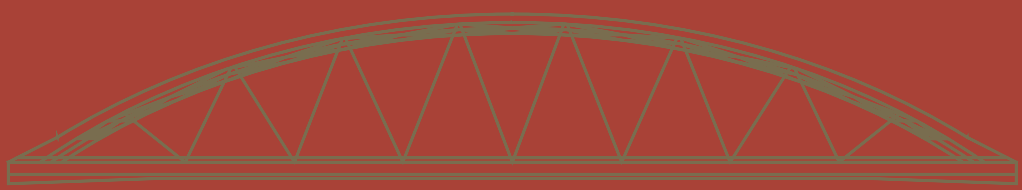


Building bridges between perinatal & preventive child healthcare

MINKE VAN MINDE

Building bridges between perinatal & preventive child healthcare

Minke van Minde

The research presented in this thesis was performed at the department of Obstetrics and Gynecology, division of Obstetrics and Prenatal Medicine, Erasmus University Medical Center, Rotterdam, The Netherlands

Part of the research in this dissertation was supported by a grant from the Ministry of Health, Welfare and Sport (VWS), the Netherlands (grant number 323911).

Financial support for the publication of this thesis was kindly provided by the department of Obstetrics and Gynecology of the Erasmus Medical Center, SBOH and ZorgTTP.

Cover illustration: 'Van Brienenoord bridge' Marloes Dekker and Eric Scholten

Layout and printing: Optima Grafische Communicatie www.ogc.nl

ISBN: 978-94-6361-766-6

Building bridges between perinatal & preventive child healthcare

Bruggen bouwen tussen perinatale zorg & jeugdgezondheidszorg

Proefschrift

ter verkrijging van de graad als doctor aan de
Erasmus Universiteit Rotterdam
op gezag van de rector magnificus

Prof. Dr. A.L. Bredenoord

en volgens het besluit van het College voor Promoties.

De openbare verdediging zal plaatsvinden op
vrijdag 2 december 2022 om 10:30 uur

door

Minke Rosanne Chaja van Minde
geboren te Utrecht

Erasmus University Rotterdam

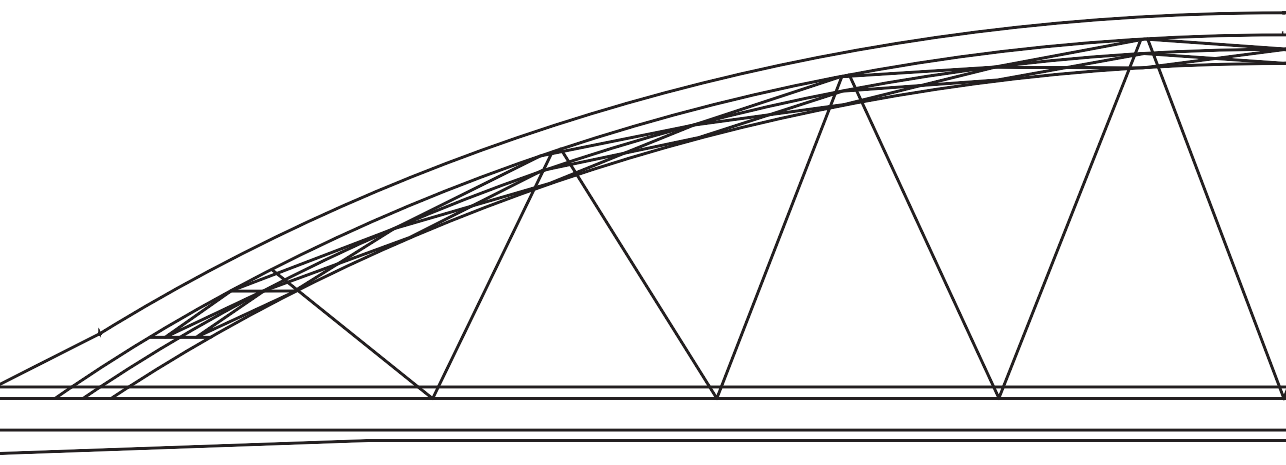
PROMOTIECOMMISSIE

Promotoren:	Prof. Dr. E.A.P. Steegers
	Prof. Dr. H. Raat
Overige leden:	Prof. Dr. V.W.V. Jaddoe
	Prof. Dr. S.A. Reijneveld
	Prof. Dr. P.C.M. Luijk
Copromotor:	Prof. Dr. M.L.A. de Kroon

Paranimfen:
mr. C.A.M. Lombert
drs. M.M. Weggemans

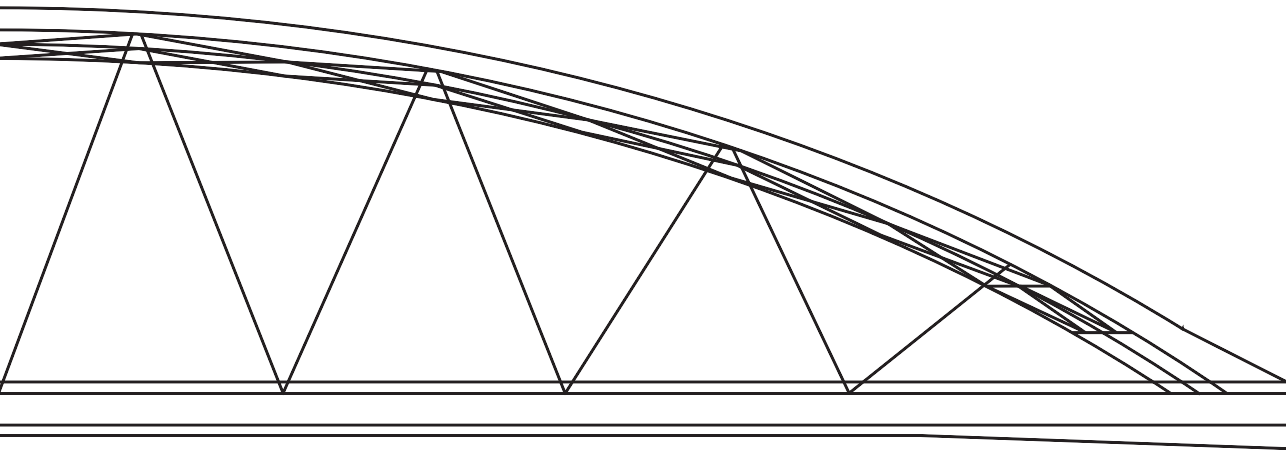
Voor mijn opa,
Siegfried Hartog van Minde,
mijn grootste inspirator

CONTENTS



Chapter 1

General introduction



PERINATAL AND CHILD HEALTH

Perinatal health (health prior, during and after birth) and health during infancy influence growth and development of children and their health at adult age. Significant suboptimal health outcomes of unfavorable perinatal and postnatal circumstances are, amongst others, overweight and obesity, (psychomotor) developmental problems, cardiovascular disease and diabetes. (1-5) Differences in perinatal health (such as preterm birth and being born small for gestational age (SGA)) in different regions in the Netherlands are significant. Children living in certain municipalities or in deprived neighborhoods in our country, are at graver risk than their peers living in more advantageous municipalities or neighborhoods. (6, 7)

RATIONALE OF RISK ASSESSMENT

Risk assessment is a term used to describe the overall process or method were you 1) identify hazards and risk factors that have the potential to cause harm (risk identification); 2) analyze and evaluate the risk associated with that hazard (risk analyses and risk evaluation); and 3) determine appropriate ways to eliminate the hazard, or control the risk when the hazard cannot be eliminated (risk control and risk management). (8)

The perinatal period and infancy have been identified as vital periods to prevent or control the risk of growth and developmental problems in children. (9-11) Children of mothers who smoked during pregnancy or children who were fed exclusively with formula have higher odds of being overweight during childhood. (9) Children born preterm show more behavioral problems, such as poor behavioral and emotional self-regulation, than their peers born at term. (12) Therefore, early postnatal risk assessment seems a necessity during these vulnerable periods in order to offer timely interventions. An innovative postnatal risk assessment could be of aid to identify vulnerable children who are at risk for growth and developmental problems. Consequently, in doing so, care can be initiated (through corresponding care pathways) to perform risk control or to, ultimately, eliminate the risk.

THE HEALTHY PREGNANCY 4 ALL-2 PROGRAM

To improve the identification, and care, of mothers and young children at risk of adverse health outcomes, the Healthy Pregnancy 4 All-2 (HP4All-2) program was developed. The program focused on creating a continuum for risk selection and tailored care pathways from preconception and antenatal care towards postpartum care, early childhood care, as well as interconception

care. The program specifically aimed to target communities in the Netherlands with a relatively disadvantageous position with regard to perinatal and child health outcomes. (7)

POINT OF DEPARTURE FOR THIS THESIS

Women and children in deprived neighborhoods are at greater risk for perinatal mortality and morbidity. Underlying medical as well as non-medical risk factors cause this inequity, which often originate from lifestyle behavior, living circumstances and psychosocial problems within vulnerable families. (13, 14)

Health care providers and municipalities can improve the Dutch public health by increased collaboration, improved screening and tailored care. By implementing new scientific insights and synchronizing obstetric care, maternity care and Preventive Child Healthcare (PCHC), risks can be better identified, better treated and can even be reversed. This may result in an increase of children with a healthy growth and development. (7, 15)

In the Netherlands, PCHC organizations are responsible for monitoring child growth and development. PCHC is offered to all children, from birth until the age of 19 years by the Dutch government, free of charge. From birth up to the age of four years, consultations comprise of growth and developmental measurements, the national vaccination program and parenting advice and support. These consultations have high attendance rates (> 95%), which gives this service a unique opportunity to reach young children starting from birth, and their parents. (16) This places PCHC organizations in a unique position to perform early risk assessment and initiate tailored care if necessary.

AIMS OF THIS THESIS

The aims are:

- To evaluate a) the current practice of risk selection and care for vulnerable families in Dutch obstetric care, maternity care and PCHC, and b) the child health status the Netherlands, on the neighborhood level.
- To develop an instrument, consisting of a postnatal risk assessment and corresponding care pathways to be implemented by PCHC.
- To evaluate the postnatal risk assessment and corresponding care pathways in PCHC in an implementation study.

THESIS OUTLINE

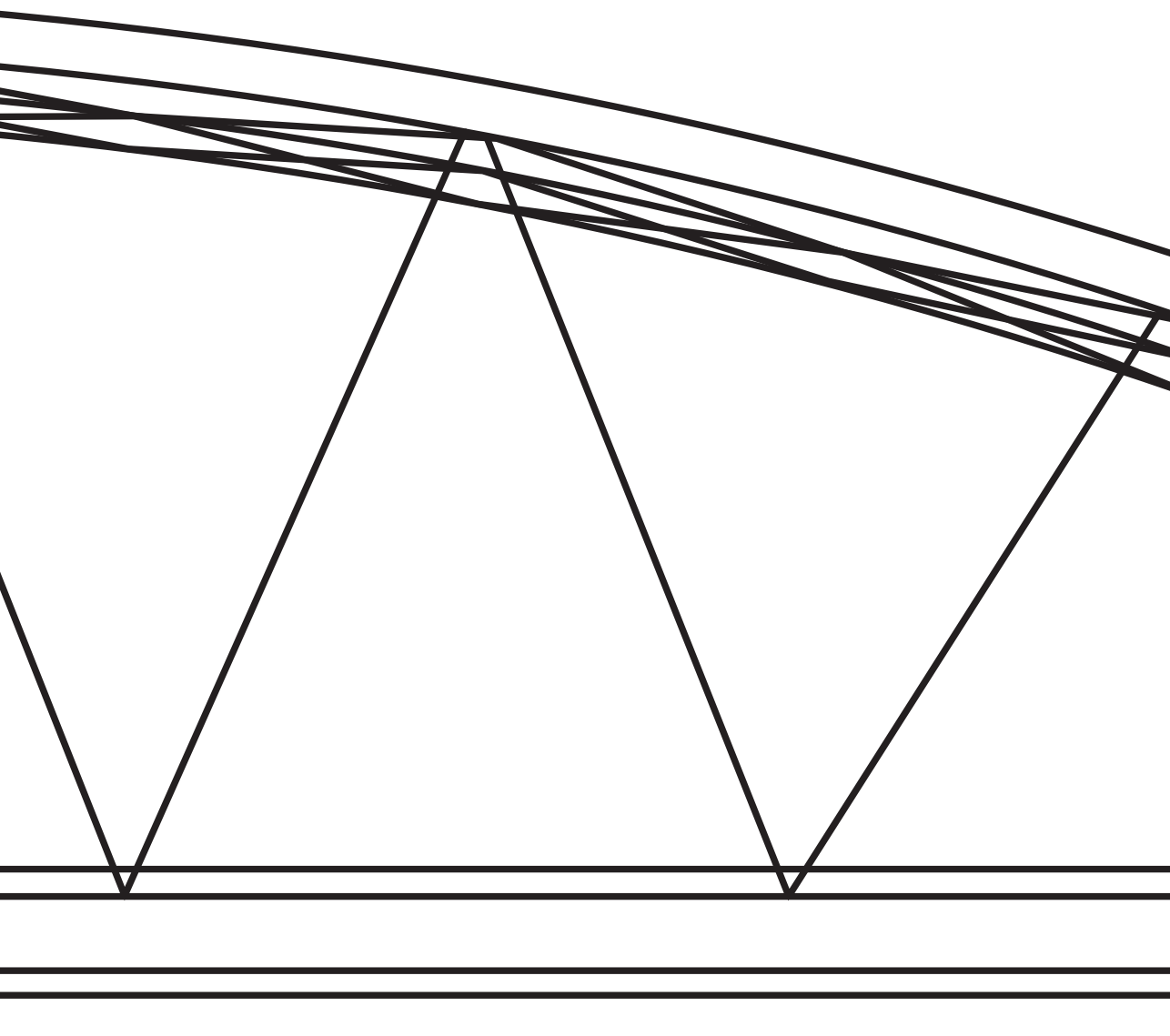
Part I (chapters 2-3-4) focuses on health inequities in children living in deprived neighborhoods and on daily practices in Dutch obstetric care, maternity care and PCHC. In chapters 2 and 3 the results of a neighborhood level epidemiology study level, a digital survey amongst PCHC professionals as well as semi-structured interviews with community obstetrics, maternity care and PCHC are presented.

Part II (chapters 5-6) describes the development of the intervention, consisting of the postnatal R4U, which is a novel postnatal risk assessment, and corresponding care pathways. Consequently, we report on the design of the study protocol for the implementation and evaluation of this innovative intervention.

Part III (chapter 7) focuses on the evaluation of the effectiveness of the postnatal R4U including its corresponding care pathways, and PCHC professional satisfaction with the innovation.

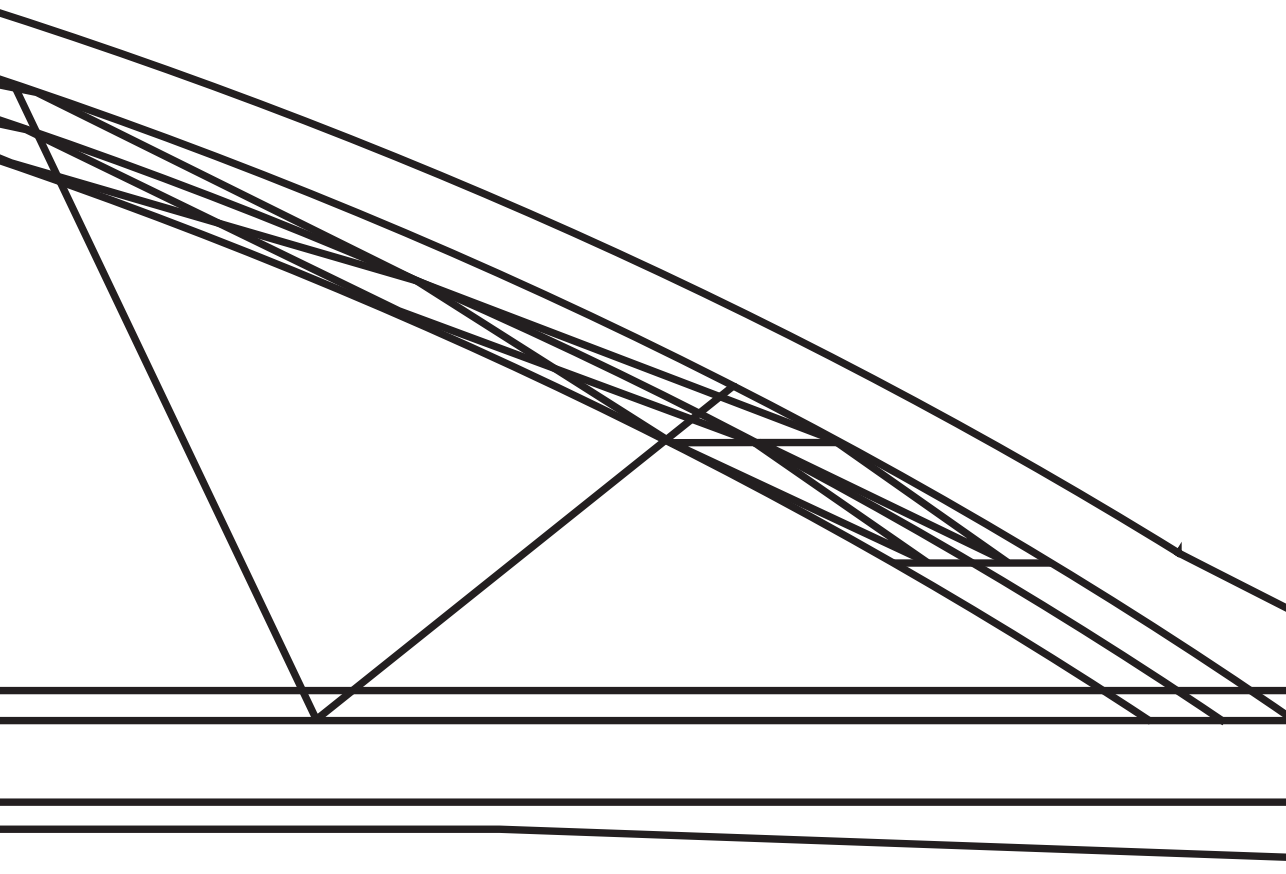
REFERENCES

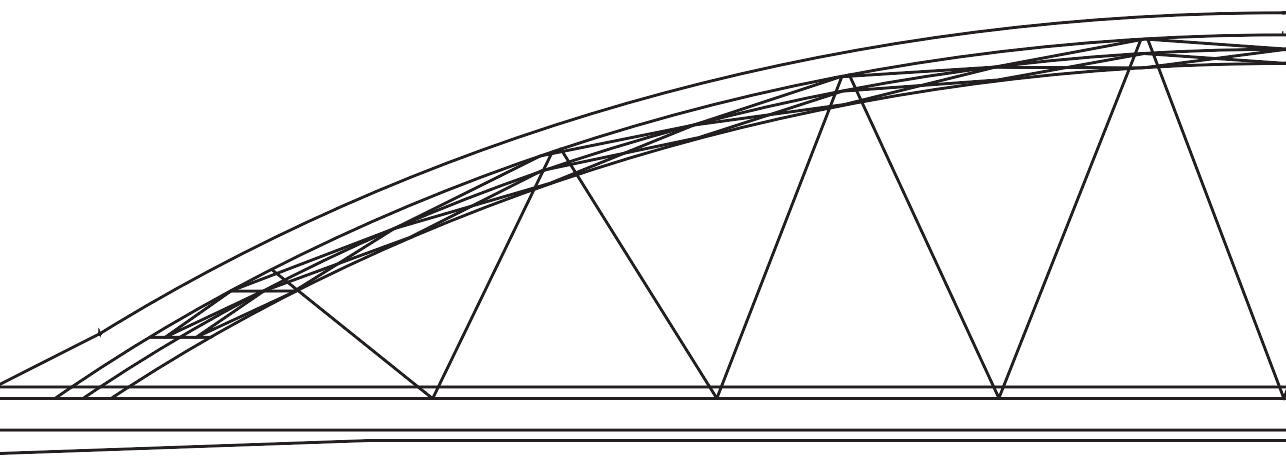
1. Dua T, Tomlinson M, Tablante E, Britto P, Yousfzai A, Daelmans B, et al. Global research priorities to accelerate early child development in the sustainable development era. Lancet Glob Health. 2016;4(12):e887-e9.
2. Heppe DH, Kiefte-de Jong JC, Durmus B, Moll HA, Raat H, Hofman A, et al. Parental, fetal, and infant risk factors for preschool overweight: the Generation R Study. Pediatr Res. 2013;73(1):120-7.
3. Bradley RH, Corwyn RF. Socioeconomic status and child development. Annu Rev Psychol. 2002;53:371-99.
4. Morandi A, Meyre D, Lobbens S, Kleinman K, Kaakinen M, Rifas-Shiman SL, et al. Estimation of newborn risk for child or adolescent obesity: lessons from longitudinal birth cohorts. PLoS One. 2012;7(11):e49919.
5. Scholte RS, van den Berg GJ, Lindeboom M. Long-run effects of gestation during the Dutch Hunger Winter famine on labor market and hospitalization outcomes. J Health Econ. 2015;39:17-30.
6. Denktas S, Poeran J, van Voorst SF, Vos AA, de Jong-Potjer LC, Waelput AJ, et al. Design and outline of the Healthy Pregnancy 4 All study. BMC Pregnancy Childbirth. 2014;14:253.
7. Waelput AJM, Sijpkens MK, Lagendijk J, van Minde MRC, Raat H, Ernst-Smelt HE, et al. Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth. 2017;17(1):254.
8. Frohnhoefer RW. Risk assessment framework: PPC Group; 2014 2014-03-12. 42 p.
9. Weng SF, Redsell SA, Swift JA, Yang M, Glazebrook CP. Systematic review and meta-analyses of risk factors for childhood overweight identifiable during infancy. Arch Dis Child. 2012;97(12):1019-26.
10. Samra HA, McGrath JM, Wehbe M. An integrated review of developmental outcomes and late-preterm birth. J Obstet Gynecol Neonatal Nurs. 2011;40(4):399-411.
11. Vaivada T, Gaffey MF, Bhutta ZA. Promoting Early Child Development With Interventions in Health and Nutrition: A Systematic Review. Pediatrics. 2017;140(2).
12. Arpi E, Ferrari F. Preterm birth and behaviour problems in infants and preschool-age children: a review of the recent literature. Dev Med Child Neurol. 2013;55(9):788-96.
13. Pillas D, Marmot M, Naicker K, Goldblatt P, Morrison J, Pikhart H. Social inequalities in early childhood health and development: a European-wide systematic review. Pediatr Res. 2014;76(5):418-24.
14. Lagendijk J, Steegers EAP, Been JV. Inequity in postpartum healthcare provision at home and its association with subsequent healthcare expenditure. Eur J Public Health. 2019;29(5):849-55.
15. Steegers EA, Been JV. [Health inequalities: congenital or preventable?] Sociale ongelijkheid: aangeboren of te voorkomen? Ned Tijdschr Geneeskd. 2015;160:D83.
16. Jambroes M, Lamkaddem M, Stronks K, Essink-Bot ML. Enumerating the preventive youth health care workforce: Size, composition and regional variation in the Netherlands. Health Policy. 2015;119(12):1557-64.



PART I

Point of departure





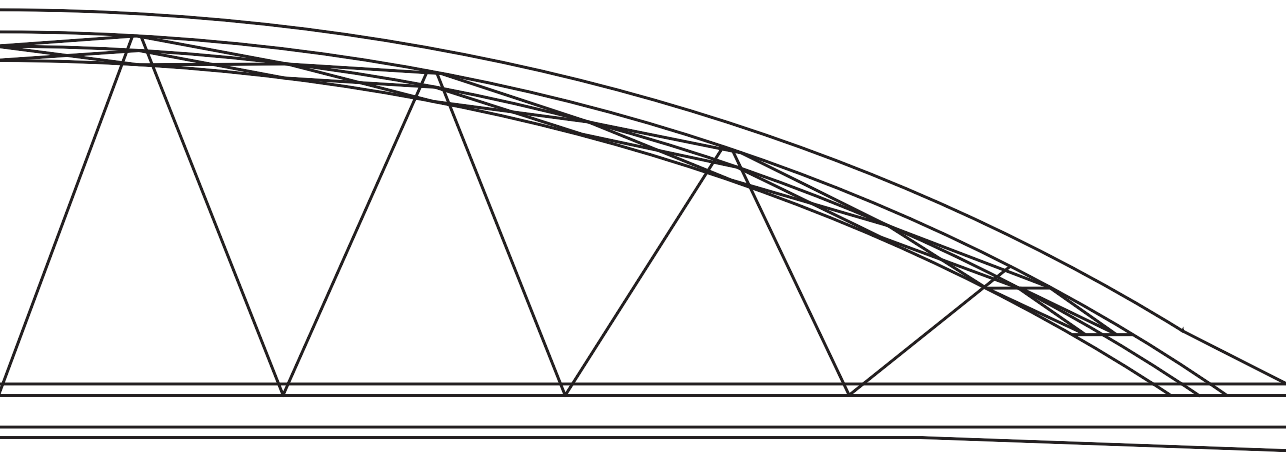
Chapter 2

Associations between socio-economic status and unfavourable social indicators of child wellbeing; a neighbourhood level data design

M.R.C. van Minde
M.L.A. de Kroon
M.K. Sijpkens
H. Raat
E.A.P. Steegers
L.C.M. Bertens

International Journal of Environmental Research and Public Health

https://doi.org/10.3390/ijerph182312661



ABSTRACT

Background

Living in deprivation is related to ill health. Differences in health outcomes between neighbourhoods may be attributed to neighbourhood socio-economic status (SES). Additional to differences in health, neighbourhood differences in child wellbeing could also be attributed to neighbourhood SES. Therefore, we aimed to investigate the association between neighbourhood deprivation, and social indicators of child wellbeing.

Methods

Aggregated data from 3,565 neighbourhoods in 390 municipalities in the Netherlands were eligible for analysis. Neighbourhood SES scores and neighbourhood data on social indicators of child wellbeing were used to perform repeated measurements, with one year measurement intervals, over a period of 11 years. Linear mixed models were used to estimate the associations between SES score and the proportion of unfavourable social indicators of child wellbeing.

Results

After adjustment for year, population size, and clustering within neighbourhoods and within a municipality, neighbourhood SES was inversely associated with the proportion of 'children living in families on welfare' (estimates with two cubic splines: -3.59 [CI: -3.99; -3.19], and -3.00 [CI: -3.33; -2.67]), 'delinquent youth' (estimate -0.26 [CI: -0.30; -0.23]) and 'unemployed youth' (estimates with four cubic splines: -0.41 [CI: -0.57; -0.25], -0.58 [CI: -0.73; -0.43], -1.35 [-1.70; -1.01], and -0.96 [1.24; -0.70]).

Conclusions

In this study using repeated measurements, a lower neighbourhood SES was significantly associated with a higher prevalence of unfavourable social indicators of child wellbeing. This contributes to the body of evidence that neighbourhood SES is strongly related to child health and a child's ability to reach its full potential in later life.

BACKGROUND

Deprivation is defined as "a state of observable and demonstrable disadvantage, relative to the local community or the wider society or nation to which an individual, family or group belongs". [1] Socio-economic status (SES) refers to an individual's level of resource or prestige in relation to others and is traditionally measured through factors such as wealth/income, place on a social hierarchy or class system, and level of education or occupation.[2] SES may be assessed at the individual or contextual level, e.g. neighbourhood level.[3] For the remainder of this work, we will focus on the contextual level SES, where low SES can be understood as indicative of material, financial or social deprivation in a neighbourhood.

Children rely on their parents SES, such as the neighbourhood they live in and the financial status of the family they belong to. [4-6]The effects of neighbourhood SES on babies and children have been studied in previous literature, for instance, when a pregnant woman lives in a deprived neighbourhood, she has higher odds of adverse perinatal outcomes, such as preterm birth (< 37 weeks gestational age), a child born small for gestational age (birthweight < 10^{th} percentile) and stillbirth.[7] Moreover, children living in deprivation are more likely to be overweight or obese during childhood and to have developmental delay when growing up.[8-10] Growing up in deprivation is related to higher odds of smoking and less physical activity in later life.[11] The longer the exposure to deprivation during childhood, the higher the odds of developmental delay and deviant behaviour in adolescence.[8, 9] For adolescents, living in deprivation is associated with less physical activity, and behavioural and psychosocial problems.[5, 6, 12] As young adults, these children show weaker work commitment.[13]

In the past two decades it is generally acknowledged that SES operates at multiple levels (e.g. contextual and personal) to affect wellbeing.[14-17] Contextual level SES measurements, such as neighbourhood SES, have been recognised to provide information about exposures to violence and hazards, as well as access to recreational and institutional resources.[14] For children, there is evidence that neighbourhood of residence is associated with health, school achievement and behavioural outcomes, even when individual level income and education of the parent are controlled for.[14, 17-19] Chetty et al. (2017) showed that neighbourhoods in which children grow up shape their earnings, college attendance rates and their fertility in later life.[20] There is also evidence that living in a low-SES neighbourhood may contribute to the development of behavioural problems and increase the likelihood of single parenthood and teenage motherhood.[21] Additionally, teenage motherhood is often accompanied with poor educational achievement and unemployment of the mother.[21] Osofsky argued that children growing up in poor urban environments are frequently exposed to guns, knives, drugs, and acts of random violence.[22] Exposure to such violence also interrupts a child's ability to solve problems.[14] Furthermore, according to Leventhal & Brooks-Gunn (2000), the most

consistent finding is that, living in a high-SES neighbourhood has positive benefits for school readiness and school achievement.[17]

In the Netherlands, a Western European, developed country, geographical differences in health outcomes between neighbourhoods are high.[23-25] These differences may be attributed to neighbourhood SES.[20, 23, 26] Additional to differences in health, neighbourhood differences in child wellbeing could also be attributed to neighbourhood SES. [27-29] To the best of our knowledge, a study on neighbourhood SES and neighbourhood social indicators of child wellbeing has not been conducted before. Most studies only focussed on child development instead of wellbeing and on the cross-sectional association between SES and health related outcomes, while the exposure (SES) and the outcomes, as well as their associations, are not fixed over time. [30, 31] Therefore, we aimed to investigate the association between neighbourhood deprivation, based on SES, and social indicators of child wellbeing over a period of 11 years. We used repeated measurements to take into account the changes over time in both SES and child wellbeing indicators. We hypothesized that neighbourhood deprivation affects neighbourhood social indicators of child wellbeing negatively.

METHODS

Study design and population

This study uses a neighbourhood-level data design, whereas ecological variables derived from neighbourhoods were used for the analysis. No individual-level date were used for this study, hence the authors did not have access to individual-level data throughout the study. Neighbourhood-level SES scores and Neighbourhood-level data on social indicators of child wellbeing from 2005 until 2015 were used to perform repeated measurements. In this paper a neighbourhood is defined as a four digit postal code (PC4) area. Data from 3,565 neighbourhoods representing 390 municipalities were initially eligible for analysis, which represent all of the neighbourhoods and municipalities in the Netherlands in 2015.

Social indicators of child wellbeing

Data on social indicators of child wellbeing were provided by 'Defence for Children' (www.defenceforchildren.nl), a non-governmental Coalition for Children's Rights. This coalition monitors data on child wellbeing, and is based on 'Kid's Count', a method adopted from the USA.[32] Neighbourhood-level aggregated data were provided on the proportion of children who were exposed to the unfavourable social indicators of child wellbeing. Data were provided per year from 2005 up to and including 2015.[33] Not all outcome measures were available for the full study period. Table 1 represents the main and secondary outcome measures. Social indicators available for the full period of eleven years (2005 – 2015) were selected as main outcome

measures, social indicators available less than eleven years were included as the secondary outcome measures.

Table 1. Social indicators of child wellbeing by 'Defence for Children'.

Main outcomes		
Social indicator of child wellbeing	**Definition by 'Defence for Children'**	**Years available**
Children living in families on welfare	The number of children (age group 0-17) living in families on welfare per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2005 - 2015
Delinquent youth	The number of delinquent adolescents (age group 12-21 years) per neighbourhood, divided by the total number of adolescents in the age group living in that neighbourhood.	2005 - 2015
Unemployed youth	The number of adolescents (age group 16-22 years) who are not working and looking for a job per neighbourhood, divided by the total number of adolescents in the age group living in that neighbourhood.	2005 - 2015
Secondary outcomes		
Social indicator of child wellbeing	**Definition by 'Defence for Children'**	**Years available**
Child social services involved	The number of children (age group 0-17) where child social services is involved (i.e. foster care, youth care or child protection services) per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2013 - 2015
Teenage mothers	The number of teenage mothers (age group 15-19) per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2005 - 2012
Single parents	The number of children (age group 0-17) who have a single parent per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2013 - 2015
Reported and confirmed child abuse	The number of children (age group 0-17), where child abuse was reported and confirmed per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2005 - 2014
Children with a handicap	The number of children with a handicap (age group 0-17) per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2012 - 2015
Disadvantaged pupils	The number of disadvantaged pupils (in primary education) per neighbourhood, divided by the total number of children in primary education living in that neighbourhood.	2005 - 2012
Children in special education	The number of children in special education (in primary and secondary education) per neighbourhood, divided by the total number of children in primary and secondary education living in that neighbourhood.	2013 - 2015
Children participating in sport clubs	The number of children (age group 0-17) who are participating in a sports association per neighbourhood, divided by the total number of children in the age group living in that neighbourhood.	2014 - 2015

Socio-economic status

The Netherlands Institute of Social Research (SCP) publishes a SES score by PC4 (neighbourhood), every four years. The SCP is a governmental agency which conducts research into the social aspects of all areas of governmental policy. This SES score indicates the social status in a neighbourhood, compared to other neighbourhoods. The SES score of a neighbourhood is calculated according to characteristics of its inhabitants: education, income and their position in the labour market. A high score represents a high neighbourhood SES, a low score represents a low neighbourhood SES. The average SES score is around 0, with a standard deviation of 1. [34] Between 1998 and 2014, the overall social status in the Netherlands increased, but in 2016 it had decreased. The SCP does not calculate a SES score for neighbourhoods with less than 100 households (0,2% of all Dutch neighbourhoods).[34] Because the SES score is calculated by the SCP every four years, the SES score of 2002 was assigned to the year 2005, the SES score of 2006 was assigned to the years 2006-2009, the SES score of 2010 was assigned to the years 2010-2013 and the SES score of 2014 was assigned to the years 2014-2015, respectively.

Statistical analyses

Descriptive statistics were applied to calculate the median and 95% ranges for the SES scores and the outcome measures. Plots were created to depict the different social indicators of child wellbeing and explore their trends over time. Neighbourhoods with one or more missing SES scores were excluded (n=7). Outliers in the SES score were removed to better approximate a normal distribution of the data. Hence, the lowest 2.5% of SES scores were removed, after which 3,531 neighbourhoods (99% of all Dutch neighbourhoods) embedded in all 390 municipalities remained for the analyses. Separate plots were created to assess the linearity of the relationship between the social indicators of child wellbeing and SES score. For the repeated measurements, linear mixed models (LMM) with random intercepts were used to estimate the association of SES score (continuous measure) and the prevalence of social indicators for children (continuous measure), with neighbourhood as analyses-unit. Cubic splines were applied to the SES score when there were non-linear relationships between SES score and the main or secondary outcomes. The number of used knots needed differed per outcome measure (range: 2 - 7). Maximum- Likelihood Estimation (MLE) was applied to estimate model parameters. Two-level hierarchical random-intercept models with neighbourhoods at level one, nested within municipalities at level two were specified. This allows for the incorporation of both neighbourhood-level and municipality-level characteristics, as well as the adjustment for clustering within a neighbourhood itself and for clustering of neighbourhoods within a municipality. The variance estimates of the random effects and the beta estimates of the fixed effects were reported, with corresponding 95% confidence intervals.

A generalised linear regression analysis was used for all outcome measures. The model used was a function of SES and year, in which both the independent variable as well as the interaction with SES was added. Additionally, a random intercept for neighborhood and a nested random effect for municipality was added.

Sensitivity analysis and subgroup analysis

Sensitivity analyses were performed to assess whether weighing for population size per neighbourhood resulted in a better fit of the LMM's. The analyses demonstrated a better fit when this weighing was applied and included into the models. At last, a subgroup analysis was performed in children of the age group zero up to and including two years old. For this subgroup, only five outcome measures were available for only one year. The available outcome measures were: 'reported and confirmed child abuse (2014)', 'children living in families on welfare (2015)', 'child social services involved (2015)', 'single parents (2015)' and 'children with a handicap (2015)'. Generalized linear regression analyses were applied for the subgroup and the whole group (0-17 year old children) as a comparison. For all analyses, the significance was set at alpha < 0.05, two tailed. Analyses were performed using R studio version 1.0.153 (R studio) and specifically, the LME4 package was used for the LMM.

RESULTS

Aggregated data of 3,558 neighbourhoods was available. Table 2 features the characteristics of this dataset. Afterwards, SES score outliers (the lowest 2,5%) were removed, after which 3,531 (99%) neighbourhoods distributed over 390 (100%) municipalities, remained for the final analyses. Figure 1 illustrates the increasing average prevalence of 'children living in families on welfare' over time, and the decreasing average proportion of 'delinquent youth' and 'unemployed youth' over time.

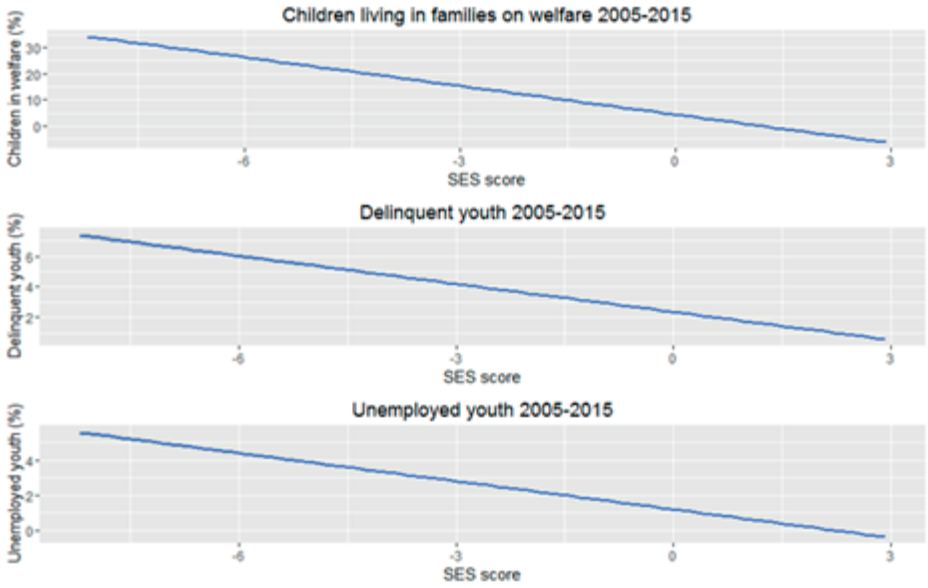


Figure 1. Trends of children living in families on welfare, delinquent youth and unemployed youth over time (2005-2015)

Table 2. Characteristics of social indicators of child wellbeing

Variable	Mean	Median	95% range	Min - max	Missing (%)
SES score	0.046	0.21	-2.63 – 1.83	-8.19 – 2.93	0.0
Children living in families on welfare (%)	4.2	2.1	0.0 – 22.9	0.0 – 62.5	0.2
Delinquent youth (%)	2.3	1.8	0.0 – 7.7	0.0 – 50.0	0.2
Unemployed youth (%)	1.2	0.6	0.0 – 5.8	0.0 – 19.2	0.2
Child social services involved (%)	10.2	10.3	4.0 – 15.0	0.0 – 51.6	0.0
Teenage mothers (%)	0.6	0.2	0.0 – 3.1	0.0 – 11.1	0.2
Single parents (%)	12.0	11.0	0.0 – 33.3	0.0 – 37.5	0.0
Reported and confirmed child abuse (%)	0.6	0.4	0.0 – 2.9	0.0 – 13.3	0.2
Children with a handicap (%)	2.3	2.2	0.0 – 5.0	0.0 – 37.5	0.1
School drop-outs (%)	2.9	2.5	0.0 – 8.2	0.0 – 40.0	0.2
Disadvantaged pupils (%)	14.9	10.8	0.0 – 58.2	0.0 – 98.2	0.2
Children in special education (%)	2.2	1.9	0.0 – 5.9	0.0 – 57.1	0.0
Children participating in sport clubs (%)	43.2	43.8	17.4 – 66.2	0.0 – 93.3	0.0

n= 3558, neighbourhoods with missing SES scores (n=7) were excluded. Data is presented as mean, median score, 95% range, minimum and maximum and percentage of missing data.

