Feijen-de Jong, E.I., Jansen, D.E.M.C., Baarveld, F., Schans, C.P. van der, Schellevis, F.G., Reijneveld, S.A. Determinants of late and/or inadequate use of prenatal healthcare in high-income countries: a systematic review. European Journal of Public Health: 2012, 22(6), 904-913

Postprint Version	1.0
Journal website	http://eurpub.oxfordjournals.org/content/22/6/904.long
Pubmed link	http://www.ncbi.nlm.nih.gov/pubmed/22109988
DOI	10.1093/eurpub/ckr164

Determinants of late and/or inadequate use of prenatal healthcare in high-income countries: a systematic review

ESTHER I. FEIJEN-DE JONG[1,2], DANIELLE E.M.C. JANSEN[3,4], FRANK BAARVELD[5], CEES P. VAN DER SCHANS[6,7], FRANCOIS G. SCHELLEVIS[8,9], SIJMEN A. REIJNEVELD[10]

1 Midwifery Academy Amsterdam-Groningen, Groningen, The Netherlands
2 Department of Midwifery Science, EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands
3 Department of Health Sciences, University Medical Center Groningen, University of Groningen, Groningen, The Netherlands
4 Department of Sociology and Interuniversity Centre for Social Science Theory and Methodology (ICS), University of Groningen, Groningen, The Netherlands
5 Department of General Practice, University Medical Center, Groningen, The Netherlands
6 Department of Applied Sciences, Hanze University, Groningen, The Netherlands
7 Department of Rehabilitation Medicine, University Medical Center, Groningen, The Netherlands
8 NIVEL (Netherlands Institute for Health Services Research), Utrecht
9 Department of General Practice/EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands
10 Department of Health Sciences, University Medical Center Groningen, Groningen, The Netherlands

Background: Prenatal healthcare is likely to prevent adverse outcomes, but an adequate review of utilization and its determinants is lacking .
Objective: To review systematically the evidence for the determinants of prenatal healthcare utilization in high-income countries. Method: Search of publications in EMBASE, CINAHL and PubMed (1992–2010). Studies that attempted to study determinants of prenatal healthcare utilization in high-income countries were included. Two reviewers independently assessed the eligibility and methodological quality of the studies. Only high-quality studies were included. Data on inadequate use (i.e. late initiation, low-use, inadequate use or non-use) were categorized as individual, contextual and health behaviour-related determinants. Due to the heterogeneity of the studies, a quantitative meta-analysis was not possible. Results: Ultimately eight high-quality studies were included. Low maternal age, low educational level, non-marital status, ethnic minority, planned pattern of prenatal care, hospital type, unplanned place

of delivery, uninsured status, high parity, no previous premature birth and late recognition of pregnancy were identified as individual determinants of inadequate use .

Contextual determinants included living in distressed neighbourhoods. Living in neighbourhoods with higher rates of unemployment, single parent families, medium–average family incomes, low-educated residents, and women reporting Canadian Aboriginal status were associated with inadequate use or entering care after 6 months. Regarding health behaviour, inadequate use was more likely among women who smoked during pregnancy. Conclusion: Evidence for determinants of prenatal care utilization is limited. More studies are needed to ensure adequate prenatal care for pregnant women at risk .

INTRODUCTION

Prenatal healthcare has largely contributed to the decline in perinatal and infant mortality rates in high-income countries during the last century. Prenatal care includes identification of medical conditions necessitating careful surveillance throughout pregnancy.[1] Moreover, it is a way for women to integrate into the medical/obstetric care system .

However, high use of prenatal healthcare services burdens the healthcare system, adds to its costs, and may medicalize pregnancy and birth.[2,3] Late or inadequate use of prenatal healthcare—that is, entry after the first trimester and/or an inappropriate number of prenatal visits—may be due to individual characteristics, contextual characteristics and health behaviour.[1,4,5] These can be understood by using Andersen's behavioural model on determinants for utilization of healthcare.[6] Variations in use may help to explain differences in infant mortality and morbidity rates, and may serve as a guide for further improvements in quality of care .

The aim of this study is to provide a systematic review of the current evidence of the determinants of use of prenatal healthcare in high-income countries. A recent systematic review on this topic is lacking, the most recent ones being those by Goldenberg et al.[7] in 1992 and by Rowe and Garcia[4] in 2003: the latter only concerned UK studies. The current review includes studies focusing on all high-income countries worldwide, published since 1992 .

METHODS

Search method

We searched the literature that was published from January 1992 to 30 September 2010 using the PubMed, Cinahl, and Embase databases .

Research published before 1992 was excluded as this was already included in the review by Goldenberg et al.[7] Search terms were 'prenatal' and 'utilization', as Mesh terms, Emtrees and Cinahl headings, and as free text words. We made no restrictions as to language of the publication. The search was performed by a librarian and by one of the authors (E.F.-J.), and aimed for high sensitivity, in order to ensure the inclusion of as many relevant studies as possible .

Search outcome

Two authors independently scanned the resulting 880 studies as to title and abstract (when available). E.F.-J. is an expert in prenatal healthcare, D.J. in models of healthcare utilization .

Studies were eligible if data were presented on the determinants of prenatal healthcare utilization in high-income countries, including countries in the World Bank's list of high-income economies (countries with a gross national income (GNI) per capita of more than USD 11 456).

