Reducing Inequalities in Timing of Antenatal Care Initiation: A Hypothetical Intervention in the Generation R Study

Clair A. Enthoven[1], Jeremy A. Labrecque[2], Hanan El Marroun[1], Nicole Lucassen[3], Dionne Gootjes[4], Eefje van Vliet[5], Hilmar Bijma[5], and Pauline W. Jansen[1]

[1]Erasmus MC Afdeling Kinder- en Jeugdpsychiatrie/psychologie
[2]Erasmus MC Afdeling Epidemiologie
[3]Erasmus University Rotterdam Erasmus School of Social and Behavioural Sciences
[4]Erasmus University Medical Center
[5]Erasmus MC Afdeling Verloskunde en Gynaecologie

May 23, 2024

Abstract

Objective To investigate inequalities in antenatal care initiation and to assess whether early pregnancy recognition may reduce these inequalities. **Design** Population-based birth cohort study. **Setting** Rotterdam, the Netherlands. **Population** A cohort of N=4196 pregnant women from Generation R. **Methods** The association of individual and socioeconomic factors and gestational age at pregnancy recognition with timing of antenatal care initiation were assessed using linear regression analyses. G-methods were used to estimate the reduction of the inequalities in antenatal care initiation, if everyone would have recognized the pregnancy within 6 weeks after the first day of menstrual period. **Main Outcome Measures** Antenatal care initiation was derived from electronic patient files of 10 midwifery practices in Rotterdam. **Results** Those who recognized their pregnancy within 6 weeks (81.7%) had their first antenatal care visit 1.26 weeks (95%CI:-1.59; -0.93) earlier than those who recognized their pregnancy after 6 weeks. All factors were significantly associated with timing of antenatal care initiation. Modeling a situation in which people would recognize their pregnancy within 6 weeks resulted in a significant reduction in the inequalities in antenatal care initiation for age, migration background, pregnancy intention, education, employment, household income, housing, and neighborhood deprivation. **Conclusions** Early recognition of pregnancy would reduce the impact of socio-economic inequalities in timely initiation of prenatal care.

Reducing Inequalities in Timing of Antenatal Care Initiation: A Hypothetical Intervention in the Generation R Study

Clair A. Enthoven (c.enthoven@erasmusmc.nl) 1,2,3; Jeremy A. Labrecque (j.labrecque@erasmusmc.nl) 4; Hanan El Marroun (elmarroun@essb.eur.nl) 1,2; Nicole Lucassen (lucassen@essb.eur.nl) 2; Dionne V. Gootjes (d.gootjes@erasmusmc.nl) 3,6; Eefje van Vliet (e.vanvliet.1@erasmusmc.nl) 6; Hilmar H. Bijma (h.bijma@erasmusmc.nl) 6; Pauline W. Jansen (p.w.jansen@essb.eur.nl) 1,2

1. Department of Child and Adolescent Psychiatry/Psychology, Erasmus University Medical Center, Rotterdam, The Netherlands.
2. Department of Psychology, Education and Child Studies, Erasmus School of Social and Behavioural Sciences, Erasmus University, Rotterdam, The Netherlands.
3. The Generation R Study Group, Erasmus University Medical Center, Rotterdam, The Netherlands.
4. Department of Epidemiology, Erasmus University Medical Center, Rotterdam, The Netherlands.
5. Department of Obstetrics and Gynaecology, Division of Obstetrics and Fetal Medicine, Erasmus MC Sophia, Rotterdam, The Netherlands.

Correspondence to : Clair A. Enthoven, Department of Child and Adolescent Psychiatry/Psychology, Erasmus MC Rotterdam, c.enthoven@erasmusmc.nl

Running title: Reducing Inequalities in Timing of Antenatal Care Initiation

Conflict of interest statement

No conflicting relationship exists for any author.

Author contributions

CAE, JAL, PWJ and HM designed the study. CAE conducted the data analyses and drafted the manuscript. All authors reviewed and revised that study proposal, contributed to data interpretation and critically reviewed and revised the manuscript. All authors approved the final version for publication.

Ethics approval

The Medical Ethics Committee of Erasmus MC in Rotterdam, the Netherlands, has approved the study in accordance with the Declaration of Helsinki of the World Medical Association (December 17, 2001, MEC 198.782/2001/31). Written informed consent was obtained from all participants.

Availability of data and materials

The data underlying this article cannot be shared publicly because participants of the Generation R study were assured raw data would remain confidential and would not be shared to the public. The data underlying the results presented in the study are available on request with a formal data sharing agreement for researchers who meet the criteria for access to confidential data. Requests should be directed toward the management team of the Generation R study (secretariaat.genr@erasmusmc.nl).

Code availability

The R script used in this study can be found at https://github.com/centhoven/antenatal_care_initiation.

Structured abstract

Objective

To investigate inequalities in antenatal care initiation and to assess whether early pregnancy recognition may reduce these inequalities.

