-1.943)	1.042 (0.901-0.157)	479 (11.2)	<0.001	2.300 (2.116-2.500)	2.370 (2.146-2.617)	95 (2.2)
Orthopedic disease (n=302)	136 (45.0)	21 (6.9)	<0.001	2.315 (1.486-3.597)	2.018 (1.255-3.244)	104 (34.4)	<0.001	7.352 (6.364-8.495)	1.159 (0.659-2.039)	35 (11.6)	<0.001	3.406 (2.536-4.575)	3.819 (2.600-5.609)	6 (1.9)
Reference group (n = 1,081,046)	893,154 (82.6)	59,403 (5.5)				53,445 (4.9)				54,912 (6.1)				20,132 (1.8)

*adjusted for age, parity, ethnicity, onset of labor.
^significance and (adjusted) Odds ratio's are calculated for the total group of chronic conditions and for every specific chronic condition to the reference category and for induction of labor, planned cesarean birth and emergency cesarean birth with the reference category of onset of labor = spontaneous.

Table 3
Secondary outcomes: preterm birth.

	Preterm birth (AD 24+0 – 36+6 weeks)				Early preterm birth (AD 24+0 – 31+6 weeks)				Late preterm birth (AD 32+0-36+6 weeks)			
	N (%)	p-value	OR (95% CI)	aOR (95% CI)*	N (%)∞	p-value	OR (95% CI)	aOR (95% CI)*	N (%)∞	p-value	OR (95% CI)	aOR (95% CI)*
Total group chronic conditions (N=36,348)	3,328 (9.2)	<0.001	1.778 (1.720-1.839)	1.829 (1.763-1.897)	342 (10.3)	>0.001	1.574 (1.403-1.754)	1.543 (1.383-1.722)	2,923 (87.8)	<0.001	1.836 (1.772-1.903)	1.883 (1.811-1.958)
Neurological disease (n=3.191)	195 (6.1)	0.023	1.172 (1.023-1.343)	1.143 (0.989-1.322)	#	0.119	1.356 (0.924-1.990)	1.313 (0.892-1.934)	#	0.057	1.157 (0.996-1.343)	1.126 (0.961-1.318)
Respiratory disease (n=1.491)	88 (5.9)	0.277	1.134 (0.926-1.388)	1.120 (0.902-1.390)	#	0.988	1.005 (0.524-1.928)	0.977 (0.507-1.883)	#	0.173	1.164 (0.936-1.447)	1.152 (0.915-1.450)
Cardiovascular disease (n=10.733)	890 (8.3)	<0.001	1.602 (1.504-1.707)	1.656 (1.545-1.775)	110 (12.4)	<0.001	1.719 (1.425-2.073)	1.720 (1.422-2.079)	762 (85.6)	<0.001	1.610 (1.502-1.725)	1.658 (1.539-1.786)
Endocrine disease (n=13.106)	1.481 (11.3)	<0.001	2.223 (2.119-2.333)	2.346 (2.221-2.478)	136 (9.2)	<0.001	1.742 (1.471-2.062)	1.697 (1.431-2.014)	1,345 (90.8)	<0.001	2.347 (2.230-2.471)	2.470 (2.332-2.616)
Internal disease (n=3.666)	299 (8.2)	<0.001	1.567 (1.405-1.747)	1.576 (1.400-1.776)	#	0.019	1.499 (1.066-2.107)	1.466 (1.040-2068)	#	<0.001	1.586 (1.410-1.785)	1.589 (1.399-1.804)
Mental disease (n=4.335)	335 (7.7)	<0.001	1.486 (1.340-1.647)	1.484 (1.327-1.660)	#	0.853	1.036 (0.711-1.510)	0.998 (0.683-1.459)	#	<0.001	1.530 (1.370-1.709)	1.528 (1.356-1.721)
Orthopedic disease (n=313)	#	0.038	1.506 (1.026-2.210)	1.456 (0.958-2.211)	#	0.535	0.544 (0.077-3.849)	0.505 (0.071-3.595)	#	0.009	1.693 (1.143-2.508)	1.647 (1.075-2.522)
Reference group (n=1,117,394)	55,655 (4.9)				6,461 (11.6)				47,342 (85.1)			

* Adjusted for age, ethnicity and parity
# due to privacy rules of Perined, we are not allowed to report the absolute numbers
∞ discrepancies in the sum of early and late preterm birth to the total of preterm births are due to unknown gestational ages

Table 4
Neonatal outcomes.