[FIGURE 1]

We removed duplicate studies (n = 66). Next, we excluded studies on the determinants of prenatal healthcare utilization by specific groups without contrast with the general population (teenage-pregnancies, migrant-farm-workers, ethnic minorities, high-risk women, or low-income groups), studies that provided no new empirical data (reviews, editorial letters, and brief items), and studies that only provided qualitative data after assessment of title and abstract (n = 714). The remaining 100 studies were independently read by two reviewers (E.F.-J./D.J. or E.F.-J./F.B.). Disagreement on ambiguous citations was resolved by consensus after additional review. We also contacted the authors of studies reporting incomplete data; however, this yielded no additional information. Based on this, 59 studies were excluded for various reasons (figure 1) .

Quality assessment

The remaining 41 studies underwent quality assessment and content abstraction using the quality assessment tool developed by Gyorkos et al.[9] to classify studies into three categories: weak, moderate, and strong. Strong meant that no major flaws threatened the internal validity of the study, that is, that there were minor chances of selection bias (selection of population, non-response bias), information bias (measurement of intervention and outcome variables), and confounding .

The further procedure was similar to that in the previous step. Seven studies were classified as moderate, 26 studies as weak, and 8 as strong. We chose to include only strong studies, to produce reliable, unbiased, and meaningful information about our review question (figure 1) .

Data synthesis

A narrative synthesis was undertaken, since a quantitative synthesis (meta-analysis) was not possible due to ample heterogeneity of research design, populations, types of interventions, and outcomes. We started with a description of the studies. Thereafter, we categorized the results using Andersen's behavioural model.[6] In the Andersen model use of health services depends on individual and contextual characteristics, and on health behaviour. For the former two, the following components we measured: predisposing, enabling, or suggesting a need for use characteristics. Predisposing characteristics are existing conditions that predispose people to use (yes/no) healthcare services. Enabling/disabling characteristics facilitate or impede use .

Need characteristics are conditions that patients or health providers recognize as requiring medical treatment.[6]

RESULTS

General study characteristics

Table 1 shows the general characteristics of the studies included. All eight studies were based on cross-sectional data. Some of these data were collected as part of a longitudinal (cohort) design, but none of them based findings on longitudinally collected data. The data were collected from birth certificates,[10,13,15] birth registers,[14] mother–baby files,[12] combined birth and death certificates[11] and surveys.[16,17] Samples sizes varied from 17 765[16] to 593 510[13] women. Studies were conducted in the United States (US) (4),[10,11,13,15] the United Kingdom (UK) (2),[16,17] Finland[14] or Canada.[12] The studies from the United States also analysed the relationship between health insurance status and prenatal healthcare utilization (enabling/disabling characteristics),[10,11,13,15] whereas the studies from the other countries focused on only demographic variables (predisposing characteristics). Two studies[12,15] assessed determinants at individual and neighbourhood (contextual) levels. The other six only examined determinants at the individual level .

[TABLE 1] [TABLE 2]

Main outcome measures

Four outcome measures were used by two studies each. Two studies[11,13] used the same definition of initiation of care, namely, starting care after the first trimester, but without clear operationalization of 'first trimester' .

Ayoola et al. [10] and Hemminki and Gissler[14] defined initiation as starting before or after 12 weeks of gestation. Marin et al.[11] and Braveman et al.[13] used the Kotelchuck Index to measure adequacy of care. The number of prenatal visits was defined similarly by Marin et al.[11,17] and Petrou et al.[17] The other studies all defined the main outcomes differently (table 2) .

Timing of initiation of prenatal care was an important outcome, just as the number of prenatal care visits. Adequacy of prenatal healthcare utilization was measured by using two indices: the Adequacy of Prenatal Care Utilisation index (APNCU) and the Graduated INDEX of PNC utilization (GINDEX), but dichotomized into adequate (>80% expected of visits) and inadequate care (<80% of expected visits).[11,13]

Determinants of prenatal healthcare utilization according to Andersen's behavioural model (table 3)

Individual predisposing characteristics

Six studies[10,13–17] examined the association between age and prenatal healthcare utilization. All showed an association between young maternal age (<20 years) and lower use of prenatal healthcare services .

Four studies[10,13–15] showed that less education (<9 years) was associated with low use,[10,13,14] late entry of prenatal care,[10,13–15] or receiving no care at all[13] .

Five studies assessed ethnicity, but with widely differing operationalizations . Kupek et al.[16] and Petrou et al.[17] categorized ethnicity as: white British, Indian, Pakistani and others. They showed that compared to white British women, all other women were less likely to initiate prenatal care by 18 weeks of gestational age,[16] and had fewer prenatal visits in pregnancy.[17] Perloff and Jaffee[15] categorized ethnicity

into four categories: white, black, Hispanic white and Hispanic black women. They concluded that women of colour were more likely to enter care late or not at all. Ayoola et al.[10] concluded that black, Asian, Hispanic, and American-Indian women were more likely to have less than 11 prenatal visits than white women. Finally, Braveman et al.[13] categorized ethnicity as African-American, Asian-American, European-American, Latina, Native-American, and other. They found that compared to European-Americans all other groups were more likely to enter prenatal care after the first trimester and to receive an inadequate number of prenatal visits. The same was found for foreign-born as compared to US-born women .

Four studies[10,13–15] examined the effect of marital status on prenatal healthcare utilization. These studies showed that unmarried women were more likely to initiate prenatal care late,[13,15] to receive an inadequate number of prenatal visits,[10,13,14] and not to enter care at all[13] as compared to married women .