Design

Population-based birth cohort study.

Setting

Rotterdam, the Netherlands.

Population

A cohort of N=4196 pregnant women from Generation R.

Methods

The association of individual and socioeconomic factors and gestational age at pregnancy recognition with timing of antenatal care initiation were assessed using linear regression analyses. G-methods were used to estimate the reduction of the inequalities in antenatal care initiation, if everyone would have recognized the pregnancy within 6 weeks after the first day of menstrual period.

Main Outcome Measures

Antenatal care initiation was derived from electronic patient files of 10 midwifery practices in Rotterdam.

Results

Those who recognized their pregnancy within 6 weeks (81.7%) had their first antenatal care visit 1.26 weeks (95%CI:-1.59; -0.93) earlier than those who recognized their pregnancy after 6 weeks. All factors were significantly associated with timing of antenatal care initiation. Modeling a situation in which people would recognize their pregnancy within 6 weeks resulted in a significant reduction in the inequalities in antenatal care initiation for age, migration background, pregnancy intention, education, employment, household income, housing, and neighborhood deprivation.

Conclusions

Early recognition of pregnancy would reduce the impact of socio-economic inequalities in timely initiation of prenatal care.

Keywords: Antenatal Care; Pregnancy Recognition; Inequalities; Hypothetical Intervention

Introduction

For long, it is known that early and adequate prenatal care is important to reduce perinatal complications, such as preterm birth.[1, 2] The World Health Organization recommends at least 8 visits in total and the first visit to take place at 13 weeks gestational age at latest.[3] Early prenatal care is important to assess the gestational age, which may be helpful later on in managing preterm birth, prolonged pregnancy or complications.[4] Early antenatal care is also essential to enable timely screening for anaemia and rubella, to assess Rh and AB0 blood typing, to offer non-invasive genetic testing and to address potential risk factors such as high body mass index and domestic violence.[5] Furthermore, considering the great impact of circumstances during pregnancy, timely education of pregnant people regarding healthy behaviours, including nutrition, supplement intake, smoking and alcohol cessation and exercise, is similarly important.[5]

In the Netherlands, antenatal care is generally accessible to pregnant people. All expenses, except travel costs, are covered by the basic health care fund, and specific government arrangements guarantee free obstetric care for pregnant people without health insurance.[6] Still, in 40% of the births in Rotterdam, a multi-ethnic city with large social and perinatal health inequalities,[7] antenatal care started only after ten weeks of pregnancy.[8] Previous research pointed at several predictors for a late antenatal care initiation, including young age, being single, lower socio-economic position, migration background, mental health problems, poorer language ability and higher parity.[9-14] Many of these factors are also predictors of preterm birth.[15, 16] Together, these observations underline the so called 'Inverse Care Law', describing that those who need care the most, have the least access to care.[17]

Thus far, most studies evaluated a wide range of predictors for late antenatal care initiation, without discerning between factors that are and are not modifiable. A potentially important modifiable reason for late antenatal care initiation is late recognition of the pregnancy.[18, 19] A study in the United States showed that participants who recognized the pregnancy early (within 6 weeks after the first day of the last menstrual period) initiated antenatal care 6 times more often timely (<12 weeks of gestation) than those with later pregnancy recognition, after adjustment for socioeconomic variables.[18] The aim of this study is therefore to investigate predictors in timing of antenatal care initiation; and to assess whether some of these inequalities would be reduced had everyone recognized the pregnancy early.

Methods

Study population

The Generation R Study is a multi-ethnic, population-based, prospective cohort from fetal life onwards. This cohort has previously been described in detail.[20, 21] Briefly, all pregnant women residing in Rotterdam with a planned delivery date between April 2002 and January 2006 were invited to participate and 9,778 (response rate 61%) women enrolled. The variable of interest, gestational age at antenatal care initiation, was available for 4,196 women. The Medical Ethics Committee of Erasmus MC in Rotterdam, the Netherlands, has approved the study in accordance with the Declaration of Helsinki of the World Medical Association. Written informed consent was obtained from all participants.

Measures

Antenatal care initiation

Information about the timing of antenatal care initiation was derived from electronic patient files (Micronatal®) of 10 midwifery practices in Rotterdam.[22] The gestational age was determined by ultrasound. The gestational age at antenatal care initiation was used as a continuous variable indicating the gestational age in weeks at the first visit. In addition, to show the number of pregnancies that did not meet the recommendations of the Dutch Society of Obstetrics and Gynaecology (NVOG) for basic antenatal care at the time of data collection, we created a dichotomous variable indicating whether initiation was within or after 14 weeks gestational age.[23]

Time of pregnancy recognition

Gestational age at pregnancy recognition was measured using a self-report questionnaire at the first research visit. Women reported to the question: "At how many weeks of pregnancy did you know you were pregnant? (based on the first day of your last menstrual period or pregnancy dating)". Early pregnancy recognition was defined as recognition within 6 weeks since the first day of the last menstrual period.