Table 3 displays the mixed models for the main outcome measures after applying weights for population size. The results of the initial analyses without applying weights are presented in Supplementary Table 1. The analyses of the main outcomes show that neighbourhood SES is inversely related with the prevalence of unfavourable social indicators of child wellbeing. All associations between neighbourhood SES and the outcomes follow different curves/shapes; 'Children living in families on welfare' shows an inverted exponential association, (with a steeper slope for lower SES scores), a more linear association for 'delinquent youth', and an inverted sigmoid association for 'unemployed youth' (with a steeper slope for medium SES scores).

The results of the secondary outcome measures are presented in S1. Supplementary Table 2. The SES score showed an almost linear association with 'child social services involved', and an inverted sigmoid association with 'teenage mothers', 'children living with a single parent' and 'school drop-outs'(with steeper slopes for higher SES scores. There is an inverted exponential association with 'reported and confirmed child abuse', 'children with a handicap' and 'children in special education' (with steeper slopes for lower SES scores). The association of SES score with 'disadvantaged pupils' represents an undefinable shape. Additionally, higher SES scores were significantly associated with higher proportions of 'children participating in sports associations' in a neighbourhood, showing an exponential relationship.

Table 3. Results of the main outcome measures, weighted for the number of children or adolescents per neighbourhood (n = 3,531)

Social indicator of child wellbeing	Effect	Beta estimate (95% confidence interval)	Variance estimate of PC4 nested within municipality (SD)	Variance estimate of municipality (SD)
Children living in families on welfare	Intercept	4.07 (3.72 ; 4.42)	17.44 (4.18)	4.35 (2.09)
	SES score, 1	-3.59 (-3.99 ;-3.19)		
	SES score, 2	-3.00 (-3.33 ; -2.67)		
	Year	0.047 (0.042 ; 0.053)		
	Population size (ages 0-17)	0.06 (0.05 ; 0.07)		
Delinquent youth	Intercept	2.01 (1.92 ; 2.11)	1.58 (1.26)	0.40 (0.64)
	SES score	-0.26(-0.30 ; -0.23)		
	Year	-0.179 (-0.184 ; -0.174)		
	Population size (ages 12-21)	-0.02 (-0.01 ; 0.03)		
Unemployed youth	Intercept	1.24 (1.07 ; 1.42)	0.40 (0.63)	0.28 (0.53)
	SES score, 1	-0.41 (-0.57 ; -0.25)		
	SES score, 2	-0.58 (-0.73 ; -0.43)		
	SES score, 3	-1.35 (-1.70 ; -1.01)		
	SES score, 4	-0.96 (-1.24 ; -0.70)		
	Year	-0.104 (-0.109 ; -0.10)		
	Population size (ages 16-22)	0.075 (0.067 ; 0.084)		

SES score 1: first cubic spline, SES score 2: second cubic spline, SES score 3: third cubic spline, etc.

The characteristics of the subgroup of children in the age group zero until two years old are presented in Supplementary Table 3. The linear regression analyses indicated an inverse association between SES score and 'reported and confirmed child abuse (2014)', 'children living in families on welfare (2015)', 'child social services involved (2015)' and 'single parents (2015)'. Similar associations were found in the linear regression analyses for the total population of 0-17 year old children in the equivalent years. (Supplementary Table 4.)

DISCUSSION

We have investigated the association between neighbourhood SES and social indicators of child wellbeing using repeated measurements with a one year measurement interval over a period of 11 years. A lower neighbourhood SES was significantly associated with a higher prevalence of unfavourable social indicators of child wellbeing. Our findings indicate that low neighbourhood SES scores are strongly associated with higher proportions of children with 'unfavourable' social indicators in a neighbourhood. The steeper slopes for lower SES scores indicate that these findings are even more pronounced for neighbourhoods with the lowest SES scores.

For the main outcome measure 'children living in families on welfare', the explained variance was 0.9, indicating that this outcome is very closely related to the neighbourhood SES scores. Furthermore, for almost all outcome measures significant associations were found, with explained variances varying between 0.44 and 0.97. This may be due to different municipal or governmental policies regarding child social services for younger and older children, for instance with a stronger focus on social services for pregnant women and infants in low SES neighbourhoods.[35] Our data did not show a significant relationship between SES score and the secondary outcome measure 'disadvantaged pupils' (2005-2012).

Our findings are consistent with previous literature from other countries (e.g. Great Britain and United States of America) and emphasize the relationship between neighbourhood SES and unfavourable social indicators during childhood. Neighbourhood SES is often considered as a constant variable. With our methodology and by using repeated measurements we took the possible variety in SES into consideration to measure our outcome. Our study results confirmed that a low neighbourhood SES is associated with unfavourable social indicators of child wellbeing such as child abuse, living with a single parent, delinquency, less sports participation, and teenage motherhood. The relevance of this finding is illustrated by the fact that these social indicators are related to the problem solving ability and adaptive learning of the child and unemployment and social isolation of the parent(s).[14, 21]

Chetty et al. (2017) argued that neighbourhoods affect a child's long-term outcomes through childhood exposure effects. The outcomes of people who move into a certain neighbourhood are likely to converge to those of permanent residents in the destination to which they move. The longer a child lives in a certain neighbourhood, the stronger the neighbourhood effects on their health related outcomes.[20] This implies that neighbourhood indicators influence the outcomes of its residents, rather than its inhabitants determine neighbourhood SES.

Children living in families on welfare grow up in an environment where parents, neighbours and other family members need to make an effort to get by. Leisure activities and sports are luxuries those children don't have access to. If those activities are not enabled through neigbourhood services or by the municipality, these children will lag behind on their peers. Delinquent and unemployed youth who live in an environment where careers are not supported or encouraged, they will negatively influence each other and their peers. [32] Our individual outcome measures are all influenced by different socio-economic stressors, and therefore show different slopes.

Strengths and limitations

A major strength of our study is that the vast majority of neighbourhoods (99%) in the Netherlands were included in the analyses. Additionally, we were able to use data over a period of 11 years, enabling us to use repeated measurements and create a more robust estimation of the

associations while taking variations over time into account. Similar associations were found in our sensitivity and subgroup analyses, indicating that our findings are robust. A limitation of this study is the absence of personal-level data. With personal level data it would have been possible to create a three-level model, taking the interpersonal variation of people living in a neighbourhood, into account. Another limitation of this study is that we were not able to analyze the effects of time trends in SES on health and wellbeing of its residents. It is hypothesized that, for instance, an increasing neighbourhood SES benefits the health of its residents. It is likely that this effect is delayed, showing a so-called lagging effect on health outcomes.[36] In order to assess the effects of socio-economic trends over time, larger longitudinal datasets are needed, including data from multiple decades of time, and personal level data, including data on residents moving into and out of a certain neighbourhood.[20, 36] In our literature search we did not find any studies showing no relationship between SES and the wellbeing of children and youth. In conclusion, future studies should consist of larger longitudinal datasets and should attempt to take the interpersonal variation into account. For example, a longitudinal study into successful and unsuccessful policies and implementation processes of help- and care facilities. When it comes to individual data studies, a qualitative semi-structured interview approach combined with a qualitative/quantitative survey could be considered.

CONCLUSIONS

This study underlines the relationship between a low neighbourhood SES and a high proportion of children with unfavourable social indicators of child wellbeing in a neighbourhood, including stronger effects for lower SES scores. This contributes to the body of evidence that neighbourhood SES is an important factor related to health and social indicators of child and adolescent wellbeing and wellbeing in later life. The general ecological hypothesis states that as the number of stressors (i.e. social disorder, environmental deterioration, violence, and crime) in a neighbourhood rise, distress among those living in the neighbourhood increases.[37, 38] A high proportion of unfavourable social indicators of child wellbeing in a neighbourhood could be a result of these stressors and contributes to widening of the gap between people of different socio-economic status. Although neighbourhood SES is largely driven by the characteristics of its adult inhabitants, it also affects a child's ability to develop to its full potential, which renders inequality between children growing up in low or high SES neighbourhoods. Attention must be paid to these inequalities, specifically in children, by governmental, social and healthcare institutions in order to provide equal opportunities for all.

Acknowledgments

the authors wish to thank D. Nieboer, PhD and Dr. S. Willemsen, PhD for their support during the statistical analyses. Special thanks go to the Defence for Children who provided the 'Kinderen in Tel' data and dr. J. Iedema of the SCP for providing more insight in the SES score data.

REFERENCES

1. Townsend, P., Deprivation. *Journal of Social Policy* **1987,** 16, (2), 125-146.
2. Finegan, M.; Firth, N.; Wojnarowski, C.; Delgadillo, J., Associations between socioeconomic status and psychological therapy outcomes: A systematic review and meta-analysis. *Depress Anxiety* **2018**.
3. Adler N.E., S. A. C., The Role of Psychosocial Processes in Explaining the Gradient Between Socioeconomic Status and Health *Current Directions in Psychological Science* **2003,** 12, (4), 119-123.
4. Pickett, K. E.; Pearl, M., Multilevel analyses of neighbourhood socioeconomic context and health outcomes: a critical review. *J Epidemiol Community Health* **2001,** 55, (2), 111-22.
5. Chzhen, Y.; Moor, I.; Pickett, W.; Toczydlowska, E.; Stevens, G., International trends in 'bottom-end' inequality in adolescent physical activity and nutrition: HBSC study 2002-2014. *Eur J Public Health* **2018**.
6. Rothon, C.; Goodwin, L.; Stansfeld, S., Family social support, community "social capital" and adolescents' mental health and educational outcomes: a longitudinal study in England. *Soc Psychiatry Psychiatr Epidemiol* **2012,** 47, (5), 697-709.
7. Vos, A. A.; Posthumus, A. G.; Bonsel, G. J.; Steegers, E. A.; Denktas, S., Deprived neighborhoods and adverse perinatal outcome: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand* **2014,** 93, (8), 727-40.
8. Schjolberg, S.; Eadie, P.; Zachrisson, H. D.; Oyen, A. S.; Prior, M., Predicting language development at age 18 months: data from the Norwegian Mother and Child Cohort Study. *J Dev Behav Pediatr* **2011,** 32, (5), 375-83.
9. Rijlaarsdam, J.; Stevens, G. W.; van der Ende, J.; Hofman, A.; Jaddoe, V. W.; Mackenbach, J. P.; Verhulst, F. C.; Tiemeier, H., Economic disadvantage and young children's emotional and behavioral problems: mechanisms of risk. *J Abnorm Child Psychol* **2013,** 41, (1), 125-37.
10. Rijlaarsdam, J.; Tiemeier, H.; Hofman, A.; Jaddoe, V. W.; Mackenbach, J. P.; Verhulst, F. C.; Stevens, G. W., Home environments of infants: relations with child development through age 3. *J Epidemiol Community Health* **2013,** 67, (1), 14-20.
11. Puolakka, E.; Pahkala, K.; Laitinen, T. T.; Magnussen, C. G.; Hutri-Kahonen, N.; Mannisto, S.; Palve, K. S.; Tammelin, T.; Tossavainen, P.; Jokinen, E.; Smith, K. J.; Laitinen, T.; Elovainio, M.; Pulkki-Raback, L.; Viikari, J. S. A.; Raitakari, O. T.; Juonala, M., Childhood socioeconomic status and lifetime health behaviors: The Young Finns Study. *Int J Cardiol* **2018,** 258, 289-294.
12. Anderson, L. R., Adolescent mental health and behavioural problems, and intergenerational social mobility: A decomposition of health selection effects. *Soc Sci Med* **2018,** 197, 153-160.
13. Nieuwenhuis, J.; Yu, R.; Branje, S.; Meeus, W.; Hooimeijer, P., Neighbourhood Poverty, Work Commitment and Unemployment in Early Adulthood: A Longitudinal Study into the Moderating Effect of Personality. *PLoS One* **2016,** 11, (12), e0167830.
14. Bradley, R. H.; Corwyn, R. F., Socioeconomic status and child development. *Annu Rev Psychol* **2002,** 53, 371-99.
15. Krieger, N.; Williams, D. R.; Moss, N. E., Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annu Rev Public Health* **1997,** 18, 341-78.
16. Adler, N. E.; Ostrove, J. M., Socioeconomic status and health: what we know and what we don't. *Ann N Y Acad Sci* **1999,** 896, 3-15.
17. Leventhal, T.; Brooks-Gunn, J., The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychol Bull* **2000,** 126, (2), 309-37.
18. Baum, A.; Garofalo, J. P.; Yali, A. M., Socioeconomic status and chronic stress. Does stress account for SES effects on health? *Ann N Y Acad Sci* **1999,** 896, 131-44.

19. Wasserman, C. R.; Shaw, G. M.; Selvin, S.; Gould, J. B.; Syme, S. L., Socioeconomic status, neighborhood social conditions, and neural tube defects. *Am J Public Health* **1998,** 88, (11), 1674-80.
20. Chetty, R. H., N. , The Impact of Neighborhoods on Intergenerational Mobility I: Childhood Exposure Effects. *The Quarterly Journal of Economics* **2017**.
21. Bradley, T.; Cupples, M. E.; Irvine, H., A case control study of a deprivation triangle: teenage motherhood, poor educational achievement and unemployment. *Int J Adolesc Med Health* **2002,** 14, (2), 117-23.
22. Osofsky, J. D., The impact of violence on children. *Future Child* **1999,** 9, (3), 33-49.
23. Waelput, A. J. M.; Sijpkens, M. K.; Lagendijk, J.; van Minde, M. R. C.; Raat, H.; Ernst-Smelt, H. E.; de Kroon, M. L. A.; Rosman, A. N.; Been, J. V.; Bertens, L. C. M.; Steegers, E. A. P., Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. *BMC Pregnancy Childbirth* **2017,** 17, (1), 254.
24. Mohangoo, A. D.; Hukkelhoven, C. W.; Achterberg, P. W.; Elferink-Stinkens, P. M.; Ravelli, A. C.; Rijninks-van Driel, G. C.; Tamminga, P.; Waelput, A. J.; van der Pal-de Bruin, K. M.; Nijhuis, J. G., [Decline in foetal and neonatal mortality in the Netherlands: comparison with other Euro-Peristat countries between 2004 and 2010] Afname van foetale en neonatale sterfte in Nederland: vergelijking met andere Euro-Peristat-landen in 2004 en 2010. *Ned Tijdschr Geneeskd* **2014,** 158, A6675.
25. Petrovic, D.; de Mestral, C.; Bochud, M.; Bartley, M.; Kivimaki, M.; Vineis, P.; Mackenbach, J.; Stringhini, S., The contribution of health behaviors to socioeconomic inequalities in health: A systematic review. *Prev Med* **2018,** 113, 15-31.
26. Gurka, M. J.; Filipp, S. L.; DeBoer, M. D., Geographical variation in the prevalence of obesity, metabolic syndrome, and diabetes among US adults. *Nutr Diabetes* **2018,** 8, (1), 14.
27. Viner, R. M.; Ozer, E. M.; Denny, S.; Marmot, M.; Resnick, M.; Fatusi, A.; Currie, C., Adolescence and the social determinants of health. *Lancet* **2012,** 379, (9826), 1641-52.
28. Kamp Dush, C. M.; Schmeer, K. K.; Taylor, M., Chaos as a social determinant of child health: Reciprocal associations? *Soc Sci Med* **2013,** 95, 69-76.
29. Munday, K.; Wilson, M., Implementing a Health and Wellbeing Programme for Children in Early Childhood: A Preliminary Study. *Nutrients* **2017,** 9, (9).
30. Khoshnood, B., Socioeconomic disparity is not a given. *Bmj* **2018,** 361.
31. Gilbert, R.; Widom, C. S.; Browne, K.; Fergusson, D.; Webb, E.; Janson, S., Burden and consequences of child maltreatment in high-income countries. *Lancet* **2009,** 373, (9657), 68-81.
32. Lippman, L. H., Indicators and Indices of Child Well-being: A Brief American History. *Social Indicators Research* **2007,** 83, (1), 39-53.
33. Steketee, M., Tierolf, B. & Mak, J. (red.) *Kinderen in Tel Databoek 2014. Kinderrechten als basis voor lokaal jeugdbeleid.*; Verwey-Jonker Instituut.: Utrecht, 2014.
34. Frans Knol, J. B., Vic Veldheer *Statusontwikkeling van wijken in Nederland 1998-2010*; Sociaal Cultureel Planbureau: 2012.
35. Inspectie voor de Gezondheidszorg (IGZ) *Thematisch toezicht geboortezorg: Afsluitend onderzoek naar de invoering van de normen van 'Een goed begin'*; Utrecht, 2016.
36. Sacker, A.; Wiggins, R. D.; Bartley, M., Time and place: putting individual health into context. A multilevel analysis of the British household panel survey, 1991-2001. *Health Place* **2006,** 12, (3), 279-90.
37. Zuvarin SJ, The ecology of child abuse and neglect: review of the literature and presentation of data. *Violence Vict* **1989**, (4), 101-20.
38. Gilster, M. E., Neighborhood stressors, mastery, and depressive symptoms: racial and ethnic differences in an ecological model of the stress process in Chicago. *J Urban Health* **2014,** 91, (4), 690-706.

ADDENDUM

Supplementary Table 1. Primary analysis for the main outcome measures, estimates of SES score and social indicators of child wellbeing, n = 3,531

Social indicator of child wellbeing	Effect	Beta estimate (95% confidence interval)	Variance estimate of PC4:municipality (SD)	Variance estimate of municipality (SD)	R squared
Children living in families on welfare	Intercept	**4.63 (4.29 ; 4.98)**	18.24 (4.27)	4.86 (2.20)	0.90
	SES score, 1	**-3.43 (-3.83 ; -3.04)**			
	SES score, 2	**-2.79 (-3.11 ; -2.46)**			
	Year	**0.045 (0.040 ; 0.050)**			
Delinquent youth	Intercept	**2.12 (2.04 ; 2.21)**	1.58 (1.26)	0.44 (0.67)	0.54
	SES score	**-0.27 (-0.31 ; -0.23)**			
	Year	**-0.18 (-0.183 ; -0.174)**			
Unemployed youth	Intercept	**1.51 (1.34 ; 1.69)**	0.45 (0.67)	0.30 (0.55)	0.33
	SES score, 1	**-0.36 (-0.53 ; -0.20)**			
	SES score, 2	**-0.62 (-0.78 ; -0.47)**			
	SES score, 3	**-1.44 (-1.79 ; -1.08)**			
	SES score, 4	**-1.20 (-1.48 ; -0.93)**			
	Year	**-0.102 (-0.107 ; -0.098)**			

Supplementary Table 2. Results of the secondary outcome measures, adjusted for the number of children or adolescents living in a certain neighbourhood, n = 3,531

Child social determinant	Effect	Estimate (95% confidence interval)	Variance estimate of PC4 nested within municipality (SD)	Variance estimate of municipality (SD)
Child social services involved	Intercept	14.92 (14.41 ; 15.06)	0.00 (0.00)	2.19 (1.48)
	SES score, 1	-1.74 (-2.13 ; -1.35)		
	SES score, 2	-1.71 (-2.00 ; -1.43)		
	Year	-1.05 (-1.10 ; -1.01)		
	Population size (ages 0-17)	0.017 (0.013 ; 0.023)		
Teenage mothers	Intercept	1.04 (0.0.94 ; 1.13)	0.14 (0.38)	0.06 (0.25)
	SES score, 1	-0.47 (-0.54 ; -0.40)		
	SES score, 2	-1.38 (-1.58 ; -1.18)		
	SES score, 3	-0.75 (-0.89 ; -0.60)		
	Year	-0.035 (-0.039 ; -0.030)		
	Population size (ages 15-19)	0.011 (0.003 ; 0.027)		
Children living with a single parent	Intercept	16.70 (15.62 ; 17.79)	23.95 (4.89)	13.32 (3.65)
	SES score, 1	-9.52 (-10.50 ; -8.55)		
	SES score, 2	-9.16 (-10.03; -8.29)		
	SES score, 3	-20.39 (-22.58 ; -18.19)		
	SES score, 4	-16.46 (-18.12 ; -14.80)		
	Year	0.35 (0.30 ; 0.40)		
	Population size (ages 0-17)	0.16 (0.14 ; 0.18)		
Reported and confirmed child abuse	Intercept	1.26 (1.19 ; 1.33)	0.11 (0.33)	0.11 (0.33)
	SES score, 1	-1.63 (-1.74 ; -1.52)		
	SES score, 2	-0.77 (-0.86 ; -0.69)		
	Year	0.017 (0.015 ; 0.019)		
	Population size (ages 0-17)	0.005 (0.003 ; 0.006)		
Children with a handicap	Intercept	2.56 (2.37; 2.76)	1.15 (1.07)	0.11 (0.33)
	SES score, 1	-2.32 (-2.65 ; -1.98)		
	SES score, 2	-1.17 (-1.41 ; -0.92)		
	Year	0.21 (0.20 ; 0.22)		
	Population size (ages 0-17)	0.005 (0.0002 ; 0.009)		

Supplementary Table 2. Results of the secondary outcome measures, adjusted for the number of children or adolescents living in a certain neighbourhood, n = 3,531 (*continued*)

Child social determinant	Effect	Estimate (95% confidence interval)	Variance estimate of PC4 nested within municipality (SD)	Variance estimate of municipality (SD)
School drop-outs	Intercept	3.99 (3.79 ; 4.19)	0.86 (0.93)	0.49 (0.70)
	SES score, 1	-1.52 (-1.67 ; -1.38)		
	SES score, 2	-2.61 (-3.02 ; -2.20)		
	SES score, 3	-1.54 (-1.84 ; -1.25)		
	Year	-0.27 (-0.281 ; -0.269)		
	Population size (number of children in primary and secondary education)	0.020 (0.008 ; 0.032)		
Disadvantaged pupils	Intercept	9.57 (8.43 ; 10.99)	114.55 (10.70)	30.42 (5.52)
	SES score, 1	2.36 (1.50 ; 3.21)		
	SES score, 2	3.24 (2.27 ; 4.22)		
	SES score, 3	2.54 (1.60 ; 3.47)		
	SES score, 4	1.88 (0.91 ; 2.85)		
	SES score, 5	-1.75 (-2.75 ; -0.76)		
	SES score, 6	5.98 (3.88 ; 8.08)		
	SES score, 7	3.86 (1.89 ; 5.84)		
	Year	-1.46 (-1.49 ; -1.43)		
	Population size (number of children in primary education	-0.21 (-0.27 ; -0.14)		
Children in special education	Intercept	2.75 (2.43 ; 3.06)	4.72 (0.2.17)	0.25 (0.50)
	SES score, 1	-2.17 (-2.72 ; -1.62)		
	SES score, 2	-0.78 (-1.16 ; -0.40)		
	Year	-0.0005 (-0.014 ; 0.013)		
	Population size (number of children in primary and secondary education)	0.06 (0.04 ; 0.07)		
Children participating in sport clubs	Intercept	24.16 (22.29 ; 26.04)	65.31 (8.08)	41.65 (6.45)
	SES score, 1	13.31 (12.04 ; 14.59)		
	SES score, 2	32.80 (29.28 ; 36.32)		
	SES score, 3	20.94 (18.59 ; 23.29)		
	Year	1.54 (1.38 ; 1.70)		
	Population size (ages 0-17)	-0.03 (-0.07 ; 0.01)		

SES score 1: first cubic spline, SES score 2: second cubic spline, SES score 3: third cubic spline, etc.

Supplementary Table 3. Analyses for the secondary outcome measures, adjusted for the number of children or adolescents living in a certain neighbourhood, n = 3,531

Social indicator of child wellbeing	Effect	Estimate (95% confidence interval)	Variance estimate of PC4:municpality (SD)	Variance estimate of municipality (SD)	R squared
Child social services involved	Intercept	**14.92 (14.41 ; 15.06)**	0.00 (0.00)	2.19 (1.48)	0.44
	SES score, 1	**-1.74 (-2.13 ; -1.35)**			
	SES score, 2	**-1.71 (-2.00 ; -1.43)**			
	Year	**-1.05 (-1.10 ; -1.01)**			
	N of children in age group 0-17	**0.017 (0.013 ; 0.023)**			
Teenage mothers	Intercept	**1.04 (0.0.94 ; 1.13)**	0.14 (0.38)	0.06 (0.25)	0.28
	SES score, 1	**-0.47 (-0.54 ; -0.40)**			
	SES score, 2	**-1.38 (-1.58 ; -1.18)**			
	SES score, 3	**-0.75 (-0.89 ; -0.60)**			
	Year	**-0.035 (-0.039 ; -0.030)**			
	N of females in age group 15-19	**0.011 (0.003 ; 0.027)**			
Children living with a single parent	Intercept	**16.70 (15.62 ; 17.79)**	23.95 (4.89)	13.32 (3.65)	0.91
	SES score, 1	**-9.52 (-10.50 ; -8.55)**			
	SES score, 2	**-9.16 (-10.03; -8.29)**			
	SES score, 3	**-20.39 (-22.58 ; -18.19)**			
	SES score, 4	**-16.46 (-18.12 ; -14.80)**			
	Year	**0.35 (0.30 ; 0.40)**			
	N of children in age group 0-17	**0.16 (0.14 ; 0.18)**			
Reported and confirmed child abuse	Intercept	**1.26 (1.19 ; 1.33)**	0.11 (0.33)	0.11 (0.33)	0.41
	SES score, 1	**-1.63 (-1.74 ; -1.52)**			
	SES score, 2	**-0.77 (-0.86 ; -0.69)**			
	Year	**0.017 (0.015 ; 0.019)**			
	N of children in age group 0-17	**0.005 (0.003 ; 0.006)**			
Children with a handicap	Intercept	**2.56 (2.37; 2.76)**	1.15 (1.07)	0.11 (0.33)	0.74
	SES score, 1	**-2.32 (-2.65 ; -1.98)**			
	SES score, 2	**-1.17 (-1.41 ; -0.92)**			
	Year	**0.21 (0.20 ; 0.22)**			
	N of children in age group 0-17	**0.005 (0.0002 ; 0.009)**			

Supplementary Table 3. Analyses for the secondary outcome measures, adjusted for the number of children or adolescents living in a certain neighbourhood, n = 3,531 (*continued*)

Social indicator of child wellbeing	Effect	Estimate (95% confidence interval)	Variance estimate of PC4:municpality (SD)	Variance estimate of municipality (SD)	R squared
School drop-outs	Intercept	**3.99 (3.79 ; 4.19)**	0.86 (0.93)	0.49 (0.70)	0.47
	SES score, 1	**-1.52 (-1.67 ; -1.38)**			
	SES score, 2	**-2.61 (-3.02 ; -2.20)**			
	SES score, 3	**-1.54 (-1.84 ; -1.25)**			
	Year	**-0.27 (-0.281 ; -0.269)**			
	N of children in primary and secondary education	**0.020 (0.008 ; 0.032)**			
Disadvantaged pupils	Intercept	**9.57 (8.43 ; 10.99)**	114.55 (10.70)	30.42 (5.52)	0.88
	SES score, 1	**2.36 (1.50 ; 3.21)**			
	SES score, 2	**3.24 (2.27; 4.22)**			
	SES score, 3	**2.54 (1.60; 3.47)**			
	SES score, 4	**1.88 (0.91 ; 2.85)**			
	SES score, 5	**-1.75 (-2.75; -0.76)**			
	SES score, 6	**5.98 (3.88 ; 8.08)**			
	SES score, 7	**3.86 (1.89 ; 5.84)**			
	Year	**-1.46 (-1.49 ; -1.43)**			
	N of children in primary education	**-0.21 (-0.27 ; -0.14)**			
Children in special education	Intercept	**2.75 (2.43 ; 3.06)**	4.72 (0.2.17)	0.25 (0.50)	0.94
	SES score, 1	**-2.17 (-2.72 ; -1.62)**			
	SES score, 2	**-0.78 (-1.16 ; -0.40)**			
	Year	-0.0005 (-0.014 ; 0.013)			
	N of children in primary and secondary education	**0.06 (0.04 ; 0.07)**			
Children participating in sport clubs	Intercept	**24.16 (22.29 ; 26.04)**	65.31 (8.08)	41.65 (6.45)	0.92
	SES score, 1	**13.31 (12.04 ; 14.59)**			
	SES score, 2	**32.80 (29.28 ; 36.32)**			
	SES score, 3	**20.94 (18.59 ; 23.29)**			
	Year	**1.54 (1.38 ; 1.70)**			
	N of children in age group 0-17	-0.03 (-0.07 ; 0.01)			

Supplementary Table 4. Characteristics of children in the age group 0-2 years old, n = 3,541

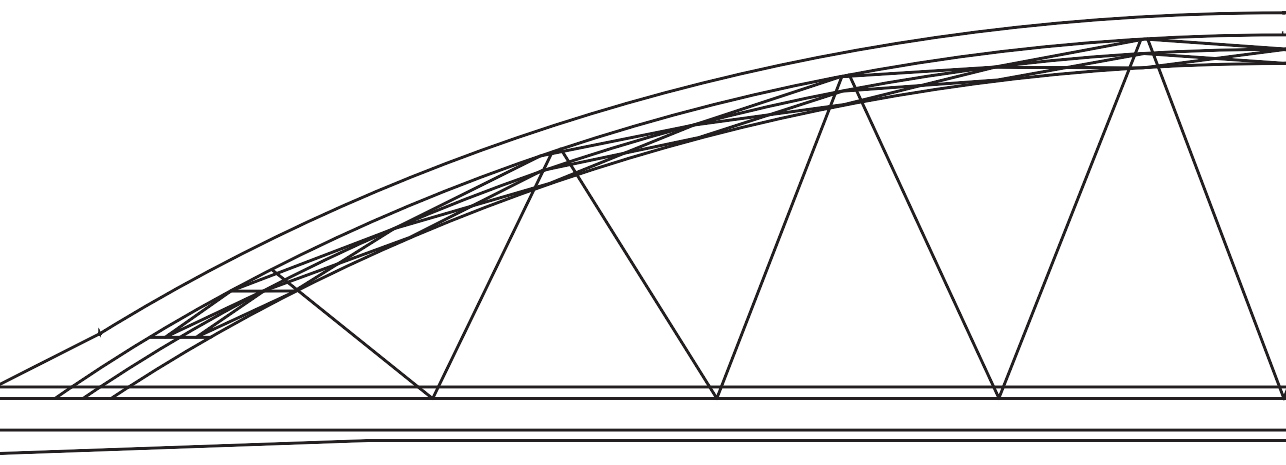
Variable	Median	95% range	Min-max
SES score 2014	0.15	-2.84 – 1.90	-8.19 – 2.93
Children living in families on welfare in 2014 (%)	2.22	0.00 – 18.18	0.00 – 42.86
Child social services involved in 2015 (%)	0.79	0.00 – 3.75	0.00 – 40.00
Single parents in 2015 (%)	5.71	0.00 – 25.00	0.00 – 66.67
Reported and confirmed child abuse in 2015 (%)	0.00	0.00 – 3.33	0.00 – 11.25
Children with a handicap in 2015 (%)	0.83	0.00 – 5.00	0.00 – 14.00

Supplementary Table 5. Linear regression analyses for SES score and social indicators of child wellbeing, adjusted for the number of children living in a certain neighbourhood, n=3,541

Year 2014	**0-2 year old children**		**0-17 year old children**	
Variable	**Beta estimate**	**95% CI**	**Estimate**	**95% CI**
Reported and confirmed child abuse*	1: **-3.61** 2: **-2.64**	(-4.57 ; -2.56) (-2.96 ; -2.32)	1: **-2.27** 2: **-2.96** **3: -2.67** **4: -3.06** **5: -2.35** **6: -5.46** **7: -2.41**	(-2.72 ; -1.78) (-3.48 ; -2.39) (-3.17 ; -2.13) (-3.58 ; -2.50) (-2.83 ; -1.86) (-6.57 ; -4.25) (-3.56 ; -1.57)
Year 2015	**0-2 year old children**		**0-17 year old children**	
Variable	**Estimate**	**95% CI**	**Estimate**	**95% CI**
Children living in families on welfare*	1: **-2.65** 2: **-3.18** 3: **-4.26**	(-2.81 ; -2.49) (-3.97 ; -2.37) (-4.78 ; -3.76)	1: **-2.97** 2: **-3.48** 3: **-4.25**	(-4.52 ; -3.59) (-5.04 ; -4.66) (-5.04 ; -4.66)
Child social services involved*	1: **-2.02** 2: **-5.25** 3: **-1.74**	(-2.26 ; -1.78) (-6.19 ; -4.23) (-2.18; -1.32)	1: **-0.90** 2: **-0.66**	(-1.29 ; -0.05) (-0.74 ; -0.58) (-1.56 ; -1.08)
Single parents*	1 **-1.06** 2: **-1.46** 3: **-1.31** 4: **-1.82**	(-1.44 ; -0.64) (-1.73 ; -1.18) (-2.20 ; -0.37) (-2.22 ; -1.42)	1: **-0.90** 2: **-1.32** 3: **-1.01** 4: **-1.33**	(-1.21; -0.57) (-1.53 ; - 1.11) (-1.72 ; - 0.28) (-1.62 ; - 1.06)
Children with a handicap*	1: 0.88 2: 0.41 3: 2.16 4: -0.23	(-0.34 ; 2.30) (-0.32 ; 1.25) (-0.48 ; 5.21) (-1.00 ; 0.54)	1: **-0.49** 2: **-0.03** 3: **-0.65**	(-0.65 ; -0.31) (-0.74 ; -0.70) (-0.87 ; -0.43)

*cubic splines were applied to model for non-linearity

- estimates in bold are statistically significant alpha <0.05



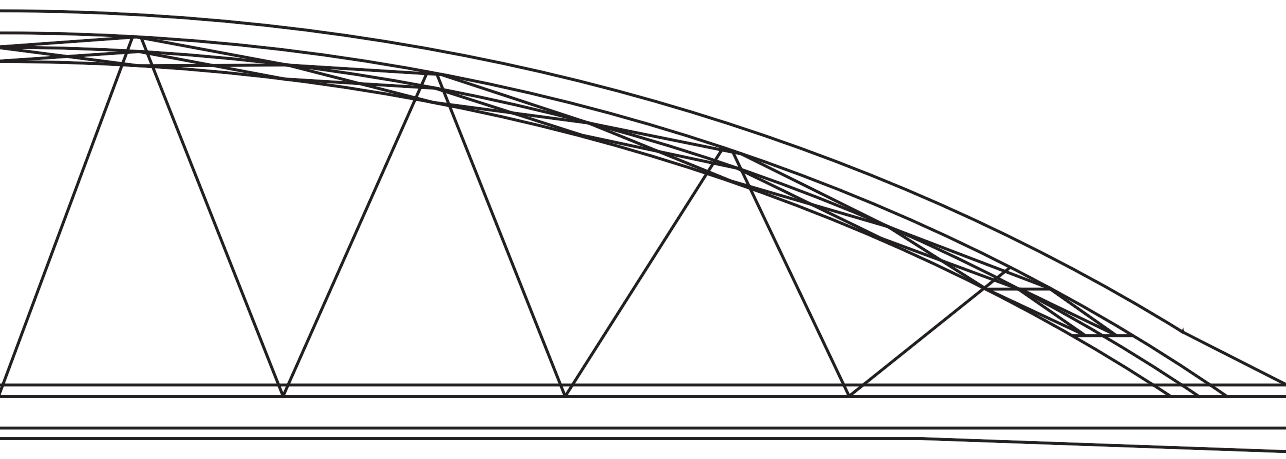
Chapter 3

Postnatal screening and care for non-medical risk factors by Preventive Child Healthcare in deprived and non-deprived neighbourhoods

M.R.C. van Minde
S.M. Hulst
H. Raat
E.A.P. Steegers
M.L.A. de Kroon

BMC Health Services Research

https://rdcu.be/cNYbw



ABSTRACT

Background

Children born in families with non-medical risk factors, such as deprivation, have higher odds of preterm birth (< 37 weeks of gestation) or being born small for gestational age (birth weight < 10th percentile). In addition, growing up they are at risk for growth and developmental problems. Preventive Child Healthcare (PCHC) monitors growth and development of babies and children. Early identification of children at risk could result in early interventions to prevent growth and developmental problems in later life. Therefore, we aimed to assess current practices in postnatal risk screening and care for non-medical risk factors and the collaboration with other healthcare professionals, in both deprived and non-deprived neighbourhoods in the Netherlands.

Methods

Eight out of ten invited PCHC organisations, from different areas in the Netherlands, consented to participate in this study. A questionnaire was designed and digitally distributed to professionals working at these organisations, where 370 physicians and nurses were employed. Data was collected between June and September 2016. Descriptive statistics, chi square tests and *t*-tests were applied.

Results

Eighty-nine questionnaires were eligible for analyses. 20% of the respondents were working in a deprived neighbourhood and 70.8% of the respondents were employed as nurse. Most of them performed screening for non-medical risk factors in at least 50% of their consultations. PCHC professionals working in deprived neighbourhoods encountered significantly more often families with non-medical risk factors and experienced significantly more communication problems than their colleagues working in non-deprived neighbourhoods. 48.2% of the respondents were satisfied with the current form of postnatal risk screening in their organisation, whereas 41.2% felt a need for a structured postnatal risk assessment. Intensified collaboration is preferred with district-teams, general practitioners and midwifes, concerning clients with non-medical risk factors.

Conclusion

This study shows that postnatal screening for non-medical risk factors is part of current PCHC practice, regardless the neighbourhood status they are deployed. PCHC professionals consider screening for non-medical risk factors as their responsibility. Consequently, they felt a need for a structured postnatal risk assessment and for an intensified collaboration with other healthcare professionals.

BACKGROUND

The developmental theory of health and disease identified the first 1000 days (from conception to the age of two years) as a critical and sensitive period for the development of a human being. [1] Initial vulnerability for future disease can be aggravated by growing up in an unfavourable socio-economic environment or by other non-medical risk factors, such as lack of social support or domestic violence, affecting a child's growth and development. [1, 2] Parental lifestyle factors such as smoking, substance abuse (drugs and alcohol) and obesity are also considered as non-medical risk factors [3] and individually influence growth and development of children. [4-7] Medical risk factors such as preterm birth and being born small for gestational age (SGA) are independently associated with a high risk for growth and developmental problems in children. [8-10] Additionally, in deprived neighbourhoods these medical risk factors are more common. [11] Both medical and non-medical risk factors, the accumulation and the interaction of these risks explain the difference in perinatal and child health among deprived and non-deprived neighbourhoods. [12-14]

In the Netherlands, Preventive Child Healthcare (PCHC) organisations are responsible for monitoring child growth and development and of the promotion of healthy lifestyles. PCHC is offered to all children, from birth until the age of 19 years by the Dutch government, free of charge. For children in the age of zero up to four years old, consultations comprise of growth and developmental measurements, regular visits to the national vaccination programme and parenting advice. These consultations have high attendance rates (>95%). [15]

To our knowledge, a structured postnatal risk assessment for growth and development, combining both medical and non-medical risk factors, does not yet exist for PCHC. However, for the early detection of developmental problems in toddlers, an instrument has been developed for the application in PCHC. [16] In obstetric care, an antenatal risk assessment has been developed and evaluated, assessing the risk of unfavourable birth outcomes in the first trimester of pregnancy. [17]

Moreover, PCHC professional opinion on this subject has not been studied before. Studies on the views and needs of PCHC professionals are scarce. Häggman-Laitila et al (2003) described public health nurses views on the needs for special support of Finnish families, where the needs varied per region. [18] Their findings correspond with the results of a qualitative study by Mundet-Tuduri et al (2017), who highlighted the different educational needs of public healthcare professionals, varying per region and organisation. [19] Concerning the implementation of screening instruments, Garg et al (2018) highlighted the practical challenges of the use of recommended screening tools as part of developmental surveillance. They stressed on the need for further research regarding the most effective integrated models of care. [20]

Objective

We aimed to assess current postnatal risk screening and care practices for non-medical risk factors, additional to medical risk factors, in PCHC. We hypothesized that the magnitude of screening and care practices in the postnatal period, could be affected by working in a deprived or non-deprived neighbourhood. Additionally, we assessed the needs of PCHC professionals and their collaboration with other healthcare providers.