Individual enabling/disabling characteristics

Four studies[10,11,13,15] assessed the effect of health insurance status on initiation of prenatal care, on non-use of prenatal care and on adequacy of care. Uninsured women,[10,11,13,15] women with Medicaid insurance[11,15] or with private prepaid insurance[13] were more likely to enter prenatal care late as compared to private fee-for-service insurance.[13] Marı´n et al.[11] and Braveman et al.[13] showed more non-use among women having Medicaid insurance,[11,13] private prepaid insurance[13] or no insurance[11,13] as compared to women having private insurance. Regarding adequacy of care, Marı´n et al.[11] found more inadequate use of care among uninsured women,[11,13] women with Medicaid insurance[11] or with private prepaid insurance[13] as compared to women with private insurance. Ayoola et al.[10] showed that women with Medicaid or private insurance more often had at least 11 prenatal visits. They also showed that women participating in a public assistance program more often had at least 16 visits than the non-public assistance group .

Two studies[16,17] examined the association between provider characteristics and initiation of care. Kupek et al.[16] showed that late prenatal care (after 10 weeks or after 18 weeks of gestation) was associated with type of hospital at booking, planned pattern of prenatal care, and planned place of delivery. Petrou et al.[17] showed that women with shared care without a midwifery team had more prenatal visits than women with other types of prenatal care (table 1). The same applied to women in urban non-teaching hospitals as compared to women in urban teaching hospitals and rural district general hospitals .

Individual need characteristics

Three studies[15–17] assessed the association between medical/obstetric risk factors and initiation of care. Kupek et al.[16] found that women who initiated care late were more often primiparous with at least one risk factor in their medical or obstetrical history. In contrast, Perloff and Jaffee[15] did not find an association between entering care after 6 months of gestation and medical risk factors, that is, having at least one medical condition that leads to pregnancy-related medical risks .

Petrou et al.[17] showed that when a high-risk status arose during the prenatal care period the number of prenatal visits increased .

Five studies[10,12–15] reported on the relationship between parity and prenatal healthcare utilization. Perloff and Jaffee[15] found that women with three or more live births were more likely to enter care late—after 6 months—or not at all. Hemminki and Gissler[14]

concluded that multiparous (_3 previous births) had fewer visits than other women. Heaman et al.[12] showed that higher parity leads to inadequate use of prenatal healthcare, according to the GINDEX. Braveman et al.[13] found the same, with higher risks of initiating care after the third month, of having too few visits (APNCU), and of receiving no prenatal care at all .
Ayoola et al.[10] showed that women with no prior births initiated prenatal care earlier (before 12 weeks gestation) and were more likely to receive more than 11 prenatal visits than other women .
Ayoola et al.[10] were the only ones that reported on the relationship between prior birth outcomes and prenatal care initiation, showing that that women with a previous premature birth were more likely to initiate care before 12 weeks gestation .
Finally, Ayoola et al.[10] found that early pregnancy recognition (before 6 weeks gestation) led to earlier prenatal-care initiation and to higher odds of receiving more than 15 prenatal visits .

Contextual predisposing variables

Two studies[12,15] assessed contextual predisposing variables. Perloff and Jaffee[15] assessed economic opportunity structure, defined at zip-code level as distressed if 60% or more of the population was non-white and 30% or more had incomes below the poverty line. They found that residence in a distressed area increased the risk of late initiation of prenatal care (after 6 months gestation) .
Heaman et al.[12] defined four contextual predisposing variables. They found more inadequate prenatal care among women living in neighbourhoods with medium and high rates of unemployment, with high rates of single parent families, with medium and high rates of women reporting Canadian Aboriginal status, and with medium and high rates of low-educated residents (<9 years of education) .

Contextual enabling/disabling variables

Two studies[12,15] reported on the relation between contextual enabling/ disabling variables and prenatal healthcare utilization. Perloff and Jaffee[15] showed that living in a neighbourhood with few office-based primary care physicians increased the likelihood of beginning prenatal care late .
Heaman et al.[12] found that women living in areas with medium average family incomes more often had inadequate prenatal care use.

Health behavior

Health behaviour was measured in four studies.[12,14,16,17] Heaman et al.[12] showed more frequent inadequate prenatal care use among women living in neighbourhoods with medium and high rates of women who smoked during pregnancy. Kupek et al.[16] reported that smokers were at higher risk for initiating prenatal care after 10 weeks of gestation and after 18 weeks of gestation. Petrou et al.[17] showed that smokers were more likely to have fewer prenatal visits than non-smokers. Finally, Hemminki and Gissler[14] found that women who smoked during pregnancy had fewer prenatal visits than non-smokers .

Findings aggregated by similar outcomes

As shown in tables 2 and 3 only two studies used identically defined outcomes and determinants. Initiation of care, no prenatal care utilization, and adequacy of care were identically measured by Marı´n et al.[11] and Braveman et al.[13] Still, the only identical determinant in these two studies was health insurance status, where both

studies found that being uninsured made late initiation of care, receiving no prenatal care, and receiving inadequate care more likely, as compared to having private insurance coverage.

DISCUSSION

This study assessed the evidence on determinants of prenatal healthcare utilization. The results show that the following variables were independently associated with late initiation or inadequate use of prenatal care: smoking, low maternal age, low educational level, non-marital status, ethnic minority, planned pattern of prenatal care, hospital type, the planned place of delivery, uninsured status, high parity, prior premature birth, obstetric risk factors, late recognition of pregnancy, and living in deprived neighbourhoods .

Determinants of inadequate use of prenatal healthcare mostly apply to general care, but some additional pregnancy-specific determinants were found. These were late recognition of the pregnancy and high parity .