Predictors

The variables age, relationship status, migration background, pregnancy intention, mental health problems, Dutch language skills and parity have previously been identified as predictors for late antenatal care initiation.[9-13] Other variables are socioeconomic factors, such as education, employment household income, housing and neighborhood deprivation.[14] In addition, we studied cognitive functioning, because this is related to someone's health literacy skills.[24]

Individual predictors

Age at conception was calculated as age at birth of the child minus gestational age at birth and categorized into <20 years, 20-25 years, 25-30 years, 30-35 years and [?]35 years. The following predictors were measured by questionnaire in the 12th week of gestation, or during enrollment in case participation started after the 12th week of gestation. Migration background was defined as one or both parents being born in another country than the Netherlands, according to the classification of Statistics Netherlands.[25] This was categorized into first- or second-generation migrant depending on whether or not the woman herself was born in the Netherlands.[23, 26] Relationship status was categorized as being married or cohabiting, versus

single. Pregnancy planning was measured using self-report by asking whether the pregnancy was planned or not. In the case of an unplanned pregnancy, women reported how they felt about the pregnancy using the following four answering categories: "pleased from the start"; "initially mixed feelings"; "still mixed feelings"; or "mostly unhappy about the pregnancy". Pregnancy intention was categorized into planned, unplanned and wanted from the start and unplanned with ambivalent feelings. History and current mental illness were assessed at 20 weeks' gestation using vignettes explaining depression, anxiety, psychosis, eating disorders and addiction to substances, followed by questions about whether the women had ever experienced these symptoms and received treatment for them, and whether these symptoms were present in the past year. Mental illness was defined as either depression, anxiety, psychosis, eating disorders or substance use addiction and categorised into recent, when the symptoms were present in the last year, or ever, when the symptoms occurred in their lifetime, but not in the last year. Proficiency in Dutch language skills was measured by a questionnaire in week 30 of gestation. The pregnant women were asked to rate their Dutch speaking, reading, and writing skills on three separate 5-point scales ranging from 'not at all' (1) to 'good' (5). This information was summed into general 'Dutch language skills' (1–9, not good; 10–14, reasonable; 15, good). [27] Parity was based on medical records and categorized into nulliparous or multiparous.

Socioeconomic predictors

The following predictors were measured by questionnaire in the 12$^{\text{th}}$ week of gestation. Education was defined as the highest attained educational level, categorized as: Low (primary school; lower vocational training; intermediate general school; 3 years general secondary school), which typically corresponds to [?]12 years of education; Medium (>3 years general secondary school; intermediate vocational training; higher vocational training; Bachelor's degree), in general corresponding with 13–17 years of education; and High (higher academic education; PhD), usually indicating 18 years of education or more. Employment was categorized into having a paid job (including being self-employed) versus having no paid job. Net household income was categorized as: Less than \euro1200/month (social security level at the time of assessment); Between \euro1200 and 2000/month; and More than \euro2000/month (modal income or more). Housing was measured by a questionnaire in week 30 of gestation and categorized into living in a bought or rented home. Neighbourhood deprivation was measured using area-based status scores provided by the Netherlands Institute for Social Research (in Dutch: Sociaal en Cultureel Planbureau).[28] The scores were matched on four-digit postcodes and are based on mean household income, proportion of the population with low income, proportion of population with low educational attainment and proportion of population without paid work.[29] The scores were categorized into tertiles (low, medium and high deprivation). Cognitive functioning was measured using the 12-item validated short version of the Raven's Progressive Matrices at the research center when the child was 5 years old.[30] This was categorized into <70 (mild intellectual disability), 70-85 (borderline intellectual functioning) and [?]85 (normal intellectual functioning).[31] We expect that this measure is relatively stable, and not influenced by the timing of antenatal care initiation.

Study design and assumptions

In this study, we are not interested in a potential causal effect of the predictors on timing of antenatal care initiation via a mechanism of timing of pregnancy recognition, which is what would be obtained when using mediation methods. From a public health point of view, it would be too complicated or even impossible to intervene on age, relationship status, migration background or socioeconomic position for people to initiate antenatal care earlier. Early pregnancy recognition might be a factor that may have a causal relationship with timing of antenatal care initiation, is amenable to intervention, and may reduce inequalities in antenatal care initiation. To answer this research question, we assessed the effect of early pregnancy recognition on timing of antenatal care initiation, and we used this information to estimate the reduction in inequalities in antenatal care initiation if everyone in our study population had recognized the pregnancy early. This design is also called a hypothetical intervention,[32] because we used data from an observational study to estimate the counterfactuals, i.e. what would have happened if we had intervened in such a way that all participants would recognize the pregnancy within 6 weeks of gestation.