METHODS

Study design

This study concerns a cross-sectional descriptive survey. The survey was conducted among PCHC professionals (physicians and nurses) working at eight different PCHC organisations in urban and rural regions in the Netherlands. This study is part of the Healthy Pregnancy 4 All-2 (HP4All-2) program [21]. HP4All-2 aims to enforce and facilitate continuous care for families at risk after birth by focusing on antenatal and postnatal risk assessment in combination with tailored care pathways by maternity care, PCHC and interconception care [21].

Setting and study population

Every municipality in the Netherlands is responsible for coordinating their own PCHC services. Most municipalities organise PCHC within their Municipal Health Services, while some of them subcontract commercial healthcare organisations to carry out PCHC. Both types of PCHC organisations were included in order to reflect the current situation in the Netherlands. PCHC professionals in the Netherlands all comply with the same training conditions and they work according to the general requirements for PCHC, imposed by the Dutch government. [22] The study population consisted of PCHC nurses and PCHC physicians employed at these organisations. Recent data indicate that there are 36 different PCHC organisations in the Netherlands, providing care for children from birth until 19 years of age (often professionals work for either the age group 0-4 years old or the age group 5-19 years old). [23] With the assistance of professionals working at organisations within the HP4All-2 network [21], we invited 10 different organisations, in both urban and rural areas across the country, to participate in our survey. We addressed healthcare professionals who work with children from zero up to four years old, because this age interval includes the postnatal period.

Development of the questionnaire

Data were collected using an electronic questionnaire, which was developed in analogy with the validated MIDI questionnaire, an instrument to measure determinants of innovations in healthcare. [24] Finally, the questionnaire contained 41 questions, which were either closed or open-ended. The questions were divided in four domains: (A) respondent characteristics,

(B) current risk screening practices (C) handover of antenatal data, and (D) collaboration with other healthcare professionals. The questions which measured the knowledge of non-medical risk factors were based on recent literature and, if available, systematic reviews or meta-analyses. [4-10, 14, 25-29] Data concerning the deprivation status of a neighbourhood in which the PCHC professional was working during the study period, was defined according to the NIVEL coding. NIVEL, the institute for health services research in the Netherlands, publishes a quadrennial overview of deprived urban areas by zip code. Every four years, the NIVEL institute aggregates neighbourhood-level data on the number of inhabitants, the area density by address, the proportion of non-western inhabitants, average income of residents with an income and the number of residents with social security benefits. Hence, a standardised formula is used to calculate the so-called deprivation index. Based on this deprivation index, deprived neighbourhoods are designated. [30, 31] The questionnaire was piloted among three PCHC professionals to examine whether terms and definitions were clear and precise. For its design and distribution we used the online survey program, LimeSurvey (Pro version, © 2003). A summary of the questionnaire is presented in Figure 1. The full questionnaire can be made available upon request.

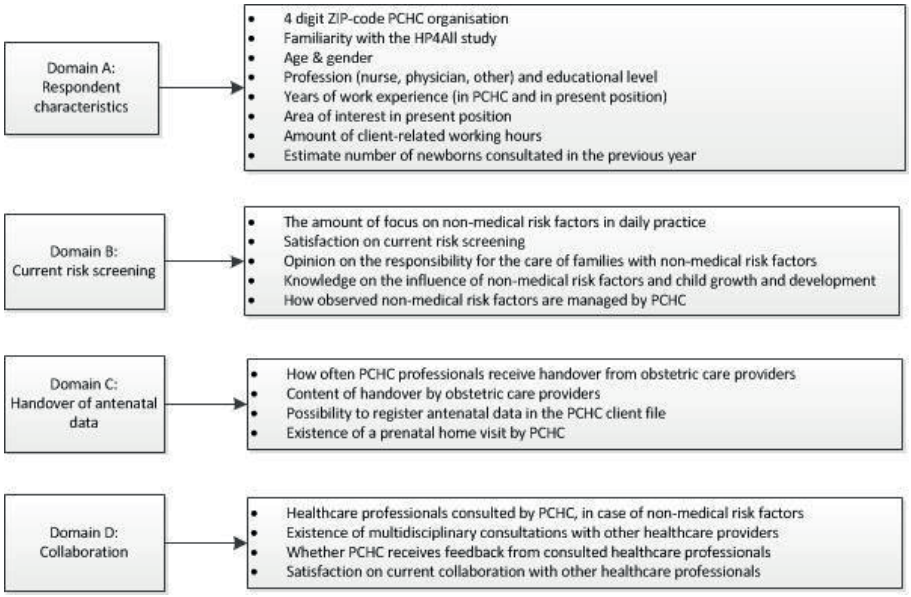


Figure 1. Domains, constructs and items of the questionnaire

Exclusion criteria

Preliminary exclusion criteria for analysis were not being employed as a PCHC physician or nurse, and not working with the age-group zero up to four years old.

Data collection

Data were collected between May and August 2016. As soon as the PCHC organisations agreed to participate, they received an email containing the link to the electronic questionnaire in LimeSurvey. The management of the participating organisations distributed the link among their (selection of) employees and they were asked to send at least one reminder. Most PCHC organisations participated with their whole workforce, others decided to distribute the questionnaire among a selected group of employees, e.g. limited to one zip code area or neighbourhood. The managers themselves made the decision on how to distribute the questionnaire within their organisation.

Data analyses

Descriptive statistics were applied to quantitatively describe the main features of the data. Additionally, comparative statistics were used, i.e. the chi-squared test and the Fisher's exact test (if expected frequencies were not greater than five) to measure associations between two categorical variables. The unpaired *t*-test or Mann-Whitney U test were applied to compare ordinal or interval variables between two (in-)dependent groups. All statistical analyses were performed using SPSS software (version 20.0). Statistical significance was defined as a p value < 0.05.

RESULTS

Eight out of ten invited PCHC organisations agreed to participate. The eight participating organisations were nationally scattered, representing both urban and rural regions of the country. The response rate per organisation varied from 100%, being the highest, to 15,6%, being the lowest response rate; 100% reflecting an organisation which had chosen to distribute to questionnaire to the employees of one specific neighbourhood and 15,6% reflecting an organisation which had sent the questionnaire to their whole workforce. Figure 2 represents the flowchart of excluded questionnaires. Eighty-nine questionnaires remained available for analyses.

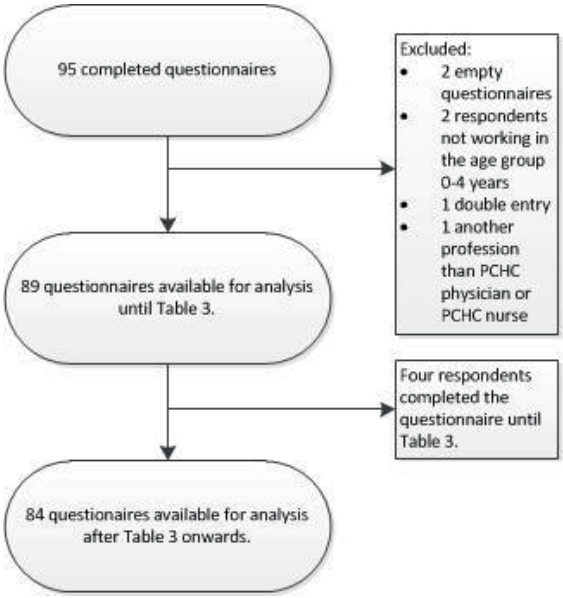


Figure 2. Process of inclusion and exclusion of questionnaires

Table 1 shows the respondents' characteristics. 20% of the respondents were working in a deprived neighbourhood according to the NIVEL coding. [30] 70.8% of the respondents were nurses and 29.2% were physicians. Age and working experience did not differ between professionals working in deprived and non-deprived neighbourhoods. Professionals working in a deprived neighbourhood had, on average, less client related activities per week and a lower number of consulted new-borns a year, than those working in a non-deprived neighbourhood.

Table 1. Respondents' characteristics stratified by deprived and non-deprived neighbourhoods (n=89)

Neighbourhood status	**Deprived neighbourhood**			**Non-deprived neighbourhood**		
	n	**Percentage**		**n**	**Percentage**	
Profession (% nurses)	11	61%		52	73%	
	n	**Mean (SD)**	**Range**	**n**	**Mean (SD)**	**Range**
Age (in years)	18	46.9 (10.1)	22 - 60	71	47.5 (0.5)	26 - 63
Working experience PCHC (in years)	18	16.2 (9.1)	1 – 28	71	16.3 (8.9)	1 - 38
Working experience in current position (in years)	18	13.8 (9.0)	1 - 28	71	14.4 (7.7)	1 - 35
Client-related activities (in number of days per week)	18	2.7 (0.8)	2 - 5	71	3.1 (0.7)	1 - 4
Consultations with new-borns (estimated number in the previous year)	16	120.9 (75.2)	50 - 350	68	132.7 (87.0)	40 - 450

Table 2 shows that 36% of the respondents encountered vulnerable families a couple of times a month and 30.3% encountered these families a couple of times a week, in the previous year.

Professionals working in deprived neighbourhoods encountered vulnerable families significantly more often (*p* value = 0.025). Most of the respondents, 47.2%, experienced severe communication problems with clients several times a year, and 32.6% a couple of times a month. This percentage was significantly higher for professionals in deprived versus non-deprived neighbourhoods (*p* value = 0.001). With respect to the availability of guidelines or protocols for postnatal screening, 83.1% of the professionals indicated that these were available or being developed. 9% indicated that protocols were not available in their organisation and 2.2% did not know. This result did not differ between professionals working in deprived and non-deprived neighbourhoods (*p* value = 0.781).

Table 2. Current risk screening in PCHC according to PCHC physicians and nurses (n=89)

	Never n (%)	**Couple of times a year n (%)**	**Couple of times per month n (%)**	**Couple of times per week n (%)**	**Every day n (%)**	**Multiple times a day n (%)**
Encountering families with non-medical risk factors, in the previous year	0 (0)	8 (9)	32 (36)	27 (30.3)	13 (14.6)	9 (10.1)
Severe communication problems with families during consultations, in the previous year	3 (3.4)	42 (47.2)	29 (32.6)	10 (11.2)	4 (4.5)	1 (1.1)

To assess current knowledge on risk factors influencing a child's growth and development, respondents could indicate whether they thought a certain risk factor influences either growth or development of a young child. Table 3 shows the percentage of respondents who gave the correct answer, based on recent literature, which varied from 39.3 to 98.9 percent. Professionals working in non-deprived neighbourhoods had significantly better knowledge of financial problems and child overweight/obesity than those working in deprived neighbourhoods. However, for most questions no significant differences were found.

With regard to how many times in the previous year respondents performed screening on the prelisted non-medical risk factors, no significant difference was found in professionals working in deprived versus non-deprived neighbourhoods. Most of the respondents discussed smoking (68,2%), drug use (65,9%) and alcohol consumption (61,2%) in every consultation. Maternal weight was discussed the least by PCHC professionals (21.2% in none of the consultations). Domestic violence was not discussed often either; 11.2% of the professionals never discussed this topic during a consultation.

When encountering non-medical risk factors during a first consultation with a new-born baby, 12.2% did never offer an intervention, whereas 10% did always intervene. These interventions consisted of additional consultations by PCHC or referral to another healthcare professional.

Table 3. Knowledge of PCHC professionals on risk factors for growth and developmental problems (n = 89)

Non-medical risk factor	Correct answer [reference]	Number of correct answers on the risk of overweight/ obesity				Correct answer [reference]	Number of correct answers on the risk of developmental problems			
		Deprived (n = 18)	Non-deprived (n = 71)	*p* value	*Total n (%)*		Deprived (n = 18)	Non-deprived (n = 71)	*p* value	*Total n (%)*
Parental smoking	Yes [32]	8	27	0.406	*35 (39.3)*	Yes [33, 34]	17	63	0.418	*80 (89.9)*
Parental drug use[1]	*NA*[1]	*NA*[1]	*NA*[1]	*NA*[1]	*NA*[1]	Yes [26, 27]	18	69	0.635	*87 (97.8)*
Family income	Yes [35]	17	68	0.602	*85 (95.5)*	Yes [36]	17	59	0.205	*76 (85.4)*
Parental relationship problems[1]	*NA*[1]	*NA*[1]	*NA*[1]	*NA*[1]	*NA*[1]	Yes [37]	18	70	0.789	*88 (98.9)*
Domestic violence	Yes [38]	14	43	0.138	*57 (64.0)*	Yes [37, 39]	18	70	0.798	*88 (98.9)*
Maternal overweight	Yes [29]	18	70	0.798	*88 (98.9)*	Yes [40]	12	43	0.424	*55 (61.8)*
Maternal alcohol abuse	No [41]	11	36	0.301	*47 (52.8)*	Yes [6]	18	65	0.246	*83 (93.3)*
Financial problems	Yes [42]	17	51	**0.035**	*68 (76.4)*	Yes [36]	17	63	0.418	*80 (89.9)*
Lack of social support	Yes [43]	18	59	0.054	*77 (86.5)*	Yes [44]	18	69	0.635	*87 (97.8)*

NA: not applicable; in our literature search no articles were found which addressed this risk factor in association with growth problems.

Most of the constraints for not offering an intervention were client related (82.4%) (e.g. financial restrictions or the prolonged traveling time to a care facility), less were related to healthcare professional restrictions (too little time during consultations) or to the intervention itself (such as waiting lists).

Healthcare professionals most often consulted by PCHC, in case of clients with non-medical risk factors, were social workers (15.3% in more than 50% of the clients) and Youth Welfare Service specialists (14.1% in more than 50% of the clients). Least consulted were gynaecologists and midwifes. No significant differences were found between professionals working in deprived and non-deprived neighbourhoods.

Figure 3 represents the opinion of the respondents on current postnatal risk screening in their organisation, stratified by neighbourhood status. Most of the respondents (49.4%) were (very) satisfied and 40% of the respondents had no opinion. When it comes to the need for a structured postnatal risk assessment, most of the respondents were in favour (50.6%) of such an assessment and 48.2% had no opinion. This finding did not significantly differ between professionals working in deprived or non-deprived neighbourhoods (Figure 4), neither did it differ between physicians and nurses.

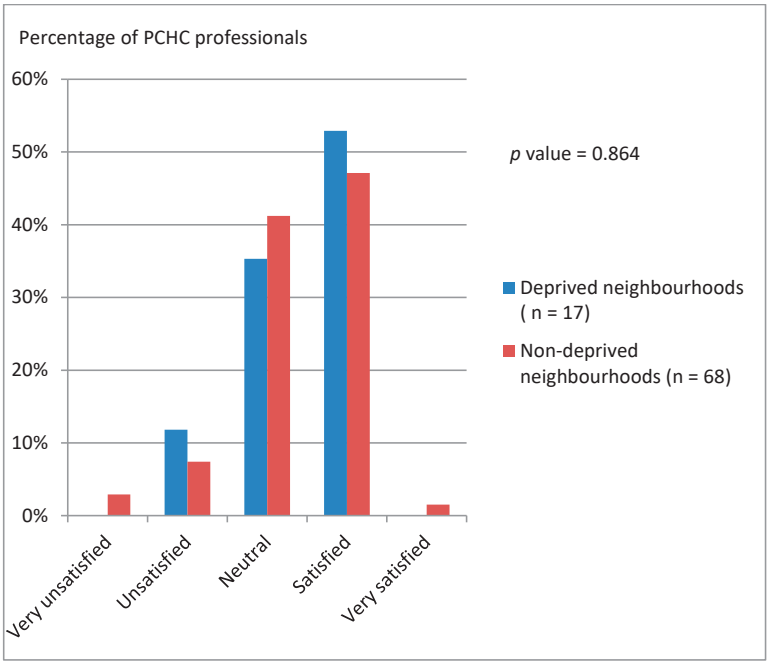


Figure 3. Opinion of PCHC professionals on current postnatal screening for non-medical risk factors (n = 85, missing = 4)

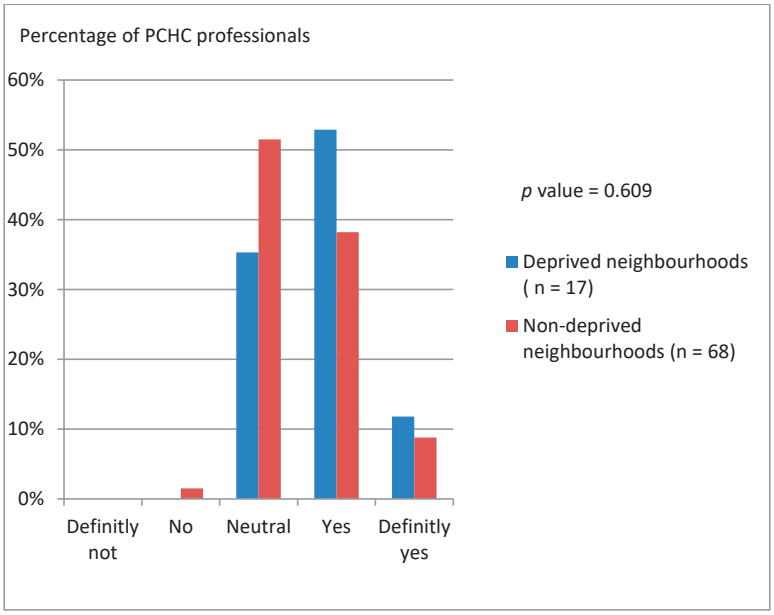


Figure 4. Opinion of PCHC professionals regarding the need for a structured postnatal risk assessment (n = 85, missing = 4)

Regarding which healthcare professional should be the primary caregiver for families with non-medical risk factors (multiple answers were allowed), PCHC professionals favoured the general practitioner (62.2%), social work (75.3), PCHC physicians (78.8%), PCHC nurses (91.8%) and the district teams (89.9%), in which, in some municipalities, PCHC is a part of. In a district team, healthcare and social care professionals from a certain neighbourhood collaborate, in order to support clients close to home. In contrast, 82.4% of the respondents did not favour the gynaecologist or the paediatrician, and 74.1% did not favour the midwife as the primary caregiver. This opinion did not differ significantly between nurses and physicians or between professionals working in deprived and non-deprived neighbourhoods. (The full list of considered healthcare professionals can be found in Supplementary Table 1.)

When it comes to the healthcare professional with whom the respondents would like to intensify collaboration, 67.1% mentioned district teams and 62.4% the general practitioner. In contrast, the majority did not feel the need to intensify collaboration with gynaecologists or the paediatrician (71.8 and 67.1%, respectively). This opinion did not significantly differ between PCHC nurses and PCHC physicians, and neither between neighbourhoods. (The full list of considered healthcare professionals can be found in Supplementary Table 2.) 18.8% of the PCHC professionals did indicate they received handover from midwifes for every client and 25.9% received handover from maternity care for every client. For the other professions these

percentages were lower. Details on smoking and substance abuse (drugs and alcohol) during pregnancy were most frequently missing in the handover, whereas almost all information can be registered in the PCHC client file.

DISCUSSION

The aim of this survey was to identify current Dutch PCHC risk screening practices and care for non-medical risk factors, during the postnatal period. Additionally, we studied different views and needs of professionals working in deprived and non-deprived neighbourhoods, the content of handover and their collaboration with other healthcare professionals.

Our study shows that PCHC professionals encounter clients with non-medical risk factors quite often, especially those working in deprived neighbourhoods. The importance of screening for non-medical risk factors seems to be recognised by PCHC professionals: most respondents often screen for important non-medical risk factors and they consider the care for vulnerable families as their responsibility. This corresponds with the development of Dutch PCHC guidelines and protocols, e.g. on parenting support, psychosocial problems, nutrition and eating habits and prevention of overweight. Although many PCHC professionals were satisfied with the current risk screening practices within their own organisation, half of the professionals feels the need for a structured postnatal risk assessment. This result did not significantly differ between professionals working in deprived or non-deprived neighbourhoods or between physicians and nurses. Neither did this need differ between professionals working in an organisation where a protocol was available or not. An explanation for this result may be, that most PCHC professionals are aware of non-medical risk factors and are satisfied with current practice, but that they screen without an official, national guideline or instrument. Johansen et al (2015) showed that a structured assessment of motor development in infants was well received by PCHC nurses, as they valued that working with this instrument increased the quality of care provided. [45]

This study shows that PCHC professionals receive relatively few handovers from obstetric care professionals. Most handover is obtained from midwifes and maternity care, though not for every client. Moreover, essential information in the handover on prenatal and early postnatal smoking and substance abuse is often lacking, only one third of the professionals indicated that this information was ‘always available’ in handover documents.

Collaboration between healthcare professionals is advocated to improve patient outcomes [46] and enhances the quality of care given to individuals and groups in communities. [47] Poutianen et al (2013) showed that PCHC nurses’ understanding of the role of family characteristics could

be valuable in promoting multidisciplinary work in healthcare. [48] Collaboration between Dutch PCHC and other healthcare professionals exists but still is quite rare. District team members were involved most often, which may be due to the fact that in some municipalities, PCHC is part of the district teams.

Limitations and strengths

A limitation of this study is that selection bias might have occurred, because of the non-random selection of participating PCHC organisations. Participating PCHC organisations might have been more eager to join the study because they were already more involved in postnatal non-medical risk screening. The response rate of the professionals within an organisation varied from 15.6% up to 100% between the PCHC organisations in this study. Nevertheless, we almost reached our target of completed questionnaires, having to rely on intermediates for the distribution of the questionnaire. The low response rate in some organisations could also be due to selection bias, as PCHC professionals who are more interested in the topic could be more willing to contribute to the survey. Another limitation of our study may be recall bias, which is a well-known restraint of survey studies. Our results show that most respondents can rely on protocols or local guidelines concerning risk screening. This might also have caused participants to respond with socially desirable answers due to their knowledge on certain risk factors, but not representing their current daily practice.

A strength of our study is that eight out of 36 PCHC organisations in the Netherlands participated. These eight organisations are likely to be a good reflection of PCHC organisations nationally, covering different areas in the south, north, east and west of the country and both rural and urban municipalities. Moreover, the mean age in our sample (47.0 years; SD 10.5) and the physician/nurse ratio (0.41, drawn from table 1) are consistent with the results of Jambroes et al, who published an overview of the workforce of the Dutch PCHC services and who found a mean age of 48.0 (SD 10.2) years and a physician/nurse ratio of 0.48. [23] This might indicate a good generalisability of our study, with a slight overrepresentation of nurses. However, since no significant differences between answers from physicians and nurses were found, this probably did not bias our results.

CONCLUSION

This study shows that postnatal screening for non-medical risk factors is part of current practice of Dutch PCHC professionals, regardless the kind of neighbourhood they are deployed. They consider screening for non-medical risk factors as their responsibility. This study, emphasizes the need felt for a structured, evidence-based, postnatal risk assessment including non-medical risk factors, as well as the need for an intensified collaboration with other healthcare profes-

sionals. In a world where family engaged care [49]is integrated in health care policy and practice, strengthening collaboration between healthcare professionals is necessary. A structured post-natal risk assessment focussing on child characteristics, as well as parental and environmental characteristics contributes to this multilevel approach.

Implications of this study

The management of PCHC organisations should invest in strengthening collaboration with other healthcare providers in a neighbourhood or municipality. Inter-professional collaboration across organisational boundaries is of utmost importance, especially for vulnerable families. Family engaged care and structured risk assessment for growth and developmental problems should become general practice in PCHC.

Acknowledgements

We would like to thank all participating Preventive Child Healthcare organisations, without their participation this study would not have been possible.

REFERENCES

1. Wallack L, Thornburg K: **Developmental Origins, Epigenetics, and Equity: Moving Upstream**. *Matern Child Health J* 2016, **20**(5):935-940.
2. Furumoto-Dawson A, Gehlert S, Sohmer D, Olopade O, Sacks T: **Early-life conditions and mechanisms of population health vulnerabilities**. *Health Aff (Millwood)* 2007, **26**(5):1238-1248.
3. RG Wilkinson MM: **Social determinants of health: the solid facts, second edition**: World Health Organisation; 2003.
4. Ino T: **Maternal smoking during pregnancy and offspring obesity: meta-analysis**. *Pediatr Int* 2010, **52**(1):94-99.
5. de Hoog ML, van Eijsden M, Stronks K, Gemke RJ, Vrijkotte TG: **Overweight at age two years in a multi-ethnic cohort (ABCD study): the role of prenatal factors, birth outcomes and postnatal factors**. *BMC Public Health* 2011, **11**:611.
6. Knudsen AK, Skogen JC, Ystrom E, Sivertsen B, Tell GS, Torgersen L: **Maternal pre-pregnancy risk drinking and toddler behavior problems: the Norwegian Mother and Child Cohort Study**. *Eur Child Adolesc Psychiatry* 2014, **23**(10):901-911.
7. Zwicker JG, Yoon SW, Mackay M, Petrie-Thomas J, Rogers M, Synnes AR: **Perinatal and neonatal predictors of developmental coordination disorder in very low birthweight children**. *Arch Dis Child* 2013, **98**(2):118-122.
8. Walden RV, Taylor SC, Hansen NI, Poole WK, Stoll BJ, Abuelo D, Vohr BR, National Institute of Child H, Human Development Neonatal Research N: **Major congenital anomalies place extremely low birth weight infants at higher risk for poor growth and developmental outcomes**. *Pediatrics* 2007, **120**(6):e1512-1519.
9. Kerstjens JM, de Winter AF, Sollie KM, Bocca-Tjeertes IF, Potijk MR, Reijneveld SA, Bos AF: **Maternal and pregnancy-related factors associated with developmental delay in moderately preterm-born children**. *Obstet Gynecol* 2013, **121**(4):727-733.
10. Delobel-Ayoub M, Kaminski M, Marret S, Burguet A, Marchand L, N'Guyen S, Matis J, Thiriez G, Fresson J, Arnaud C *et al*: **Behavioral outcome at 3 years of age in very preterm infants: the EPIPAGE study**. *Pediatrics* 2006, **117**(6):1996-2005.
11. Denktas S, Poeran J, van Voorst SF, Vos AA, de Jong-Potjer LC, Waelput AJ, Birnie E, Bonsel GJ, Steegers EA: **Design and outline of the Healthy Pregnancy 4 All study**. *BMC Pregnancy Childbirth* 2014, **14**:253.
12. Kerstjens JM, de Winter AF, Bocca-Tjeertes IF, Bos AF, Reijneveld SA: **Risk of developmental delay increases exponentially as gestational age of preterm infants decreases: a cohort study at age 4 years**. *Dev Med Child Neurol* 2012, **54**(12):1096-1101.
13. Timmermans S, Bonsel GJ, Steegers-Theunissen RP, Mackenbach JP, Steyerberg EW, Raat H, Verbrugh HA, Tiemeier HW, Hofman A, Birnie E *et al*: **Individual accumulation of heterogeneous risks explains perinatal inequalities within deprived neighbourhoods**. *Eur J Epidemiol* 2011, **26**(2):165-180.
14. Bradley RH, Corwyn RF: **Socioeconomic status and child development**. *Annu Rev Psychol* 2002, **53**:371-399.
15. Dunnink G L-SW: **Activiteiten Basistakenpakket Jeugdgezondheidszorg 0-19 jaar per Contactmoment**. 2008.
16. Staal, II, Hermanns JM, Schrijvers AJ, van Stel HF: **Risk assessment of parents' concerns at 18 months in preventive child health care predicted child abuse and neglect**. *Child Abuse Negl* 2013, **37**(7):475-484.

17. Vos AA, van Veen MJ, Birnie E, Denktas S, Steegers EA, Bonsel GJ: **An instrument for broadened risk assessment in antenatal health care including non-medical issues**. *Int J Integr Care* 2015, **15**:e002.
18. Haggman-Laitila A, Euramaa KI: **Finnish families' need for special support as evaluated by public health nurses working in maternity and child welfare clinics**. *Public Health Nurs* 2003, **20**(4):328-338.
19. Mundet-Tuduri X, Crespo R, Fernandez-Coll ML, Saumell M, Millan-Mata F, Cardona A, Codern-Bove N: **Expectations and perceptions of primary healthcare professionals regarding their own continuous education in Catalonia (Spain): a qualitative study**. *BMC Med Educ* 2017, **17**(1):212.
20. Garg P, Ha MT, Eastwood J, Harvey S, Woolfenden S, Murphy E, Dissanayake C, Williams K, Jalaludin B, McKenzie A *et al*: **Health professional perceptions regarding screening tools for developmental surveillance for children in a multicultural part of Sydney, Australia**. *BMC Fam Pract* 2018, **19**(1):42.
21. Waelput AJ: **Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program**. *BMC Pregnancy Childbirth* 2017, **17**(254).
22. Staatssecretaris Ministerie VWS: **Besluit van 5 november 2014, houdende aanpassing van het Besluit publieke gezondheid vanwege een gewijzigd basistakenpakket jeugdgezondheidszorg**. *Staatsblad van het Koninkrijk der Nederlanden* 2014, **449**.
23. Jambroes M, Lamkaddem M, Stronks K, Essink-Bot ML: **Enumerating the preventive youth health care workforce: Size, composition and regional variation in the Netherlands**. *Health Policy* 2015, **119**(12):1557-1564.
24. Fleuren MAH, Paulussen TGWM, Van Dommelen P, Van Buuren S: **Towards a measurement instrument for determinants of innovations**. *International Journal for Quality in Health Care* 2014, **26**(5):501-510.
25. Radford L, Corral S, Bradley C, Fisher HL: **The prevalence and impact of child maltreatment and other types of victimization in the UK: findings from a population survey of caregivers, children and young people and young adults**. *Child Abuse Negl* 2013, **37**(10):801-813.
26. Lewis BA, Minnes S, Short EJ, Weishampel P, Satayathum S, Min MO, Nelson S, Singer LT: **The effects of prenatal cocaine on language development at 10 years of age**. *Neurotoxicol Teratol* 2011, **33**(1):17-24.
27. El Marroun H, Hudziak JJ, Tiemeier H, Creemers H, Steegers EA, Jaddoe VW, Hofman A, Verhulst FC, van den Brink W, Huizink AC: **Intrauterine cannabis exposure leads to more aggressive behavior and attention problems in 18-month-old girls**. *Drug Alcohol Depend* 2011, **118**(2-3):470-474.
28. El Marroun H, White TJ, van der Knaap NJ, Homberg JR, Fernandez G, Schoemaker NK, Jaddoe VW, Hofman A, Verhulst FC, Hudziak JJ *et al*: **Prenatal exposure to selective serotonin reuptake inhibitors and social responsiveness symptoms of autism: population-based study of young children**. *Br J Psychiatry* 2014, **205**(2):95-102.
29. Yu Z, Han S, Zhu J, Sun X, Ji C, Guo X: **Pre-pregnancy body mass index in relation to infant birth weight and offspring overweight/obesity: a systematic review and meta-analysis**. *PLoS One* 2013, **8**(4):e61627.
30. Reijneveld SA, Verheij RA, de Bakker DH: **The impact of area deprivation on differences in health: does the choice of the geographical classification matter?** *J Epidemiol Community Health* 2000, **54**(4):306-313.

31. van Vuuren CL, Reijneveld SA, van der Wal MF, Verhoeff AP: **Neighborhood socioeconomic deprivation characteristics in child (0-18 years) health studies: a review**. *Health Place* 2014, **29**:34-42.
32. Oken E, Levitan EB, Gillman MW: **Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis**. *Int J Obes (Lond)* 2008, **32**(2):201-210.
33. Alvik A: **Variables predicting low infant developmental scores: maternal age above 30 years is a main predictor**. *Scand J Public Health* 2014, **42**(2):113-119.
34. Roza SJ, Verhulst FC, Jaddoe VW, Steegers EA, Mackenbach JP, Hofman A, Tiemeier H: **Maternal smoking during pregnancy and child behaviour problems: the Generation R Study**. *Int J Epidemiol* 2009, **38**(3):680-689.
35. Demment MM, Haas JD, Olson CM: **Changes in family income status and the development of overweight and obesity from 2 to 15 years: a longitudinal study**. *BMC Public Health* 2014, **14**:417.
36. Gershoff ET, Aber JL, Raver CC, Lennon MC: **Income is not enough: incorporating material hardship into models of income associations with parenting and child development**. *Child Dev* 2007, **78**(1):70-95.
37. Gilbert AL, Bauer NS, Carroll AE, Downs SM: **Child exposure to parental violence and psychological distress associated with delayed milestones**. *Pediatrics* 2013, **132**(6):e1577-1583.
38. Gooding HC, Milliren C, Austin SB, Sheridan MA, McLaughlin KA: **Exposure to violence in childhood is associated with higher body mass index in adolescence**. *Child Abuse Negl* 2015, **50**:151-158.
39. Gilbert R, Widom CS, Browne K, Fergusson D, Webb E, Janson S: **Burden and consequences of child maltreatment in high-income countries**. *Lancet* 2009, **373**(9657):68-81.
40. Jo H, Schieve LA, Sharma AJ, Hinkle SN, Li R, Lind JN: **Maternal prepregnancy body mass index and child psychosocial development at 6 years of age**. *Pediatrics* 2015, **135**(5):e1198-1209.
41. Mourtakos SP, Tambalis KD, Panagiotakos DB, Antonogeorgos G, Arnaoutis G, Karteroliotis K, Sidossis LS: **Maternal lifestyle characteristics during pregnancy, and the risk of obesity in the offspring: a study of 5,125 children**. *BMC Pregnancy Childbirth* 2015, **15**:66.
42. Weden MM, Brownell P, Rendall MS: **Prenatal, perinatal, early life, and sociodemographic factors underlying racial differences in the likelihood of high body mass index in early childhood**. *Am J Public Health* 2012, **102**(11):2057-2067.
43. Shin HS, Valente TW, Riggs NR, Huh J, Spruijt-Metz D, Chou CP, Ann Pentz M: **The interaction of social networks and child obesity prevention program effects: the pathways trial**. *Obesity (Silver Spring)* 2014, **22**(6):1520-1526.
44. Crockenberg SB: **Infant Irritability, Mother Responsiveness, and Social Support Influences on the Security of Infant-Mother Attachment**. *Child Development* 1981, **52**(3, (september 1981)):857-865.
45. Johansen K, Lucas S, Bokstrom P, Persson K, Sonnander K, Magnusson M, Sarkadi A: **'Now I use words like asymmetry and unstable': nurses' experiences in using a standardized assessment for motor performance within routine child health care**. *J Eval Clin Pract* 2016, **22**(2):227-234.
46. Nembhard IM, Tucker AL, Horbar JD, Carpenter JH: **Improving patient outcomes: The effects of staff participation and collaboration in healthcare delivery**: Division of Research, Harvard Business School; 2007.
47. Fewster-Thuente L, Velsor-Friedrich B: **Interdisciplinary collaboration for healthcare professionals**. *Nurs Adm Q* 2008, **32**(1):40-48.

48. Poutiainen H, Hakulinen-Viitanen T, Laatikainen T: **Associations between family characteristics and public health nurses' concerns at children's health examinations**. *Scand J Caring Sci* 2014, **28**(2):225-234.
49. Wieczorek CC, Nowak P, Frampton SB, Pelikan JM: **Strengthening patient and family engagement in healthcare - The New Haven Recommendations**. *Patient Educ Couns* 2018.

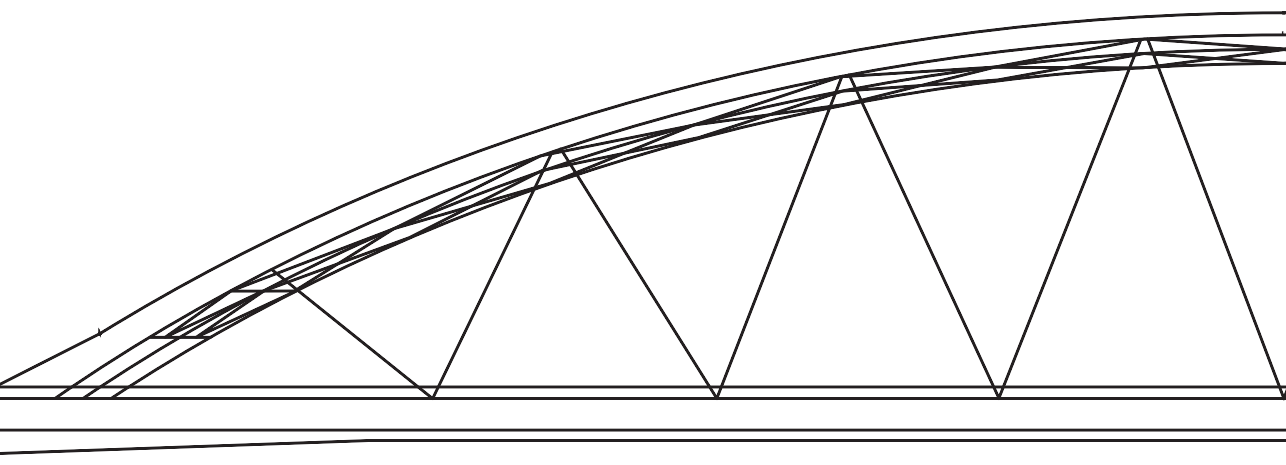
ADDENDUM

Supplementary Table 1. Respondents' opinion on which healthcare professional should care for families with non-medical risks (n=85)

Health care professional	Yes, n (%)	No, n (%)
Midwife	22 (25.9)	63 (74.1)
Gynaecologist	15 (17.6)	70 (82.4)
General Practitioner	52 (62.2)	33 (38.8)
Paediatrician	15 (17.6)	70 (82.4)
Social work	64 (75.3)	21 (24.7)
Maternity care	19 (22.4)	66 (77.6)
PCHC Physician	67 (78.8)	18 (21.2)
PCHC Nurse	78 (91.8)	7 (8.2)
District Teams	73 (85.9)	12 (14.1)
Youth Social Services	46 (54.1)	39 (45.9)
Others: social team, youth team, medical social work, parenting support team, pre-primary education	12 (14.1)	73 (85.8)

Supplementary Table 2. Respondents' opinion on with which healthcare professional collaboration should be intensified (n=85)

Healthcare professional	Yes, n (%)	No, n (%)
Midwife	45 (52.9)	40 (47.1)
Gynaecologist	24 (28.2)	61 (71.8)
General Practitioner	53 (62.4)	32 (37.6)
Paediatrician	28 (32.9)	57 (67.1)
Social work	43 (50.6)	42 (49.4)
Postnatal care	35 (41.2)	50 (58.8)
District Teams	57 (67.1)	28 (32.9)
Youth Welfare Services	42 (49.4)	43 (50.6)



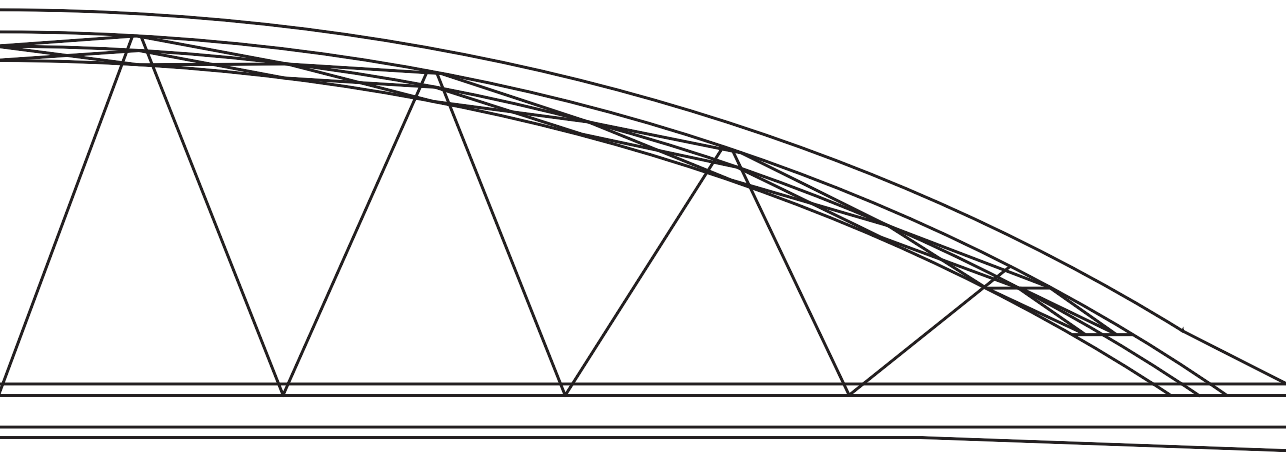
Chapter 4

Handover of care and of information by community midwives, maternity care assistants preventive child healthcare professionals, a qualitative study

M.R.C. van Minde
D.W. van Veen-Belle
H.E. Ernst-Smelt
A.N Rosman
H. Raat
E.A.P. Steegers
M.L.A. de Kroon

Midwifery

https://doi.org/10.1016/j.midw.2019.07.012



ABSTRACT

Introduction

Handover of care has been internationally acknowledged as an important aspect in patient safety. Families who are vulnerable due to low socio-economic status, a language barrier or poor health skills, benefit especially from a decent handover of care from one healthcare professional to another. The handover from primary midwifery care and maternity care to Preventive Child Healthcare (PCHC) is not always successful, especially not in case of vulnerable families.