	Birthweight			Perinatal asphyxia			NICU admission				Perinatal mortality up to 28 days post partum	
	N (%)	Mean (SD)	p-value*	N (%)	p-value	OR (95% CI)	aOR (95% CI)*	N (%)^	p-value	OR (95% CI)	aOR (95% CI)*	(‰)	p-value
Total group chronic conditions (n=36,348)	36,346 (100)	3341 (596)	0.031	831 (7.3)	<0.001	2.337 (2.179-2.506)	1.697 (1.575-1.828)	518 (1.4)	<0.001	2.461 (2.251-2.693)	1.955 (1.780-2.147)	0.71	0.018
Neurological disease (n=3,191)	3,191 (100)	3,341 (569)	0.009	#	0.003	1.524 (1.154-2.014)	1.296 (0.975-1.724)	#	0.002	1.729 (1.2130-2.4209)	1.463 (1.026-2.088))	0.63	0.638
Respiratory disease (n=1,491)	1,491 (100)	3,292 (542)	0.009	#	0.010	1.666 (1.129-2.459)	1.268 (0.844-1.906)	#	0.002	2.020 (1.275-3.199)	1.657 (1.025-2.678)	0.68	0.687
Cardiovascular disease (n=10,733)	10,724 (99)	3,275 (595)	0.028	187 (1.8)	<0.001	1.743 (1.510-2.011)	1.311 (1.128-1.525)	148 (1.4)	<0.001	2.334 (1.985-2.744)	1.871 (1.576-2.220)	0.85	0.056
Endocrine disease (n=13,106)	13,096 (99)	3,427 (620)	0.002	330 (2.6)	<0.001	2.543 (2.283-2.834)	1.660 (1.478-1.864)	193 (1.5)	<0.001	2.502 (2.171-2.884)	1.885 (1.625-2.187)	0.70	0.198
Internal disease (n=3,666)	3,664 (99)	3,310 (574)	0.013	71 (2.0)	<0.001	1.926 (1.529-2.426)	1.529 (1.201-1.945)	#	<0.001	2.239 (1.694-2.960)	1.836 (1.370-2.461)	0.83	0.292
Mental disease (n=4,335)	4,334 (99)	3,288 (558)	0.016	163 (3.8)	<0.001	3.770 (3.239-4.387)	3.039 (2.583-3.576)	67 (1.6)	<0.001	2.596 (2.045-3.296)	2.191 (1.711-2.805)	0.47	0.971
Orthopedic disease (n=313)	313 (100)	3,304 (517)	0.004	# (2.0)	0.095	1.946 (0.881-4.299)	1.124 (0.498-2.535)	#	<0.001	5.465 (2.969-10.056)	3.828 (2.030-7.219)	0.0	n.a.
Reference group (n=1,116,414)	1,080,068 (97)	3,439 (557)		10,617 (0.94)				6,297 (59.3)				0.45	

* adjusted for parity, age, ethnicity and mode of birth
^ percentage of total born neonates
# due to privacy rules of Perined we are not allowed to present the absolute numbers

and post-term pregnancy. The researchers summarized considerations in relation to the timing of labour induction for common clinical indications (which is often before 40 weeks gestation) but also stated that induction of labour should be part of the total picture of the mother.

In 2017 Rejnö et al. (2017) published a population-based family design study of pregnant women with asthma and their sisters without asthma. In this study, women with asthma were at higher risk for pre-eclampsia (aOR 1.17 (95%CI 1.13-1.21), emergency caesarean birth (aOR 1.24 (95%CI 1.22-1.27), or having a child small for gestational age (aOR 1.18 (95%CI 1.12-1.23)) (Rejnö et al., 2017). A systematic review and meta-analysis of Bramham et al (2014) showed increased risks for adverse perinatal outcomes for women with chronic hypertension. Preterm delivery < 37 weeks gestation (OR 2.7 (95%CI 1.9-3.6)), neonatal unit admission (OR 3.2 (2.2-4.4)) and perinatal death (OR 4.2 (2.7-6.5)) if compared to a general population (Bramham et al., 2014). These results are comparable to our results for women with respiratory conditions. The systematic review and meta-analysis of Xu et al. (2022) showed similar results (Xu et al., 2022). In our study we could not specify sub-groups within the main categories but according to Statline (2021) among women aged 20-40 years, asthma and chronic obstructive pulmonary disease (COPD) are the most diagnosed respiratory conditions (12.2%) (Statline, 2021). We also found elevated Caesarean birth rates: adjusted OR rates varied from 1.210 (95%CI 1.146-1.277) to 2.794 (2.706-2.886) except for women with internal conditions (aOR 0.966 (95%CI 0.892-1.047)).

Neonates of women in all sub-groups of CMC had significantly lower birthweights than in the reference group. This conforms with the findings of other study results (Rejnö et al.(2017),Xu et al. (2022)).

We found significantly more perinatal deaths in the total group of women with CMC if compared to women without CMC but not if we looked at the groups separately. To explain the difference in perinatal deaths, in depth analyses of all perinatal mortality cases is necessary. This could be done for example by performing perinatal audits on perinatal mortality or by undertaking case studies.