Three causal assumptions apply in respect to the intervention and the outcome.[33] First, exchangeability refers

to no residual confounding or bias in the association between pregnancy recognition and timing of antenatal care initiation. We therefore adjusted for all predictors as potential confounders. Second, positivity means that the probability of receiving the intervention (early pregnancy recognition) conditional on the covariates must be greater than 0. This was tested by estimating propensity scores in a model of the non-imputed dataset with early pregnancy recognition as dichotomous outcome and all the covariates as predictors. As the participant with the smallest propensity score had a score of 0.217 to receive the intervention, the positivity assumption was satisfied. Third, consistency requires the intervention to be clearly defined. In practice, our intervention would require sexually active women of reproductive age to take a pregnancy test in case of pregnancy suspicion (e.g. their menstruation did not start in the week that they expected). This would be complicated for those with an irregular cycle, thereby potentially violating the consistency assumption. Therefore, in order to relax this assumption, we repeated the analyses in only those with a regular cycle (28 days plus minus 4 days) in sensitivity analyses.[34]

Statistical analyses

Prior to analyses, multiple imputations were performed to replace the missing values in the predictors (ranging from 1.1% to 36.2%) and timing of pregnancy recognition (25.5%) using multivariate imputation by chained equations.[35] We created 50 imputed datasets with 100 iterations. Besides the study variables, we used body mass index at intake, gestational age at intake, and apgar score 5 minutes after birth as predictors for imputation.[36]

First, the inequalities, i.e. the associations between the different predictors and timing of antenatal care initiation, were estimated using linear regression models. The reference level was the level of the predictor with the earliest antenatal care initiation, e.g. '30-35 years' in age, or 'high' in educational attainment, to ensure that the inequality was always positive because that simplified the interpretation. Second, the association between early pregnancy recognition and timing of antenatal care initiation was estimated using linear regression analyses adjusted for all predictors (age, migration background, relationship status, pregnancy intention, mental illness, Dutch language skills, parity, education, employment household income, housing, neighborhood deprivation, and cognitive functioning). This model was subsequently used to estimate the timing of antenatal care initiation if the intervention was set to pregnancy recognition within 6 weeks. By comparing the timing of antenatal care initiation with the hypothetical intervention (i.e. had all participants recognized the pregnancy within 6 weeks) and without the hypothetical intervention (i.e. timing of pregnancy recognition as it appears in the data), the reduction in the inequalities driven by the predictors was estimated.[32] Bootstrapping with 1000 iterations was used to calculate the 95% confidence intervals. All analyses were conducted in IBM SPSS version 28 and R statistical software version 4.2.1.

Results

The participants were on average 29.1 (SD: 5.3) years old. The first antenatal care visit was on average at 12.9 (SD: 3.7) weeks, and 81.4% of the participants started antenatal care in the first 14 weeks of pregnancy. The pregnancy was on average recognized at 5.4 (SD: 2.3) weeks, and 81.7% of the participants recognized their pregnancy within 6 weeks. The participants who had their first antenatal visit within 14 weeks of pregnancy significantly differed in all studied predictors from participants who had their first antenatal visit later than 14 weeks, except for mental illness. Table 1 shows a detailed description of the study population.

Participants who recognized their pregnancy within 6 weeks had their first visit in antenatal care 1.25 weeks earlier (95% CI=-1.60; -0.91) than those who recognized their pregnancy later than 6 weeks ($\beta_{adjusted}$=-0.63; 95% CI=-0.97; -0.28). In addition, all predictors were significantly associated with timing of antenatal care initiation (Table 2). The associations were most prominent for the following predictors: participants aged <20 years were 2.95 (95% CI=2.31; 3.63) weeks later than those aged 30-35 years; first generation migrants were 1.53 (95% CI=1.29; 1.78) weeks later than those without migration background; those with unplanned pregnancy and ambivalent feelings were 2.14 (95% CI=1.75; 2.54) weeks later than those with planned pregnancy; participants without sufficient Dutch language skills were 1.63 (95% CI= 1.25; 2.02) weeks later than those with sufficient Dutch language skills; those who already had 3 children or more

were 1.57 (95% CI=0.90; 2.29) weeks later than nulliparous participants; participants with lower educational attainment were 1.50 (95% CI= 1.20; 1.81) weeks later than participants with higher educational attainment; unemployed participants were 1.60 (95% CI=1.35; 1.86) later than employed participants; those with a lower household income were 2.05 (95% CI=1.77; 2.34) weeks later than those with a higher household income; and those living in highly deprived neighborhoods were 1.52 (95% CI=1.24; 1.79) weeks later than those living in low deprived neighborhoods.