Aim

Obtaining insight in and providing recommendations for the proces of handover of information by primary midwifery care, maternity care and PCHC in the Netherlands.

Methods

A qualitative research through semi-structured interviews was conducted. Community midwives, maternity care nurses and PCHC nurses from three municipalities in the Netherlands were invited for interviews with two researchers. The interviews took place from February to April 2017. The qualitative data was analyzed using NVivo11 software (QSR International).

Results

A total of 18 interviews took place in three different municipalities with representatives of the three professions involved with the handover of care and of information concerning antenatal, postnatal and child healthcare: six community midwives, six maternity care assistants and six PCHC nurses. All those interviewed emphasized the importance of good information transfer in order to provide optimum care, especially when problems within the family ar present. In order to improve care, a large number of healthcare professionals prefered a fully digitized handover of information, providing the privacy of the client is warrented and the system works efficiently. To provide high quality care, it is considered desirable that healthcare workers get to know each other and more peer agreements are prepared. The 'obstetric collaborative network' or another structured meeting was considered most suitable for this exchange.

Conclusion

This study shows that the handover of care and of information between professionals in the fields of antenatal, postnatal and child healthcare is gaining awareness, but a more rigorous chain of care and collaboration between these disciplines is desired. Digitizing seems important to improve the handover of information.

INTRODUCTION

Handover of care implies "temporarily or permanently transferring the professional responsibility and accountability for some or all aspects of care for a patient or client or for a group of patients, to another healthcare worker or professional group". (Merten, van Galen et al., 2017) Handover of care has been internationally acknowledged as an important factor in patient safety and multiple initiatives have been started to prevent mistakes in the handover of care. (Moore, Wisnivesky et al., 2003) Families who are vulnerable due to low socio-economic status, a language barrier or poor health skills, benefit especially from a good handover of care from one health professional to another. (Groene, Orrego et al., 2012)

Table 1
The Dutch perinatal care system

Antenatal care in The Netherlands is based on the concept that pregnancy, childbirth, and the postpartum period are fundamentally physiologic processes. Obstetric risk selection is performed by community midwives or obstetricians/gynecologists and is based on the 'List of Obstetric Indications' (LOI), which specifies manifest conditions that define a low, medium, or high-risk pregnancy. An obstetrician/gynecologist will care for women with a high-risk pregnancy whereas community midwife may provide care to women with a low or a medium risk. Women with a low or medium risk can chose to have a home birth or an out-patient hospital birth. In case of an uncomplicated institutional delivery the mother and child will be discharged home within a few hours. Regardless of the risk indication based on the LOI, the community midwife will be responsible for care of the mother when discharged home during the postpartum period. Maternity care is provided by maternity care assistants and will start at home, or – less frequently – in a primary care birth center, under supervision of the community midwife. Following delivery, a maternity care assistant visits and supports the family at home on a daily basis for the first eight to ten consecutive days. Initially maternity care covers six to eight hours a day but this is tapered off towards the end of the care period. (Reference: Lagendijk, Been et al., BMC Pregnancy Childbirth)

Table 2
The Dutch Child Preventive Healthcare

Preventive Child Healthcare (PCHC) in the Netherlands is executed by autonomous PCHC organisations and provides information, early identification of growth and developmental problems and where necessary, providing additional help to parents/care takers and children. Additionally, PCHC executes the national vaccination program. PCHC is offered to all children from birth until 19 years old, by the Dutch government, free of charge. For children in the age group zero until four years old, consultations comprise of growth and developmental measurements, regular visits to the national vaccination programme and parenting advice. PCHC exists in the Netherlands over 100 years. Approximately 6,000 professionals work in different PCHC organisations, including PCHC physicians, PCHC nurses, nursing specialists and physician assistants. In some organisations speech therapists and behavioural scientists are part of PCHC. PCHC for children aged zero until four years old is executed in different neighbourhoods by well-baby clinics affiliated to one of the PCHC organisations. (Reference: Dutch Centre for child healthcare, www.ncj.nl)

In the Netherlands, handover of care and of information has also gained awareness in the past few years. In 2014 the Dutch Health and Youth Care Inspectorate published a report on the study into the collaboration between primary midwifery care, maternity care and Preventive Child Healthcare (PCHC) in the Netherlands, on recognizing signals from clients, adequately

deploying additional care and a thorough handover of information to each other. (The Health Care Inspectorate 2014) This study showed that the handover from community midwives and maternity care assistants to the PCHC was not always successful, especially not in case of vulnerable families. Therefore, the professional and client associations have developed a national guideline with concomitant products. (Beckers et al., 2011; Beckers et al., 2016) These products concerned an 'exemplary collaborative agreement' and a 'minimal information set' for the handover from primary midwifery care and maternity care to the PCHC. The main focus points were children growing up in safety and health, a continuity of care, identifying vulnerable families and where needed the deployment of a so-called 'warm handover' to PCHC. (Beckers et al., 2016) A 'warm handover' entails an oral handover to another professional, in addition to the paper or digital handover. This oral handover can be held by telephone or by face to face contact. The exact interpretation and execution of a 'warm handover' can differ between municipality, organization or collaborative network.

Research program Healthy Pregnancy 4 All-2

The handover in antenatal, postnatal and child healthcare in the Netherlands has been studied for the research program Healthy Pregnancy 4 All-2 (HP4All-2). The focus of this program contains risk assessment, customized care and an improved collaboration between primary obstetric healthcare, maternity care, PCHC and other municipal care providers. (Waelput, Sijpkens et al., 2017) One of the research themes of HP4All-2 is to study whether the current method of handover of care and of information from community midwives and maternity care assistants to the PCHC professionals, since the development of the national guideline, has led to a seamless approach to healthcare within the chain of antenatal and child healthcare.

Aim of this study

The research questions prior to this study were: 1) How is care for vulnerable families organized 2) Who is responsible for the handover of care and of information, and 3) What is necessary for an efficient and complete handover?

METHODS

Setting

In the Netherlands, the community midwife transfers the care for mother and child to the maternity care assistant after childbirth. During the maternity care period (the first eight days after childbirth), the community midwife still bears final responsibility for the medical care of the mother and her child. At the end of the maternity care period (8th day after childbirth), the community midwife and maternity care assistant handover care to the general practitioner and to the PCHC, of which the latter will visit the family on the 14th day postpartum. This does not

imply an early handover of information cannot or should not take place between community midwives, maternity care and PCHC, for instance when a prenatal home visit by the PCHC is indicated or during a meeting of the 'obstetric collaborative network'. An obstetric collaborative network is an inter-professional care system in which community midwives, obstetricians, pediatricians, and maternity care providers share local guidelines and protocols. Figure 1 shows how the antenatal and child healthcare, in which multiple handovers take place, is organized in the Netherlands. (Vos, van Voorst et al., 2015)

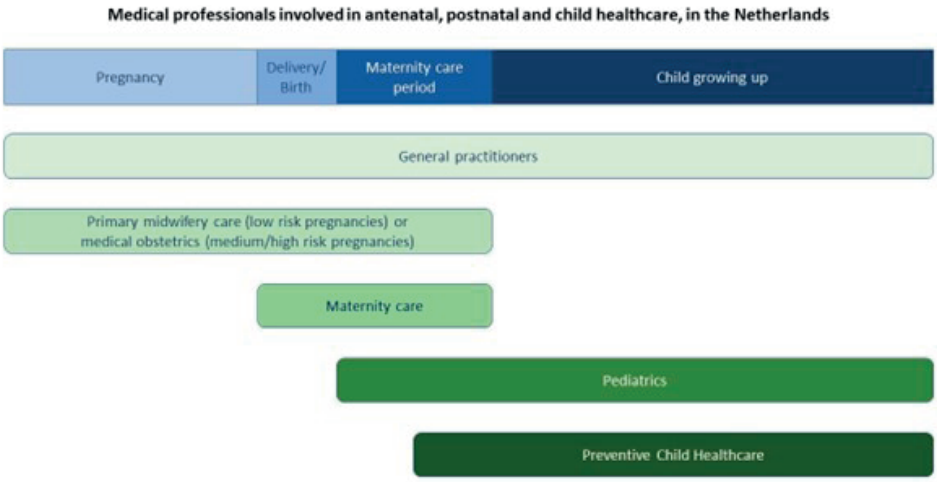


Figure 1. Organization of antenatal, postnatal and child healthcare in the Netherlands

Participants

This study took place in three of the ten participating municipalities in the HP4All-2 program. (8) In each of the selected municipalities, two community midwives, two maternity care assistants and two PCHC nurses were invited for a semi-structured interview by email, telephone or through their managers. Within the three municipalities the interviewed professionals were employed at different primary midwifery practices, maternity care organizations and PCHC locations and were deployed in both urban and rural areas.

Data collection

The semi-structured interviews were conducted in the months of February, March and April 2017 at the workplace of the professional, in the professional's residence or at the Erasmus Medical Center in Rotterdam. Beforehand, interviewees were informed on the backgrounds of the interviewers and the motivation of the research topic concerned. The interview was conducted by two researchers (MM and DV or MM and AR), the primary researcher, conducted the interview (MM) and the other researcher (DV or AR) ensured all questions were solicited

and answered. Additional or more in-depth questions were recorded. Audio recordings were made of all interviews with permission of the interviewee. The questions for the interviews were compiled according to the guidelines for qualitative research with as many open ended questions as possible. (Ann Bowling, 2002) The questions compiled prior to the interviews can be found in Appendix 1. The order of the questions was conducted analogously for all 18 interviews.

Analyses

Thematic content analysis was applied. The 18 interviews were transcribed by a research assistant and checked by one of the authors (MM). Hereafter, the written copy was submitted to the participants for approval of content and the accuracy of the interview. After approval, the name of the interviewee was removed and ID-codes were produced. NVivo11 software (QSR International) was used for the analyses. Every question was linked to the accompanying answers, producing sets of answers per subject. Every themed set was coded, to facilitate analyses by code.

RESULTS

All those interviewed were female, their ages ranged from 25 to 55 years old and their work experience ranged from two to 25 years. The average duration of the interviews was 60 minutes.

Using thematic content analysis we identified the following categories: 'content of handover', 'logistics of the handover process', 'responsibility for the handover', 'agreements on the handover', 'digital handover and privacy', 'involvement of other medical professionals', 'current quality of the handover and future aspirations'.

Content of handover

It was discovered that using the developed protocols, the information that was transferred is generally identical in the participating municipalities. Main differences concerned the extensiveness of information and the possibility of transferring a certain risk profile. There also proved to be differences in the risks that can be assessed and the possibility of addressing personal observations. Especially family structure and home environment, the nutrition and weight (increase) of the child were considered to be important for PCHC by those interviewed. Two midwives and one PCHC nurse were of the opinion that specific information concerning pregnancy or delivery to be less relevant to the PCHC. Examples of the certain information were the mother's blood type or specific obstetric interventions during the delivery.

In answer to the question: "What is important information for the PCHC to receive?" midwife 5 replied: "… data on the mother, where she lives, whether she works, I don't know if that's relevant, maybe important medical stuff if that is relevant." … "How the delivery went, is sort of the question, but maybe a few basic things about the delivery: whether it was a vaginal birth, for instance, but not everything. Then more detailed information about the child. And remarkable issues in the psychosocial area. Whether it's a stable family."

In answer to the question: "What is important information for the PCHC to receive?" maternity care assistant 5 replied: "Specifically the things that differ are important. Insecurity of the mother, social problems, certain behavior of the parents, how do the parents interact with the baby, do the parents need help."

In answer to the question: "What is important information for the PCHC to receive?" PCHC nurse 2 replied: … any complications during pregnancy. Specifically during the maternity care period; the interaction in the family, how does the family manage thei household, how is the hygiene, often its written in the handover. Weight change and feeding of the baby, does the weight decrease rapidly, because then I should take further actions. Of course I follow the last weight measurement of the maternity care assistant in order for me to adjust the feeding policy, if necessary."

Logistics and responsibility

A large majority of those interviewed usually complete two handover documents at the end of the first week after delivery: a digital handover by the community midwife and a paper handover by the maternity care assistant. In the majority of municipalities the paper handover for the PCHC is left behind with the family by the maternity care assistant. In some neighborhoods, the arrangement is met, where the maternity care assistant transports the handover document to the PCHC location. Sometimes, there is a joint handover by the community midwife and maternity care assistant to the PCHC, where they each fill in their part of the paper document and/or both sign the handover document. A joint oral handover mainly takes place when there is motivation for a so-called 'warm handover', for instance when problems within the family are present. Sometimes the 'warm handover' can be organized in the family residence, with all parties present including (one of the) parents. Three professionals indicated that a 'warm handover' together with the parents would be the ideal situation, especially if there are concerns in the family. Most of those interviewed thought a joint handover as standard protocol would be an improvement. A minority of the professionals did not find a jointly signed document necessary. The majority of the community midwives considered themselves as finally responsible for the handover to the PCHC. Maternity care assistants and PCHC nurses most often shared the opinion that they all are jointly responsible, all being responsible for their own part in the chain of handover. Most of the maternity care assistants and midwives stated that they have no

insight into how the PCHC receives and processes the handover documents. The PCHC nurses said that in most cases the handover document can be found in the residence of the family. It sometimes happens that there is information missing on the handover document, or that the document is not with the family. There is a general arrangement in PCHC that the handover document is scanned into the digital patient file or the information from the handover is manually entered into the digital file at the PCHC location.

> *In response to the question: "How does the PCHC receive the handover?" PCHC nurse 6 answered: "There is an agreement nowadays that the maternity care assistant leaves the handover form with the family. We used to get the handover beforehand, that was preferred in my opinion because it gave you information prior to the consultation. Now you start a conversation and don't see the handover form until that moment, that's a pity. Nowadays the midwife sends us a digital handover form. It has become two separate things."*

> *In response to the question: "Who is responsible for the handover?" midwife 1 answered: "I think the midwife ultimately, but I think it is necessary that the maternity care assistant provides her share of the handover herself. PCHC facilitates the handover."*

> *In response to the question: "Who is responsible for the handover?" maternity care assistant 3 replied: "maternity care and in case of particularities the community midwife."*

Agreements on the handover

Interviewees are generally satisfied with how the other professions live up to the agreements regarding the handover. Motives not to adhere to the agreements are: uncertainty regarding the protocol, too much workload, smaller maternity care organizations not being involved in the development of the protocol/ the signing of the collaboration agreement, and the handover document arriving too late at the PCHC. Solutions mentioned are: "everyone using the same handover document", "adaptation of the Information and Communication Technology (ICT)", "improved communication and/or improved collaboration in the 'obstetric collaborative network'", "obtaining additional information by phone", "organizing meetings with all professionals involved" and "arranging a standard 'warm handover' were the home visit bij PCHC overlaps with the maternity care assistant being present with the family".

> *In response to the question: "How do the other professionals live up to the agreements?" PCHC nurse 1 said: "It doesn't often happen that there is information missing from the handover, that is an exception. Maternity care assistants are good at detecting problems, they know how to find us and are well-informed about the work agreements."*

In response to the question: "What can be improved in the handover process?" PCHC nurse 1 replied: "Small maternity care organizations, who did not sign the agreement, do not use the new protocol/ handover document."

In response to the question: "What can be improved in the handover process?" midwife 2 replied: "An improved warm handover from secondary or tertiary care, we should involve general practitioners more often, not a large document, a simple telephone call or face –to-face handover can sometimes be just as efficient."

In response to the question: "Why do other professionals sometimes not live up to the agreements?" maternity care assistant 1 said: "Not everyone uses the protocol in the same manner, some items in the protocol are not clear or the PCHC nurse does not take the handover document with him/her."

Most of those interviewed stated that there are agreements on the handover of information to the PCHC during pregnancy. In all three municipalities (or in several neighborhoods within the municipality) PCHC offers a prenatal home visit when indicated by the community midwife or obstetrician. When a prenatal home visit is indicated by primary midwifery care, medical obstetrics, or social welfare the PCHC nurse schedules an appointment with the pregnant woman to assess the care she needs and gives support during pregnancy onwards.

Digital handover and privacy

In the three municipalities involved in this study, none of the maternity care organizations employ a digital handover. According to the maternity care assistants, this is because of concerns regarding the security of personal data. Other reasons mentioned are 'being comfortable with using paper forms', financial considerations, the risk of information being sent too late digitally and the fact that other organizations use a different digital system. Some maternity care assistants mentioned that it could be difficult to discuss sensitive subjects with clients, for example if she does not feel safe when alone in the family home. A number of midwives stated that they sometimes do not handover information, to guarantee the privacy of the client as much as possible.

In response to the question: "Is the ICT system adjusted to the handover, and if not, why not?" maternity care assistant 4 said: "No, because of the privacy. It would be practical if the joined handover would be transferred digitally.

In response to the question: "Is the ICT system adjusted to the handover, and if not, why not?" PCHC nurse 2 said: "I don't know why, maternity care does not have a laptop or Ipad."

In response to the question: "Is the ICT system adjusted to the handover, and if not, why not?" midwife 4 said: "We specifically chose a paper handover. I think it's because every organization uses a different digital system."

Involvement of other medical professionals

General practitioner (GP)

According to most, the role of the GP in the information handover of mother and child is minimal. The community midwife and the PCHC physician do most regularly confer with the GP. Those interviewed stated that the role of the GP in the care for mother and child is an important one and they emphasize that this role deserves more attention.

In response to the question: "What is the added value of other medical professionals to the information handover?", midwife 2 said: "The GP has a long relationship of care with the patient and therefor needs to have an overview of their medical history. I think he/she needs to be informed if there is really something going on, especially if it is in the best interest of the safety of the family."

Medical specialists

The pediatrician and gynecologist/obstetrician mainly become involved in the handover when they have treated the child or mother respectively. Maternity care assistants and PCHC nurses reported that in such cases, they are generally in touch with the nurses of the medical specialties concerned. Contact is often by phone or in person at the hospital. In one of the three selected municipalities, the maternity care assistant comes to one of the hospitals before the family goes home, so that oral handover can take place with the obstetric nurse, clinical midwife or physician at the hospital.

In response to the question: "What is the added value of other medical professionals to the information handover?", maternity care assistant 2 said: "maternity care can respond better to certain situations when they're fully informed."

In response to the question: "What is the added value of other medical professionals to the information handover?", PCHC nurse 3 said: "… It's very important for us to be aware of medical issues. … we should follow-up on it."

Current quality of the handover and future aspirations

Most are not aware of the nationally developed guideline (6). Five of those interviewed think this guideline exists, but have never seen or read it. One of those interviewed was actually informed about the content of the guideline. As points of improvement for the future, the

interviewed professionals stated that there should be a nationally identical handover agreement and that the handover should preferably be digital. There should be more collaboration between all professionals involved, with the provision of more feedback from all parties. Many professionals said they would prefer to give and receive a 'warm handover' and more joint handovers, especially in case of a vulnerable pregnant woman and a vulnerable family. Possible solutions mentioned are setting up regular teams per municipality or neighborhood, and participation of maternity care and PCHC in the 'obstetric collaborative network' to ensure healthcare workers get to know each other and will collaborate with each other more often.

In response to the question: "What can be improved in the handover process?" maternity care assistant 1 replied: "one system for transfer of information, all working with the same protocol/ guidelines, preferably digital of transferring by mail to the PCHC."

In response to the question: "What can be improved in the handover process?" maternity care assistant 3 replied: "Always a warm handover between maternity care and PCHC."

In response to the question: "What can be improved in the handover process?" PCHC nurse2 replied: "The handover should be more complete. Preferably, all maternity care organizations should use the same handover document."

In response to the question: "What can be improved in the handover process?" PCHC nurse 4 replied: First, a joined warm handover between maternity care and PCHC, for the handover between midwife and PCHC a joined warm handover is more difficult to organize. Second, a joined digital handover."

In response to the question: "Where should the implementation of an improved handover take place?" midwife 2 replied: "We have a joined meeting, a certain 'obstetric collaborative network' between primary and secondary care."

In response to the question: "Where should the implementation of an improved handover take place?" midwife 5 replied: "In a working group with all professionals involved."

DISCUSSION

Previous literature

The midwife-woman relationship has been identified as the vehicle in which personalized care, trust and empowerment are achieved in antenatal healthcare. (Perriman, Davis et al., 2018) This finding also seems evident in the handover from community midwives and maternity care

assistants to PCHC professionals, in which the established relationship with one care provider should be continued by the subsequent care provider involved. A systematic review on the collaborative relationship between midwives and public health nurses emphasized the positive views on interprofessional collaboration, on both sides, but also stressed on several barriers that hinder an appropriate partnership. These barriers were mainly poor communication, limited resources, and poor understanding of each other's role. (Aquino, Olander et al., 2016) Our study also addresses poor communication(e.g. information lacking from the handover document or no handover by telephone or face-to-face) and poor understanding of each other role (e.g. on all sides professionals were not fully aware of the job content of the other professionals). Olander et al stressed on the development of communication pathways for midwives and health visitors to improve care provided to women during and after pregnancy in the United Kingdom. (Olander, Aquino et al., 2019) These communication pathways have been developed in the Netherlands, were the next phase has been initiated: improving those pathways and adhering to them. Previous evidence has highlighted the importance of standardizing handover procedures and systems to promote communication and collaboration in order to ensure patient safety. (Yu, Lee et al., 2018) This is in line with the need for a standardized, preferably, digitized handover, in our study. McCloskey at el. highlighted patient experiences with patient presence during handover. In their study patients and families describe bedside handover positively, feeling more informed and engaged in care. These finding support the need of the professionals in our study who expressed the urgency of a warm (joined) handover when the family concerned is present. (McCloskey, Furlong et al., 2019)

Strengths and limitations

One strength of this study is that the community midwives, maternity care assistants and PCHC nurses have been interviewed in different municipalities in the Netherlands. These professionals were employed in both urban and rural areas. One limitation of this study is the possibility of selection bias. The professionals could sign up for the interview through their managers; probably those with a greater affinity for the subject were more inclined to do so. Another limitation is that professionals have been interviewed in only three municipalities. We think it is realistic to assume similar results will be found in other municipalities, because of the diversity of the municipalities in which this study took place. Still, one should be cautious in generalizing the results to the national situation.

Implications of this study

This study shows that several initiatives have been initiated in the past few years on the municipal and organizational level to improve the handover of information. Examples are the intensification of handover during pregnancy and the early involvement of the PCHC through prenatal home visits for vulnerable pregnant women. Even when this has not been implemented throughout the whole municipality, it has been tackled independently by individual organizations. In spite of

the steps taken, there is much to be gained regarding information handover when it comes to efficiency and collaboration within the healthcare chain. This study showed that there are no protocols or guidelines for a 'warm handover' in the participating municipalities. In general, it depends on the professional sensing that 'something is off' in the family concerned. Hence, the nationally developed guideline needs more attention on the municipal and organizational level to create awareness for those working with clients/patients. The three professional groups all desire a fully digitized information handover in antenatal, postnatal and child healthcare, so that data can be exchanged safely and on time, provided the privacy of the client can be guaranteed. By joint organization of care, the care for the family will improve in both quality and efficiency. By focusing on the family, they will receive satisfactory care at the right time. Presumably, in every country caregivers need to collaborate with each other and face the same problems in handover and communication when it comes to pregnant women, young families and newborns. All over the world antenatal and postnatal care is delivered and this manuscript portrays a Dutch example, from which others could gain knowledge of.

Conclusion and implications for practice

Our results show that there is attention to the handover of information between professionals in antenatal, postnatal and child healthcare and in identifying vulnerable families, but awareness on national guidelines and the intensification of care is needed. The three professions involved know where to find each other when necessary, but not every selected municipality has a structured organized meeting. The 'obstetric collaborative network' appears to offer a solution, provided maternity care and PCHC can participate during these meetings. This has already been realized in several municipalities. Digitizing the handover appears essential to the improvement of the handover process. 'Warm handover' is considered valuable by the three professions involved, and should occur more often in the opinion of most professionals. Clearer local agreements and knowledge of the social map of the neighborhood could possibly improve the handover. Municipalities and the healthcare organizations involved should work together to get different healthcare workers in touch with each other. This will help ensure a better continuity of care.

REFERENCES

Ann Bowling, 2002. Research methods in health- investigating health and health services.

Aquino, M. R., Olander, E. K., Needle, J. J. and Bryar, R. M., 2016. Midwives' and health visitors' collaborative relationships: A systematic review of qualitative and quantitative studies. Int J Nurs Stud 62, 193-206.

Beckers et al., 2011. Positionpaper on handover of information from maternity care and primary midwifery care to Preventive Child Healthcare. T. i. h. w. gegevensoverdracht). Utrecht, The Netherlands, Dutch Institute on Child and Youth Health (NCJ).

Beckers et al., 2016. Factsheet for the handover of obstetric care providers and maternity care to Preventive Child Healthcare. T. i. h. w. gegevensoverdracht). Utrecht, The Netherlands, Dutch Institute on Child and Youth Health (NCJ).

Groene, R. O., Orrego, C., Sunol, R., Barach, P. and Groene, O., 2012. "It's like two worlds apart": an analysis of vulnerable patient handover practices at discharge from hospital. BMJ Qual Saf 21 Suppl 1, i67-75.

McCloskey, R. M., Furlong, K. E. and Hansen, L., 2019. Patient, family and nurse experiences with patient presence during handovers in acute care hospital settings: a systematic review of qualitative evidence. JBI Database System Rev Implement Rep 17, 754-792.

Merten, H., van Galen, L. S. and Wagner, C., 2017. Safe handover. Bmj 359.

Moore, C., Wisnivesky, J., Williams, S. and McGinn, T., 2003. Medical errors related to discontinuity of care from an inpatient to an outpatient setting. J Gen Intern Med 18, 646-651.

Olander, E. K., Aquino, M., Chhoa, C., Harris, E., Lee, S. and Bryar, R. M., 2019. Women's views of continuity of information provided during and after pregnancy: A qualitative interview study. Health Soc Care Community.

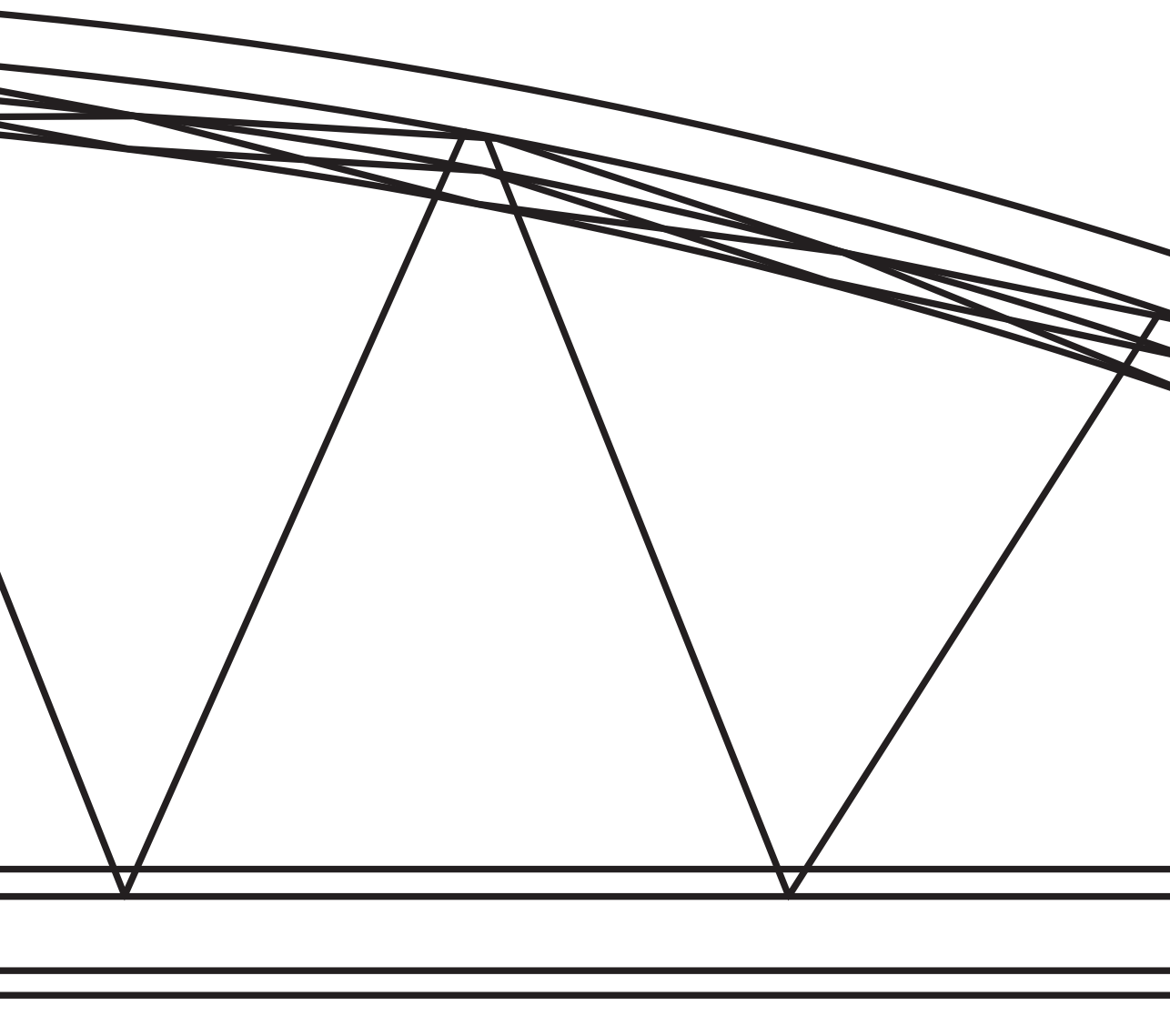
Perriman, N., Davis, D. L. and Ferguson, S., 2018. What women value in the midwifery continuity of care model: A systematic review with meta-synthesis. Midwifery 62, 220-229.

The Health Care Inspectorate 2014. The necessity of improvement for the collaboration between maternity care and Preventive Child Healthcare for safe antenatal, postnatal care and child care. Utrecht, The Netherlands.

Vos, A. A., van Voorst, S. F., Waelput, A. J., et al., 2015. Effectiveness of score card-based antenatal risk selection, care pathways, and multidisciplinary consultation in the Healthy Pregnancy 4 All study (HP4ALL): study protocol for a cluster randomized controlled trial. Trials 16, 8.

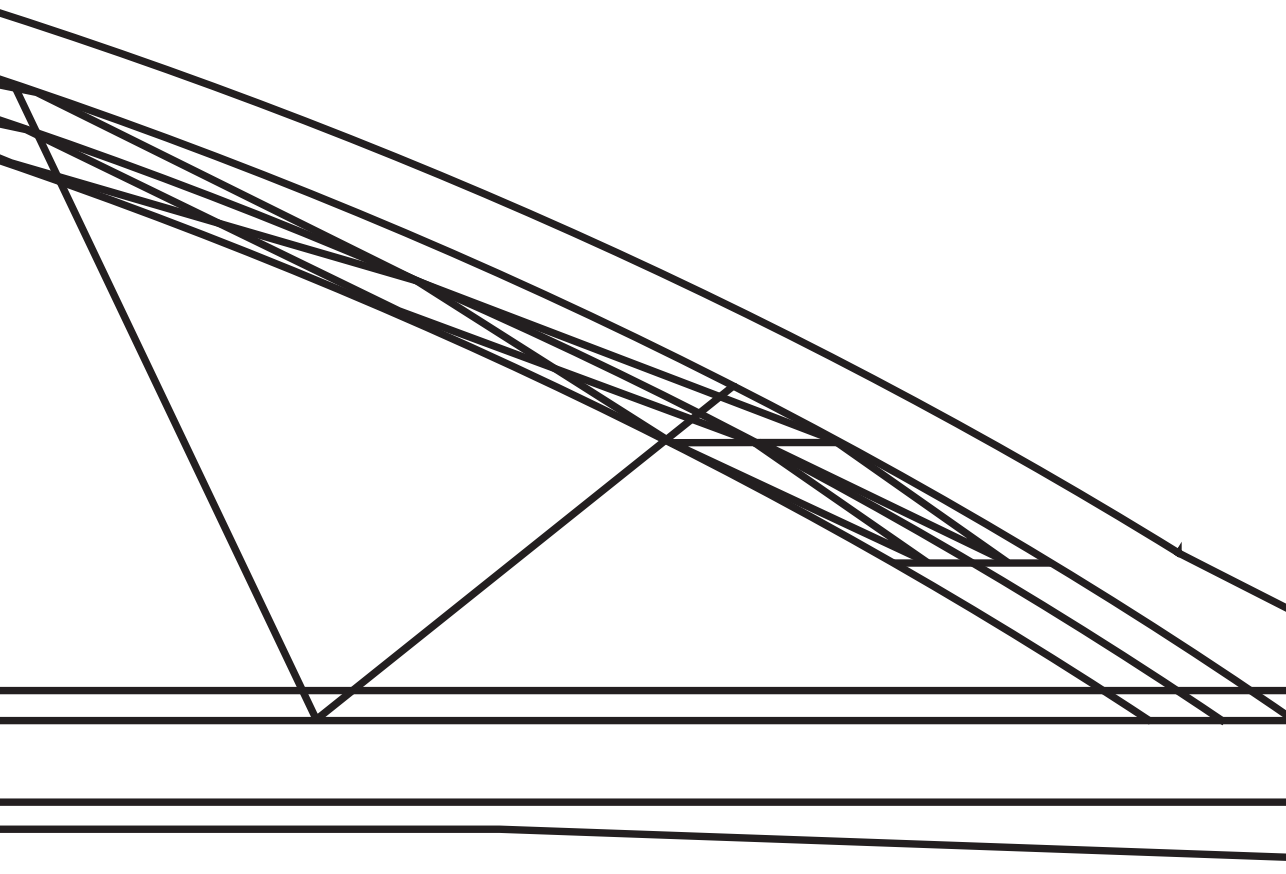
Waelput, A. J. M., Sijpkens, M. K., Lagendijk, J., et al., 2017. Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth 17, 254.

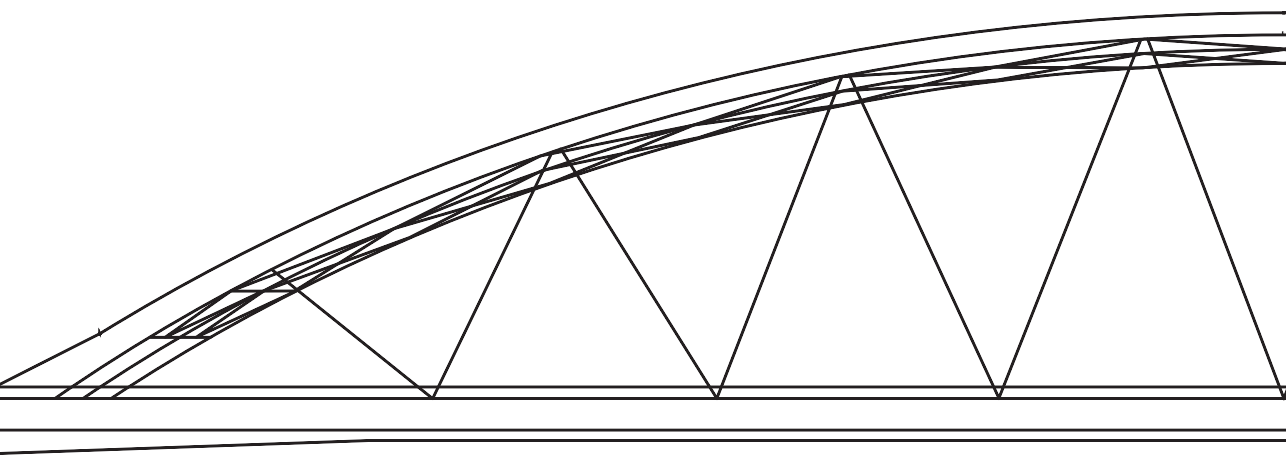
Yu, M., Lee, H. Y., Sherwood, G. and Kim, E., 2018. Nurses' handoff and patient safety culture in perinatal care units: Nurses' handoff evaluation and perception of patient safety culture at delivery room and neonatal unit in South Korea. J Clin Nurs 27, e1442-e1450.



PART II

Development and implementation





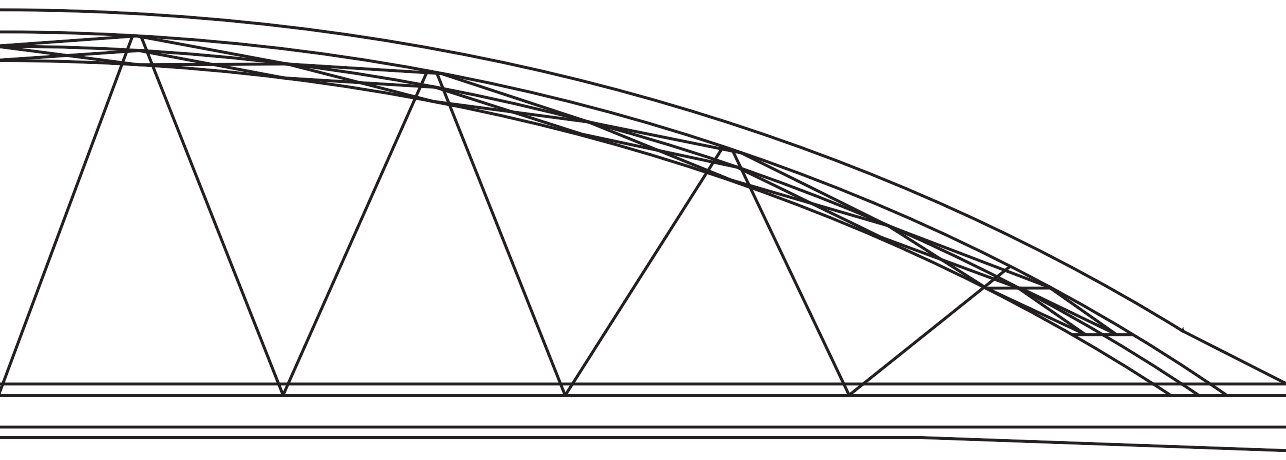
Chapter 5

Reducing growth and developmental problems in children: Development of an innovative postnatal risk assessment

M.R.C van Minde
L.M.G. Blanchette
H. Raat
E.A.P. Steegers
M.L.A. de Kroon

PloS One

https://doi.org/10.1371/journal.pone.0224160



ABSTRACT

Introduction

Globally, awareness of the relevance of both medical and non-medical risk factors influencing growth and development of children has been increasing. The aim of our study was to develop an innovative postnatal risk assessment to be used by the Preventive Child Healthcare (PCHC) to identify at an early stage children at risk for growth (catch-up growth, overweight and obesity) and developmental problems (such as motor, cognitive, psychosocial and language/speech problems).