Moreover, the effects of some 'regular' determinants such as socioeconomic status may be altered by pregnancy related issues .

Further research, quantitative and qualitative, is needed to disentangle the impact of these pregnancy-specific factors on use of prenatal care .

Our findings mostly confirm those of Goldenberg et al.,[7] but with more recent data of better quality. Similar to that review, we found age, parity, educational level, marital status, and ethnicity to be related to inadequate prenatal care utilization. In addition, Goldenberg et al.[7] also presented findings on other variables (psychosocial variables, e.g., feelings about pregnancy, family relations) that were not assessed in the studies that we included. A likely explanation is our exclusion of lower quality studies that, for example, assessed determinants such as wantedness and timing of the pregnancy, and the mother's belief in the necessity of prenatal care. Our findings also confirm the review of Rowe and Garcia[4] on socio-demographic determinants in the UK, but now in a study on all high-income countries that also comprized other determinants .

Interestingly, all the strong evidence comes from only four countries, which encompass only some of the available prenatal healthcare arrangements, both regarding first care giver and reimbursement system. It is very likely that these characteristics modify the effects of the other determinants of prenatal healthcare utilization. To properly assess the effects of system-specific factors comparative research is needed on several countries with varying systems .

Finally, next to frequency, our attention also needs to turn to the content and quality of prenatal services and to the individual, sociodemographic, financial and other factors associated with their access and utilization .

Methodological issues of the included studies

Although all included studies assessed prenatal healthcare utilization, they employed 12 different definitions. Similar variations were found regarding determinants that were assessed, resulting in only two studies employing identically defined determinants and outcomes.[11,13] Standardization is highly needed to be able to integrate findings .

Only eight out of 41 included studies had a strong internal validity .

These eight studies employed retrospective data collection, mostly from birth certificates. This may explain why evidence is lacking on other potential

determinants of prenatal care utilization, such as psychosocial variables. Moreover, only one study[15] used a theoretical framework to explain the determinants of prenatal healthcare utilization. Using a theoretical framework can help to overcome deficiencies of current research about prenatal healthcare utilization. Finally, all included studies adjusted for confounders, but for a widely varying range .

Strengths and weaknesses of the study

A strength of our study was the use of a comprehensive search strategy with broad search terms in order not to miss any possible relevant study .

Also, we did not restrict to studies published in English. However, we did not review grey literature and did not explore bibliographies, so we may have missed relevant studies.

CONCLUSION AND IMPLICATIONS

Overall, our review shows that the evidence on the determinants of prenatal care utilization is limited, but it mostly confirms the results of the earlier syntheses regarding prenatal healthcare utilization. However, comprehensive data on the determinants of prenatal healthcare utilization are lacking. A means to obtain these is the routine inclusion of possible theory-driven determinants in databases on prenatal healthcare .

We obtained findings on factors that are associated with poor use of prenatal care, but not on the mechanisms that cause these associations .

Additional research is needed to disentangle these mechanisms as a basis for interventions targeting at improved use of prenatal care .

[TABLE 3]

We found rather large inequities in prenatal healthcare utilization, which highlights the importance of carefully tailoring interventions, such as home visiting programs, general to the needs of deprived pregnant women .

Efforts need to be expanded to ensure adequate prenatal care for those who are at risk of receiving inadequate prenatal care .

ACKNOWLEDGEMENT

E.F.-J. had full access to all of the data in the study and takes responsibility for the integrity of the data, the accuracy of the data analysis. E.F.-J., D.J., F.B. and S.R. conceived and designed the study; E.F.-J. acquired the data; E.F.-J., D.J., and F.B. analysed the data; E.F.-J., D.J., F.B., F.S. and S.R .
interpreted the data; and E.F.-J., D.J., F.B. and S.R. drafted the manuscript. D.J., F.B., C.S., F.S. and S.R. critically revised the article for important intellectual content. All authors approved the final version to be published .

FUNDING

E.F.-J. is funded by the Midwifery Academy Amsterdam/Groningen (AVAG), the Netherlands. The AVAG had no involvement in the design and conduct of the study; collection, management, analysis and interpretation of the data; or preparation review, or approval of the article .

KEY POINTS

_ Prenatal care has highly contributed to the decline in perinatal and infant mortality rates in high-income countries during the last century .

_ No recent summary is available on the factors leading to late or inadequate use of prenatal healthcare, that is, entry after the first trimester and/or an inappropriate number of prenatal healthcare visits .

_ Adverse individual characteristics (low maternal age, low educational level, non-marital. status, ethnic minority, planned pattern of prenatal care, hospital type, unplanned place of delivery, uninsured status, high parity, no previous premature birth, and late recognition of pregnancy), living in a deprived context and smoking during pregnancy were al associated with late or inadequate use of prenatal care .

_ Evidence is still highly incomplete, additional evidence is needed, in particular on the joint effects of these determinants.

REFERENCES

1 Wildman K, Blondel B, Nijhuis J, Defoort P, Bakoula C. European indicators of health care during pregnancy, delivery and the postpartum period. Eur J Obstet Gynecol Reprod Biol 2003;111(Suppl. 1):S53–65 .

2 Gissler M, Merilainen J, Vuori E, Hemminki E. Register based monitoring shows decreasing socioeconomic differences in Finnish perinatal health. J Epidemiol Community Health 2003;57:433–439 .

3 Backe B. Overutilization of antenatal care in Norway. Scand J Public Health 2001;29:129–132 .

4 Rowe RE, Garcia J. Social class, ethnicity and attendance for antenatal care in the United Kingdom: a systematic review. J Public Health Med 2003;25:113–119 .