Hypothetically intervening on pregnancy recognition ([?]6 weeks) reduced the inequalities in antenatal care initiation. These reductions were significant for age, migration background, pregnancy intention, education, employment, household income, housing, and neighborhood deprivation. Table 2 and Figure 1 show the inequality before and after the intervention, and the corresponding reductions. For example, the inequality between those aged <20 years and those aged 30-35 years was β=2.95 weeks (95% CI=2.31; 3.63) prior to the intervention, which became β=2.55 weeks (95% CI=1.91; 3.23) after the intervention, indicating a significant reduction of β=-0.40 (95% CI=-0.69; -0.15). Similarly, the inequality between those with unplanned and ambivalent pregnancy and those with planned pregnancy was β=2.14 weeks (95% CI=1.75; 2.54) prior to the intervention, which became β=1.77 weeks (95% CI=1.38; 2.18) after the intervention, indicating a significant reduction of β=-0.37 (95% CI=-0.57; -0.18).

Sensitivity analyses including only participants with a regular cycle (n=2360) are shown in Table S1. Participants who recognized their pregnancy within 6 weeks had their first visit in antenatal care 1.14 weeks (95%CI -1.58; -0.69) earlier than those who recognized their pregnancy after 6 weeks ($\beta_{adjusted}$=-0.47, 95%CI -0.91; -0.03). All predictors remained associated with timing of antenatal care initiation. Hypothetically intervening on pregnancy recognition significantly reduced the inequalities for pregnancy intention (planned vs unplanned and ambivalent), migration background (no vs first generation), and neighborhood deprivation (low vs high).

Discussion

Main findings

Our aims were to investigate predictors for late antenatal care initiation; and to assess whether hypothetically intervening on early pregnancy recognition would reduce some of these inequalities in late antenatal care initiation. The results of our study showed that almost one out of five pregnant participants started antenatal care only after 14 weeks of pregnancy during the study period between 2002 and 2006 in Rotterdam. Participants who recognized their pregnancy within the first 6 weeks had their first visit in antenatal care on average 4.4 days earlier than those who recognized their pregnancy later than 6 weeks. All predictors were associated with timing of antenatal care initiation, and the associations were most strong for age, migration background, pregnancy intention, parity, education, household income, employment, neighborhood deprivation, and Dutch language skills. Hypothetically intervening on early pregnancy recognition [?]6 weeks may reduce these differences for all of these predictors except for parity and language skills.

Interpretation

All predictors were significantly associated with late antenatal care initiation which confirms inequalities shown in previous studies.[9-13] Also in line with other studies, the results from our hypothetical intervention suggest that the inequality in antenatal care initiation could be reduced if the pregnancy would be timely recognized.[18, 19] The majority (>80%) of our participants recognized the pregnancy within 6 weeks. To detect a pregnancy, most people use home tests.[37] Home pregnancy tests are easily available in drug stores, pharmacies, grocery stores and online retailers. Still, ensuring timely recognition may be challenging due to several reasons. Firstly, some people may experience an access barrier to home pregnancy tests, potentially due to costs to purchase them, or being able to get to the store.[37] Secondly, even though most manufacturers claim that home pregnancy tests are 99% reliable, in practice this is lower due to user errors, or testing too early.[38] Thirdly, recognizing a pregnancy requires knowledge of the reproductive system, which may be more limited in women with lower socioeconomic position.[39-41] Finally, some people may feel ambivalent about a potential pregnancy, and wait with testing because they fear the result or want time to think about what to do

if pregnant.[37] In a recent pilot study, people with increased risk of delayed pregnancy recognition (i.e., young people, people with irregular menses, and those who have recently had a second trimester induced abortion) were provided free home pregnancy tests. The results of this study suggested that self-testing was feasible and acceptable and many participants described to continue to test after the study.[43] Another study showed that young age, being single, unintended pregnancy, lower education and lower income were associated with a later pregnancy recognition.[42]Together, these and our results suggest that providing information and free home pregnancy tests to a specific group of people with an increased risk of delayed pregnancy recognition, may help to reduce inequalities in the timing of antenatal care initiation.

The results of our study showed that early pregnancy recognition could partly reduce inequalities in antenatal care initiation, suggesting that other mechanisms may also occur. Based on analyses in the same dataset as the current study, Choté et al. (2011) focused on ethnic inequalities in early antenatal care initiation and reported that mothers with migration background were relatively more likely to be less educated, less likely to be employed, and relatively more likely to be multiparous. All of these factors were also predictors for a later antenatal care initiation as identified in our study. Additional adjustment for enabling factors (educational level and employment), predisposing factors (age, parity, relationship status, pregnancy intention), and behavioral factors (intake folic acid, maternal smoking, alcohol use) showed a reduction in the ethnic inequalities in antenatal care initiation.[23] Together with our findings, this suggests that antenatal care initiation is affected by a complex interplay of many different factors in which causal factors are hard to distinguish from correlational factors when using regular regression methods. Other explanations underlying inequalities mostly come from qualitative studies. The results of these studies suggested that some pregnant women postponed their first appointment because they felt healthy, had other responsibilities or did not feel it was urgent.[19, 44] This is in line with research from non-Western countries showing that some people do not perceive a pregnancy as a health condition.[45] In addition, some pregnant women wanted to avoid antenatal care, because they were afraid of judgement or stigma. This occurred notably for young people and for those with ambivalent feelings toward the pregnancy,[19]two predictors that were also identified in our study. Finally, having difficulties with navigating antenatal healthcare, in particular when encountering a language barrier, may also lead to delayed access. This hypothesis is supported by our finding that those with reduced Dutch language skills entered antenatal care 1.3 weeks later than those with sufficient Dutch language skills.[44]