Methods

We used the Intervention Mapping process. Step 1: Review of the literature and focus group discussions. Step 2: Identification of program objectives on how to develop and implement a risk assessment in PCHC daily practice. Step 3: Application of the ASE model to initiate behavioral change in the target group. Step 4: Development of the postnatal R4U and corresponding care pathways. Step 5: Design of the program adoption and implementation in four PCHC organizations. Step 6: Planning program evaluation by a questionnaire and an evaluation meeting.

Results

Subsequently in 2015, the 41 item postnatal R4U (the postnatal Rotterdam Reproduction Risk Reduction checklist) was developed according to steps one until four of the Intervention Mapping process and was implemented in four PCHC organizations.

Conclusions

It was feasible to design and implement a postnatal risk assessment identifying both medical and non-medical risks for growth and developmental problems, using the Intervention Mapping process.

INTRODUCTION

The most common causes of perinatal morbidity are congenital anomalies, being born small for gestational age (SGA, birth weight under the 10th percentile, adjusted for gestational age), preterm birth (before 37 weeks), or a low Apgar score (below 7 five minutes after birth) [1, 2]. The prevalence of perinatal morbidity is higher in deprived neighborhoods due to adverse effects of socio-economic non-medical risks [3-5]. The presence of both medical and non-medical risk factors predict adverse outcomes at birth [6] and influences long term health outcomes in children [7-9].

These children, for example born in a low socio-economic environment, have an increased risk of not reaching their developmental potential and of acquiring growth problems, such as obesity [10-13]. This vulnerability can persist into later life and can affect the health of their offspring, the next generation [14, 15]. Consequently, the accumulation of heterogeneous risk factors might be even more important than individual 'high risk' factors when it comes to adverse health outcomes [16-18].

Although Preventive Child Healthcare (PCHC) professionals seem to be aware of the importance of medical, as well as non-medical risk factors, such related risk assessment is currently not systematically applied, neither are related tailored care pathways. Our aim was to develop such a postnatal risk assessment, the postnatal Rotterdam Reproductive Risk Reduction checklist (postnatal R4U). With this instrument, PCHC professionals will be able to detect and weigh the severity of early medical and non-medical risk factors for growth and developmental problems in children. Subsequently, tailored care pathways can be offered to reduce these risks, in time.

In this study we aim to develop the postnatal R4U and tailored care pathways, as part of the Healthy Pregnancy 4 All-2 (HP4All-2) program [19]. HP4All-2 is the sequel of the HP4All program, initiated by the Erasmus Medical Center in cooperation with Dutch municipalities [3]. HP4All-2 aims to enforce and facilitate continuous care for families at risk after birth by focusing on antenatal and postnatal risk assessment in combination with tailored care pathways by maternity care, PCHC and interconception care [19].

MATERIALS & METHODS

Trial registration

The qualitative study was reviewed by the Daily Board of the Medical Ethics Committee Erasmus MC as part of a larger study on implementation of interconception care in the Netherlands (MEC-2015-697). As a result of this review, the Board declared that the rules laid down in the

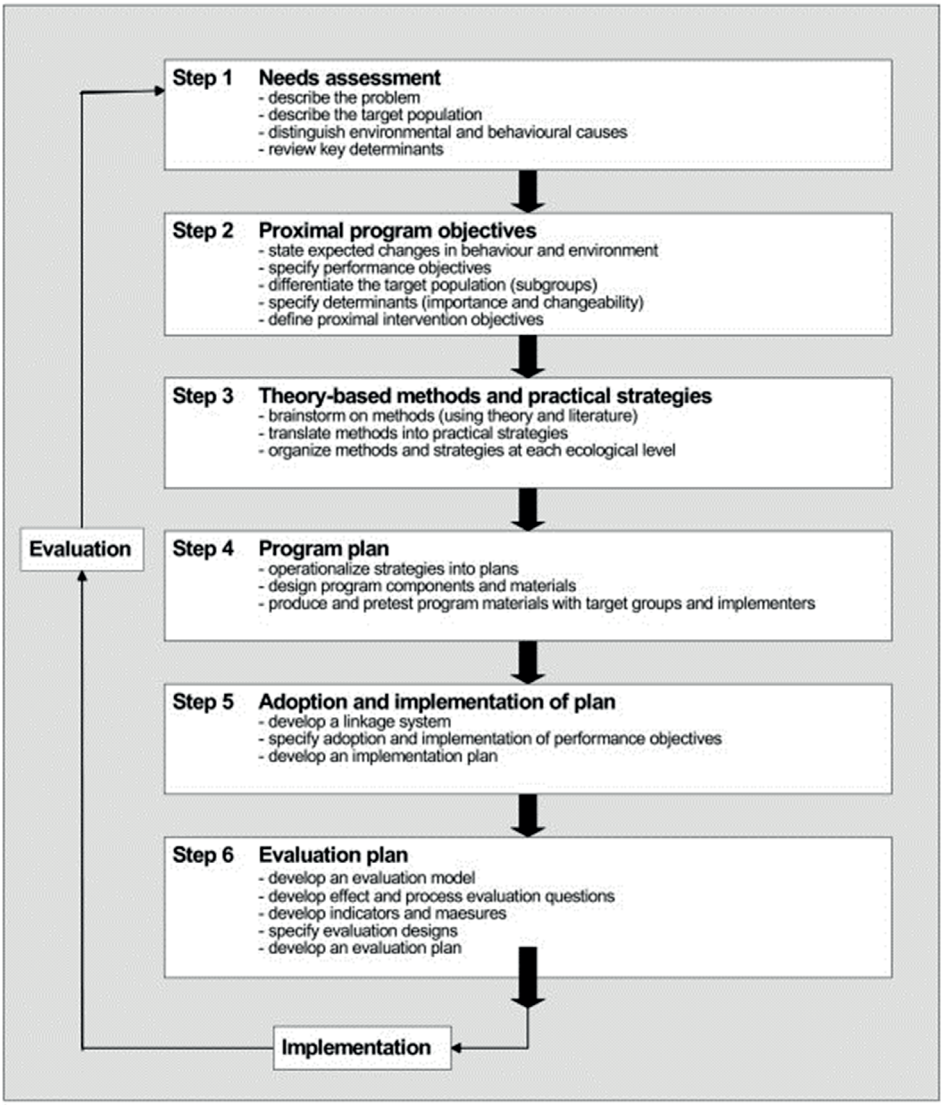


Figure 1. The six steps of the Intervention Mapping process [20]

Medical Research Involving Human Subjects Act (also known by its Dutch abbreviation WMO) do not apply to the study. No additional approval was requested for the current study since it is not based upon a clinical study or patient data.

Development of the risk assessment

In order to develop an innovative postnatal risk assessment, the postnatal R4U, in combination with tailored care pathways, the Intervention Mapping (IM) process was applied. IM is a protocol

for the development of theory-based and evidence-based health promotion programs [20]. (Figure 1). In a recently published systematic review IM has been successfully used to plan, implement and evaluate interventions that showed a significant increase in uptake of disease prevention programs [21].

Step 1: Needs assessment

The IM process starts with a needs assessment of the health problem, which includes identification of risk factors, target groups, and of the aspired program outcomes. The methods used for the needs assessment were a study of the literature followed by three focus group discussions with relevant stakeholders.

Study of the literature

First, we performed an electronic literature search on the 12th of February 2015 in Medline, Embase, Psycinfo and Cochrane for (1) risk factors of childhood overweight, obesity or catch-up growth, and (2) risk factors for developmental problems in children. Developmental problems were defined as psychomotor, cognitive, social and language/speech problems. Catch-up growth in early life has been associated in the literature with overweight, obesity and developmental problems in later life. [22-25] Attention was restricted to publications from western countries (because of generalizability to our target population) from 2005 onward, because of the amount of literature found in the search. We assumed that more recent publications would show the most relevant outcomes. A search strategy (2005-2015) was developed based on 'perinatal risk factors', 'growth' and 'development' and their Mesh terms. The search was restricted to Dutch and English.

Stakeholder consultations: focus group discussions

The second part of the needs assessment consisted of collecting information from important stakeholders. Therefore we organized three focus group discussions with stakeholders (with expertise on child growth and development and its risk factors), including physicians, nurses, researchers and policy makers from Obstetrics and Gynaecology, General Paediatrics and Neonatology, PCHC, Primary Healthcare and Research Institutions. This consultation enabled a deeper understanding of the context or communities in which the intervention was to be delivered [20]. During the discussions we addressed the nature of the problem and the findings of our literature review, seeking ideas on the presented associations and looking for risk factors that were missed in the literature. Additionally we discussed what the desired outcomes of the program should be, we identified both a primary and a secondary target group for the postnatal risk assessment (and corresponding care pathways) and discussed how the program should be implemented within the PCHC organizations. One of the researchers moderated the discussions, another researcher took notes. The three focus group discussions were tape-recorded with verbal informed consent from the participants and were subsequently transcribed. Data

were analysed using the program Nvivo (version 11.4.1/February 2017, Qualitative Data Analysis computer software package, QSR International software), for qualitative data analysis. To integrate results of the discussions and literature review, themes derived from the discussions were linked to risk factors found in literature.

Step 2: Specification of proximal program objectives

The objectives of the program were specified in step two of the IM process [20]. Based on the program outcomes formulated in the needs assessment, different performance objectives were conveyed at the individual level (PCHC nurses and physicians) and at the interpersonal level (PCHC organizations). These performance objectives stated what the involved professionals had to do or how the PCHC organizational environment had to be modified in order to successfully introduce and implement the postnatal R4U, and thereby contribute to optimal health related outcomes and preventing growth and developmental problems in children. The literature review and the focus group discussions supported us to identify important behavioral and environmental determinants of behavior change of professionals. Subsequently, we identified a suitable theoretical model, referred to as the attitude/ social norm/ self-efficacy model (ASE model) [26] as the most applicable model to use as a basis for the development of the implementation process of the postnatal R4U and related care pathways. ASE is a model that has general scientific acceptance and explains behavior by linking various determinants such as attitude, social norm and and self-efficacy with behavioral intention and behavior [27]. Therefore, this model seemed to be appropriate as a basis to guide the way in which the PCHC professionals can be involved and ensure a permanent behavioral change within their daily practices. Figure 2 shows the process of this model.

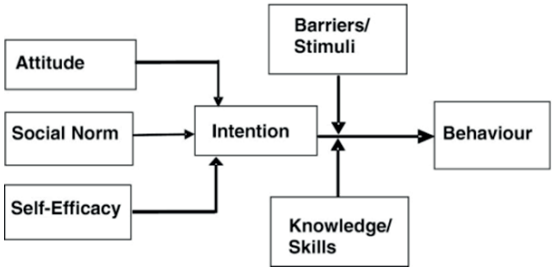


Figure 2. The ASE model which was applied to accomplish behavioral change in PCHC professionals

Step 3: Theoretical model, theory-based methods and practical strategies

In the third step of the IM process we focused on different methods of change.

In the ASE model, it is assumed that intention and subsequent behavior are primarily determined by the following cognitive variables: attitudes, social influences/norms, and self-efficacy expectations. Moreover, the model postulates that intention predicts subsequent behavior. A

person's attitude towards a specific behavior (e.g. applying a new risk assessment instrument in daily practice) is a result of the consequences that a person expects from performing the behavior (e.g. "applying this risk assessment instrument will take extra time during my consultation"). Social influences can be described as the processes whereby people directly or indirectly influence the thoughts, feelings, and actions of others. Self-efficacy expectations pertain to a person's belief in his or her ability to perform desired behavior [28].

Subsequently, appropriate theoretical methods could be selected and translated into practical strategies in order to positively influence each of the identified determinants. Related materials and tools were developed. Taken together, these elements would ensure ongoing implementation and a persistent behavioral change of the involved professional's and their organization.

Step 4. Producing intervention components and materials

During the fourth step of the IM process, the information from all previous steps was combined and led to the development of the postnatal R4U, related care pathways and different program components and materials. Most of the program components and materials were tested and revised based on feedback from PCHC professionals in the participating municipalities.

Step 5. Planning program adoption and implementation

During the fifth step of the IM process, the intervention adoption and implementation was planned. Based on the first step of the IM process, the PCHC physicians and nurses were considered as the intervention adopters and implementers. Demographic and cultural differences of the target population at the specific PCHC locations were taken into account to ensure feasibility of implementing the postnatal R4U and its corresponding care pathways in all participating PCHC organizations. Subsequently, a clear implementation plan and training was developed to inform all PCHC employees in the participating organizations about the different core components of the intervention and about details on how to deliver the intervention to the parents visiting PCHC. The emphasis of the implementation plan was placed on achieving a high level of commitment and completeness. During the implementation plan we focused on flexibility and easy to use methods to ensure and easy adoption.

Step 6. Evaluation planning

The last step of the IM process included the development of a plan for the evaluation of the outcomes and the process of the intervention. A process evaluation as well as an outcome and efficacy evaluation were planned.

RESULTS

Results of step 1: Needs assessment

Study of the literature

The full literature search can be found in S1 Supplement 1. The initial literature search resulted in 12,039 articles. After excluding the articles published before 2005, 7049 articles remained. After screening the titles and abstracts on eligibility, 496 were left for full article reading. These articles were structurally reviewed for the following topics: predicted outcome (growth and/or development), identified risk factor(s) from preconception until the age of 8 weeks old, type of analysis and statistical results (e.g. odds ratio, hazard ratio, risk ratio, regression coefficients), quality of the study, age of the children during the assessment, possible confounders, generalizability and size of the research cohort. These papers were read by the first reviewer. 376 articles were excluded because they lacked statistical results, did not assess the predicted outcome or did not assess relevant risk factors. 120 articles remained for a second reviewer within the project team and were scored on generalizability, validity and overall quality, by at least two reviewers. Finally, 69 articles remained to be considered, according to their high scores. Additionally, several articles suggested by participants in the focus groups were added and reviewed. 9 articles were approved according to the above mentioned criteria by two reviewers. This resulted in 78 articles that were eligible for the risk assessment. These articles described a wide range of risk factors influencing growth and development of children, each article containing one or more risk factors. Social risk factors included low socio-economic status and ethnicity. Maternal risk factors included maternal psychological/psychiatric problems, intoxications such as smoking and drug abuse, gestational diabetes and maternal overweight. Fetal/neonatal risk factors included small and large for gestational age, preterm birth and a low Apgar score. See S2 Supplement 2 for the full list of included articles and the identified risk factors.

Focus group discussions

The three focus group discussions each respectively included 8, 9 and 15 stakeholders, with a median age of 45 years old (range 25 – 65 years old), of which 90% was female. The discussions lasted between 140 and 150 minutes, with a mean of 145 minutes.

We identified a need for an early, systematic and evidence based postnatal risk assessment within PCHC, in which the accumulation of risk factors can be taken into account and care pathways can be selected. Indeed, during the focus group discussions the participants stressed on the fact that a risk assessment can not exist without corresponding care pathways. Identifying a risk should lead towards suitable care to prevent further risk or negative outcomes in the future. As a result, we decided to organize a third focus group discussion concerning the development of tailored care pathways.

During the focus group discussions we identified the PCHC physicians and nurses as the primary target group of the intervention. The secondary target group consists of their clients; parents and their children from 0 until 8 weeks old.

The age from 0 until 8 weeks old was chosen because the assessment has to take place in the early postnatal period. A maximum of 8 weeks was chosen because of organizational reasons; the home visit by the PCHC nurse takes place between 12-14 days after birth, during which many items of the postnatal R4U are discussed according to protocol. At 4 weeks a consultation by the PCHC physician is scheduled, and at 8 weeks another consultation by the PCHC nurse takes place at the specific PCHC location. During this consultation extra focus can be given to the social domain, in which certain items included in the postnatal R4U can be addressed as well. In order to ensure that the R4U can be implemented during standard care, without putting too much weight on one single visit, we chose these three eligible consultations for the risk assessment using the postnatal R4U. In case of preterm birth, the corrected age can be applied, to safeguard referral to appropriate care and participation in the study.

Results from the focus group discussions are presented in S2 Supplement 2.

Aspired program outcomes

Based upon the above mentioned results, specific aspired outcomes were formulated in order to evaluate the effectivity of the program.

Primary outcomes are overweight (>1 SDS for length), obesity (>2 SDS for length) [29] and catch-up growth (>0,67 SDS) [30] and developmental problems (psychomotor, cognitive, psychosocial and language/speech) in the first six months of life. Secondary outcomes are the use of the postnatal R4U and its corresponding care pathways by PCHC professionals and their knowledge, attitude and intention after the implementation.

Results of step 2: Proximal program objectives

The selection of the risk factors to be included in the postnatal R4U was carefully discussed within the research team, with regards to scientific evidence as well as the implementation feasibility in PCHC organizations. Hence, certain risk factors were not selected due to lack of evidence (i.e. pets in the household influencing child development, which was only mentioned in one article) or the infeasibility of applying it in PCHC daily practice (such as hemoglobin levels of the mother, which can not be measured in PCHC).

Two main program objectives were identified on how to develop and implement a risk assessment in PCHC daily practice. First, risk factors should be identified in a systematic manner by the healthcare professionals, in order to be able to screen objectively and without missing any

risks. Second, based on the risk assessment, care pathways should be identified and developed, assisting professionals to direct parents to the appropriate care within a certain neighborhood or municipality. The identified important behavioral and environmental determinants of behavior change of the professionals were attitude, social influence, self-efficacy and PCHC organizational environment.

Results of step 3: Theoretical model, theory-based methods and practical strategies

The ASE theoretical model [31] enabled us to consider all different determinants of professional behavior and the way these determinants interact together and might influence a person's intention and subsequent behavior. From there on, we were able to select appropriate theoretical methods and conceptualize practical strategies and tools for the implementation of the postnatal R4U and care pathways (see Table 1).

Results of step 4: Producing intervention components and materials

The postnatal R4U

The postnatal R4U was created using the previous mentioned steps in the IM process. See Figure 3 for the result.

Risk factors identified in the literature or the focus group discussions were categorized into different domains: (1) social, (2) ethnic descent and language barriers, (3) lifestyle, (4) healthcare behaviors, (5) general medical and (6) obstetric.

During the development we used 'weighing' and a cumulative risk score, as has been done in a precedent study [32]. To obtain a cumulative risk score for an individual patient, weights have to be assigned to each positive item. A cumulative risk score above a predefined threshold would imply the need for a multidisciplinary consultation between PCHC professionals and other healthcare providers. The authors propose a threshold of 15, since this would imply a large amount of different accumulating risk factors for a patient or family. This offers the opportunity to customize care policy to the specific needs of a child and his/her family. Such a threshold may be locally adapted to accommodate the availability of facilities [32]. For instance when the workload of the multidisciplinary consultations is too scarce or too heavy or when professionals feel that certain vulnerable families with a lower score than 15 should benefit from a multidisciplinary consultation. These specific organizational needs could be subject to environmental factors in a certain neighborhood or municipality. After the implementation study, it might be possible to define a more evidence based threshold, using statistical analysis.

Table 1. Personal and environmental determinants according to the ASE model, theoretical methods, preconditions, practical strategies and tools for the design and implementation of the postnatal risk assessment and care pathways (Rotterdam, The Netherlands, 2015)

Determinant	Theoretical method	Precondition	Practical strategy	Tools	Who is responsible
Attitude	Passive/active learning	Credibility and clarity of the source. Knowledge of trainer and/or teacher	Research group and management of the organization provide emphatic, accessible written and verbal information.	Group training on scientific evidence of risk factors influencing child growth and development. /Provision of all background information including all identified risk factors, care pathways and literature references. / Pocket size guide for the use of the postnatal R4U and its corresponding care pathways.	Research team including a professional communication specialist. /Research team./ Research team.
Social influence/ norm	Mobilizing social support and control	Involvement of management and staff of the organization. / Involvement and presence of research group.	Management and staff: monitor, encourage and remind professionals. /Research group: updates on the statistics of the risk assessment.	Discuss the progress of the program during team consultations, sent frequent reminders about the risk assessment. /Frequent visits to the PCHC locations and presentations on the statistics of the study.	Research team and PCHC management. / Research team.
Self-efficacy	Passive/active and interactive learning	Credibility and clarity of the source. /Knowledge of trainer and/or teacher.	Research group and management of the organization provide emphatic, accessible written and verbal information.	Group training by professional trainer on communication strategies in case of parents who are in resistance. /Syllabus/hand out on communication models.	Research team and professional communication specialist./Research team.
Environment	Environmental changes	Involvement of all PCHC professionals.	Management and staff: provide secure environment in which there is time and space to implement and work with the postnatal R4U. /ICT: Adjustment of the digital file to facilitate working with the postnatal R4U	Prolonged consultations. /Postnatal R4U embedded in digital file.	PCHC management. / Research team and ICT.

Script	Home environment	SCORE		PATHWAY
	Social situation parents	YES	NO	
P1	Single parent	1	0	**Social**
P2	Lack of social support	1	0	**Social**
P3	Presence of domestic violence	2	0	**Social**
P4	Child Social Services involved with borthers/sisters	2	0	**Social**
P5	Child Social Services involved during pregnancy or after birth	3	0	**Social**
	Work and income parents	YES	NO	
P6	Unemployed (> 3 months)	1	0	**Social**
P7	Family living on low income (< 1000 Euros a month)	2	0	**Financial**
P8	Financial problems	1	0	**Financial**
	Edcution parents	YES	NO	
P9	Low educated / illiterate	2	0	**Social**
	Living environment of the family	YES	NO	
P10	Unsafe living environment	1	0	**Housing**
P11	Living in deprived neighborhood (based on 4 digit zipcode)	2	0	**Social**
	Script: 4 digit zipcode for deprived neighborhoods			
	ETHNICITY			
	Ethnicity father/mother	YES	NO	
P12	Surinam-Creole	1	0	**Weight**
	Surinam-Hindu	1	0	**Weight**
	Surinam-Indonesian	1	0	**Weight**
	Antillian-Aruban	1	0	**Weight**
	Capeverdian	1	0	**Weight**
	Turkish	1	0	**Weight**
	Maroccan	1	0	**Weight**
	Other non-western	1	0	**Weight**
	Language/communication	YES	NO	
P13	Doesn't speak Dutch or English	1	0	**Social**
P14	Mentally disabled parent(s)	1	0	**Social**
	CARE			
	General	YES	NO	
P15	No (healthcare) insurance	1	0	**Social**
	Family planning	YES	NO	
P16	Mother age < 20 years	2	0	**Finances**

Script	MEDICAL	SCORE		PATHWAY
	Health of the parents	YES	NO	
P27	One or more chronical illness of the parent(s)	0	0	**Chronic**
P28	Diabetes of the mother	1	0	
P29	Epilepsie with medication of the mother	2	0	
	PSYCHIATRY	YES	NO	
P30	Psychiatric problems parent(s) in history or present	1	0	**Psychiatry**
P31	Psychiatric drugs during pregnancy by the mother	1	0	**Psychiatry**
P32	Psychiatric problems in the family (1st and 2nd degree)	1	0	**Psychiatry**
	OBSTETRIC			
	During pregancy	YES	NO	
P33	Insulin or diet because of diabtes gravidarum	2	0	**Weight**
P34	Gained more than 16 kg in weight	1	0	**Weight**
P35	Untreated hypothyroid in first trimester	1	0	
	Birth outcomes	YES	NO	
P37	Birth weight < P10	1	0	**Weight/dys**
	Birth weight > P90	2	0	**Weight**
P38	Prematurity (< 37 weeks of gestation)	2	0	**Premature**
P39	Low Apgar score (<7 after 5 min)	1	0	
P40	Congenital anomalies	1	0	**Congenital**
P41	Formula feeding directly after birth	1	0	**Weight**

RESULT				
Domain		*Max. score*	*Score*	
SOCIAL		18		
ETHNICITY		3		
CARE		3		
LIFESTYLE		18		
MEDICAL		6		
OBSTETRIC		11		
Total		59		

DIRECTED CARE	YES	NO	ACTION
Use of care pathways			
Mutlidisciplinary consultation			
Interconception advice			
Consult of the General Practitioner			
Consult at outpatient clinic			
Other: …			

	LIFESTYLE			
	Intoxications	YES	NO	
P17	Smoking in pregnancy	1	0	**Smoking**
P18	Mother smokes	1	0	**Smoking**
P19	Father smokes	1	0	**Smoking**
P20	Alcohol in pregnancy	1	0	**Toxic**
P21	Alcohol abuse by mother	1	0	**Toxic**
P22	Alcohol abuse by father	1	0	**Toxic**
P23	Drug use in pregnancy	3	0	**Toxic**
P24	Drug abuse mother	3	0	**Toxic**
P25	Drug abuse father	3	0	**Toxic**
	Weight of the mother	YES	NO	
P26	BMI < 18,5	1	0	
	BMI >25	2	0	**Weight**
R4U©Erasmus MC	***version: postnatal***			

Figure 3. Postnatal R4U: presenting risk factors (second column), the corresponding score (column 3 and 4) and care pathway(s) (column 5)

We expressed weights in points, depending on odds ratios/relative risks mentioned in the reviewed literature (S3 Supplement 3). Risk factors consistently associated with odds ratios/relative risks smaller than two were assigned 1 point, higher than two were assigned 2 points, and for risk factors associated with odds ratios/relative risks higher than four, 3 points were assigned. For some items, expert opinion prevailed, due to missing odds ratios/relative risks in the literature, such as substance abuse of a parent. The item chronic illness of the parent, for which there was no evidence in the literature review, received 0 points.

Care pathways

Tailored care pathways were developed in collaboration with PCHC professionals themselves, including staff members, physicians and nurses and with other local healthcare providers, such as social welfare workers. Care pathways were: 'psychosocial', 'financial and housing problems', 'weight', 'smoking', 'substance abuse', 'chronic illness', 'psychiatry', 'preterm birth/SGA' and 'congenital anomalies'. Each care pathway was individually designed for a participating municipality or neighborhood. These care pathways are very elaborate and specifically designed for one of the participating PCHC organizations. Therefore, we added examples of the care pathways developed. See S3 Supplement 3.

Results of step 5: planning program adoption and implementation

An implementation plan was designed. As a result, a group training was developed, in collaboration with a professional training company, to inform and educate PCHC professionals on the postnatal R4U, its scientifically identified risk factors and its corresponding care pathways. Program materials were developed and distributed, such as posters for the PCHC organizations, flyers for the parents and educational booklets for the PCHC professionals.

The postnatal R4U has been incorporated in the digitized files of the PCHC centers, automatically transferring data of already obtained relevant risk factors from the digital file to the risk assessment.

Results of step 6: Evaluation planning

As the last step of the IM process, a process evaluation of the pilot implementation, using a questionnaire for PCHC professionals and a meeting for the evaluation of the intervention with PCHC professionals, PCHC management and municipality officials will take place. The outcome and efficacy of the postnatal R4U will be analyzed using an intervention cohort (n=3120), in which the postnatal R4U has been implemented, and an historical cohort (n=3120), in which the instrument has not been used. Child growth and development in both cohorts will be compared. The design of this specific study will be published separately.

DISCUSSION

We have developed a postnatal risk assessment for PCHC organizations, using the steps of the IM process.

The IM process is one of many validated methods for intervention development in medical sciences. In the past years, IM has been successfully used to plan, implement and evaluate interventions that showed a significant increase in uptake of disease prevention programs [21]. Another method, primarily used in pediatric psychology, is an author's checklist for measure development by Holmbeck and Devine (2009) [33]. Similar to IM they highlight the establishment of the scientific need for the instrument as well as clinical experience, rational deduction, related instruments and consultation with experts. Unlike IM they focus on the evaluation of the diagnostic utility and translating the measure in other languages. Because IM was more broadly used in the medical field, we chose this method.

This instrument, the postnatal R4U, enables to screen for medical and non-medical risk factors that influence a child's growth and development. This assessment can be done in a structured manner, at an early age, and subsequently, offer care using the corresponding care pathways.

As most children and their parents visit the PCHC locations on a regular basis, PCHC plays an important role in the primary prevention of these problems by timely identification and advising parents or referring them to other care providers [34]. Therefore, an instrument for a swift and structured identification of risk factors accompanied by corresponding care pathways seems valuable.

Within the HP4All program, an antenatal risk assessment (the antenatal R4U) has been developed to assess in early pregnancy, the risks of congenital anomalies; being born small for gestational age; preterm birth; and a low Apgar score. The antenatal R4U has been evaluated in multiple research projects [6, 32, 35]. The postnatal R4U seems a good sequel of the antenatal R4U in order to screen for the antenatal R4U main outcomes and other risk factors [36], which can separately increase the risk of growth and developmental problems in affected children [22, 37, 38].

In different fields of preventive healthcare and pediatrics, risk assessments have been developed, such as a psychosocial risk assessments [39] and the child abuse inventory at emergency rooms [40, 41]. In Child Preventive Healthcare the SPARK, an instrument for the early detection of developmental problems in toddlers has been recently developed [42, 43]. A postnatal risk assessment, which screens for both medical and non-medical risk factors, has, to our knowledge, not previously been developed.

In the future, after demonstrating the effectiveness and efficacy of the postnatal R4U, based on the evaluation study, national implementation of the postnatal R4U may be advised. The Dutch Center of Youth Health (www.ncj.nl), which is nationally responsible for promoting the implementation of guidelines and new working methods in PCHC, would have an important role in the national implementation process of the postnatal R4U. Moreover, as of November 2018 the postnatal R4U has been made available on a digitized promotional forum for PCHC organizations, where they can view and pilot possible digital instruments for their organization.

Strengths and limitations

When developing the risk assessment, we performed a literature search on the most recent published data on perinatal risk factors and their influence on growth and development of children. By doing so, we tried to gain knowledge on the background of the problem, as suggested by Moore et al [44]. This resulted in scientifically identified risk factors influencing child growth and development. Moore also underlines the importance of consulting important stakeholders, while developing a new intervention, through intervention coproduction [44]. In order to consider the point of view of professionals during the development and implementation of the postnatal R4U, we involved important stakeholders in Preventive Child Healthcare during the focus group interviews, which we consider a strength of this study. However, during this process, we did not consider the opinion of the parents, the clients of PCHC. We chose not to do so because our aim was to facilitate current care practices in PCHC and first target the attitude, intention and behavior of the caregivers. Nevertheless, in future research the opinion of parents concerning the offered care to their children should be considered.

Although many factors influencing the health and the wellbeing of children have been studied, research on the influence of non-medical risk factors on child development remains scarce. In this study, we tried to overcome this issue by consulting stakeholders in focus group discussions in addition to the literature review.

A postnatal risk assessment for child growth and development is probably most effective if corresponding care pathways direct to the appropriate care. These care pathways should be known to the professionals and time should be allocated to study them properly. In addition, the subsequent care offered should be accessible for parents and children. We aim to evaluate the accessibility to these care pathways, together with studying the predictive value of the postnatal R4U, in an implementation study.

CONCLUSIONS

In conclusion, we successfully designed a postnatal risk assessment, the postnatal R4U, and related care pathways using the Intervention Mapping process. Moreover, we were able to implement the postnatal R4U, which is currently being used and evaluated in four PCHC organizations. Future research will involve the evaluation of the assessment and will show whether such early risk identification and related care pathways may result in a decrease of growth and developmental problems in children.

Acknowledgements

We would like to thank all focus group participants for their contribution to this research project, Downsideup training company and Wichor Bramer for his assistance and guidance during the literature search. We would like to express special appreciation and thanks to all reviewers of the literature review: Gouke Bonsel, Celine van den Hazel, Jacqueline Lagendijk, Meertien K. Sijpkens and Ageeth. N. Schonewille-Rosman.

REFERENCES

1. de Waal CG, Weisglas-Kuperus N, van Goudoever JB, Walther FJ, NeoNed Study G, Group LNFS. Mortality, neonatal morbidity and two year follow-up of extremely preterm infants born in The Netherlands in 2007. PLoS One. 2012;7(7):e41302. PubMed PMID: 22911776.
2. Zeitlin J, Mohangoo AD, Delnord M, Cuttini M, Committee E-PS. The second European Perinatal Health Report: documenting changes over 6 years in the health of mothers and babies in Europe. J Epidemiol Community Health. 2013;67(12):983-5. PubMed PMID: 24052513.
3. Vos AA, Posthumus AG, Bonsel GJ, Steegers EA, Denktas S. Deprived neighborhoods and adverse perinatal outcome: a systematic review and meta-analysis. Acta Obstet Gynecol Scand. 2014;93(8):727-40. PubMed PMID: 24834960.
4. Blumenshine P, Egerter S, Barclay CJ, Cubbin C, Braveman PA. Socioeconomic disparities in adverse birth outcomes: a systematic review. Am J Prev Med. 2010;39(3):263-72. PubMed PMID: 20709259.
5. Metcalfe A, Lail P, Ghali WA, Sauve RS. The association between neighbourhoods and adverse birth outcomes: a systematic review and meta-analysis of multi-level studies. Paediatr Perinat Epidemiol. 2011;25(3):236-45. PubMed PMID: 21470263.
6. Posthumus AG, Birnie E, van Veen MJ, Steegers EA, Bonsel GJ. An antenatal prediction model for adverse birth outcomes in an urban population: The contribution of medical and non-medical risks. Midwifery. 2016;38:78-86. PubMed PMID: 26616215.
7. Kerstjens JM, de Winter AF, Sollie KM, Bocca-Tjeertes IF, Potijk MR, Reijneveld SA, et al. Maternal and pregnancy-related factors associated with developmental delay in moderately preterm-born children. Obstet Gynecol. 2013;121(4):727-33. PubMed PMID: 23635671.
8. Potijk MR, de Winter AF, Bos AF, Kerstjens JM, Reijneveld SA. Behavioural and emotional problems in moderately preterm children with low socioeconomic status: a population-based study. Eur Child Adolesc Psychiatry. 2015;24(7):787-95. PubMed PMID: 25293643.
9. Potijk MR, Kerstjens JM, Bos AF, Reijneveld SA, de Winter AF. Developmental delay in moderately preterm-born children with low socioeconomic status: risks multiply. J Pediatr. 2013;163(5):1289-95. PubMed PMID: 23968750.
10. Dua T, Tomlinson M, Tablante E, Britto P, Yousfzai A, Daelmans B, et al. Global research priorities to accelerate early child development in the sustainable development era. Lancet Glob Health. 2016. PubMed PMID: 27717631.
11. Heppe DH, Kiefte-de Jong JC, Durmus B, Moll HA, Raat H, Hofman A, et al. Parental, fetal, and infant risk factors for preschool overweight: the Generation R Study. Pediatr Res. 2013;73(1):120-7. PubMed PMID: 23138398.
12. Bradley RH, Corwyn RF. Socioeconomic status and child development. Annu Rev Psychol. 2002;53:371-99. PubMed PMID: 11752490.
13. Morandi A, Meyre D, Lobbens S, Kleinman K, Kaakinen M, Rifas-Shiman SL, et al. Estimation of newborn risk for child or adolescent obesity: lessons from longitudinal birth cohorts. PLoS One. 2012;7(11):e49919. PubMed PMID: 23209618.
14. Steegers-Theunissen RP, Steegers EA. Embryonic health: new insights, mHealth and personalised patient care. Reprod Fertil Dev. 2015;27(4):712-5. PubMed PMID: 25771352.
15. Scholte RS, van den Berg GJ, Lindeboom M. Long-run effects of gestation during the Dutch Hunger Winter famine on labor market and hospitalization outcomes. J Health Econ. 2015;39:17-30. PubMed PMID: 25461896.
16. Power C, Matthews S. Origins of health inequalities in a national population sample. Lancet. 1997;350(9091):1584-9. PubMed PMID: 9393337.

17. Pinto Pereira SM, van Veldhoven K, Li L, Power C. Combined early and adult life risk factor associations for mid-life obesity in a prospective birth cohort: assessing potential public health impact. BMJ Open. 2016;6(4):e011044. PubMed PMID: 27072572.
18. Wells NM, Evans GW, Beavis A, Ong AD. Early childhood poverty, cumulative risk exposure, and body mass index trajectories through young adulthood. Am J Public Health. 2010;100(12):2507-12. PubMed PMID: 20966374.
19. Waelput AJ. Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth. 2017;17(254).
20. Bartholomew Eldridge LK, Markham, C. M., Ruiter, R. A. C., Fernàndez, M. E., Kok, G., & Parcel, G. S., . Planning health promotion programs; an Intervention Mapping approach. 4th ed2016.
21. Garba RM, Gadanya MA. The role of intervention mapping in designing disease prevention interventions: A systematic review of the literature. PLoS One. 2017;12(3):e0174438. PubMed PMID: 28358821.
22. Taal HR, Vd Heijden AJ, Steegers EA, Hofman A, Jaddoe VW. Small and large size for gestational age at birth, infant growth, and childhood overweight. Obesity (Silver Spring). 2013;21(6):1261-8. PubMed PMID: 23666877.
23. Dunger DB, Ahmed ML, Ong KK. Early and late weight gain and the timing of puberty. Mol Cell Endocrinol. 2006;254-255:140-5. PubMed PMID: 16824679.
24. Zimmerman E. Do Infants Born Very Premature and Who Have Very Low Birth Weight Catch Up With Their Full Term Peers in Their Language Abilities by Early School Age? J Speech Lang Hear Res. 2018;61(1):53-65. PubMed PMID: 29255846.
25. Polk S, Thornton RJ, Caulfield L, Munoz A. Rapid infant weight gain and early childhood obesity in low-income Latinos and non-Latinos. Public Health Nutr. 2016;19(10):1777-84. PubMed PMID: 27231870.
26. Fishbein & Ajzen. Prediction and Change of Health Behavior: Applying the reasoned action approach2010.
27. H. de Vries EB, G. Kok, M. Dijkstra,. The impact of social influences in the context of attitude, self-efficacy, intention and previous behaviour as predictors of smoking onset. J Appl Soc Psychol, . 1995;25:237-57.
28. J. Brug LL, H. de Vries,. Psychosocial determinants of fruit and vegetable consumption. Appetite. 1995;25:285-96.
29. Organization. WH. Training course on child growth assessment. Module C: interpreting growth indicators. . Geneva, Switzerland.: Geneva, Switzerland: World Health Organization., 2008.
30. Wit JM, Boersma B. Catch-up growth: definition, mechanisms, and models. J Pediatr Endocrinol Metab. 2002;15 Suppl 5:1229-41. PubMed PMID: 12510974.
31. de Vries H, Dijkstra M, Kuhlman P. Self-efficacy: the third factor besides attitude and subjective norm as a predictor of behavioural intentions. Health Education Research. 1988;3(3):273-82.
32. Vos AA, van Veen MJ, Birnie E, Denktas S, Steegers EA, Bonsel GJ. An instrument for broadened risk assessment in antenatal health care including non-medical issues. Int J Integr Care. 2015;15:e002. PubMed PMID: 25780351.
33. Holmbeck GN, Devine KA. Editorial: an author's checklist for measure development and validation manuscripts. Journal of pediatric psychology. 2009;34(7):691-6. Epub 2009/05/31. doi: 10.1093/jpepsy/jsp046. PubMed PMID: 19487232.
34. cie-de Winter. Rapport: Een stevig fundament: evaluatie van het basistakenpakket JGZ. 2013.