5 LaVeist TA, Keith VM, Gutierrez ML. Black/white differences in prenatal care utilization: an assessment of predisposing and enabling factors. Health Serv Res 1995;30:43–58 .

6 Andersen RM, Rice TH, Kominski GF. Changing the U.S. Health Care System; Key Issues in Health Services Policy and Management. San Francisco, CA: Jossey-Bass, 2007 .

7 Goldenberg RL, Patterson ET, Freese MP. Maternal demographic, situational and psychosocial factors and their relationship to enrollment in prenatal care: a review of the literature. Women Health 1992;19:133–151 .

8 Centre for reviews and dissemination. Systematic reviews: CRD's guidance for undertaking reviews in health care. York: CRD University of York, 2009 .

9 Gyorkos TW, Tannenbaum TN, Abrahamowicz M, Oxman AD, Scott EA, Millson ME, et al. An approach to the development of practice guidelines for community health interventions . Can J Public Health 1994;85(Suppl 1):S8–13 .

10 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;37:37–43 .

11 Marin HA, Ramirez R, Wise PH, Pena M, Sanchez Y, Torres R. The effect of Medicaid managed care on prenatal care: the case of Puerto Rico. Matern Child Health J 2009;13:187–197 .

12 Heaman MI, Green CG, Newburn-Cook CV, Elliott LJ, Helewa ME. Social inequalities in use of prenatal care in Manitoba. J Obstet Gynaecol Can 2007;29:806–816 .

13 Braveman P, Bennett T, Lewis C, Egerter S, Showstack J. Access to prenatal care following major medicaid eligibility expansions. JAMA 1993;269:1285–1289 .

14 Hemminki E, Gissler M. Quantity and targetting of antenatal care in Finland. Acta Obstet Gynecol Scand 1993;72:24–30 .

15 Perloff JD, Jaffee KD. Late entry into prenatal care: the neighborhood context. Soc Work 1999;44:116–28 .

16 Kupek E, Petrou S, Vause S, Maresh M. Clinical, provider and sociodemographic predictors of late initiation of antenatal care in England and Wales. BJOG 2002;109:265–73 .
17 Petrou S, Kupek E, Vause S, Maresh M. Clinical, provider and sociodemographic determinants of the number of antenatal visits in England and Wales. Soc Sci Med 2001;52:1123–34 .