Strengths and limitations

Broad insight in perinatal outcomes of women with CMC was lacking in the Netherlands. Due to a reliable perinatal registry we were able to select these women and to compare their outcomes with a reference group. Firstly, we identified women with chronic medical conditions using a (yes/no) analysis of the Perined database. We then filtered this data based on type of chronic medical condition which resulted in seven sub-groups of CMC. However, the perinatal registry has a restricted number of subcategories which can be registered. A woman can have more than one disease out of different main categories which can't be registered separately. Therefore, we are unaware of how many women have more than one chronic medical condition. This is a limitation of the study which can influence the generalizability of our results.

While the perinatal registry is comprehensive it is however not 100% inclusive for all indications. For example the registration does not have information about indications for caesarean sections or induction of labour. In addition, causes of perinatal mortality are specified in categories such as neurological problems, chromosomal abnormalities or metabolic diseases. Therefore, we could not perform in-depth analyses which may have been more helpful when interpreting the results.

Nevertheless, in so far as we know, this is one of the first studies in which outcomes of women with several CMC are compared to a reference group. However, the distinct (but collective) nature of the seven sub-groups hampers insight into outcomes of women with specific conditions or disabilities.

Conclusion and recommendations

Our aim in this study was to gain insight into perinatal outcomes in women with chronic medical conditions, in order to fill a lacunae of knowledge relating to (potential) special needs for women with CMC in prenatal care and during labour. By publishing perinatal outcomes of these women in scientific journals but also in nationwide guidelines, in letters to professional organisations in the Netherlands such as the Dutch Society of Obstetricians and Gynaecologists (NVOG) and the Royal Organisation of Midwives (KNOV) our study can contribute to the optimization of personalized prenatal care. Our study results suggest that women with chronic medical conditions more likely to experience preterm birth, caesarean deliveries, NICU admission of the newborn, and increased perinatal mortality. With regard to future research, it would be interesting to gain more insight into the reasons for these outcomes and whether these are related to the medical condition of the pregnant woman, her preferences, or to the advice or intervention of their health provider. Furthermore, as we assume under-reporting of pregnancies of women with a known chronic medical condition in our database, we need to pay attention to this gap in the registration of data in our health information system.

It is important to incorporate data relating to perinatal outcomes of women with chronic medical conditions within curricula and practice of both midwifery and obstetric professionals and other professionals in order to adequately equip them to provide personalized care to these women. At this moment this is an under represented aspect in the training of midwives and obstetricians. Student midwives can immerse themselves in a non-compulsory elective course during the regular education programme.

It is important that care can be provided in close collaboration with women and that with professionals have up-to-date expertise about pregnancy and childbirth. This is particularly relevant where women have specific needs. The outcomes of our study can contribute to a better understanding by equipping maternity service providers as well as other professionals involved in the care of pregnant women and their families, with specific knowledge and skills regarding special needs for women with a chronic medical condition.

Ethical approval

Ethical approval was not necessary for this study. Informed consent of individual women was not required. In the Netherlands every woman who registers for perinatal care is informed about the use of her data for scientific research. In the leaflet 'Pregnant' an opt-out procedure is explained and offers every woman to withdraw her data of the national perinatal registry of Perined.

Perined approved the use of data for this study under approval number 20.26 on January 4th, 2021. Due to privacy rules of Perined and the law 'General Data Protection Regulation' we were not allowed to present absolute numbers in cells if the number was below n=50.

Funding sources

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Credit author Statement

AR, HW, SH outlined the idea and wrote the research proposal. AR performed the analyses and discussed this with HW and SH. AR wrote the first manuscript. HW and SH reviewed the manuscript. AR, HW and SH wrote the final manuscript.

Conflict of interest

All authors declare to have no conflicts of interests.

Acknowledgements

We thank all women who have given their consent to make their perinatal data available for scientific research. We also thank Dr. D.J. Cronie for his help to improve the grammar and style of the manuscript.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.midw.2022.103572.

References

Angras, K., Sullivan, M., Young, A., Paglia, M., Mackeen, A., 2021. A retrospective review of pregnancy outcomes in women with uncomplicated mild to moderate chronic hypertension. J. Maternal, Fetal Neonatal Med. 1–7. doi:10.1080/14767058.2021.2014451.

Beer, M.d., Vrijkotte, T., Wal, M.v., Weissenbruch, M.v., Gemke, R., 2010. Relation of maternal hypertension with infant growth in a prospective birth cohort: the ABCD study. J. Dev. Origin. Health Dis. 347–355. doi:10.1017/S2040174410000462.

Bramham, K., Parnell, B., Nelson-Piercy, C., Seed, P., Poston, L., Chappell, L., 2014. Chronic hypertension and pregnancy outcomes: systematic review and meta-analysis. Brit. Med. J. 1–20. doi:10.1136/bmj.g2301.