Strengths and limitations

This study had several strengths and limitations. Strengths were the novel statistical methods, the large availability of variables and the large and representative sample. Inclusion in Generation R was aimed at the first trimester, but was still possible until birth ensuring that those with a late antenatal care initiation were still eligible.[20] Some limitations should also be taken into account. We were limited by self-report of pregnancy recognition. This may be subject to recall bias or socially acceptable answers, which may have diluted the associations. In addition, as mentioned in the methods section, one of the assumptions of this causal study design is consistency, which means that the hypothetical intervention (early pregnancy recognition) must be well-defined. In practice, an intervention that ensures everyone will recognize the pregnancy within 6 weeks does not exist. In the third paragraph of the discussion we explained that varying reasons may complicate timely recognizing a pregnancy, therefore potentially violating the consistency assumption. To reduce the possibility of bias, we performed sensitivity analyses in those with a regular cycle, because they would be more likely to know when they miss their period. The results indicated that the reductions in inequalities in antenatal care initiation were only significant for pregnancy intention, migration background and neighborhood deprivation, showing that our initial results may have been slightly overestimated.

Conclusion

In this population-based birth cohort in Rotterdam, many inequalities in antenatal care initiation were observed, and many of these were socioeconomically driven. This is problematic because it may lead to sustaining or perhaps even exacerbating inequalities into the next generation. Importantly, our results suggest that hypothetically intervening on early pregnancy recognition may reduce, but not eliminate, these inequalities.
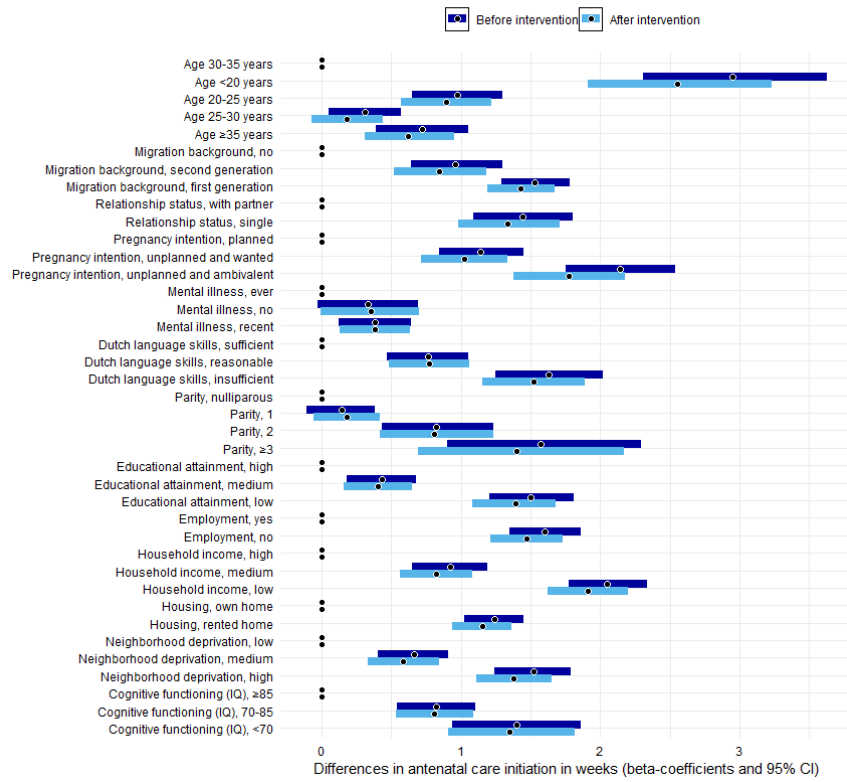
Therefore, it is recommended that people at risk of unintended pregnancy and people from socioeconomically disadvantaged groups are supported in early pregnancy recognition, for example by providing free tests and education, which is also in line with promoting preconception care.

References

1. Knight E, Morris M, Heaman M. A descriptive study of women presenting to an obstetric triage unit with no prenatal care. Journal of Obstetrics and Gynaecology Canada. 2014 2014/03/01/;36(3):216-22.

2. Papiernik E, Maine D, Rush D, Richard A. Prenatal care and the prevention of preterm delivery. International Journal of Gynecology & Obstetrics. 1985 1985/10/01/;23(5):427-33.