TABLES AND FIGURES

Figure 1 identification of studies

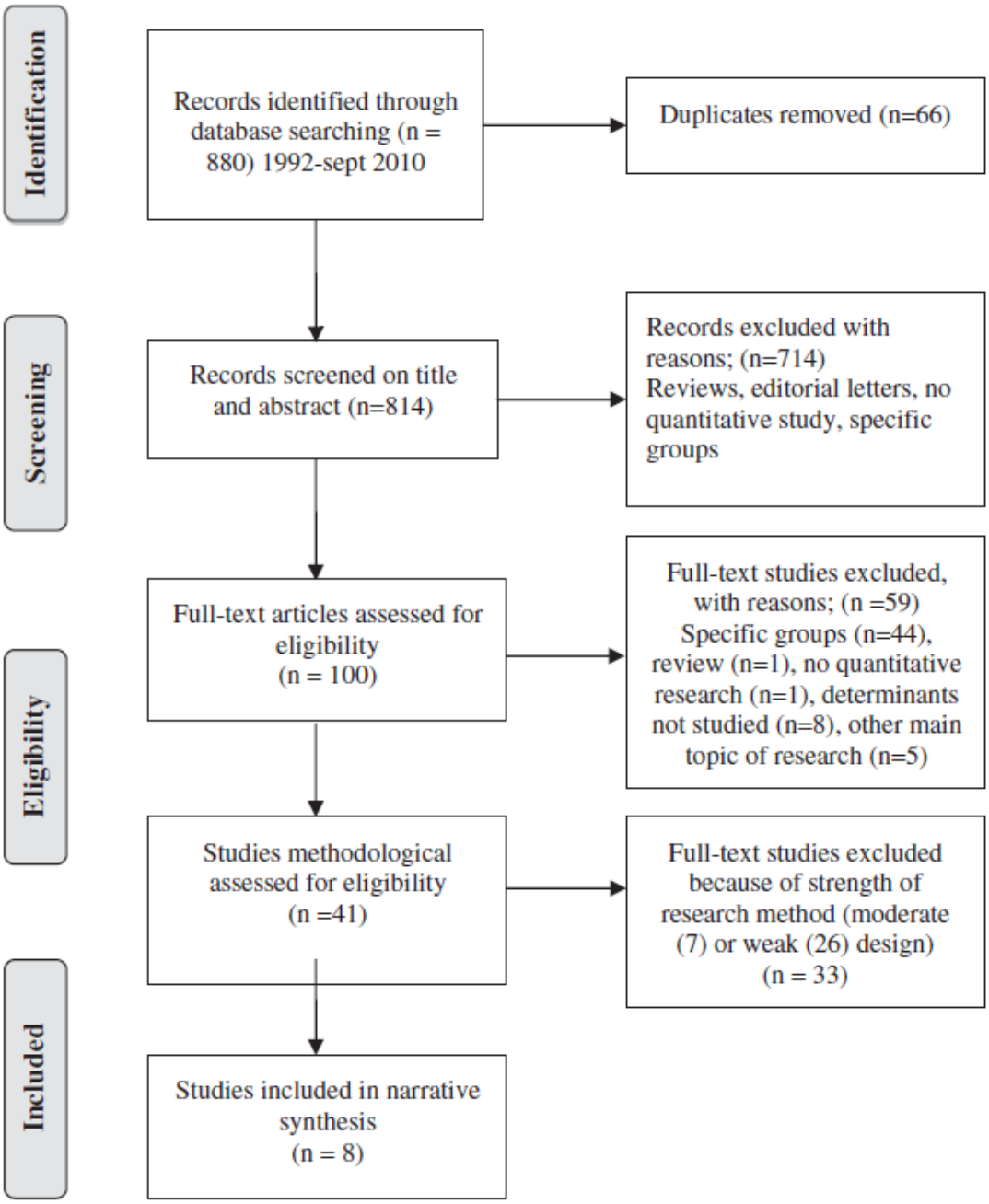

Table 1 Main characteristics of the included studies ($N = 8$): design, size, determinants, main outcomes, and main findings

Study	Design	Number of participants	Determinants	Main outcome	Main findings (only significant results corrected for confounders)
Ayoola *et al.*[10], USA	Data analysis (2000–2004) Individual level	136 373 (live births)	Time of pregnancy recognition (early; within 6 weeks of gestation, late; after 6 weeks of gestation), maternal age, parity, marital status, level of education, insurance status, socio-economic status, race/ethnicity, prior birth outcomes	1. Time of first prenatal visit (first trimester or other) 2. Frequency of prenatal care visits (< 11 visits, 11–15 visits, > 15 visits)	1. Variables predicting initiation of care before 12 weeks: Early pregnancy recognition compared to late recognition, no prior birth compared to one or more prior births, married women compared to unmarried women, high school and above high school compared to below high school, age of mother, non-hispanic whites compared to black, Asian and Hispanic women, Medicaid and private insurance compared to no insurance, previous premature birth compared to no previous premature birth 2. < 11 visits (compared to 11–15 visits), late pregnancy recognition compared to late pregnancy recognition, one or more prior births compared to no prior birth, unmarried women compared to married women, below high school compared to high school and above high school, women aged 16 to 40 years compared to women aged 11 to 15 years, Hispanic, Asian, American Indian/Alaska native, black women compared to non Hispanic white women, no insurance compared to Medicaid or private insurance. >15 visits (compared to 11–15 visits), early pregnancy recognition compared to late recognition, public assistance compared to no public assistance[a,b]
Marin[11], Puerto Rico, USA	Quasi experimental time series (1995–2000) Individual level	370 652 (live births)	Health insurance	1. Use and nonuse of prenatal care (any visit or no visit). 2. Timely of initiation of care (first trimester or other). 3. The number of visits for prenatal care. 4. The adequacy of care APNCU[c] Distribution in two categories. • Adequate (adequate and adequate plus) • Inadequate (intermediate and inadequate)	- more nonuse of prenatal care (pnc) for Medicaid, MMC and uninsured women compared to private insured women. - more pnc use in the first trimester for private insured women compared to Medicaid, MMC and uninsured women. - less visits for Medicaid, MMC and uninsured women compared to private insured women. - more inadequate use for Medicaid, MMC and uninsured women compared to private insured women[d].

(continued)

Table 1 Continued

Study	Design	Number of participants	Determinants	Main outcome	Main findings (only significant results corrected for confounders)
Heaman *et al.*[12], Canada	Population based cohort study (1991–2000) Individual and neighbourhood level	149 291 (live births)	Maternal variables: age, parity, single parent status, employment status, aboriginal status, family income, smoking, education, recent immigrants.	Gindex[e] distribution in two categories; • inadequate care and no care • adequate care	Neighbourhood characteristics associated with inadequate prenatal care are: high percentage of single parent families compared to low single parent families, high and medium unemployment rates compared to low unemployment rates, high and medium percentage of people reporting Aboriginal status compared to low percentage of people reporting Aboriginal status, high and medium smoking rates compared to low smoking rates, high and medium percentage of women reporting less than nine years of education compared to a low percentage of women reporting less than nine years of education and a high rate of recent immigrants compared to neighbourhoods with low recent immigrants.[f]
Kupek *et al.*[16], UK	Cross sectional study (August 1994–July 1995) Individual level	17 765 (liveborn and stillborn babies)	*Obstetric risk factors:* History of diabetes mellitus, cardiac disease, essential hypertension, renal disease, thrombosis, substance abuse and a range of less prevalent disorders[g]. Diminutive stature (<152 cm), extremities in weigth (<45 kg or >89 kg) and extremities in maternal age (primiparous:<18 or >30 years, multiparous: <18 or > 35 years). For multiparous women; lower segment caesarean section, previous stillbirth or neonatal death, previous preterm delivery, previous intrauterine growth retardation, previous delivery of a low birth weight infant and previous deliver of more than three liveborn infants. *Provider characteristics:*Type of hospital, planned pattern of prenatal care, planned place of delivery *Sociodemographic characteristics:*Ethnicity, smoking status, parity, maternal age	Late initiation of prenatal care: • later than 10 weeks of gestation. • later than 18 weeks of gestation.	Variables associated with late initiation of prenatal care (>10 weeks): low risk multiparous compared to all other groups, young maternal age, smokers compared to non-smokers, Pakistani women compared to white British women, hospital type(urban non teaching compared to urban teaching and rural district general), planned pattern of prenatal care (GP/midwife/Team Midwifery (TM) care compared to shared care without TM), planned place of delivery (isolated GP unit compared to hospital consultant unit). Variables associated with late initiation of prenatal care (>18 weeks): low risk multiparous compared to low risk. primiparous, young maternal age, smokers compared to non-smokers, Pakistani, Indian and all others compared to white British women, hospital type (urban teaching compared to non urban teaching), hospital type (hospital consultant care compared to shared care without team midwifery), planned place of delivery (hospital consultant unit compared to GP unit within hospital).[h]