35. van Veen MJ, Birnie E, Poeran J, Torij HW, Steegers EA, Bonsel GJ. Feasibility and reliability of a newly developed antenatal risk score card in routine care. Midwifery. 2015;31(1):147-54. PubMed PMID: 25194982.
36. van der Kooy J, Poeran J, de Graaf JP, Birnie E, Denktass S, Steegers EA, et al. Planned home compared with planned hospital births in the Netherlands: intrapartum and early neonatal death in low-risk pregnancies. Obstet Gynecol. 2011;118(5):1037-46. PubMed PMID: 22015871.
37. Razaz N, Boyce WT, Brownell M, Jutte D, Tremlett H, Marrie RA, et al. Five-minute Apgar score as a marker for developmental vulnerability at 5 years of age. Arch Dis Child Fetal Neonatal Ed. 2016;101(2):F114-20. PubMed PMID: 26187935.
38. Arpi E, Ferrari F. Preterm birth and behaviour problems in infants and preschool-age children: a review of the recent literature. Dev Med Child Neurol. 2013;55(9):788-96. PubMed PMID: 23521214.
39. Weigl M, Muller A, Paramythelli A, Angerer P, Petru R. Checklist for psychosocial risk evaluation: a prospective evaluation study. Occup Med (Lond). 2017;67(1):7-12. PubMed PMID: 27834226.
40. Schouten MC, van Stel HF, Verheij TJ, Houben ML, Russel IM, Nieuwenhuis EE, et al. The Value of a Checklist for Child Abuse in Out-of-Hours Primary Care: To Screen or Not to Screen. PLoS One. 2017;12(1):e0165641. PubMed PMID: 28045904.
41. Sittig JS, Uiterwaal CS, Moons KG, Nieuwenhuis EE, van de Putte EM. Child abuse inventory at emergency rooms: CHAIN-ER rationale and design. BMC Pediatr. 2011;11:91. PubMed PMID: 22008625.
42. Staal, II, van Stel HF, Hermanns JM, Schrijvers AJ. Early detection of parenting and developmental problems in toddlers: A randomized trial of home visits versus well-baby clinic visits in the Netherlands. Prev Med. 2015;81:236-42. PubMed PMID: 26375964.
43. van Stel HF, Staal, II, Hermanns JM, Schrijvers AJ. Validity and reliability of a structured interview for early detection and risk assessment of parenting and developmental problems in young children: a cross-sectional study. BMC Pediatr. 2012;12:71. PubMed PMID: 22697218.
44. Moore GF, Evans RE. What theory, for whom and in which context? Reflections on the application of theory in the development and evaluation of complex population health interventions. SSM - Population Health. 2017;3((Moore G.F., MooreG@cardiff.ac.uk; Evans R.E.) Centre for the Development and Evaluation of Complex Interventions for Public Health Improvement (DECIPHer), School of Social Sciences, Cardiff University, Wales, United Kingdom):132-5.

ADDENDUM

S1. Literature search

Embase.com 9106

('growth disorder'/de OR 'failure to thrive'/de OR 'growth retardation'/de OR 'postnatal growth'/exp OR 'postnatal development'/exp OR 'growth curve'/de OR 'short stature'/de OR stunting/de OR 'body height'/de OR 'body weight disorder'/de OR obesity/de OR 'childhood obesity'/de OR 'body mass'/de OR 'developmental disorder'/de OR 'psychomotor development'/de OR 'motor development'/de OR 'language development'/de OR 'developmental language disorder'/exp OR 'speech development'/de OR 'psychosocial development'/de OR 'child development'/de OR 'head circumference'/exp OR 'body composition'/exp OR development/de OR (((behav*) NEAR/3 (disorder* OR disturba* OR anomal* OR arrest* OR failure* OR retard* OR deficien* OR stunt* OR disabilit* OR abnormal* OR restrict* OR problem* OR outcome* OR impair*)) OR (failure* NEAR/3 thrive*) OR underdevelop* OR growth OR development* OR ((short* OR small) NEAR/3 stature*) OR stunting OR (body NEAR/3 (height* OR length* OR stature OR small OR weight OR mass* OR fat OR composition)) OR obes* OR overweight* OR adipos* OR bmi OR ((psychomot* OR motor* OR language* OR speech* OR psychosocial OR psycho-social OR psychologic*) NEAR/3 (develop* OR delay*)) OR ((development* OR growth) NEAR/3 delay*) OR neurodevelopment* OR ((child* OR infan*) NEAR/3 development*) OR (grow* NEAR/3 curve*) OR ((head OR cranial) NEAR/3 circumference)):ab,ti) AND ('newborn assessment'/de OR 'newborn screening'/de OR 'developmental screening'/exp OR 'risk factor'/de OR 'risk assessment'/exp OR 'high risk population'/de OR screening/de OR prediction/exp OR Prognosis/exp OR 'scoring system'/de OR 'rating scale'/de OR ((risk NEAR/3 (factor* OR high* OR assess*)) OR screen* OR predict* OR scoring OR rating OR scale*):ab,ti) AND ('newborn period'/de OR newborn/de OR 'perinatal period'/de OR 'puerperal disorder'/exp OR (baby OR babies OR newborn* OR neonat* OR (birth* NEAR/3 cohort*) OR postnatal* OR puerper* OR perinatal*):ab,ti) AND (infant/de OR infancy/de OR (infan* OR ((2 OR two OR 1 OR one OR first OR second) NEXT/2 year*)):ab,ti) AND ('cohort analysis'/exp OR 'longitudinal study'/exp OR 'retrospective study'/exp OR 'prospective study'/exp OR 'controlled study'/exp OR 'follow up'/exp OR (cohort* OR longitudinal* OR retrospectiv* OR prospectiv* OR control* OR trial* OR 'follow up'):ab,ti) AND [english]/lim NOT ([Conference Abstract]/lim OR [Letter]/lim OR [Note]/lim OR [Conference Paper]/lim OR [Editorial]/lim OR 'case report'/exp OR 'case report':ti) NOT ('congenital deafness'/de OR hearing/exp OR 'hearing disorder'/exp OR Africa/exp OR Asia/exp OR 'developing country'/exp OR (deaf* OR hearing* OR Africa OR Asia OR ((developing OR underdevelop*) NEAR/3 countr*)):ab,ti) NOT ([animals]/lim NOT [humans]/lim)

Medline (OvidSP) 7275

(Growth Disorders/ OR failure to thrive/ OR "Growth and Development"/ OR "Growth and Development".xs. OR Growth Charts/ OR Dwarfism/ OR body height/ OR obesity/ OR Pediatric Obesity/ OR Body Mass Index/ OR Developmental Disabilities/ OR Child Development/ OR language development/ OR Language Development Disorders/ OR exp body composition/ OR (((behav*) ADJ3 (disorder* OR disturba* OR anomal* OR arrest* OR failure* OR retard* OR deficien* OR stunt* OR disabilit* OR abnormal* OR restrict* OR problem* OR outcome* OR impair*)) OR (failure* ADJ3 thrive*) OR underdevelop* OR growth OR development* OR ((short* OR small) ADJ3 stature*) OR stunting OR (body ADJ3 (height* OR length* OR stature OR small OR weight OR mass* OR fat OR composition)) OR obes* OR overweight* OR adipos* OR bmi OR ((psychomot* OR motor* OR language* OR speech* OR psychosocial OR psycho-social OR psychologic*) ADJ3 (develop* OR delay*)) OR ((development* OR growth) ADJ3 delay*) OR neurodevelopment* OR ((child* OR infan*) ADJ3 development*) OR (grow* ADJ3 curve*) OR ((head OR cranial) ADJ3 circumference)).ab,ti.) AND (Neonatal Screening/ OR risk factors/ OR risk assessment/ OR prediction/ OR prognosis/ OR ((risk ADJ3 (factor* OR high* OR assess*)) OR screen* OR predict* OR scoring OR rating OR scale*).ab,ti.) AND (Puerperal Disorders/ OR (baby OR babies OR newborn* OR neonat* OR (birth* ADJ3 cohort*) OR postnatal* OR puerper* OR perinatal*).ab,ti.) AND (infant/ OR (infan* OR (("2" OR two OR "1" OR one OR first OR second) ADJ2 year*)).ab,ti.) AND (exp Cohort Studies/ OR exp Clinical Trial/ OR Follow-Up Studies/ OR (cohort* OR longitudinal* OR retrospectiv* OR prospectiv* OR control* OR trial* OR follow up).ab,ti.) AND english.la. NOT (letter OR news OR comment OR editorial OR congresses OR abstracts).pt. NOT (deafness/ OR exp hearing/ OR exp Hearing Disorders/ OR exp Africa/ OR exp Asia/ OR developing countries/ OR (deaf* OR hearing* OR Africa OR Asia OR ((developing OR underdevelop*) ADJ3 countr*)).ab,ti.) NOT (exp animals/ NOT humans/)

Psycinfo (OvidSP) 1480

(failure to thrive/ OR exp body height/ OR exp obesity/ OR Body Mass Index/ OR exp Developmental Disabilities/ OR exp Childhood Development/ OR exp Infant Development/ OR exp Cognitive Development/ OR exp language development/ OR (((behav*) ADJ3 (disorder* OR disturba* OR anomal* OR arrest* OR failure* OR retard* OR deficien* OR stunt* OR disabilit* OR abnormal* OR restrict* OR problem* OR outcome* OR impair*)) OR (failure* ADJ3 thrive*) OR underdevelop* OR growth OR development* OR ((short* OR small) ADJ3 stature*) OR stunting OR (body ADJ3 (height* OR length* OR stature OR small OR weight OR mass* OR fat OR composition)) OR obes* OR overweight* OR adipos* OR bmi OR ((psychomot* OR motor* OR language* OR speech* OR psychosocial OR psycho-social OR psychologic*) ADJ3 (develop* OR delay*)) OR ((development* OR growth) ADJ3 delay*) OR

neurodevelopment* OR ((child* OR infan*) ADJ3 development*) OR (grow* ADJ3 curve*) OR ((head OR cranial) ADJ3 circumference)).ab,ti.) AND (Screening/ OR exp risk factors/ OR risk assessment/ OR prediction/ OR prognosis/ OR ((risk ADJ3 (factor* OR high* OR assess*)) OR screen* OR predict* OR scoring OR rating OR scale*).ab,ti.) AND ((baby OR babies OR newborn* OR neonat* OR (birth* ADJ3 cohort*) OR postnatal* OR puerper* OR perinatal*).ab,ti.) AND (140.ag. OR (infan* OR (("2" OR two OR "1" OR one OR first OR second) ADJ2 year*)).ab,ti.) AND (exp Cohort Analysis/ OR exp Clinical Trials/ OR Followup Studies/ OR (cohort* OR longitudinal* OR retrospectiv* OR prospectiv* OR control* OR trial* OR follow up).ab,ti.) AND english.la. NOT (letter OR news OR comment OR editorial OR congresses OR abstracts).pt. NOT (deaf/ OR exp Hearing Disorders/ OR exp developing countries/ OR (deaf* OR hearing* OR Africa OR Asia OR ((developing OR underdevelop*) ADJ3 countr*)).ab,ti.) NOT (exp animals/ NOT humans/)

Cochrane 547

((((behav*) NEAR/3 (disorder* OR disturba* OR anomal* OR arrest* OR failure* OR retard* OR deficien* OR stunt* OR disabilit* OR abnormal* OR restrict* OR problem* OR outcome* OR impair*)) OR (failure* NEAR/3 thrive*) OR underdevelop* OR growth OR development* OR ((short* OR small) NEAR/3 stature*) OR stunting OR (body NEAR/3 (height* OR length* OR stature OR small OR weight OR mass* OR fat OR composition)) OR obes* OR overweight* OR adipos* OR bmi OR ((psychomot* OR motor* OR language* OR speech* OR psychosocial OR psycho-social OR psychologic*) NEAR/3 (develop* OR delay*)) OR ((development* OR growth) NEAR/3 delay*) OR neurodevelopment* OR ((child* OR infan*) NEAR/3 development*) OR (grow* NEAR/3 curve*) OR ((head OR cranial) NEAR/3 circumference)):ab,ti) AND (((risk NEAR/3 (factor* OR high* OR assess*)) OR screen* OR predict* OR scoring OR rating OR scale*):ab,ti) AND ((baby OR babies OR newborn* OR neonat* OR (birth* NEAR/3 cohort*) OR postnatal* OR puerper* OR perinatal*):ab,ti) AND ((infan* OR ((2 OR two OR 1 OR one OR first OR second) NEXT/2 year*)):ab,ti) AND ((cohort* OR longitudinal* OR retrospectiv* OR prospectiv* OR control* OR trial* OR 'follow up'):ab,ti)

S2. Supplementary tables

Table A. Selected articles from the original literature search

	Author	Year of publication	Risk factor	Associated with
1	Alvik (1)	2014	Maternal depression, smoking	Development
2	Arpi (2)	2014	Prematurity	Development
3	Baptiste-Roberts (3)	2011	Gestational diabetes	Growth
4	Beaino (4)	2011	Prematurity	Development
5	Birbilis (5)	2013	Maternal obesity, smoking	Growth
6	Blustein (6)	2013	Maternal overweight	Growth
7	Cents (7)	2013	Maternal depression	Development
8	Conroy (8)	2012	Personality disorder, postnatal depression	Development
9	De Hoog (9)	2011	Gestational diabetes, ethnicity, (low) SES, LGA, maternal overweight, smoking	Growth
10	Deave (10)	2008	Maternal depression	Development
11	Durmus (11)	2011	Formula feeding	Catch-up growth
12	El Marroun (12)	2011	Cannabis, prematurity, smoking.	Development
13	El Marroun (13)	2014	Maternal depression	Development
14	Figueras (14)	2009	SGA	Development
15	Flores (15)	2013	Gestational diabetes, maternal overweight	Growth
16	Gaillard (16)	2013	Excessive maternal weight gain during pregnancy, maternal overweight, maternal underweight	Growth
17	Gao (17)	2007	Maternal psychological disorder, smoking	Development
18	Gibbs (18)	2014	Formula feeding	Growth
19	Gillman (19)	2008	Maternal overweight	Growth
20	Gutteling (20)	2005	Smoking	Development
21	Helderman (21)	2012	Prematurity, ethnicity, maternal overweight	Development
22	Henrichs (22)	2012	Hypothyroid	Development
23	Heppe (23)	2013	Maternal overweight, paternal overweight	Growth
24	Hinkle (24)	2012	Maternal overweight, maternal underweight	Growth
25	Hummel (25)	2009	Diabetes, LGA	Growth
26	Ino (26)	2010	Smoking	Growth

Table A. Selected articles from the original literature search (*continued*)

	Author	Year of publication	Risk factor	Associated with
27	Jedrychowski (27)	2011	Maternal excessive weight gain in pregnancy, maternal overweight	Growth
28	Jordan (28)	2005	SGA	Catch-up growth
29	Kakinami (29)	2014	Low SES	Growth
30	Karaolis-Danckert (30)	2008	Formula feeding	Growth
31	Kerstjens (31)	2012 (August)	Prematurity, SGA	Development
32	Kerstjens (32)	2013	Prematurity, maternal overweight	Development
33	Kerstjens (33)	2012 (December)	Prematurity	Development
34	Kiechl-Kohlendorfer (34)	2010	Prematurity, smoking	Development
35	Knudsen (35)	2014	Alcohol	Development
36	Koutra (36)	2013	Maternal depression, postnatal depression	Development
37	Lewis (37)	2011	Cocaine	Development
38	Li (38)	2007	LGA, maternal overweight	Growth
39	Moller (39)	2014	Excessive maternal weight gain during pregnancy, maternal overweight, smoking	
40	Morinis (40)	2013	Teen mom	Development
41	Noten (41)	2015	Hypothyroid	Development
42	Odd (42)	2013	Prematurity	Development
43	Oddy (43)	2010	Formula feeding, Depression, smoking	Development
44	Oken (44)	2005	Smoking	Growth
45	Pan (45)	2013	Low SES, ethnicity	Growth
46	Peralta-Carcelen (46)	2013	SGA, low SES	Development
47	Pham (47)	2013	LGA, maternal overweight	Growth
48	Power (48)	2010	Smoking	Growth
49	Reeske (49)	2013	Ethnicity, smoking	Catch-up growth
50	Rijlaarsdam (50)	2013	Ethnicity, low SES	Development
51	Robinson (51)	2013	Prematurity	Development
52	Roza (52)	2009	Ethnicity, low SES, smoking	Development
53	Salsberry (53)	2005	Maternal overweight, smoking, prematurity	Growth
54	Samra (54)	2011	Prematurity	Development

Table A. Selected articles from the original literature search (*continued*)

	Author	Year of publication	Risk factor	Associated with
55	Schjolberg (55)	2011	SGA, ethnicity, low Apgar score, low SES, prematurity, non-native speaking parents	Development
56	Skurtveit (56)	2014	Maternal depression, SSRI medication	Development
57	Talge (57)	2010	Prematurity	Development
58	Timmermans (58)	2014	Smoking	Growth, catch-up growth
59	Tong (59)	2006	SGA	Development
60	Twells (60)	2010	Formula feeding	Growth
61	Van Rossem (61)	2014	Ethnicity	Growth
62	Veiby (62)	2013	Antiepileptic medication	Development
63	Weden (63)	2012	Low SES	Growth
64	Wen (64)	2014	Maternal overweight	Growth
65	Weng (65)	2012	Formula feeding, smoking	Growth
66	Weyerman (66)	2006	Formula feeding	Growth
67	Xiong (67)	2006	SGA, LGA	Catch-up growth
68	Zhu (68)	2012	Prematurity	Development
69	Zwicker (69)	2013	SGA	Development

Table B. Selected articles from the additional literature search

	Author	Year of publication	Risk factor	Associated with
1.	Bilic-Kirin (70)	2014	Socioeconomic status, maternal unemployment	Growth
2.	Bradley (71)	2002	Socioeconomic status, single parent, family conflict	Development
3.	Crockenberg (72)	1981	Lack of social support	Development
4.	Gilbert (73)	2013	Home violence	Development
5.	Stewart (74)	2012	Maternal unemployment	Growth
6.	Yeung (75)	2002	Financial problems	Development
7.	Gershoff (76)	2007	Financial problems, unsafe home environment, no insurance	Development
8.	Masten (77)	1993	Being homeless/unsafe home environment	Development
9.	Van der Heide (78)	2010	Single parent	Development

Table C. Quotes from focusgroup participants on the development of the postnatal R4U

1. Implementation of the assessment:
   a. A consultation has an added value over questionnaires because of its possibility to explain the content.
   b. Privacy should be taken into account.
   c. There seems to be a trend of parents who are reluctant to share their data with PCHC, possibly because they don't want their vulnarabilty to become public.
   d. Not all parents know which diagnostic tests are done to their child in the hospital.
   e. PCHC organizations have different definitions of prematurity and the care for premature born children is differently organized.
   f. A postnatal home consultation takes place with every child, as well after discharge from the hospital
   g. There are important risk factors which are not part of the basic dataset. These could be analyzed with the postnatal R4U.
   h. I suggest to take the experience of the parent into account as well.
   i. I see a possibility for the postnatal home visit to ask for informed consent and ask some additional questions.
   j. I would assess which regular consultations are similar in different PCHC locations/municipalities. This can vary widely.
   k. I would take already developed protocols and guidelines into account.
   l. Parents become increasingly critical when it comes to saving data at governmental institutions. Some parents object to creating a digital patient file at the PCHC.
   m. Training in motivational speaking could aid nurses to be more confident in counseling for the research project.
   n. Parents sometimes don't understand the patient information leaflet.
   o. An inclusion fee could be risky. You can put a lot of effort in including patients, but still don't reach the predefined limit.
   p. I would suggest to ask parents what they need, this is included in other questionnaires as well.
   q. There is a lot of ambiguity when it comes to parents with a low IQ. How do you assess it and what can you do about it?
   r. The same accounts for illiteracy.
2. Growth:
   a. Disharmonic growth is the most dangerous kind, especially in the first three months of life.
   b. Catch-up growth is a difficult definition and not easy to measure. The literature is not ambiguous.
   c. The measurement of height with young children is subject to bias, due to intra-observer and inter-observer variation.
   d. I suggest to add the head circumference in the research project.
3. Development:
   a. There is a big difference in language development disorder and lack of stimulation.
   b. I suggest to consider questionnaires such as the ASQ or CBCL in the research project, to measure development.
   c. Language or speech developmental delay can in reality be detected starting with the age of 2 years old.

Table C. Quotes from focusgroup participants on the development of the postnatal R4U (*continued*)

4. Social risk factors:
   a. Considering maternal high workload, you could look at mothers who work in shifts.
   b. In research little associations are found considering high workload and being a single parent.
   c. On the contrary, more associations are found in height of the father, parity and the age of the mother.
   d. Family income and paternal income are very defining for the health of the child.
   e. Level of education should be considered as a risk factor.
   f. Work status and unemployment are very important risk factors and are related with low socio economic status.
   g. You could design a scale model for socioeconomic status and combine multiple factors.
   h. Low income, below 1000 euros a month should be considered in the assessment as well.
   i. Teen pregnancies are a huge risk.
   j. Age of the mother should be considered above the age of 40.
   k. There is a big ethnic diversity in the Netherlands.
   l. Considering ethnicity you should well define what you are going to measure.
   m. Humidity and fungus are probably more related to low socio economic status.
   n. If possible, you could consider air pollution as a risk factor.
   o. Child marriages and arranged marriages impose a risk.
   p. I would consult the foundation on reading and writing when it comes to risk factors concerning speech and language development.
   q. Stress doesn't have to be the same thing as experiencing a high workload.
   r. Stress is a difficult definition to grasp.
   s. In high SES there is more alcohol abuse.
   t. High SES comes with high pressure to perform well and parents often don't adjust their lifestyle when children come into the family.
   u. My experience in practice is that high SES children are frequently restless.
   v. Excessive crying in babies is more frequently seen in high SES families.
   w. Low SES children respond more calmly.
   x. Low SES families have a larger network in their close vicinity.
   y. Postal code is not the most reliable item to assess SES with.
   z. There is a big difference in first and third generation immigrants.
   aa. Having a large social network is an important protecting factor.
   bb. The quality of the social network is also important. Two people could be of better support than ten other people.
   cc. You could ask the parent what kind of childhood they had themselves, did they get the right example of their parents? There is a lot of evidence about the wrong example from parents and risks for the child.
   dd. Multilingualism could be a protecting factor as well as a risk factor. For gifted children it could be an advantage, for others it could decrease development.
   ee. Children who speak their parents native language well but don't speak Dutch very well (yet), do not have impaired development.

Table C. Quotes from focusgroup participants on the development of the postnatal R4U (*continued*)

5. Lifestyle:
   a. In some research they find a positive association with alcohol, because of the confounding effect with a high socio economic status.
   b. The problem with alcohol is that there is no safe detectable bottom-limit.
   c. People who smoke incidentally, usually don't smoke during pregnancy.
   d. Drug use during pregnancy obviously has a negative effect on the child.
   e. It seems better not to separate the use of soft drugs and hard drugs, since cannabis abuse shows evident effects.
   f. For the development of a risk score is seems better to take all drugs together.
   g. Gambling addiction is a risk factor as well.
   h. With a large amount of animals in the household, there is bad hygiene and less finances for basic life support.
   i. In PCHC, BMI of the mother is not asked during a consultation, only the height of the mother is discussed.
   j. Weight is a painful question, it should be available from the handover from the midwife.
   k. Lifestyle includes: are you able to implement structure and regularity into your daily rhythm? That's an important factor on how things are organized at home. This could influence your adult life.
   l. The previous mentioned could be difficult to assess within 6 weeks postnatally. Parents are often searching for structure in their new life until then.
   m. The amount of people in an household could be a risk factor. For example, three families in one house. A too small living environment. This could show during a home visit by the PCHC nurse.
   n. Could music be a protective factor?

6. Medical:
   a. Opiates are considered to have a negative effect on child's health.
   b. Most research on the use of antidepressants in pregnancy show (almost) no association with a child's development.
   c. An embryo is dependent on the thyroid hormone of the mother. The pituitary gland starts being active around 20 weeks of gestation.
   d. The influence of depression and psychiatric diseases on the child seems to be transgenerational and possibly epigenetic. Not only is there a relationship between mother and child, but also a relationship between father and child and a relationship between previous generation and the child.
   e. The influence of depression could also have a causally related. It could have added to insufficient parenting techniques in several generations.
   f. Ace inhibitors are known to influence the development of the kidneys, not the development of the brain.
   g. I would suggest to combine all eating disorders, for the risk assessment.
   h. There is an increasing prevalence of women who underwent bariatric surgery before pregnancy. Their children have an increased risk of malnutrition as well as overfeeding. For now, this group is small.
   i. Children from mothers with diabetes gravidarum are born with a bonus for height and weight, and take it with them in the upcoming years. They remain to grow parallel on the top of the growth curve.
   j. Deaf or hearing impaired parents, seems to influence speech and language development of the child.
   k. Severely ill father or mother and the other parent becomes caregiver, hence the child receives less attention or could become a primary caregiver as well.
   l. Dyslexia in parents could influence speech and language development of the child.

Table C. Quotes from focusgroup participants on the development of the postnatal R4U (*continued*)

7. Obstetrical:
   a. I suggest to choose between formula feeding as a risk factor or breastfeeding as a protecting factor, not both.
   b. First born children are often born a bit smaller, so they show more catch-up growth.
   c. The second, third etc children are born a bit more heavier.
   d. Catch-up growth depends on the gestational age at birth. If you're born closer to 40 weeks of gestation, the smaller the chance for catch-up growth.
   e. Reproductive assisted technology seems to be associated with developmental problems, there should be evidence in scientific literature.
   f. I suggest to consider the Institute of Medicine criteria for gestational weight gain on the weight gain in pregnancy. This depends on the weight before pregnancy.
   g. I suggest to make clear definitions for small for gestational age, prematurity and low Apgar score.
   h. I suggest make categories of prematurity: extreme premature under 27 weeks of gestation, premature in two categories from 27 weeks until 32 weeks and 32 weeks until 34 weeks, late premature from 34 weeks until 37 weeks of gestation.
   i. Late premature born children and children who are born at 37 until 38 weeks of gestation are an interesting group which could well identified in PCHC.
   j. Asphyxia is an important factor for later outcome in post term birth (above 42 weeks of gestation).
   k. Hypoglycemia in premature born children is an important factor in later outcome.
   l. De health outcomes for children born with congenital anomalies seems to be associated with the severity of the anomaly and the necessary medical care.
   m. Caesarean sections seems to be associated with the risk of childhood obesity.
   n. Breech position might be associated with low thyroid function of the mother. The baby does not think of turning upside down.
   o. Formula feeding might be only a risk factor in combination with other risk factors for obesity?
   p. Other risk factors could be pre-eclampsia and HELLP syndrome.
   q. Could a traumatic delivery be a risk factor?
   r. Mothers of premature born children are often better motivated to breastfeed.
   s. Mother-child bonding is difficult to measure in PCHC, especially until six weeks postnatally.
   t. Is there research done to compare term born LGA children with premature born LGA children?
   u. An infection during delivery and after birth can influence the development of the child. Especially in children who had meningitis.
   v. Children who were born after prematurely ruptured membranes re admitted longer at the NICU, which increases the chance of developmental problems.
   w. I would suggest to balance protective factors against risk factors. In PCHC practice there is more focus on positive factors.
   x. In the PCHC digital file there is an item called: "what kind of child is this?"

Table D. Quotes from focus group participants on the development of the care pathways

1.	Care pathways:
	a. The most important thing is to have a good overview of the community (care) resources.
	b. Social work could assist in creating the overview of the community (care) resources.
	c. When developing care pathways I would suggest to also use national and organizational guidelines regarding that subject.
	d. In a care pathway it is important to add the appointment of a case manager.
	e. PCHC seems more appropriate as case manager because maternity care has a short care agreement with the family.
	f. Maternity care could provide important information because they're primary working in the household.
	g. There seem to be a lot organizations who work separately and are not informed about the others existence.
2.	Psychosocial:
	a. A care pathway for illegal persons seems of more value than a care pathway on people who don't have insurance.
	b. Often there are more problems than one, when someone has financial issues they often have housing problems, for example.
	c. A lot of different social care pathways seems redundant, because you would like to connect them all to each other.
	d. It's starting to become common practice to have multidisciplinary consultations together with the parents of the child.
3.	Growth problems:
	a. I would suggest to start a care pathway in case of BMI of the mother is above 30, not above 25. Otherwise you would create a very large target population for the care pathway. This is not feasible.
	b. In this care pathway I would also add children who are born small for gestational age (SGA). These children often develop long-term complications because of overweight.
	c. In this care pathway parental factors are important as well.
	d. I would suggest to also focus on children who show catch-up growth after birth.
4.	Smoking/alcohol/drugs:
	a. Smoking in the environment of the child is also an important risk factors, but maybe a bit more difficult to find out.
	b. The use of drugs by one or both parents should justify a report to child welfare services.
	c. In case of drug abuse and/or contact with child welfare services you could add in the care pathway: 'action taken during pregnancy?'. In case of no action or care during pregnancy, action postnatally could be indicated.
	d. In case of substance abuse, there is an indication for an addiction program.
	e. In case of parental smoking, the risk of obesity of the child should be taken into account.
5.	(Chronical) illness of a parent:
	a. Hypothyroid disease of the mother during pregnancy is difficult to find out for PCHC professionals.
	b. Chronical illness of a parent could result in less attention to the child. It doesn't matter which disease, the burden for the family is the most important aspect.
	c. In case of chronical illness the family composition and care for the children are the most important aspects.
	d. It is important to have a good overview of what care arrangements are already taken.
6.	Psychiatry:
	a. For psychiatric disease of the parent I would suggest to design a separate care pathway.
	b. I would suggest to use the Edinburgh Postnatal Depression Scale in this care pathway. And possibly combine this with 'excessive crying'.
	c. An excessive crying baby is an indication to watch out for depression in the mother.

Table D. Quotes from focus group participants on the development of the care pathways (*continued*)

7.	Congenital anomalies:
	a. I would definitely add congenital anomalies to the intervention concerning the impact on parents and the family.
	b. One visible anomaly is an indication to perform additional research for more anomalies.
	c. Congenital anomalies could predict future developmental problems.
	d. You could add the postnatal screening protocol to the intervention.
8.	Prematurity and small for gestational age:
	a. I would suggest to involve regional aftercare facilities (in which PCHC collaborates with pediatric care) during the development of the care pathway.
9.	Developmental problems:
	a. In care pathways one could direct to developmental protocols, guidelines or questionnaires.

S3. Care pathways

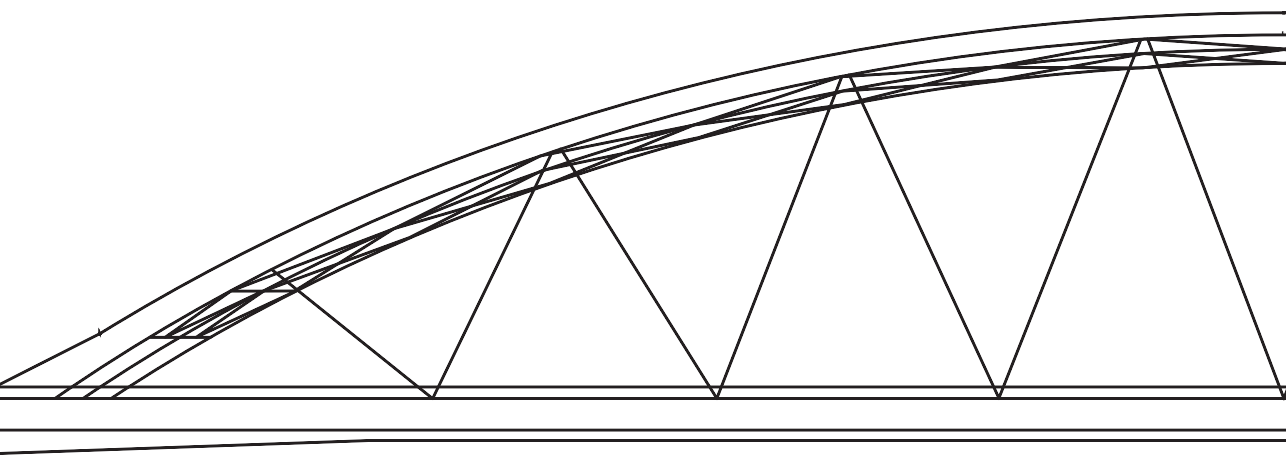
Chapter 6 Supplementary file 1.

S4. Question route focus groups

(not published in this thesis)

S5. PRISMA 2005 checklist

(not published in this thesis)



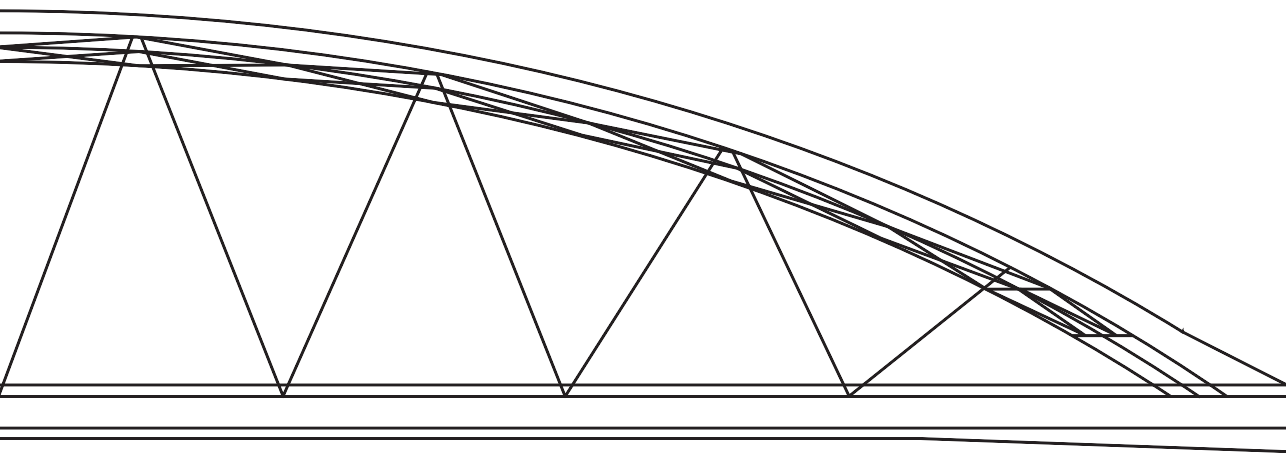
Chapter 6

Innovative postnatal risk assessment in Preventive Child Healthcare: a study protocol

M.R.C van Minde
M. Remmerswaal
H. Raat
E.A.P. Steegers
M.L.A. de Kroon

Journal of Advanced Nursing

https://doi.org/10.1111/jan.14547



ABSTRACT

Aim

To introduce the rationale and design of a postnatal risk assessment study, which will be embedded within Preventive Child Healthcare. This study will evaluate (1) the predictive value of an innovative postnatal risk assessment, meant to assess the risk of growth and developmental problems in young children, and (2) its effectiveness in combination with tailored care pathways.

Design

This study concerns a historically controlled study design and is designed as part of the Healthy Pregnancy 4 All-2 program. We hypothesize that child growth and developmental problems will be reduced in the intervention cohort due to the postnatal R4U risk assessment and corresponding care pathways.

Methods

The study was approved in August 2016. Children and their parents, visiting well-baby clinics during regular visits, will participate in the intervention (n = 2,650). Additional data of a historical control group (n = 2,650) in the same neighbourhoods will be collected. The intervention, consisting of the risk assessment and its corresponding care pathways, will be executed in the period between birth and two months of (corrected) age. The risk assessment is based on perinatal, medical and non-medical, risk factors. The predictive value of the risk assessment and its effectiveness in combination with its corresponding care pathways will be assessed by Preventive Child Healthcare nurses and physicians in four Preventive Child Healthcare organisations in three municipalities with adverse perinatal outcomes. A total risk score above a predefined threshold, which is based on a weighted risk score, determines structured multidisciplinary consultation.

Discussion

The successful implementation of this innovative postnatal risk assessment including corresponding care pathways has potential for further integration of risk assessment and a family centred approach in the work process of Preventive Child Healthcare nurses and physicians.

Impact

This study introduces a systematic approach within postnatal healthcare which may improve growth and developmental outcomes of children and even future generations.

Trial registration

This study is registered at the Open Science Framework: Minde, Minke R van. 2020. "Innovative Postnatal Risk Assessment in Preventive Child Healthcare, the Healthy Pregnancy 4 All-2 Program." OSF. June 29. osf.io/3q26k.

INTRODUCTION

Prenatal, perinatal and neonatal health influence a child's growth and development and their well-being until adulthood (Barker 2007). Health problems such as obesity, diabetes, coronary heart disease and psychological disorders may partly originate during embryonic and foetal development (Barker 2007, Heindel and Vandenberg 2015, Calkins and Devaskar 2011, Gillman 2015). Vulnerable women (Grabovschi et al. 2013) have an increased risk of preterm delivery, a child who is born small for gestational age (SGA), has congenital anomalies or is born with a low Apgar score (<7 after 5 minutes). These four adverse pregnancy outcomes are also called the Big4 (Bonsel and Steegers 2011). The Big4 outcomes account for 85% of perinatal death and are related to growth and developmental problems in children in The Netherlands (Vos et al. 2016). These children are more likely to grow up in poverty or experience child abuse, which may have an impact on their cognitive, psychosocial and/or physical development (Gilbert et al. 2009, Gilbert et al. 2013, Gershoff et al. 2007, Yeung et al. 2002). In addition, the burden of disease for Big4 survivors is high, often due to complications in their growth and development (Vos et al. 2014, Scholmerich et al. 2014, Poeran et al. 2013).

Background

The Dutch child healthcare system is unique in its design and approach. In the Netherlands, preventive and curative medicine have separate care systems. For children aged 0 to 4 years Preventive Medicine or Preventive Child Healthcare (PCHC) is delivered by well-baby clinics. At fixed ages infants and children are offered check-ups to assess health, growth and development; this is a national program imposed by the government free of charge. The attendance rate is approximately 95%. At every check-up, weight and length/height are measured and plotted in growth charts (Talma H 2010). Development of a child is recorded using the "Van Wiechen" developmental test (VWDT) (Laurent de Angulo M.S. 2015).

In Dutch PCHC, risk selection of children with increased risk of growth and developmental problems (such as the increased risk in preterm born children) and early detection of problems (for example psychosocial problems) are supported by guidelines and the use of measuring instruments. PCHC professionals use growth charts, which have been developed for different ethnicities living in the Netherlands (van Buuren 2014, van Dommelen and van Buuren 2014, Schonbeck et al. 2011, Schonbeck et al. 2015) and other instruments, such as (validated) questionnaires. These instruments are incorporated in guidelines, which are developed under the responsibility of the Dutch Centre for Child Healthcare (NCJ).

Table 1 highlights in short HP4All-1 and the antenatal R4U. HP4All-2 focuses on preconception, antenatal and postnatal risk assessment in combination with tailored care pathways by maternity care and PCHC. Consequently, this program consists of three studies concerning

interconception care, maternity care and risk assessment in PCHC organizations. This paper focuses on the latter.

