An antenatal prediction model for adverse birth outcomes in an urban population: The contribution of medical and non-medical risks

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ABSTRACT

Objectives: in the Netherlands the perinatal mortality rate is high compared to other European countries. Around eighty percent of perinatal mortality cases is preceded by being small for gestational age (SGA), preterm birth and/or having a low Apgar-score at 5 minutes after birth. Current risk detection in pregnancy focusses primarily on medical risks. However, non-medical risk factors may be relevant too. Both non-medical and medical risk factors are incorporated in the Rotterdam Reproductive Risk Reduction (R4U) scorecard.
We investigated the associations between R4U risk factors and preterm birth, SGA and a low Apgar score.
Design: a prospective cohort study under routine practice conditions.
Setting: six midwifery practices and two hospitals in Rotterdam, the Netherlands.
Participants: 836 pregnant women.
Interventions: the R4U scorecard was filled out at the booking visit.
Measurements: after birth, the follow-up data on pregnancy outcomes were collected. Multivariate logistic regression was used to fit models for the prediction of any adverse outcome (preterm birth, SGA and/or a low Apgar score), stratified for ethnicity and socio-economic status (SES).
Findings: factors predicting any adverse outcome for Western women were smoking during the first trimester and over-the-counter medication. For non-Western women risk factors were teenage pregnancy, advanced maternal age and an obstetric history of SGA. Risk factors for high SES women were low family income, no daily intake of vegetables and a history of preterm birth. For low SES women risk factors appeared to be low family income, non-Western ethnicity, smoking during the first trimester and a history of SGA.
Key conclusions: the presence of both medical and non-medical risk factors early in pregnancy predict the occurrence of adverse outcomes at birth. Furthermore the risk profiles for adverse outcomes differed according to SES and ethnicity.
Implications for practice: to optimise effective risk selection, both medical and non-medical risk factors should be taken into account in midwifery and obstetric care at the booking visit.

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Introduction

The perinatal mortality rate in the Netherlands is high compared to other European countries (9 per 1000 births) (EURO-PERISTAT project in collaboration with SCPE, 2008). A Dutch study demonstrated that 85% of perinatal mortality cases are preceded by one or more of the following adverse outcomes: preterm birth, small for gestational age (SGA), low Apgar score and congenital anomalies. Together these outcomes have been labelled the 'Big4' (Poeran et al., 2011). The perinatal mortality rate is 6% in neonates with one Big4-outcome and increases to 79% if two or more Big4-outcomes are present (van der Kooy et al., 2011).

In the Netherlands the assignment of a presumed low or high risk status to each pregnant woman is a key feature of the current care system. Low risk women receive care from autonomously working community midwives ('first level' of care). High risk women receive care from obstetricians in hospitals ('second or

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third level' of care). Because a woman's risk status can change during pregnancy, labour or the postpartum period, she may be transferred at any stage from one level of care to the other. The current method of risk assignment is based on the 'List of Obstetric Indications' (LOI), which specifies criteria defining a high risk status (Obstetric Vademecum, 2003). A high risk status is based on the presence of a distinct (single) medical or obstetric risk factor for adverse outcomes.

Particularly in deprived urban areas the medically focused risk assignment of the LOI may fall short, since public health research has long established the influence of deprivation on health outcomes (Townsend et al., 1988). Moreover multiple cohort studies have revealed strong associations between non-medical risk factors and adverse birth outcome. The increased prevalence of such risk factors is held responsible for part of the elevated adverse birth outcomes in urban areas (Sellstrom et al., 2007; Gray et al., 2008; Agyemang et al., 2009; Timmermans et al., 2011). Non-Western ethnic descent, low income and a lack of social support are among the non-medical risk factors which are often reported in this context.

Previous research has demonstrated that the accumulation of multiple small to intermediate risk factors, both medical and non-medical, are the cause of inequalities in perinatal mortality (Timmermans et al., 2011). This sliding scale of risk accumulation is not reflected in the current LOI which is based on a low/high risk dichotomy. To account for the principle of risk accumulation and the equally important role of non-medical risks, a new antenatal risk scorecard was developed, the Rotterdam Reproductive Risk Reduction scorecard (R4U) (van Veen et al., 2015; Vos et al., 2015). The R4U was created as part of the comprehensive municipal 'Ready for a Baby' programme in the city of Rotterdam. In this programme health researchers and policy makers collaborated to develop and implement multiple strategies to improve perinatal outcomes (Denktaş et al., 2011).