(continued)

Table 1 Continued

Study	Design	Number of participants	Determinants	Main outcome	Main findings (only significant results corrected for confounders)
Petrou *et al.*[17], UK	Cross-sectional study (August 1994-July 1995) Individual level	17 978 (liveborn and stillborn babies)	*All variables similar as Kupek et al.,and additionally:* Gestational age at delivery, number of hospital admissions	Total number of prenatal visits	Variables associated with **decreased** numbers of prenatal visits:low risk multiparous compared to high risk multiparous, low-risk primiparous, high-risk primiparous and unknown risk primiparous, hospital type (urban non teaching compared to urban teaching an rural district general), planned pattern of prenatal care (shared care without midwifery compared to GP/midwife/team midwifery care and hospital consultant care), change in pattern of prenatal care for clinical reasons compared to no change, no change in pattern of prenatal care compared to a change for non-clinical reasons, White British women compared to Indian, Pakistani and all other women, non-smokers compared to smokers, gestational age at booking per week change (decrease), gestatonial age at delivery per week change (increase), maternal age at booking per year change (increase), number of hospital admissions per admission change (increase) and fragmentation of care leads to less visits[j]
Perloff and Jaffee[15], USA	Retrospective analysis of birth certificates (1991-1992) Individual and neighbourhood level	220 694 (liveborn and stillborn babies)	Predisposing variables: age, education, race or ethnicity, parity Enabling variables: Marital status, type of health insurance Neighbourhood level factors: evidence of medical risk, economic opportunity structure, healthcare opportunity.	Late initiation of prenatal care: later than 6 months of pregnancy (months seven, eight and nine or not at all).	Predisposing characteristics associated with late initiation of prenatal care: 11-19 years of age, not high school graduate, Hispanic white, non-Hispanic black, Hispanic black, three or more live births Enabling variables associated with late initiation of prenatal care: unmarried, uninsured, Medicaid Neighbourhood characteristics associated with late initiation of prenatal care: living in a shortage area[l], distressed zip code[k,l]
Hemminki and Gissler[14], Finland	Retrospective analysis of birth certificates (1987) Individual level	59 579 (liveborn and stillborn babies)	Age, marital status, education, smoking status, previous births	1. Number of prenatal visits • Many visits (>1.7) • Average visits (1.0–1.7) • Few visits (<1.0)[m] 1. Timing of first prenatal visit • Early (<8 weeks of gestation) • average (8–12 weeks) • late (> 12 weeks)	1. Variables associated with many visits: Primigravida: age ≥ 20 years, being married, education > 9 years Multigravida: education >9 years, previous births <3 Variables associated with few visits: Primigravida: age < 20 years, non-married, education ≤ 9years, smoker Multigravida: age < 20 years, non-married, education ≤ 9years, smoker, previous births ≥3. 2. Variables associated with early attending: Primigravida: being married Multigravida: education >9 years, previous births<3 Variables associated with late attending: Primigravida: age < 20 years, non-married, education ≤ 9years, smoker Multigravida: age < 20 years, non-married, education ≤ 9years, previous births ≥3[n].

(continued)

Table 1 Continued

Study	Design	Number of participants	Determinants	Main outcome	Main findings (only significant results corrected for confounders)
Braveman *et al.*[13], USA	Retrospective analysis of birth certificates (1990) Individual level	593 510 (live births)	Insurance coverage Maternal characteristics: racial or ethnic group, birthplace, age, parity, education, marital status	1. Timing of first visit Untimely; after first trimester 2. The adequacy of care APNCU[c] Distribution in two categories; • Adequate (adequate and adequate plus) • Inadequate (intermediate and inadequate) 3. Receiving no prenatal care	1. Factors associated with untimely initiation of first visit: insurance status (uninsured, medi-Cal, Kaiser North, other private prepaid compared to private insurance), race/ethnicity (African American, Asian American, Latina, Native American compared to European American), birthplace(foreign born compared to US-born), age group (≤17, 18–19, 20–34 compared with ≥ 35), previous live births (1–3, ≥4 compared to none), education (0–9, 10–11, 12, 13–15 compared with ≥ 16), Non-married compared with married. 2. Factors associated with inadequate use of prenatal care: insurance status (uninsured, medi-Cal, Kaiser North, Kaiser South, other private prepaid) race/ethnicity (African American, Asian American, Latina, Native American), birthplace(foreign born), age group (≤17, 18–19, 20–34), previous live births (1–3, ≥4), education (0–9, 10–11, 12, 13–15), non-married. 3. Factors associated with no prenatal care use: (uninsured, Kaiser North) race/ethnicity (African American, Asian American, Native American), birthplace(foreign born), age group (≤17, 18–19, 20–34), previous live births (1–3, ≥4), education (0–9, 10–11, 12, 13–15), Non-married[o]