Clements, K., Mitra, M., Zhang, J., Lezzoni, L., 2016. Pregnancy characteristics and outcomes among women at risk for disability from health conditions identified in medical claims. Women's Health Iss. 26 (5), 504–510. doi:10.1016/j.whi.2016.06.001.

Deierlein, A., Antoniak, K., Chan, M., Sassano, C., Stein, C., 2021. Pregnancy-related outcomes among women with physical disabilities: a systematic review. Paediatric Perinat. Epidemiol. 35 (6), 758–778. doi:10.1111/ppe.12781.

Heideveld-Gerritsen, M., Vulpen, M.v., Hollander, M., Oude Maatman, S., Ockhuijsen, H., Hoogen, A.v.d., 2021. Maternity care experiences of women with physical disabilities: a systematic review. Midwifery 96, 102938. doi:10.1016/j.midw.2021.102938.

Horner-Johnson, W., Kulkarni-Rajasekhara, S., Darney, B., Dissanayake, M., Caughey, A., 2017. Live birth, miscarriage, and abortion among US women with and without disabilities. Disabil. Health J. 10 (3), 382–386. doi:10.1016/j.dhjo.2017.02.006.

Mitra, M., Clements, K., Zhang, J., Lezzoni, L., Smeltzer, S., Long-Bellil, L., 2015. Maternal characteristics, pregnancy complications, and adverse birth outcomes among women with disabilities. Med. Care 53 (12), 1027–1032. doi:10.1097/MLR.0000000000000427.

Ornoy, A., Becker, M., Weinstein-Fudim, L., Ergaz, Z., 2021. Diabetes during pregnancy: a maternal disease complicating the course of pregnancy with long-term deleterious effects on the offspring: a clinical review. Int. J. Mol. Sci. 22 (6), 2965–3001. doi:10.3390/ijms22062965.

Papalia, N., D'Souza, R.d., Hobson, S.r., 2022. Optimal timing of labour induction in contemporary clinical practice. Best Practice Res. Clin. Obstetric. Gynecol. 79, 18–26. doi:10.1111/1471-0528.16968.

Perined. (2020). https://www.perined.nl/onderwerpen/publicaties-perined/kerncijfers-2020 Accessed on 4 March 2022.

Perined, 2021. Methodologie perinatologie data: Van ontvangst tot gebruiksklare. data voor onderzoek.

..., Rejnö, G., Lundholm, C., Larsson, K., D'Onofrio, B., Saltvedt, S., Almqvist, C., 2017. Adverse pregnancy outcomes in asthmatic women: a population-base family design study. J. Allergy Clin. Immunol. 6 (3), 916–922. doi:10.1016/j.jaip.2017.07.036, In practice.

Relph, S., Patel, T., Delaney, L., Sobhy, S., Thangaratinam, S., 2021. Adverse pregnancy outcomes in women with diabetes-related microvascular disease and risks of disease progression in pregnancy: a systematic review and meta-analysis. PLoS Med. 18 (11), e1003856. doi:10.1371/journal.pmed.1003856.

Sonnaville, C.d., Hukkelhoven, C., Vlemmix, F., Groen, H., Schutte, J., Mol, B., Pampus, M.v., 2020. Impact of hypertension and preeclampsia intervention trial at near term-I (HYPITAT-1) on obstetric management and outcome in The Netherlands. Ultrasound Obstetric. Gynecol. 55 (1), 58–67. doi:10.1002/uog.20417.

Tarasoff, L., Ravindran, S., Malik, H., Salaeva, D., Brown, H., 2020. Maternal disability and risk for pregnancy, delivery and postpartum complications: a systematic review and meta-analysis. Am. J. Obstetric. Gynecol. 222 (1), 27.e1–27.e32.

Statline (2019). https://opendata.cbs.nl/statline/#/CBS/nl/dataset/88384NED/table?ts=1648641732376.Accessed on 14 February 2022

Statline (2021) https://opendata.cbs.nl/statline/#/CBS/nl/dataset/83005NED/table?ts=1652365192258 Accessed on 4 March 2022

Voormolen, D., DeVries, J., Sanson, R., Heringa, M., Valk, d.H., Kok, M., et al., 2018. Continuous glucose monitoring during diabetic pregnancy (GlucoMOMS): a multicentre randomized controlled trial. Diabet. Obes. Metabol. 20 (8), 1894–1902.

Xu, Z., Doust, J., Wilson, L., Dobson, A., Dharmage, S., Mishra, G., 2022. Asthma severity and impact on perinatal outcomes: an updated systematic review and meta-analysis. Brit. J. Obstetric. Gynaecol. 129 (3), 367–377. doi:10.1111/1471-0528.16968.