3. World Health O. WHO recommendations on antenatal care for a positive pregnancy experience: summary: highlights and key messages from the World Health Organization's 2016 global recommendations for routine antenatal care: World Health Organization; 2018.

4. Neilson JP, Cochrane P, Childbirth G. Ultrasound for fetal assessment in early pregnancy. Cochrane Database of Systematic Reviews. 1996;2010(1).

5. Kirkham C, Harris S, Grzybowski S. Evidence-based prenatal care: Part I. General prenatal care and counseling issues. American family physician. 2005;71(7):1307-16.

6. Jans S, Westra X, Crone M, Elske van den Akker-van Marle M, Rijnders M. Long-term cost savings with Centering-based group antenatal care. Midwifery. 2023 2023/11/01/;126:103829.

7. Poeran J, Denktas S, Birnie E, Bonsel GJ, Steegers EAP. Urban perinatal health inequalities. The Journal of Maternal-Fetal & Neonatal Medicine. 2011 2011/05/01;24(4):643-6.

8. Perined. Vroeggeboorte en/of te laag geboortegewicht (Big 2). 2020 15-9-2022 [cited 2022 25-11-2022]; Available from: https://www.waarstaatjegemeente.nl/jive/

9. Baker EC, Rajasingam D. Using Trust databases to identify predictors of late booking for antenatal care within the UK. Public Health. 2012 2012/02/01/;126(2):112-6.

10. Gadson A, Akpovi E, Mehta PK. Exploring the social determinants of racial/ethnic disparities in prenatal care utilization and maternal outcome. Seminars in Perinatology. 2017 2017/08/01/;41(5):308-17.

11. Ali SA, Dero AA, Ali SA, Ali GB. Factors affecting the utilization of antenatal care among pregnant women: a literature review. J Preg Neonatal Med. 2018;2(2).

12. Feijen-de Jong EI, Jansen DEMC, Baarveld F, van der Schans CP, Schellevis FG, Reijneveld SA. Determinants of late and/or inadequate use of prenatal healthcare in high-income countries: a systematic review. The European Journal of Public Health. 2012;22(6):904-13.

13. Kapaya H, Mercer E, Boffey F, Jones G, Mitchell C, Anumba D. Deprivation and poor psychosocial support are key determinants of late antenatal presentation and poor fetal outcomes-a combined retrospective and prospective study. BMC Pregnancy and Childbirth. 2015 2015/11/25;15(1):309.

14. Cresswell JA, Yu G, Hatherall B, Morris J, Jamal F, Harden A, et al. Predictors of the timing of initiation of antenatal care in an ethnically diverse urban cohort in the UK. BMC Pregnancy and Childbirth. 2013 2013/05/03;13(1):103.

15. Wallace ME, Mendola P, Chen Z, Hwang BS, Grantz KL. Preterm birth in the context of increasing income inequality. Maternal and Child Health Journal. 2016 2016/01/01;20(1):164-71.

16. Kelly RH, Russo J, Holt VL, Danielsen BH, Zatzick DF, Walker E, et al. Psychiatric and substance use disorders as risk factors for low birth weight and preterm delivery. Obstetrics & Gynecology. 2002 2002/08/01/;100(2):297-304.

17. Watt G. The inverse care law today. The Lancet. 2002;360(9328):252-4.

18. Ayoola AB, Nettleman MD, Stommel M, Canady RB. Time of Pregnancy Recognition and Prenatal Care Use: A Population-based Study in the United States. Birth. 2010;37(1):37-43.

19. Haddrill R, Jones GL, Mitchell CA, Anumba DOC. Understanding delayed access to antenatal care: a qualitative interview study. BMC Pregnancy and Childbirth. 2014 2014/06/16;14(1):207.

20. Jaddoe VWV, Mackenbach JP, Moll HA, Steegers EAP, Tiemeier H, Verhulst FC, et al. The Generation R Study: design and cohort profile. European journal of epidemiology. 2006;21(6):475.

21. Kooijman MN, Kruithof CJ, van Duijn CM, Duijts L, Franco OH, van Ijzendoorn MH, et al. The Generation R Study: design and cohort update 2017. European journal of epidemiology. 2016;31(12):1243-64.

22. Choté AA, De Groot CJ, Bruijnzeels MA, Redekop K, Jaddoe VWV, Hofman A, et al. Ethnic differences in antenatal care use in a large multi-ethnic urban population in the Netherlands. Midwifery. 2011;27(1):36-41.

23. Choté AA, Koopmans GT, Redekop WK, de Groot CJM, Hoefman RJ, Jaddoe VWV, et al. Explaining ethnic differences in late antenatal care entry by predisposing, enabling and need factors in the Netherlands. The Generation R Study. Maternal and Child Health Journal. 2011 2011/08/01;15(6):689-99.

24. Federman AD, Sano M, Wolf MS, Siu AL, Halm EA. Health literacy and cognitive performance in older adults. Journal of the American Geriatrics Society. 2009;57(8):1475-80.