a: Adjusted for: age, parity, marital status, level of education, insurance status, socioeconomic status, race/ethnicity, and prior birth outcomes as prematurity or low birth weight.
b: The socioeconomic status was measured according to whether a woman was receiving any public assistance program during pregnancy or not, and when the source of income came from government aid.
c: Kotelchuck's adequacy of prenatal care utilization index (APNCU), this index combines information on the time of initiation of prenatal care and the total number of prenatal visits. The Kotelchuck index classifies the adequacy of initiation as follows: pregnancy months 1 and 2, months 3 and 4, months 5 and 6 and months 7–9, with the underlying assumption that the earlier prenatal care begins the better. To classify the adequacy of received services, the number of prenatal visits is compared to the expected number of visits for the period between the first prenatal care visit and the delivery date. The expected number of visits is based on the American College of Obstetricians and Gynecologists prenatal care standards for uncomplicated pregnancies and is adjusted for the gestational age when care began and for the gestational age at delivery. A ratio of observed to expected visits is calculated and grouped into four categories: Inadequate (less than 50% of expected visits, intermediate (50–79%), adequate (80–109%) and adequate plus (110% or more).
d: Adjusted for maternal age, years of formal education, marital status, tobacco use, alcohol use, medical risk factors, median family income, population density, rate of physicians per thousand persons, infant mortality rate.
e: Gindex is calculated on the basis of the number of PNC visits and the month care began. It consist of three categories; ''no care'' category is assigned to women with no PNC visits, 'inadequate care' category is assigned to women who (1) began PNC in the first or second trimester and who had only one visit if delivering at or before 29 weeks' gestation, two or fewer visits at 30–31 weeks, three or fewer visits at 32–33 weeks, and four or fewer visits at 34 weeks or later; or (2) began PNC in the third trimester and had nine or fewer visits if delivering between 26 and 31 weeks' gestation, 10 or fewer visits at 32–35 weeks, or 12 or fewer visits at 36 weeks or later.[13]
f: Adjusted for age, parity, single parent families, unemployment, aboriginal status, average family income, smoking, education, recent immigrants and interactions between age, parity, and within mother independency.
g: Anorexia, asthma, depression, epilepsy and schizophrenia.
h: Adjusted for the effects of risk status at booking, maternal age at booking, smoking status, ethnicity, type of hospital at booking, planned pattern of prenatal care an planned place of delivery.
i: Adjusted for the effects of risk status at booking, risk status during prenatal care, type of hospital at booking, planned pattern of prenatal care, changes in pattern of prenatal care, ethnicity, smoking status, gestational age at booking, gestational age at delivery, maternal age at booking, number of hospital admissions and fragmentation of care.
j: Fewer than 32 office-based primary care physicians.
k: Sixty per cent or more non white population and 30% incomes below the poverty line.
l: All the variables were included in a full logistic regression model and were controlled for predisposing, enabling and neighbourhood characteristics.
m: The actual number of visits was divided by the recommended number of visits for that gestation length (recommended number: until 32 weeks every four weeks one visit, weeks 33–36 one visits every two weeks, weeks 37–40 every week one visits and after the 40th week two visits a week.
n: Adjusted for marital status, age, years of education, previous births, smoking status.
o:Adjusted for maternal insurance status, race/ethnicity, birthplace, age, parity, education and marital status.

Table 2 Differences and variations of the main outcomes between the included studies

Initiation of care	No prenatal care	Number of prenatal visits	Adequacy of prenatal care
– First trimester or other (Marín *et al.*[11] and Braveman *et al.*[13]) – >10 weeks (Kupek *et al.*[16]) – >12 weeks (Hemminki and Gissler[14] and Ayoola *et al.*[10]) – >18 weeks (Kupek *et al.*[16]) – >6 months (Perloff and Jaffee[15]) – < 8 weeks (Hemminki and Gissler[14]) – 8 to 12 weeks (Hemminki and Gissler[14])	Non-use of prenatal care and receiving no prenatal care (Marín *et al.*[11]; Perloff and Jaffee[15] and Braveman *et al.*[13])	– Frequency (Marín *et al.*[11] and Petrou *et al.*[17]) – Actual number of visits divided by the recommended number of visits (Hemminki and Gissler[14]) – Frequency, categorized into three groups: < 11 visits, 11–15 visits, > 15 visits (Ayoola *et al.*[10])	– Kotelchuck index, adequacy of prenatal care utilization index (combination of initiation of care and the received services) categorized into two groups: adequate care and non-adequate care (Marín *et al.*[11] and Braveman *et al.*[13]) – Gindex (Heaman *et al.*[12])

Table 3 Determinants stratified according to the behavioural model of Andersen

Study	Individual predisposing variables	Individual enabling/disabling variables	Individual need variables	Contextual predisposing variables	Contextual enabling/disabling variables	Health behaviours
Ayoola *et al.*[10]	Age Marital status Education Ethnicity	Health insurance coverage Public assistance program	Parity Prior birth outcomes Time of pregnancy recognition			
Marin *et al.*[11]		Health insurance coverage				
Heaman *et al.*[12]	Age (not corrected for confounders)		Parity	Employment Family structure Population composition Education	Family income	Smoking
Kupek *et al.*[16]	Age Ethnicity	Hospital type Planned pattern of prenatal care Planned place of delivery	Obstetric risk factors			Smoking
Petrou *et al.*[17]	Age Ethnicity	Hospital type Planned pattern of prenatal care	Obstetric risk factors Change in pattern of prenatal care			Smoking
Perloff and Jaffee[15]	Age Education Ethnicity Marital status	Health insurance coverage	Parity Medical risk factors	Economic opportunity structure	Healthcare opportunity structure	
Hemminki and Gissler[14]	Age Marital status Education		Parity			Smoking
Braveman *et al.*[13]	Age Education Marital status Ethnicity Birth place	Health insurance coverage	Parity			