Table 1.
Healthy Pregnancy 4 All and the antenatal R4U

The risk of Big4 outcomes and adverse perinatal health is high, especially in socially deprived neighbourhoods [Vos at el., Acta Obset Gynecol Scand, 2014; Poeran et al., J Matern Fetal Neonat Med, 2011]. Therefore, Dutch municipalities and health scientists of the Erasmus Medical Centre initiated the Healthy Pregnancy 4 All (HP4All) program in 2011 [Vos et al., Acta Obset Gynecol Scand, 2014; Denktas et al., Maten Child Health J, 2012]. A scorecard-based risk screening, the antenatal Rotterdam Reproductive Risk Reduction checklist (antenatal R4U) has been implemented in antenatal healthcare. Corresponding care pathways were developed and piloted [Van Veen et al., Midwifery, 2015]. These experiences were used to further improve and implement these tools in other municipalities with high perinatal mortality and morbidity. The sequel of the HP4All program is the HP4All-2 program, with the aim to endorse and facilitate continuous care for families at risk after birth [Waelput et al., BMC Pregnancy & Childbirth, 2017].

Aim

We aim to describe the rationale and design of a postnatal risk selection study, which is embedded within PCHC. This study is designed to evaluate (1) the predictive value of the innovative postnatal R4U, meant to assess the risk of growth and developmental problems in early life, and (2) its effectiveness in combination with tailored care pathways.

METHODS

Design

In this study we aim to use a historically controlled study design, in which the outcomes in the intervention cohort will be evaluated and compared to the outcomes of a historical cohort in the same four digit postal code areas. The historical control group will consist of children who visited the participating PCHC organization prior to the study and were of the same age as the intervention cohort at time of growth and developmental assessments. The intervention and control group will be matched for heritage and the four digit postal code area of their neighbourhood, to make sure that individual differences within the two groups cannot confound the results. We presume that the above mentioned variables correlate highly with our outcomes: a child's ethnicity influences its growth and development (Rijlaarsdam et al. 2013, Reeske et al. 2013), and environmental inequalities such as socio-economic status (Marmot 2005) and neighbourhood deprivation affect health (Rajaratnam et al. 2006). We chose to define neighbourhoods by the four digit postal code area. Growth and development will be assessed at the PCHC during regular scheduled consultations in a certain timeframe. Gender-adjustment will be applied during the time of analysis. Figure 1. represents an overview of the study design.

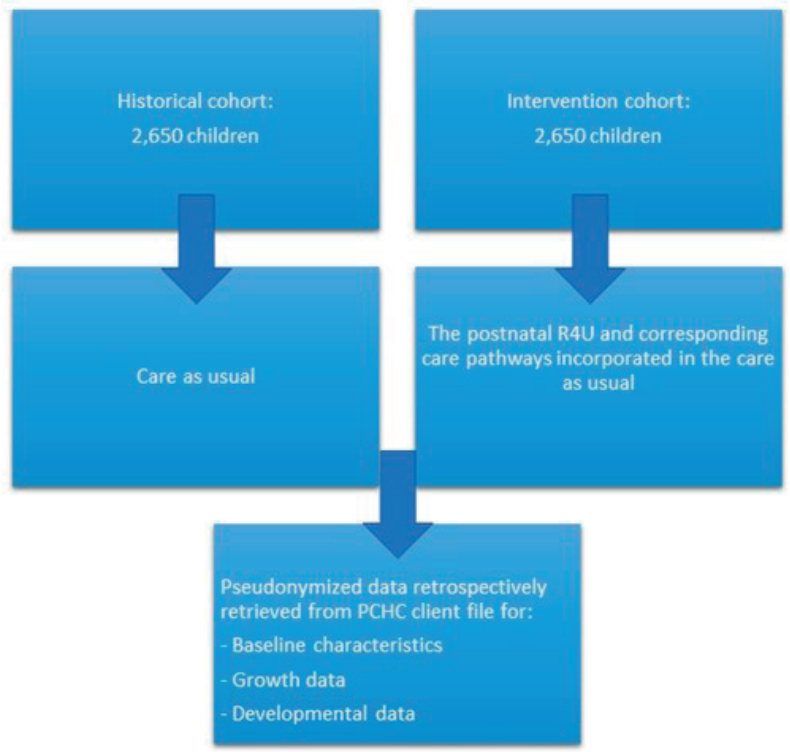


Figure 1. Study design

Sample/participants

The study will be executed in three municipalities in the Netherlands; Amsterdam, Rotterdam and Dordrecht. All three are included in the ranking of high perinatal mortality, high prematurity and high SGA rates and high frequencies of children living in deprivation (Waelput 2017). All new-borns in these municipalities, aged zero to eight weeks of age, will be eligible for inclusion in this study, during a maximum of 18 months. For children born preterm, their corrected age will be used (Lems et al. 1993). In Table 2. the study is presented according to the TIDieR checklist.

Outcomes

Primary outcomes

The primary outcomes will be overweight (>1 standard deviation score (SDS) for length) or obesity (>2 SDS for length), catch-up growth (change in length/weight > 0,67 SDS) in the first six months of life (Schonbeck et al. 2011), and developmental problems (based on the D-score of the VWDT, reflecting an overall assessment of motor, cognitive, psychosocial and language problems in total) (Jacobusse et al. 2006, Jacobusse G.W. 2008).

Table 2. Items included in the Template for Intervention Description and Replication (TIDieR) checklist

Item		Description
1.	Brief name	An innovative postnatal risk assessment study.
2.	Rationale/theory/goal	This study is designed to evaluate (1) the predictive value of the innovative postnatal R4U, meant to assess the risk of growth and developmental problems in early life, and (2) its effectiveness in combination with tailored care pathways.
3.	Materials	- Posters for the well-baby clinics to inform parents about the study - Flyers for the well-baby clinics to inform parents about the study. - Educational booklet for the PCHC nurses and physicians about the background of the risk factors assessed and effective communication skills. - Educational pocketbook with a summary of all risk factors included in the postnatal R4U. - The postnatal R4U risk assessment embedded in the PCHC digital file
4.	Procedures	- A pre-training will be delivered by a professional training company for PCHC nurses and physicians on the background of the study and effective communication skills. - Regular well-baby clinic visits by one of the researchers to offer support, assess the progress and answer questions.
5.	Intervention provider	The intervention will be provided by PCHC nurses and PCHC physicians who deliver care as usual. If applicable (in case of a care pathway or multidisciplinary consultation) they will refer to other healthcare providers such as social workers, physiotherapists, dieticians who will also deliver care as usual.
6.	Modes of delivery	The postnatal R4U will be assessed face to face by PCHC nurses and physicians during care as usual.
7.	Types of location	The postnatal R4U will be assessed at the parents' home during the regular PCHC home visit or during regular well-baby clinic consultations.
8.	Delivery of the intervention	We aim to include 3,120 children.

Secondary outcomes

Secondary outcomes will be the use of the 'postnatal R4U scorecard' and the referral to care pathways by the PCHC nurses and physicians and their knowledge, attitude and intention after implementation.

Independent variables

Independent variables are the intervention itself (including the assessment of risk factors in six domains: social, ethnic, healthcare, lifestyle, general medical and obstetric) and several other covariates, collected from the digital patient files including ethnicity, gender, age of the child in days, age of the parent(s) in years, the four digit postal code area and weight and height of the mother.

Data collection

Data will be collected during the first home visit by the PCHC nurse and regular visits to the participating well-baby clinics starting at the age of two or three weeks until the age of 18 months. No additional visits to the PCHC will be necessary or planned for this study. An

opt-out methodology will be applied (Vellinga et al. 2011); all new-borns will be included unless parents object to the use of their data for anonymous scientific research. We will be able to use this methodology because the study uses data which is already being recorded in the digital patient files by the PCHC nurses and physicians when they will provide care as usual.

Intervention

The intervention will consist of the assessment of the risk of future growth and developmental problems by the postnatal R4U in combination with corresponding care pathways (if applicable), delivered during care as usual. The development of the 41 item postnatal R4U scorecard resembled the development of the antenatal R4U (Vos et al. 2015). Whereas the antenatal R4U is applied during the first trimester of pregnancy, the postnatal R4U will be applied during the first eight weeks of life. In case of preterm birth, the postnatal R4U can be applied until the corrected age of eight weeks (Lems et al. 1993). It focuses on risk factors associated with growth and developmental problems, based on reviewed literature and focus group discussions with healthcare nurses, physicians and researchers. These risk factors originate from both medical and non-medical domains. The design of the postnatal R4U has been published in more detail, separately (van Minde et al. 2019). The postnatal R4U will be integrated in the digital PCHC patient files, automatically transferring data of relevant risk to the postnatal R4U (van Minde et al. 2019). Figure 2 presents the previously developed postnatal R4U.

Tailored care pathways will be developed in collaboration with PCHC organisations, municipalities and other care providers in the participating neighbourhoods, such as social services. Every care pathway will be developed to reflect the actual situation in a participating neighbourhood. PCHC nurses and physicians will have a single overview of the care available for their clients in their neighbourhood. Care pathways are related to psychosocial problems, financial problems, smoking, substance abuse, weight, chronical illness, psychiatry, preterm birth/SGA and congenital anomalies (van Minde et al. 2019). Examples of care pathways that will be designed can be found in Supplement 1.

Statistics

Power calculation and sample size

Power calculation took place in June and July 2015 by an independent statistician who was not involved in executing the study. Calculation was based on the prevalence of catch-up growth in the Netherlands, defined as a change in height standard deviation scores of >0.67 standard deviation (SD) from birth to 6 months of age (Taal et al. 2013), and the D score derived from the Van Wiechen developmental research. (Laurent de Angulo M.S. 2015) The prevalence of catch-up growth in the Netherlands was estimated at 20% on the basis of analyses of Generation R cohort data (Taal et al. 2013). The VWDT is a 75 item survey on motor, speech/language,

psychosocial and cognitive domains. The D-score is a summary of the development of a child at a certain age point, which is a summarizing objective measure of the VWDT (Jacobusse et al. 2006). The average outcome of the D-score and the standard deviation score (SDS) at the age of 6 months is 35.5 with a SDS of 2.93 (E. Dusseldorp et al. 2011).

We hypothesize that growth and developmental problems will be reduced in the intervention cohort due to the postnatal R4U risk assessment and corresponding care pathways. For catch-up growth we assumed a relevant decrease in the intervention group from 20 to 17% and for development a relevant increase of the D-score of 0.41 points at the age of 6 months. Aiming at a power of 80% and an alpha of 0,05 both outcomes warrant 2,650 children in both the intervention group and the historical control group until the end of the follow-up period. Considering a loss to follow up of 15% of the children, 3,120 children should be included at starting point.

Statistical analysis

Data will be collected anonymously using pseudonyms instead of PCHC client numbers. Hence, data will be analysed anonymously. To guarantee anonymity of the PCHC organisations, we will not analyse the data on PCHC organisational level. Study participants, municipalities or PCHC organisations will not be traceable.

The effectiveness of the postnatal R4U, corresponding care pathways and multidisciplinary consultation versus the conventional care as usual in PCHC will be assessed by using univariable and multivariable linear and logistic regression analysis with random effects. Results will be presented as effect estimates or odds ratio's with a measure of precision (95% confidence interval). Backward logistic regression analysis and ROC analysis will be used for prediction modelling; the prediction models will be internally validated by bootstrapping.

Rigour

Several actions will be taken to ensure rigour in quantitative data collection and analysis. The data collected will be protected and stored according to Dutch law (College Bescherming Persoonsgegevens 2013, translation: Data Protection Board). Data will be retrieved from the digital files of the PCHC organisations and will be sent to a secured application which uses pseudonymization. Pseudonymization is a procedure by which most identifying fields within a data record are replaced by one or more artificial identifiers, or pseudonyms. There can be a single pseudonym for a collection of replaced fields or a pseudonym per replaced field. The purpose is to render the data record, not identifying and not traceable to a single person. After the pseudonymization process, the data will be sent to the researchers who have a secured application.

Script	Home environment	SCORE		PATHWAY
	Social situation parents	YES	NO	
P1	Single parent	1	0	**Social**
P2	Lack of social support	1	0	**Social**
P3	Presence of domestic violence	2	0	**Social**
P4	Child Social Services involved with borthers/sisters	2	0	**Social**
P5	Child Social Services involved during pregnancy or after birth	3	0	**Social**
	Work and income parents	YES	NO	
P6	Unemployed (> 3 months)	1	0	**Social**
P7	Family living on low income (< 1000 Euros a month)	2	0	**Financial**
P8	Financial problems	1	0	**Financial**
	Edcution parents	YES	NO	
P9	Low educated / illiterate	2	0	**Social**
	Living environment of the family	YES	NO	
P10	Unsafe living environment	1	0	**Housing**
P11	Living in deprived neighborhood (based on 4 digit zipcode)	2	0	**Social**
	Script: 4 digit zipcode for deprived neighborhoods			
	ETHNICITY			
	Ethnicity father/mother	YES	NO	
P12	Surinam-Creole	1	0	**Weight**
	Surinam-Hindu	1	0	**Weight**
	Surinam-Indonesian	1	0	**Weight**
	Antillian-Aruban	1	0	**Weight**
	Capeverdian	1	0	**Weight**
	Turkish	1	0	**Weight**
	Maroccan	1	0	**Weight**
	Other non-western	1	0	**Weight**
	Language/communication	YES	NO	
P13	Doesn't speak Dutch or English	1	0	**Social**
P14	Mentally disabled parent(s)	1	0	**Social**
	CARE			
	General	YES	NO	
P15	No (healthcare) insurance	1	0	**Social**
	Family planning	YES	NO	
P16	Mother age < 20 years	2	0	**Finances**

Script	MEDICAL	SCORE		PATHWAY
	Health of the parents	YES	NO	
P27	One or more chronical illness of the parent(s)	0	0	**Chronic**
P28	Diabetes of the mother	1	0	
P29	Epilepsie with medication of the mother	2	0	
	PSYCHIATRY	YES	NO	
P30	Psychiatric problems parent(s) in history or present	1	0	**Psychiatry**
P31	Psychiatric drugs during pregnancy by the mother	1	0	**Psychiatry**
P32	Psychiatric problems in the family (1st and 2nd degree)	1	0	**Psychiatry**
	OBSTETRIC			
	During pregancy	YES	NO	
P33	Insulin or diet because of diabtes gravidarum	2	0	**Weight**
P34	Gained more than 16 kg in weight	1	0	**Weight**
P35	Untreated hypothyroid in first trimester	1	0	
	Birth outcomes	YES	NO	
P37	Birth weight < P10	1	0	**Weight/dys**
	Birth weight > P90	2	0	**Weight**
P38	Prematurity (< 37 weeks of gestation)	2	0	**Premature**
P39	Low Apgar score (<7 after 5 min)	1	0	
P40	Congenital anomalies	1	0	**Congenital**
P41	Formula feeding directly after birth	1	0	**Weight**

RESULT			
Domain	*Max. score*	*Score*	
SOCIAL	18		
ETHNICITY	3		
CARE	3		
LIFESTYLE	18		
MEDICAL	6		
OBSTETRIC	11		
Total	59		

DIRECTED CARE	YES	NO	ACTION
Use of care pathways			
Mutlidisciplinary consultation			
Interconception advice			
Consult of the General Practitioner			
Consult at outpatient clinic			
Other: ...			

	LIFESTYLE			
	Intoxications	YES	NO	
P17	Smoking in pregnancy	1	0	**Smoking**
P18	Mother smokes	1	0	**Smoking**
P19	Father smokes	1	0	**Smoking**
P20	Alcohol in pregnancy	1	0	**Toxic**
P21	Alcohol abuse by mother	1	0	**Toxic**
P22	Alcohol abuse by father	1	0	**Toxic**
P23	Drug use in pregnancy	3	0	**Toxic**
P24	Drug abuse mother	3	0	**Toxic**
P25	Drug abuse father	3	0	**Toxic**
	Weight of the mother	YES	NO	
P26	BMI < 18,5	1	0	
	BMI >25	2	0	**Weight**
R4U©Erasmus MC	***version: postnatal***			

Figure 2. The postnatal R4U

DISCUSSION

This study provides the evaluation of an innovative postnatal risk selection method combining medical and non-medical risk factors influencing a child's growth and development, the postnatal R4U.

To support the nurses and physicians during the implementation of the risk assessment, a training is offered at starting point, which has been developed in collaboration with a professional training company. During this training, PCHC nurses and physicians will be able to practice and improve their communication techniques in addressing delicate subjects to parents (van Minde et al. 2019).

Strengths and limitations of this study

This study may result in improved perinatal health and long term health of new-borns by enhancing the role of PCHC in the continuous care of vulnerable families, postnatally. Consequently, this may strengthen PCHC collaboration with other healthcare professionals, such as midwifes, obstetricians, gynaecologists, paediatricians and social workers.

Often a randomized controlled trial (RCT) is the preferred study design, as it is supposed to minimize the effect of confounders. Nevertheless, an RCT has its own limitations, such as the possibility of contamination between the intervention and control groups. For example, caregivers/PCHC nurses and physicians might hear about the intervention and adopt it themselves. With this historically design the intervention cannot be implemented in the control group.

The postnatal R4U will enable a systematic and profound assessment and summary of medical and non-medical risk factors. Therefore, this method could reveal risks at an earlier stage of life. This could enable nurses and physicians in offering timely, adequate and tailored interventions. At start, this may result in consulting other healthcare professionals more frequently, which could be more time consuming. However, in the long run this possibly results in a benefit for families at risk, who receive care at an earlier stage, preventing the further increase or accumulation of problems. Hence, this approach may aid healthcare/PCHC nurses and physicians and healthcare in general, by avoiding the necessity of crisis management at a later stage.

PCHC nurses and physicians will apply a new working strategy, implementing the postnatal R4U and possible care pathways in their daily working routine. During the initial phase of the implementation, items could be misinterpreted or scored erroneously. In order to optimize implementation and prepare PCHC nurses and physicians adequately, a training is therefore offered concerning the development and content of the postnatal R4U and its incorporated

risk factors. By doing so, we intend to increase knowledge and the use of the instrument, and knowledge on perinatal risk factors and their influences on health.

CONCLUSION

Through early detection of risk factors and early deployment of care pathways we aim to achieve a decrease of growth and developmental problems in childhood. This intervention may result in healthier lifestyles and additionally, in the long run, in a healthier life for future generations.

REFERENCES

Barker, D.J. (2007) The origins of the developmental origins theory. *J Intern Med,* **261**(5), 412-7.

Bonsel, G.J. & Steegers, E.A. (2011) [Differences in perinatal mortality between provinces: dependence on many factors]. *Ned Tijdschr Geneeskd,* **155**, A3112.

Calkins, K. & Devaskar, S.U. (2011) Fetal origins of adult disease. *Curr Probl Pediatr Adolesc Health Care,* **41**(6), 158-76.

College Bescherming Persoonsgegevens (2013) CBP Richtsnoeren: Beveiliging van Persoonsgegevens.

E. Dusseldorp, M. M. Boere-Boonekamp & E. Coenen-van Vroonhoven (2011) Pilotstudie D-screening: screening op ontwikkelingsachterstand bij het jonge kind, uitgevoerd door de jeugdarts. 46.

Gershoff, E.T., Aber, J.L., Raver, C.C. & Lennon, M.C. (2007) Income is not enough: incorporating material hardship into models of income associations with parenting and child development. *Child Dev,* **78**(1), 70-95.

Gilbert, A.L., Bauer, N.S., Carroll, A.E. & Downs, S.M. (2013) Child exposure to parental violence and psychological distress associated with delayed milestones. *Pediatrics,* **132**(6), e1577-83.

Gilbert, R., Widom, C.S., Browne, K., Fergusson, D., Webb, E. & Janson, S. (2009) Burden and consequences of child maltreatment in high-income countries. *Lancet,* **373**(9657), 68-81.

Gillman, M.W. (2015) Prenatal famine and developmental origins of type 2 diabetes. *Lancet Diabetes Endocrinol,* **3**(10), 751-2.

Grabovschi, C., Loignon, C. & Fortin, M. (2013) Mapping the concept of vulnerability related to health care disparities: a scoping review. *BMC Health Serv Res,* **13**, 94.

Heindel, J.J. & Vandenberg, L.N. (2015) Developmental origins of health and disease: a paradigm for understanding disease cause and prevention. *Curr Opin Pediatr,* **27**(2), 248-53.

Jacobusse, G., van Buuren, S. & Verkerk, P.H. (2006) An interval scale for development of children aged 0-2 years. *Stat Med,* **25**(13), 2272-83.

Jacobusse G.W., v.B.S., Verkerk P.H. (2008) Ontwikkeling van de D-score: Een samenvattende maat voor het Van Wiechenonderzoek. *Tijdschrift voor de Jeugdgezondheidszorg,* **40**(1), 11-14.

Laurent de Angulo M.S., B.-d.J.E.A. (2015) *Developmental research in Child Health Care*.

Lems, W., Hopkins, B. & Samson, J.F. (1993) Mental and motor development in preterm infants: the issue of corrected age. *Early Hum Dev,* **34**(1-2), 113-23.

Marmot, M. (2005) Social determinants of health inequalities. *Lancet,* **365**(9464), 1099-104.

NCJ, https://www.ncj.nl/richtlijnen.

Poeran, J., Maas, A.F., Birnie, E., Denktas, S., Steegers, E.A. & Bonsel, G.J. (2013) Social deprivation and adverse perinatal outcomes among Western and non-Western pregnant women in a Dutch urban population. *Soc Sci Med,* **83**, 42-9.

Rajaratnam, J.K., Burke, J.G. & O'Campo, P. (2006) Maternal and child health and neighborhood context: the selection and construction of area-level variables. *Health Place,* **12**(4), 547-56.

Reeske, A., Spallek, J., Bammann, K., Eiben, G., De Henauw, S., Kourides, Y., Nagy, P. & Ahrens, W. (2013) Migrant background and weight gain in early infancy: results from the German study sample of the IDEFICS study. *PLoS One,* **8**(4), e60648.

Rijlaarsdam, J., Tiemeier, H., Hofman, A., Jaddoe, V.W., Mackenbach, J.P., Verhulst, F.C. & Stevens, G.W. (2013) Home environments of infants: relations with child development through age 3. *J Epidemiol Community Health,* **67**(1), 14-20.

Scholmerich, V.L., Erdem, O., Borsboom, G., Ghorashi, H., Groenewegen, P., Steegers, E.A., Kawachi, I. & Denktas, S. (2014) The association of neighborhood social capital and ethnic (minority) density with pregnancy outcomes in the Netherlands. *PLoS One,* **9**(5), e95873.

Schonbeck, Y., Talma, H., van Dommelen, P., Bakker, B., Buitendijk, S.E., Hirasing, R.A. & van Buuren, S. (2011) Increase in prevalence of overweight in Dutch children and adolescents: a comparison of nationwide growth studies in 1980, 1997 and 2009. *PLoS One,* **6**(11), e27608.

Schonbeck, Y., van Dommelen, P., HiraSing, R.A. & van Buuren, S. (2015) Trend in height of Turkish and Moroccan children living in the Netherlands. *PLoS One,* **10**(5), e0124686.

Taal, H.R., Vd Heijden, A.J., Steegers, E.A., Hofman, A. & Jaddoe, V.W. (2013) Small and large size for gestational age at birth, infant growth, and childhood overweight. *Obesity (Silver Spring),* **21**(6), 1261-8.

Talma H, S.Y., Bakker B, HiraSing R, Buuren Sv. (2010) *Growth diagrams 2010. Manual measuring and weighing of children and completing growth charts.*

van Buuren, S. (2014) Growth charts of human development. *Stat Methods Med Res,* **23**(4), 346-68.

van Dommelen, P. & van Buuren, S. (2014) Methods to obtain referral criteria in growth monitoring. *Stat Methods Med Res,* **23**(4), 369-89.

van Minde, M.R.C., Blanchette, L.M.G., Raat, H., Steegers, E.A.P. & Kroon, M.L.A. (2019) Reducing growth and developmental problems in children: Development of an innovative postnatal risk assessment. *PLoS One,* **14**(6), e0217261.

Vellinga, A., Cormican, M., Hanahoe, B., Bennett, K. & Murphy, A.W. (2011) Opt-out as an acceptable method of obtaining consent in medical research: a short report. *BMC Med Res Methodol,* **11**, 40.

Vos, A.A., Posthumus, A.G., Bonsel, G.J., Steegers, E.A. & Denktas, S. (2014) Deprived neighborhoods and adverse perinatal outcome: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand,* **93**(8), 727-40.

Vos, A.A., van Veen, M.J., Birnie, E., Denktas, S., Steegers, E.A. & Bonsel, G.J. (2015) An instrument for broadened risk assessment in antenatal health care including non-medical issues. *Int J Integr Care,* **15**, e002.

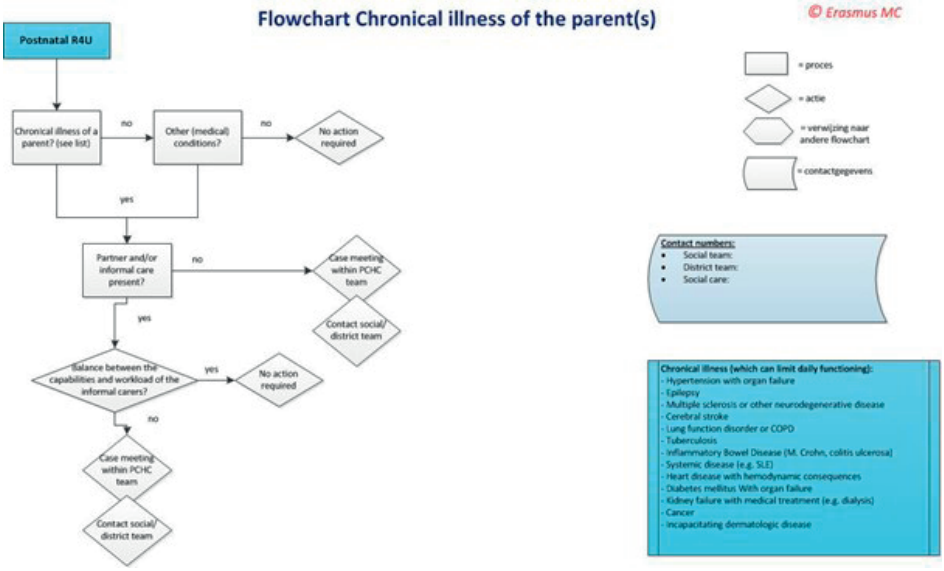
Vos, A.A., van Voorst, S.F., Steegers, E.A. & Denktas, S. (2016) Analysis of policy towards improvement of perinatal mortality in the Netherlands (2004-2011). *Soc Sci Med,* **157**, 156-64.

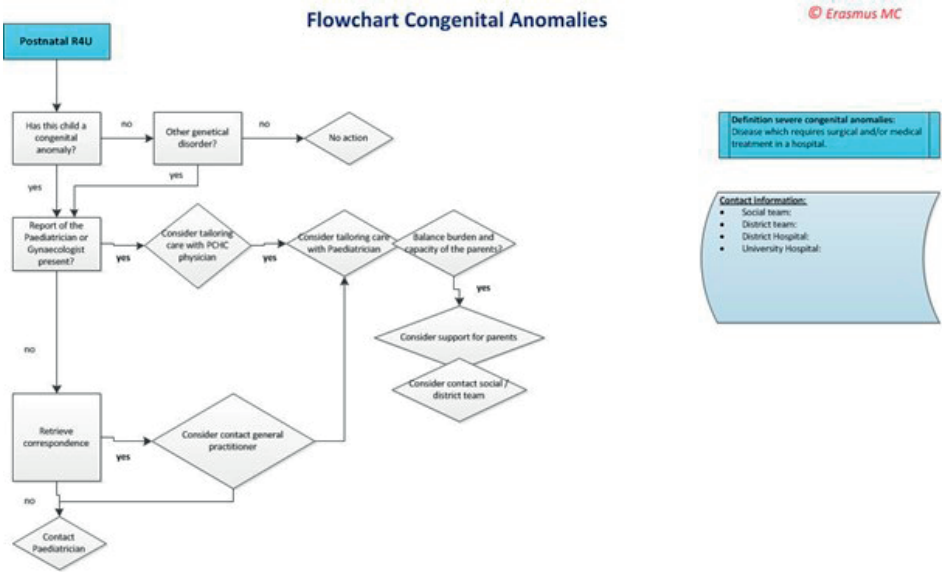
Waelput, A.J. (2017) Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. *BMC Pregnancy Childbirth,* **17**(254).

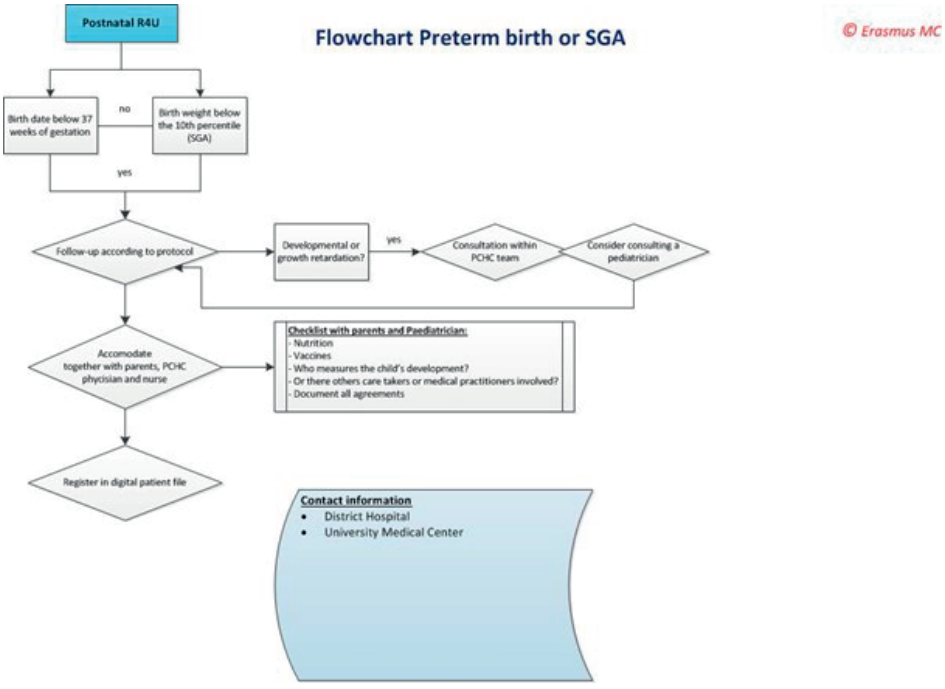
Yeung, W.J., Linver, M.R. & Brooks-Gunn, J. (2002) How money matters for young children's development: parental investment and family processes. *Child Dev,* **73**(6), 1861-79.

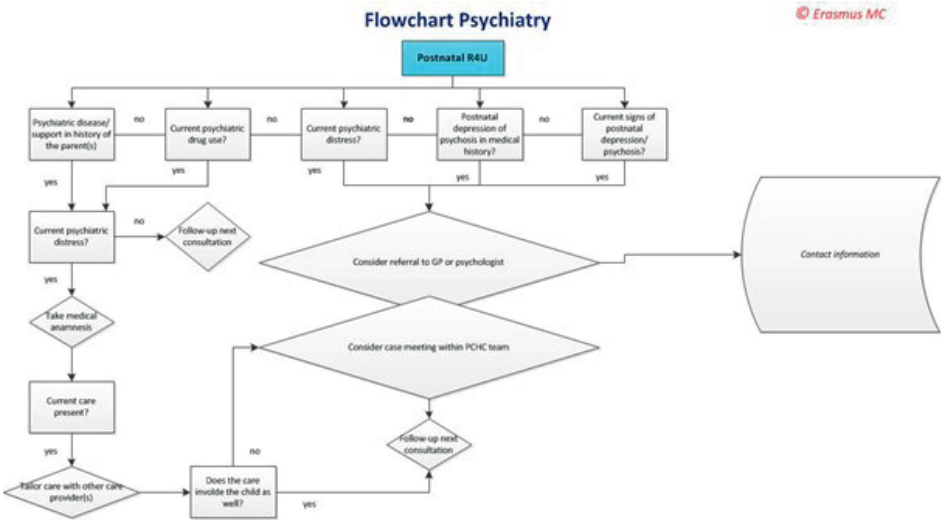
ADDENDUM

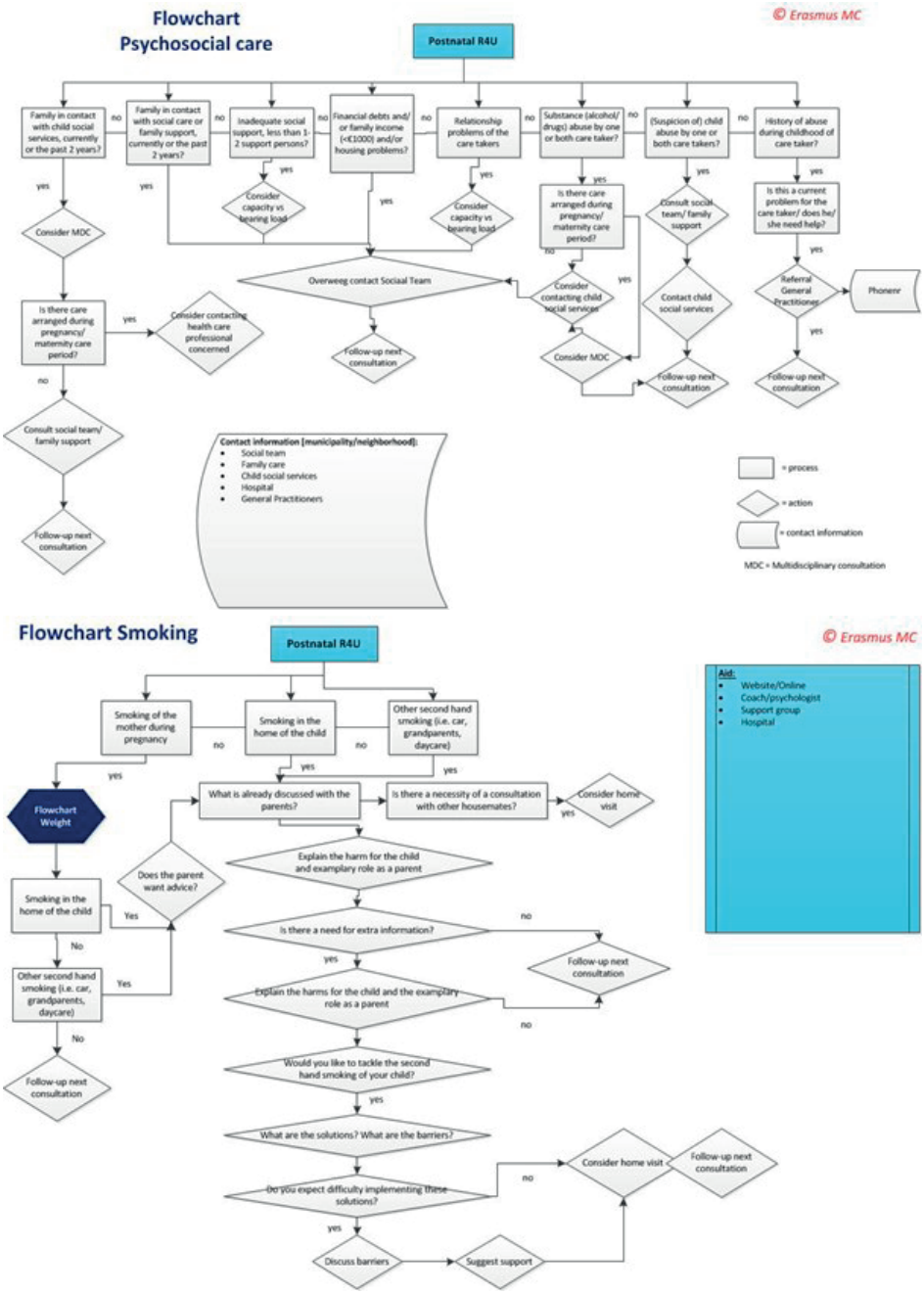
Supplementary file 1.

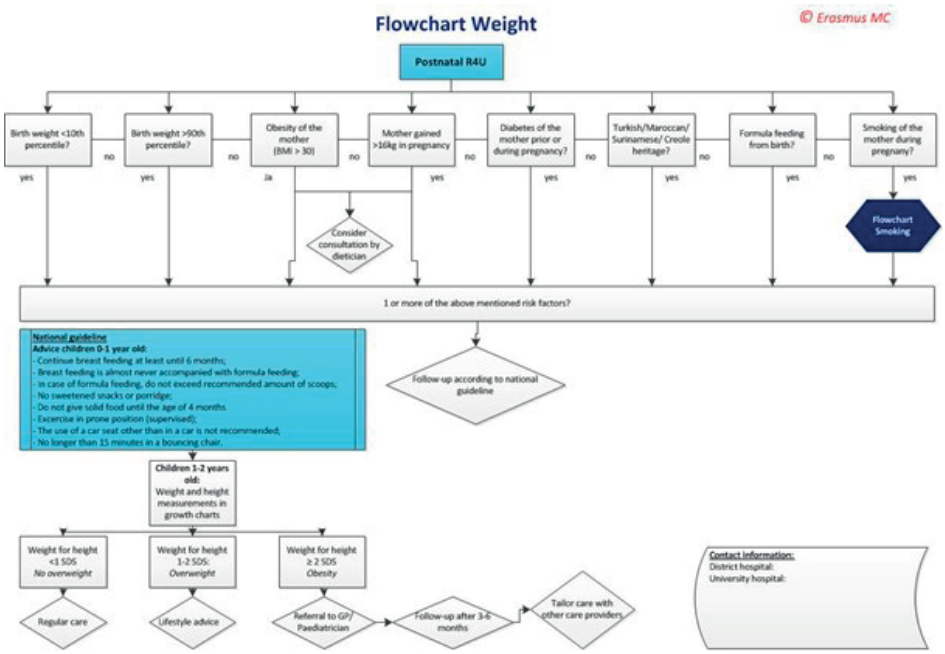


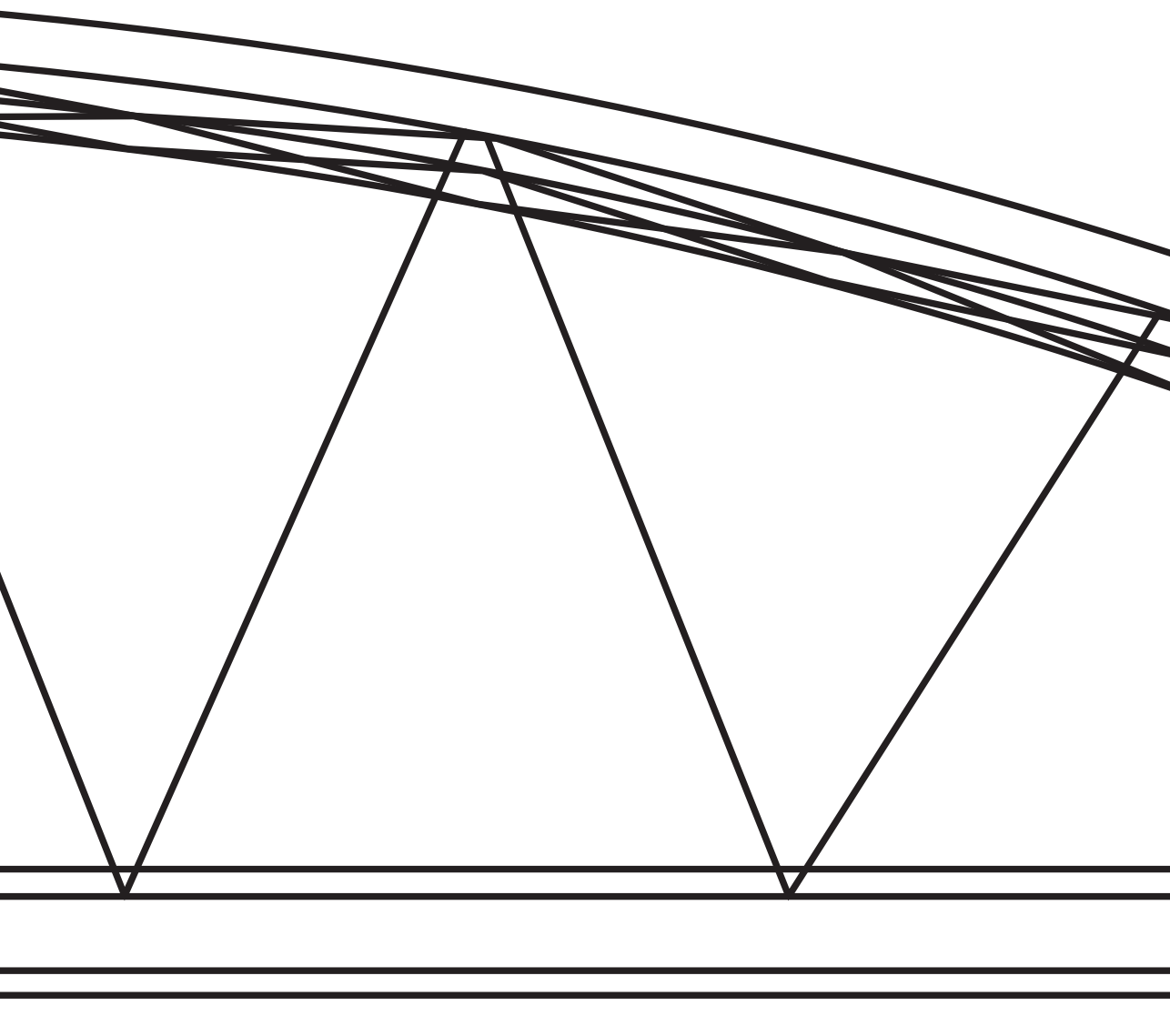



Postnatal R4U
Flowchart Preterm birth or SGA
© Erasmus MC
Birth date below 37 weeks of gestation
no
Birth weight below the 10th percentile (SGA)
yes
Follow-up according to protocol
Developmental or growth retardation?
yes
Consultation within PCHC team
Consider consulting a pediatrician
Accomodate together with parents, PCHC phycisian and nurse
Checklist with parents and Paediatrician:
- Nutrition
- Vaccines
- Who measures the child's development?
- Or there othens care takers or medical practitioners involved?
- Document all agreements
Register in digital patient file
Contact information
District Hospital
University Medical Center


Flowchart Psychiatry
© Erasmus MC
Postnatal R4U
Psychiatric disease/ support in history of the parent(s)
Current psychiatric drug use?
Current psychiatric distress?
Postnatal depression of psychosis in medical history?
Current signs of postnatal depression/ psychosis?
no
yes
Current psychiatric distress?
Follow-up next consultation
Consider referral to GP or psychologist
Contact information
Take medical anamnesis
Consider case meeting within PCHC team
Current care present?
Follow-up next consultation
Tailor care with other care provider(s)
Does the care involde the child as well?