25. Netherlands S. Allochtonen in Nederland 2004. Voorburg/Heerlen. 2004.

26. Choté AA, Koopmans GT, de Groot CJM, Hoefman RJ, Jaddoe VWV, Hofman A, et al. Differences in timely antenatal care between first and second-generation migrants in the Netherlands. Journal of Immigrant and Minority Health. 2014 2014/08/01;16(4):631-7.

27. Jansen PW, Raat H, Mackenbach JP, Jaddoe VWV, Hofman A, van Oort FV, et al. National origin and behavioural problems of toddlers: the role of family risk factors and maternal immigration characteristics. Journal of abnormal child psychology. 2010;38:1151-64.

28. Duijn VAN. Sociaal-economische status indicator op postcode niveau. Maandstatistiek van de bevolking. 2002;50:32-5.

29. Gootjes DV, Posthumus AG, Jaddoe VWV, Steegers EAP. Association between neighbourhood deprivation, fetal growth, small-for-gestational age and preterm birth: a population-based prospective cohort study. BMJ Open. 2021;11(11):e049075.

30. Irrgang M, Dorenkamp M, Reohr P, Vik P. C-28 Raven's Progressive Matrices: Validation of a Short Form. Archives of Clinical Neuropsychology. 2019;34(6):1057-.

31. Nouwens PJG, Lucas R, Smulders NBM, Embregts PJCM, van Nieuwenhuizen C. Identifying classes of persons with mild intellectual disability or borderline intellectual functioning: a latent class analysis. BMC Psychiatry. 2017 2017/07/17;17(1):257.

32. Lara M, Labrecque JA, van Lenthe FJ, Voortman T. Estimating Reductions in Ethnic Inequalities in Child Adiposity from Hypothetical Diet, Screen Time, and Sports Participation Interventions. Epidemiology. 2020;31(5):736-44.

33. Hernán MA, Robins JM. Causal Inference: What If. Boca Raton: Chapman & Hall/CRC. 2020.

34. Mook-Kanamori DO, Steegers EAP, Eilers PH, Raat H, Hofman A, Jaddoe VWV. Risk factors and outcomes associated with first-trimester fetal growth restriction. Jama. 2010;303(6):527-34.

35. Buuren Sv, Groothuis-Oudshoorn K. mice: Multivariate imputation by chained equations in R. Journal of statistical software. 2010:1-68.

36. Austin PC, White IR, Lee DS, van Buuren S. Missing data in clinical research: a tutorial on multiple imputation. Canadian Journal of Cardiology. 2021;37(9):1322-31.

37. Ralph LJ, Foster DG, Barar R, Rocca CH. Home pregnancy test use and timing of pregnancy confirmation among people seeking health care. Contraception. 2022 2022/03/01/;107:10-6.

38. Gnoth C, Johnson S. Strips of hope: accuracy of home pregnancy tests and new developments. Geburtshilfe und Frauenheilkunde. 2014;74(07):661-9.

39. Ayoola AB, Zandee GL, Adams YJ. Women's knowledge of ovulation, the menstrual cycle, and Its associated reproductive changes. Birth. 2016;43(3):255-62.

40. Lundsberg LS, Pal L, Gariepy AM, Xu X, Chu MC, Illuzzi JL. Knowledge, attitudes, and practices regarding conception and fertility: a population-based survey among reproductive-age United States women. Fertility and Sterility. 2014 2014/03/01/;101(3):767-74.e2.

41. Ip W-Y, Chan M-Y, Chan DSK, Chan CWH. Knowledge of and attitude to contraception among migrant woman workers in mainland China. Journal of Clinical Nursing. 2011;20(11-12):1685-95.

42. Branum AM, Ahrens KA. Trends in timing of pregnancy awareness among US Women. Maternal and Child Health Journal. 2017 2017/04/01;21(4):715-26.

43. Morris N, Ehrenreich K, Gurazada T, Grossman D. Feasibility and acceptability of at-home routine pregnancy testing in the United States: A pilot study. Women's Health Issues. 2023 2023/05/01/;33(3):258-65.

44. Hatherall B, Morris J, Jamal F, Sweeney L, Wiggins M, Kaur I, et al. Timing of the initiation of antenatal care: An exploratory qualitative study of women and service providers in East London. Midwifery. 2016 2016/05/01/;36:1-7.

45. Warri D, George A. Perceptions of pregnant women of reasons for late initiation of antenatal care: a qualitative interview study. BMC Pregnancy and Childbirth. 2020 2020/02/03;20(1):70.

Differences in antenatal care initiation in weeks (beta-coefficients and 95% CI)

Hosted file

`Tables05042024.docx` available at https://authorea.com/users/786348/articles/980052-reducing-inequalities-in-timing-of-antenatal-care-initiation-a-hypothetical-intervention-in-the-generation-r-study