To reflect the equal importance of medical and non-medical risks in pregnancy and childbirth, the R4U scorecard consists of both types of risk factors. These risks were selected for their contribution to adverse perinatal outcomes, and have been derived from publications on large perinatal cohort studies. The selected 69 risk factors in the R4U are categorized into six risk domains: (1) social, (2) ethnic descent and language barriers, (3) life style, (4) health care behaviours, (5) general medical, and (6) obstetric. In prior studies Van Veen et al. and Vos et al. showed the R4U to be a feasible and reliable tool for professional based risk detection in daily midwifery and obstetric practice (van Veen et al., 2015; Vos et al., 2015). However, the predictive properties of the R4U have not yet been investigated under practice circumstances.

In this study we therefore investigated the associations between the risk factors of the R4U scorecard at booking visit and the subsequent perinatal outcomes in a cohort of urban, deprived pregnant women in the city of Rotterdam.

Methods

Study design and setting

To investigate the associations between the risk factors of the R4U scorecard and perinatal outcomes, we conducted a prospective cohort study under routine practice conditions between November 2010 and February 2013 in the city of Rotterdam, the Netherlands. The study took place in six community midwifery practices and two hospitals, in urban relatively deprived areas. Details on the study setting have been published previously (van Veen et al., 2015). All pregnant women who came to these facilities for their booking visit were invited for study participation. The

booking visit is the first antenatal appointment a pregnant woman has with her care provider and it usually takes place before 11 weeks of gestation. For inclusion, women had to have sufficient command of the Dutch or English language. Women with multiple pregnancies were excluded. Approval of the study protocol was obtained from the Medical Ethics Committee of the Erasmus Medical Centre, Rotterdam (MEC-2010-332). Study consent entailed access to and collection of the R4U data at the booking visit and follow-up data on perinatal outcomes at the time of delivery and the first postnatal week.

Data collection

At thegynaecolog/gynaecology resident or nurse) in addition to the usual medical history taking and examination. In practice, approximately one-third of the R4U risk factors overlapped with current history taking, while the remaining risk factors were new. Caregivers received a short training and instruction sheet on the use of the R4U. After the R4U scorecard was filled out, care was provided as usual.

Once a woman had given birth, the researchers collected the follow-up data on birth outcomes by reviewing the patients' obstetric chart. Specific attention was paid to the presence of so called Big3-outcomes (see below).

Outcome measures

The primary outcome in this study was the presence of a Big3-outcom, comprising: SGA (birth weight below the 10th percentile stratified for gender, gestational age and parity), preterm birth (<37 weeks of gestation) and low APGAR-score at five minutes after birth (score <7). Congenital anomalies were excluded. Four pregnancies with congenital anomalies in our study were terminated after antenatal screening/diagnostics. Additionally 50 pregnancies resulted in a spontaneous miscarriage, and we have no information on the presence or absence of congenital anomalies in these cases.

Exclusions and handling of missing data

Included were 836 pregnancies (see Fig. 1). Multiple pregnancies were excluded from the study because this determinant is itself already associated with a high risk status, independent from other considerations.

We were able to retrieve follow-up data on pregnancy outcomes of 98.6% of pregnancies included in the study. Not all 69 items of the R4U scorecard were filled out completely for all patients. Data on Chlamydia was missing in more than 92.0% of cases and this item was therefore excluded. Of the other risk factors, missing rates varied between 0.1% and 20.6%. We tested whether values were missing completely at random (MCAR) using Little's MCAR test. No statistically significant deviation from randomness was found ($\chi^2=0.255$, df$=2$, $p=0.880$).

First, some missing values were replaced, based on information available on other variables of the same record (e.g. if data on 'postpartum haemorrhage during prior deliveries' was missing, this missing value was replaced by 'no' in nulliparous women). Values that could not be replaced were imputed (Sterne et al., 2009). Each missing value was imputed five times, using the available data from the other variables within the same R4U domain (social, communication and ethnic descent, life style, health care behaviours, general medical, obstetric). After this procedure the risk factors 'refuses blood transfusion', 'shoulder dystocia during delivery prior to the index pregnancy' and 'congenital anomaly in prior birth' were removed because multiple imputation produced unrealistic results (e.g. in the original data