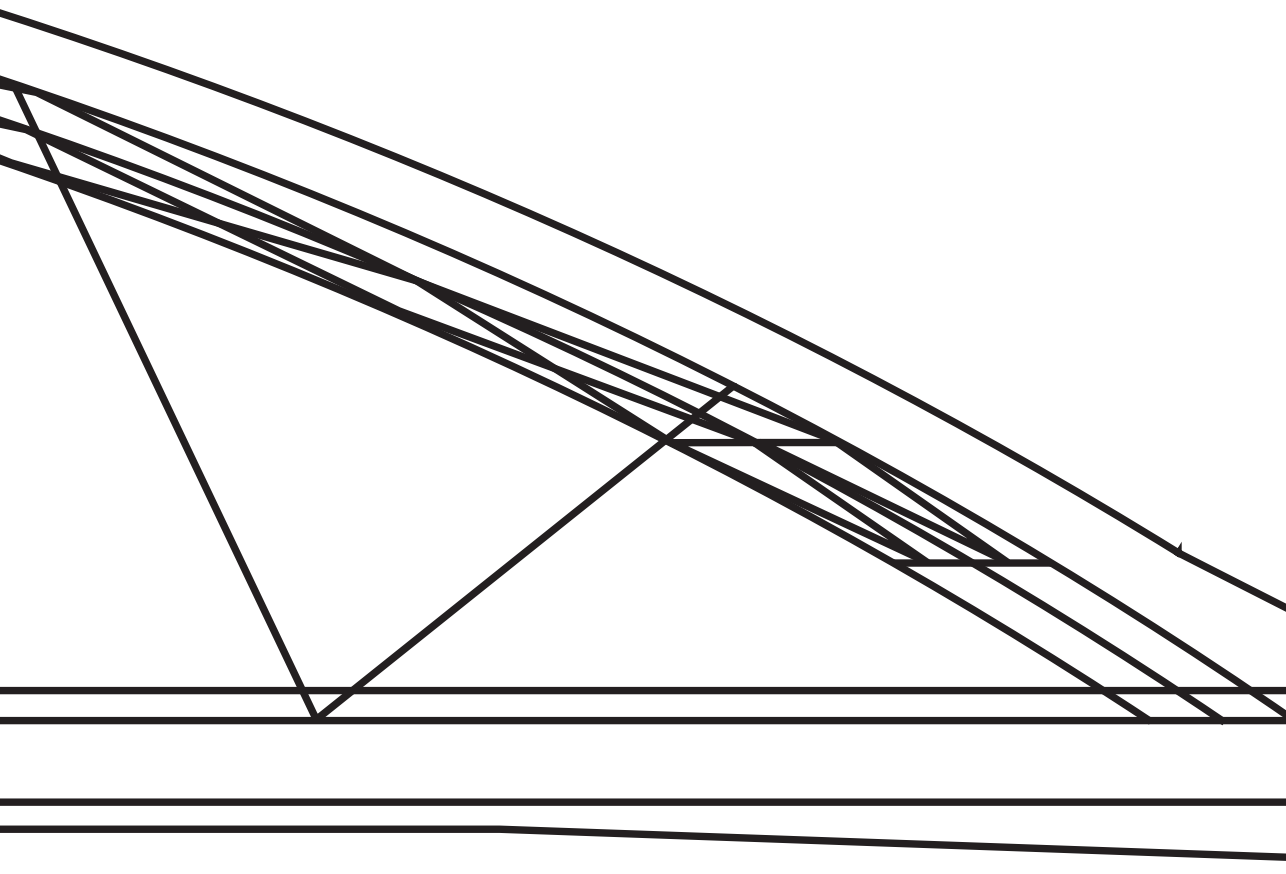

Flowchart
Psychosocial care
© Erasmus MC
Postnatal R4U
Family in contact with child social services, currently or the past 2 years?
Family in contact with social care or family support, currently or the past 2 years?
Inadequate social support, less than 1-2 support persons?
Financial debts and/ or family income (<€1000) and/or housing problems?
Relationship problems of the care takers
Substance (alcohol/ drugs) abuse by one or both care taker?
(Suspicion of) child abuse by one or both care takers?
History of abuse during childhood of care taker?
Consider capacity vs bearing load
Consider capacity vs bearing load
Consider MDC
Overweeg contact Sociaal Team
Is there care arranged during pregnancy/ maternity care period?
Consider contacting child social services
Consult social team/ family support
Contact child social services
Is this a current problem for the care taker/ does he/ she need help?
Referral General Practitioner
Phonenr
Is there care arranged during pregnancy/ maternity care period?
Consider contacting health care professional concerned
Follow-up next consultation
Consider MDC
Follow-up next consultation
Follow-up next consultation
Consult social team/ family support
Follow-up next consultation
Contact information [municipality/neighborhood]:
Social team
Family care
Child social services
Hospital
General Practitioners
= process
= action
= contact information
MDC = Multidisciplinary consultation
Flowchart Smoking
© Erasmus MC
Postnatal R4U
Aid:
Website/Online
Coach/psychologist
Support group
Hospital
Smoking of the mother during pregnancy
Smoking in the home of the child
Other second hand smoking (i.e. car, grandparents, daycare)
Flowchart Weight
What is already discussed with the parents?
Is there a necessity of a consultation with other housemates?
Consider home visit
Explain the harm for the child and examplary role as a parent
Does the parent want advice?
Smoking in the home of the child
Is there a need for extra information?
Follow-up next consultation
Other second hand smoking (i.e. car, grandparents, daycare)
Explain the harms for the child and the examplary role as a parent
Follow-up next consultation
Would you like to tackle the second hand smoking of your child?
What are the solutions? What are the barriers?
Consider home visit
Follow-up next consultation
Do you expect difficulty implementing these solutions?
Discuss barriers
Suggest support

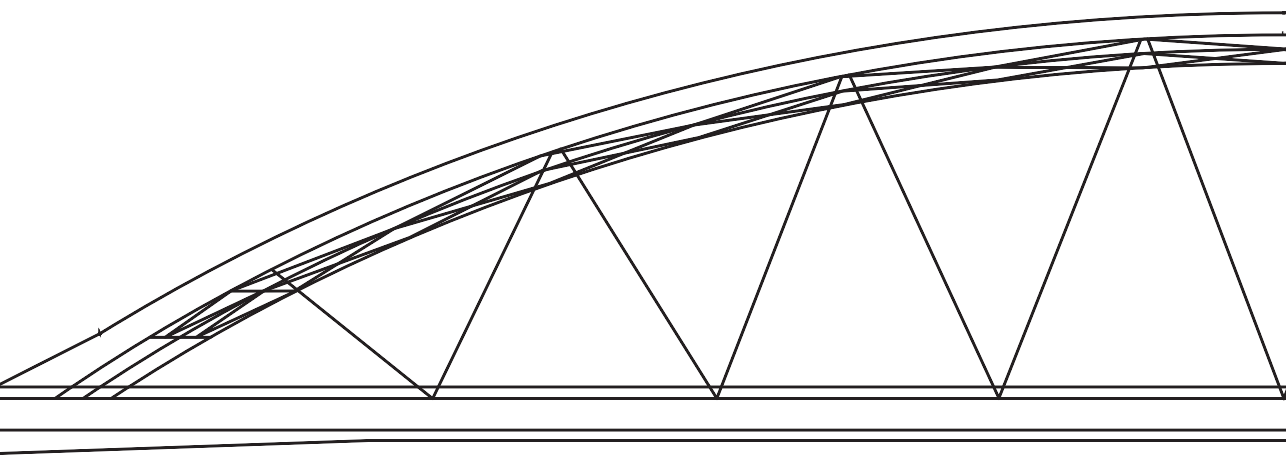

Flowchart Weight
© Erasmus MC
Postnatal R4U
Birth weight <10th percentile?
Birth weight >90th percentile?
Obesity of the mother (BMI > 30)
Mother gained >10kg in pregnancy
Diabetes of the mother prior or during pregnancy?
Turkish/Maroccan/ Surinamese/ Creole heritage?
Formula feeding from birth?
Smoking of the mother during pregnany?
no
yes
Consider consultation by dietician
Flowchart Smoking
1 or more of the above mentioned risk factors?
National guideline
Advice children 0-1 year old:
- Continue breast feeding at least until 6 months;
- Breast feeding is almost never accompanied with formula feeding;
- In case of formula feeding, do not exceed recommended amount of scoops;
- No sweetened snacks or porridge;
- Do not give solid food until the age of 4 months
- Excercise in prone position (supervised);
- The use of a car seat other than in a car is not recommended;
- No longer than 15 minutes in a bouncing chair.
Follow-up according to national guideline
Children 1-2 years old:
Weight and height measurements in growth charts
Weight for height <1 SDS
No overweight
Weight for height 1-2 SDS
Overweight
Weight for height ≥ 2 SDS
Obesity
Regular care
Lifestyle advice
Referral to GP/ Paediatrician
Follow-up after 3-6 months
Tailor care with other care providers
Contact information:
District hospital:
University hospital:



PART III

Postnatal risk assessment in Preventive Child Healthcare





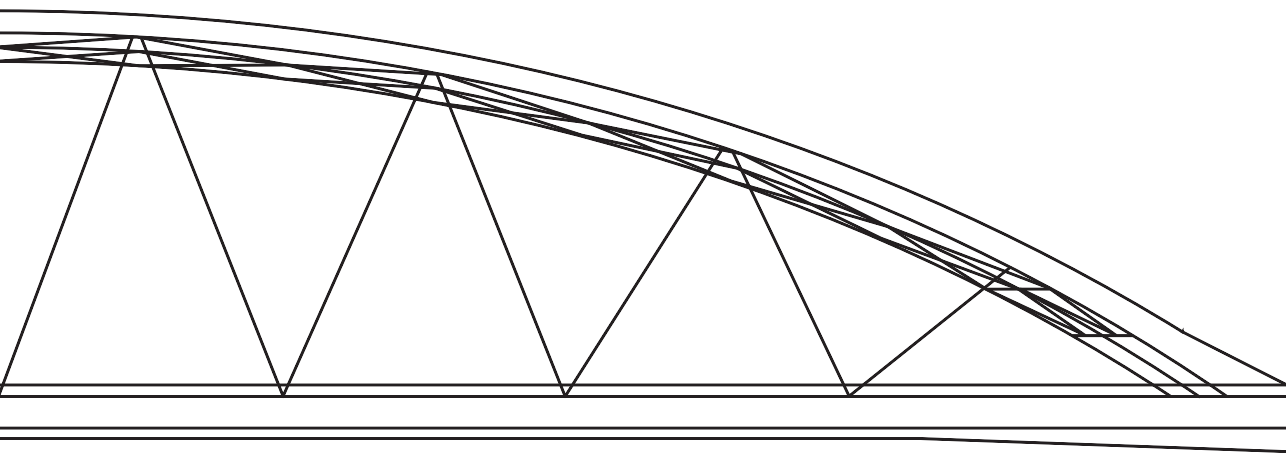
Chapter 7

An innovative postnatal risk assessment in Preventive Child Healthcare: The Healthy Pregnancy 4 All-2 Program

M.R.C. van Minde
J. Lagendijk
H. Raat
E.A.P. Steegers
M.L.A. de Kroon

Journal of Advanced Nursing

https://doi.org/10.1111/jan.15003



ABSTRACT

Aims

This study aims to evaluate the effectiveness of an innovative postnatal risk assessment (the postnatal Rotterdam Reproductive Risk Reduction checklist: R4U) and corresponding care pathways in Preventive Child Healthcare (PCHC), along with PCHC professional satisfaction.

Design

Four PCHC organizations located in three municipalities with a higher adverse perinatal outcome than the national average were selected for participation. The study concerns a historically controlled study design.

Methods

The study enrolled participants from September 2016 until December 2017. The historical cohort existed of children born in previous years from 2008 until 2016. The outcome measure was defined as catch-up growth: more than 0.67 standard deviation score weight for height increase in the first six months of life. PCHC professional opinion was assessed with a digital survey.

Results

After the inclusion period 1,953 children were included in the intervention cohort and 7,436 children in the historical cohort. Catch-up growth was significantly less common in the intervention cohort; 14,9% versus 19,5% in the historical cohort ($p<0.001$). A regression sensitivity analysis, using matching, showed an odds ratio of 0.957 (95% CI 0.938 – 0.976) for the intervention cohort. In the survey, 74 PCHC physicians and nurses participated; most of them were neutral concerning the benefits of the postnatal R4U.

Conclusion

This study shows that the implementation of a novel postnatal risk assessment including in PCHC is feasible and effective. Final efforts to ensure a widespread implementation should be taken.

Impact

PCHC offers a unique opportunity to recognize and address risk factors for growth and development in children and to implement care pathways. Effective and widely implemented risk assessments in antenatal and PCHC are scarce. To our knowledge, this kind of evidence based postnatal risk assessment has not been implemented in PCHC before and seizes the opportunity to prevent catch-up growth and its long-term effects.

INTRODUCTION

Preconception, prenatal, perinatal and postnatal risk factors affect growth and development. (Kerstjens et al. 2013, Potijk et al. 2015, Bocca-Tjeertes et al. 2014, Bocca-Tjeertes et al. 2013, Timmermans et al. 2014, Baptiste-Roberts et al. 2012, Delobel-Ayoub et al. 2009, Arpi and Ferrari 2013, El Marroun et al. 2011, El Marroun et al. 2014, Henrichs et al. 2013, Kuhle et al. 2015, Gaillard et al. 2013, Koutra et al. 2013, Morinis et al. 2013, Knudsen et al. 2014) These include medical risk factors, such as preterm birth and being born small for gestational age (SGA, birthweight < 10^{th} percentile), and non-medical risk factors, such as living in deprivation and social isolation. (Kakinami et al. 2014, Bradley and Corwyn 2002, Crockenberg 1981, Enlow et al. 2013, Bilic-Kirin et al. 2014, Gershoff et al. 2007) Children who showed intra-uterine growth retardation (IUGR) as a fetus, or who were born SGA or large for gestational age (LGA, birthweight > 90^{th} percentile) more often display growth realignment in the first years of life. Growth realignment has been identified as an important risk factor for growth and developmental problems in later life. (Jordan et al. 2005, Xiong et al. 2007, Taal et al. 2013, Claris et al. 2010) Furthermore, being born in a family with a low socio-economic status (SES) gives higher odds for growth realignment, partially moderated through unhealthy lifestyle choices. (Layte et al. 2014) An important measure for growth realignment is catch-up growth (defined as > 0.67 standard deviation score (SDS) change in weight for height). (Wit and Boersma 2002) There is evidence that "accelerated" or too fast growth, i.e. catch-up growth, during critical or sensitive periods in early life has unfavorable effects on long-term health, and particularly the risk of obesity and cardiovascular disease. (Singhal 2017) Catch-up growth in infancy is associated with being overweight or obese in childhood and developmental delay when growing up. (Taal et al. 2013, Zimmerman 2018, Polk et al. 2016) Adolescents who showed catch-up growth in infancy have a higher body mass index and have a shorter adult stature than their peers. (Salgin et al. 2015) Additionally, girls who experienced catch-up growth have higher odds of an earlier menarche. (Salgin et al. 2015, Dunger et al. 2006) Conversely, catch-up growth has also been studied as a benefit, namely for preterm born children. (Singhal 2017)

Background

One of the earliest studies to show adverse effects of catch-up growth found that faster weight gain in the first 6 weeks of life increased the risk of obesity 6-8 years later (Eid 1970). In the following years, there has been a huge increase in evidence to support this concept. Faster infant growth has been associated with later obesity in 6 systematic reviews (Singhal 2016, Woo Baidal 2016, Druet 2012) including an individual-level meta-analysis (Patro-Golab 2016). These associations are seen in both high- and low-income countries, in infants born preterm or at term, in infants with normal or low birth weight for gestation, and in both breast- and formula-fed infants (Singhal 2016, Woo Baidal 2016, Druet 2012).

Preventive Child Healthcare (PCHC) offers a unique opportunity to prevent, recognize and address growth and developmental problems during childhood. PCHC in the Netherlands is delivered by well-baby clinics, and is free of charge. During the visits to well-baby clinics, nurses and physicians assess the weight, height and development of children from zero until 19 years old. Additionally, the national vaccination program is executed. (Dunnink G 2008) The attendance rate is high, with over 95% attendance for all children under the age of four. (G. Dunnink 2010) This offers a large window of opportunity to address certain risk factors and implement corresponding care pathways, if necessary.

During a previous study the postnatal R4U (Rotterdam Reproductive Risk Reduction checklist) was developed for the early risk assessment of growth and developmental problems in infants by PCHC physicians and nurses. (van Minde et al. 2019) The postnatal R4U consists of 41 items that assess both medical and non-medical risk factors that influence child growth and development. Together with corresponding care pathways the postnatal R4U was implemented in four PCHC organizations in three municipalities. (van Minde et al. 2020) The aim of this paper was to study the effectiveness of the postnatal R4U and its corresponding care pathways on reducing catch-up growth in the first six months of life and to evaluate PCHC professional satisfaction with this intervention during the study period.

THE STUDY

Aims

This study aimed to evaluate (1) the predictive value of an innovative postnatal risk assessment, the postnatal R4U, meant to assess the risk of growth and developmental problems in young children, and (2) its effectiveness in combination with tailored care pathways.

Design

This study was embedded in the Healthy Pregnancy 4 All-2 (HP4All-2) program. Participants were enrolled from September 2016 until December 2017. (Vos et al. 2014, Waelput et al. 2017) HP4All-2 is the sequel of the HP4All-1 program (see Box 1). In the HP4All-1 program the antenatal R4U has been implemented and evaluated. (Lagendijk et al. 2018, Vos et al. 2015a, Vos et al. 2015b) Both Hp4All programs aimed to improve maternal, perinatal and child health by implementing risk selection and tailored care from the preconception through antenatal and postpartum care until the interconception period. (Waelput et al. 2017) Full details of both the design of the postnatal R4U and the design of the study can be found elsewhere. (van Minde et al. 2019, van Minde et al. 2020)

Box 1: Healthy Pregnancy 4 All

Healthy Pregnancy 4 All and the antenatal R4U

The risk of preterm birth, being born small for gestational age, perinatal mortality and adverse perinatal health is high, especially in socially deprived neighbourhoods [Vos at el., Acta Obset Gynecol Scand, 2014; Poeran et al., J Matern Fetal Neonat Med, 2011]. Therefore, Dutch municipalities and health scientists of the Erasmus Medical Centre initiated the Healthy Pregnancy 4 All (HP4All) program in 2011 [Vos et al., Acta Obset Gynecol Scand, 2014; Denktas et al., Maten Child Health J, 2012]. A scorecard-based risk screening, the antenatal Rotterdam Reproductive Risk Reduction checklist (antenatal R4U), has been pilot implemented in antenatal healthcare. Corresponding care pathways were developed and piloted [Van Veen et al., Midwifery, 2015]. These experiences were used to further improve and implement these tools in other municipalities with high perinatal mortality and morbidity. The sequel of the HP4All program is the HP4All-2 program, with the aim to endorse and facilitate continuous care for families at risk after birth [Waelput et al., BMC Pregnancy & Childbirth, 2017].

Reference: van Minde, Remmerswaal; J Adv Nurs. 2020 Dec.

The current study was conducted in four PCHC organizations within relatively deprived neighborhoods in three municipalities. (Waelput et al. 2017) Together with local government representatives (i.e. municipal program directors and councilors), collaboration was sought at first with the management of the PCHC organizations. (Waelput et al. 2017) The innovation was implemented as standard care, provided by the PCHC professionals of the well-baby clinics.

Intervention and historical cohort

The effectiveness of the postnatal R4U was assessed using an historically controlled study design where the prevalence of catch-up growth in the intervention cohort was compared to the prevalence of catch-up growth in the historical cohort. Children and their parents, consulting PCHC during regular visits, participated in the intervention through an opt-out procedure. In order to have a representative control group the historical control group consisted of children in the same age group, living in the same neighbourhoods as the intervention group.

Participants

Children

Four PCHC organizations in three municipalities in the Netherlands participated in the study. (37) Children visiting the well-baby clinics of the participating PCHC organizations were included through an opt-out methodology. (Vellinga et al. 2011) This methodology was applied because of the use of already existing, registered data in the PCHC digital client files. PCHC professionals could perform their care as usual during the study period. The historical control group consisted of children who visited the collaborating well-baby clinics prior to the study and were of the same age as the intervention cohort at the time of growth and developmental assessments, in the years 2008 until 2016. (van Minde et al. 2020)

Power calculation

Power calculation resulted in 2,650 children to be included in the intervention cohort until the end of the follow-up period. Calculation was based on the prevalence of catch-up growth in the Netherlands, defined as a change in height standard deviation scores of >0.67 standard deviation (SD) from birth to 6 months of age (Taal et al. 2013). The prevalence of catch-up growth in the Netherlands was estimated at 20% on the basis of analyses of Generation R cohort data (Taal et al. 2013). We assumed a relevant decrease of 3% in the prevalence of catch-up in the intervention cohort compared to the historical cohort. Aiming at a power of 80% and an alpha of 0,05 this outcome warranted 2,650 children in both the intervention group and the historical control group until the end of the follow-up period. Considering a loss to follow up of 15% of the children, 3,120 children had to be included in the intervention cohort at the end of the study. (van Minde et al. 2020) When 3,120 children were enrolled in the intervention, inclusion at the well-baby clinics ended.

Professionals

The PCHC professionals involved were PCHC physicians and PCHC nurses. Prior to the start of the study and the implementation of the postnatal R4U and corresponding care pathways, they were trained by the researchers and a professional training company (www.downsideup.nl). The training consisted of an explanation of the rationale behind HP4All-2 and the postnatal R4U, a demonstration of the postnatal R4U in the PCHC digital client file, and a communication training on addressing delicate subjects to parents. Six months after the start of the study, a digital survey was sent to the PCHC professionals to assess their satisfaction and opinion on the intervention.

Data collection

Mothers

Many previous studies have shown that maternal smoking, maternal excessive weight gain in pregnancy and maternal obesity are associated with higher neonatal fatness and early childhood obesity. (Jedrichowski 2011, Wen 2014, Hinkle 2012, Moller 2014, Flores 2013, Pham 2013). We aimed to assess the maternal predictors alongside the predictors of the children regarding these adverse health outcomes.

Children

Risk assessment based on the postnatal R4U took place during one of the first three consultations: the PCHC home visit at 14 days of age of the new-born, the PCHC consultation at four weeks of age or the PCHC consultation at eight weeks of age. These different time points were chosen to perform the risk assessment at an early age of the infant and to enable PCHC professionals to execute the risk assessment (and tailored care pathways) when they had suf-

ficient time. The postnatal R4U was integrated in the PCHC digital client files, which enabled the automated transfer of relevant data of the postnatal R4U. (Dunger et al. 2006) The postnatal R4U could be assessed by all PCHC physicians and nurses they participated in our training program. The tailored care pathways were also applied when necessary by these professionals. Care pathways were related to psychosocial problems, financial problems, smoking, substance abuse, weight, chronical illness, psychiatry, preterm birth/SGA and congenital anomalies. (van Minde et al. 2019)"

Quantitative data was collected from the digital client files of the PCHC organisations for both the intervention and historical cohort. The information regarding gender, gestational age, head circumference, length and weight at birth was also available from the PCHC client files. Data which were retrieved from the digital client files were sent to a trusted third party, using pseudonymization (www.zorgttp.nl). (van Minde et al. 2020)

Professionals

Data collection in professionals was performed using a questionnaire, developed by the authors. (van Minde et al. 2018) PCHC professional satisfaction was measured using the reduced questionnaire where PCHC nurses and PCHC physicians could indicate on Likert scales how they experienced working with the postnatal R4U and its corresponding care pathways. The final questionnaire consisted of the domains: baseline characteristics, experience with the pre-training experience and knowledge on risk screening, experiences and satisfaction with the postnatal R4U, availability of antenatal data, and collaboration with other healthcare professionals. The full questionnaire can be found in Supplement 1. The questionnaire, consisting of 57 questions, was distributed through LimeSurvey (Pro version, © 2003), digitally to all PCHC nurses and physicians after a study period of six months. The professionals were invited to participate by a PCHC manager or staff member. Due to a low response rate for the full questionnaire, a reduced questionnaire was later on distributed only assessing the experiences and satisfaction with the postnatal R4U, which consisted of 10 questions from the original questionnaire. (Supplement 1: Questionnaire.)

The intervention

The intervention, which has been developed based on the Intervention Mapping process, consisted of the postnatal R4U and its corresponding care pathways. (van Minde et al. 2020) The postnatal R4U is a 41-item risk assessment, assessing both medical and non-medical risks which influence child growth and development. Risk factors were identified and selected by performing a scoping review of the literature and by organizing focus group interviews with important stakeholders. (van Minde et al. 2019) Tailored care pathways were developed in collaboration with PCHC professionals, local government representatives and other care providers in the participating neighbourhoods, such as social services. Every care pathway has been developed to

reflect the actual situation in a participating neighbourhood. (van Minde et al. 2019) Care pathways developed were related to 1) psychosocial problems, 2) financial problems, 3) substance abuse including smoking, 4) overweight/obesity, 5) chronical illness of a parent, 6) psychiatric problems, 7) preterm birth/SGA and congenital anomalies. (van Minde et al. 2019) During the final analyses the two cohorts (intervention and historical cohort) were matched on nationality and their residential four-digit postal code area, to reduce individual differences regarding background characteristics between the two groups. (van Minde et al. 2020)

Catch-up growth

Catch-up growth was defined as > 0.67 SDS weight for height in the first six months of life. (28) We created sex-and gestational age-adjusted length and weight standard deviation scores (SD scores) within our study population using Growth Analyzer 4.1 (www.growthanalyser.org); Dutch Growth Research Foundation, Rotterdam, the Netherlands). The reference to determine the SDS values was a North European cohort. (Niklasson and Albertsson-Wikland 2008)

Data analysis

Children: intervention and historical cohort

Descriptive statistics were used to quantitatively describe the main features of the data. Catch-up growth was calculated between the first measurement in the first month of life and the measurement at six months (range 5 – 7 months) in which growth and development were measured. First, outliers and implausible measurements of the variables age, height and weight were removed. Then, SDS per measurement was calculated using Growth Analyzer (version 4.1). (Gerver WJM 2001) Changes in SDS between the two measurements were calculated and dichotomized into yes (in case of catch-up growth) or no. Lastly, the presence of catch-up growth was determined in the intervention and historical cohort and the ANOVA (F-test) was applied.

For the sensitivity analysis, one participant from the intervention cohort was matched by three participants from the historical cohort using the 'MatchIt' package. Matching was done by nationality and residential four digit postal code. Then, logistic regression analysis was applied. For all analyses, the significance was set at alpha < 0.05, two tailed. Analyses were performed using an R package in CRAN, studio version 1.0.153 (R studio).

Professionals

Comparative statistics were used, i.e. the chi-squared test and the Fisher's exact test (if expected frequencies were not greater than five) to measure associations between two categorical variables. All statistical analyses were performed using SPSS software (version 20.0). Statistical significance was defined as a p value < 0.05.

Validity, reliability and rigour

Several actions have been taken to ensure validity and rigour in the quantitative data collection and analysis. The data collected are protected and stored according to the Dutch law (College Bescherming Persoonsgegevens 2013). Data were extracted from the digital files of the PCHC organizations and were sent to a secured application which uses pseudonymization. (van Minde et al. 2020) During the analysis we performed a sensitivity analysis to ensure that nationality and the residential four digit postal code of a child did not interfere with our results.

Table 1. Baseline characteristics and outcomes of the mothers and children in the intervention cohort (n = 1.953) and historical cohort (n = 7.436)

Covariates	Intervention cohort (n = 1,953)		Historical cohort (n = 7,436)	
	Count	Missing (%)	Count	Missing (%)
Mean age in days at first measurement (min-max)	25.1 (9.0 ; 30.0)	-	23.0 (6.0 ; 30.0)	-
Mean age in days at 6 months measurement (min-max)	186.2 (153.0 ; 213.0)	-	187.2 (153 ; 213)	-
Mean height in of the mother cm (min-max)	167.3 (132 ; 192)	44 (2.3)	166.8 (145 ; 187)	7127 (95.8)
Mean weight of the mother in cm (min-max)	68.1 (34.0 ; 178.0)	86 (4.4)	-	-
Gender, female (%)	939 (48)	-	3600 (48)	-
Dutch heritage (%)	1804 (92)	-	5780 (78)	-
Western heritage (%)	1825 (93)	-	5825 (78)	-
Parent(s) functionally illiterate 'yes' (%)	43 (2.2)	-	47 (0.6)	6399 (86)
Parity of the mother during pregnancy of this child (%)	nulliparous: 962 (49) multiparous: 991 (51)	-	nulliparous: 5 (0.07) multiparous: 11 (0.15)	7420 (99.8)
Smoking during pregnancy, 'yes' (%)	104 (1.4)	-	2 (0.03)	7415 (99.7)
Alcohol during pregnancy , 'yes' (%)	9 (0.5)	-	0 (0.0)	7415 (99.7)
Drugs during pregnancy, 'yes' (%)	4 (0.2)	-	0 (0.0)	7415 (99.7)
Mean gestational age, weeks (min-max)	39.4 (29.1 ; 42,1)	1 (0.05)	39.5 (34.0 ; 42.2)	7052 (94.8)
Mean birthweight, grams (min-max)	3372 (1330 ; 5160)	-	3402 (2085 ; 4990)	7223 (97.1)
Mean lowest weight, grams (min-max)	3193 (2085 ; 4370)	1797 (92)	3239 (2180 ; 4680)	7226 (97.2)

Table 1. Baseline characteristics and outcomes of the mothers and children in the intervention cohort (n = 1.953) and historical cohort (n = 7.436) (*continued*)

Covariates	Intervention cohort (n = 1,953)		Historical cohort (n = 7,436)	
	Count	Missing (%)	Count	Missing (%)
Mean height at birth, cm (min-max)	50.4 (46.0 ; 54.0)	1901 (97)	50.4 (45 ; 57)	7387 (99.3)
Mean HC at birth, cm (min-max)	34.5 (32.0 ; 39.0)	1917 (98)	34.6 (31.8 ; 37.5)	7404 (99.6)
Exclusive breastfeeding at day of birth, 'yes' (%)	1660 (85)	-	7 (0.09)	7427 (99.9)
Low Apgar score after 5 minutes after birth (<7), 'yes'	19 (1.0)	-	0 (0.0)	7416 (99.7)
Outcomes				
Year of first measurement	2016 ; 2017	-	2008 ; 2016	-
Year of 6 months measurement	2017 ; 2018	-	2009 ; 2017	-
Mean weight at first measurement, grams (min-max)	4053 (1450 ; 6175)	-	3901 (1420 ; 6055)	-
Mean height at first measurement, cm (min-max)	53.1 (38.0 ; 60.7)	-	52.3 (36 ; 63)	-
Mean HC at first measurement, cm (min-max)	36.6 (28.5 ; 40.8)	71 (3.6)	36.4 (28.0 ; 48)	-
Mean weight at 6 months measurement, grams (min-max)	7832 (5045 ; 11,970)	-	7891 (3300 ; 16700)	-
Mean height at 6 months measurement, cm (min-max)	67.6 (58.8 ; 76.0)	-	67.7 (58.5 ; 101.0)	-
Mean HC at 6 months measurement, cm (min-max)	43.3 (39.0 ; 48.0)	47 (2.4)	43.4 (37.2 ; 48.5)	-
Mean SDS at the first measurement (min-max)	0.63 (-2.2 ; 3.6)	-	0.66 (-4.12 ; 6.16)	-
Mean SDS at the 6 months measurement (min-max)	0.33 (-2.2 ; 4.22)	-	0.44 (-4.36 ; 6.54)	-
Outcome	Intervention cohort (n = 1.953)		Historical cohort (n = 7.436)	*p* value (ANOVA test)
Catch-up growth n (%)	291 (14,9)		1421 (19,5)	< 0.0001

RESULTS/FINDINGS

Catch-up growth

Table 1 represents the baseline characteristics of both cohorts. Results are categorized into results of the mothers and those of the children. During the study period 3,210 children were included in the intervention cohort. After correction for loss to follow-up and missing data, 1,953 children remained for the final analysis. In the historical cohort 17,552 individual cases were retrieved from the PCHC client files, after correction for outliers, loss to follow-up and missing data, 7,436 children remained for the final analysis.

Mothers

For most variables no significant differences were found. Many variables from the historical cohort containing information of the mothers had a high percentage of missing values. The mean height and weight of the mother was most frequently missing in both cohorts; height was missing in 2.3% of the mothers in the intervention cohort and in 95.8% of the mothers in the historical cohort. Weight was missing in 4,4% of the mothers in the intervention cohort and in 100% of the mothers in the historical cohort. In addition, parity of the mother and intoxication of the mother were also frequently missing in the historical cohort. Due to this high percentage of missing values we decided not the use this information in our analysis.

Children

The mean age at the first consultation in the intervention cohort was 25.1 days and in the historical cohort 23.0 days. In the intervention cohort this was also the time where the postnatal R4U was to be administered. The mean age at the second consultation was 186.2 days (5,7 months) for the intervention cohort and 187.2 days (6,1 months) for the historical cohort. The distribution of gender was equal for both cohorts (48% female), which is in line with the female/male distribution in the Netherlands (48,7% female). (Centraal Bureau voor de Statistiek 2018) In the intervention cohort 93% was of Western heritage which was statistically significantly lower in the historical cohort (93% versus 78%, p value: <0.001). Mean gestational age at birth was 39.4 weeks in de intervention cohort and 39.5 in the historical cohort, however 94,8% of the data for gestational age in the historical cohort was missing. The mean birthweight in the intervention cohort was 3372 grams versus 3402 grams in the historical cohort. However, 91,7% of the of the children in the historical cohort had no birthweight registered. Mean weight at the first consultation by the PCHC was 4053 grams in the intervention cohort versus 3901 grams in the historical cohort. Catch-up growth in the intervention cohort (14,9%) was 4,6% lower than in the historical cohort (19,5%) (ANOVA test: $p\ value < 0.0001$). (Table 1).

We performed a sensitivity analysis to examine whether the result remained significant when corrected for nationality and residential postal code. With a logistic regression model we

matched one child of the intervention group for three children in the historical cohort. This resulted in 1,953 children from the intervention cohort, matching 1:3 5,859 children from the historical cohort. The odds for having experienced catch-up growth in the first six months of life compared to the historical cohort was 0.957 (0.938 – 0.976) for the intervention cohort, which was statistically significant.

Table 2. PCHC professional opinion on working with the postnatal R4U risk assessment (n=74)

	Completely agree	**Agree**	**Neutral**	**Disagree**	**Completely disagree**	**Total**
I find it easy to work with the postnatal R4U, n(%)	8 (10,8)	35 (47,3)	20 (27)	8 (10,8)	3 (4,1)	74 (100)
Certain topics are easier to address since I'm working with the postnatal R4U, n(%)	1 (1,4)	5 (6,8)	31 (41,9)	32 (43,2)	5 (6,8)	74 (100)
Referring to other healthcare professionals occurs more often, since I'm working with the postnatal R4U, n(%)	0 (0)	1 (1,4)	27 (36,5)	37 (50)	9 (12,2)	74 (100)
Care for vulnerable children/families is faster organized since I'm working with the postnatal R4U, n(%)	0 (0)	6 (8,1)	30 (40,5)	29 (39,2)	9 (12,2)	74 (100)
Consulting other healthcare professionals is more common, since I'm working with the postnatal R4U, n(%)	0 (0)	1 (1,4)	21 (28,4)	42 (50)	10 (13,5)	74 (100)
The postnatal R4U represents all possible risk factors influencing a child's growth and development, n(%)	1 (1,4)	28 (37,8)	31 (41,9)	12 (16,2)	2 (2,7)	74 (100)
The total score derived from the postnatal R4U, corresponds with my own judgment of present risk factors in a certain family n(%)	4 (5,4)	27 (36,5)	37 (50)	6 (8,1)	0 (0)	74 (100)

Professionals

Table 2 shows the opinions of 74 (82%) of the PCHC nurses and physicians after six months working with the postnatal R4U. Most important findings were that 47,3% found the postnatal R4U easy to work with, 43,2% disagreed that with the postnatal R4U it was easier to address certain topics to parents and 50% disagreed that it was easier to refer patients to other health-care professionals, using the postnatal R4U. Only 20% agreed that care for vulnerable families was, in their opinion, quicker organized with the help of the postnatal R4U and related care pathways. According to 50% of the PCHC nurses and physicians, consulting other healthcare professionals was not more common after using the postnatal R4U. Concerning the question whether the total score of the postnatal R4U corresponded with their own judgment they were more positive; 50% was neutral and 36,5% agreed.

DISCUSSION

Findings of this study

This study showed that the structured postnatal risk assessment, the postnatal R4U, together with its corresponding care pathways significantly decreased the odds of catch-up growth in the first six months of life. In contrast, PCHC professional satisfaction with the instrument was less evident.

Comparison with previous literature

Too fast, accelerated infant growth or catch-up growth and adverse health outcomes in later life is a controversial topic in the literature and has been a major focus of research in the past few years. (Singhal 2017) In a recent review article Singhal et al. concluded that especially infants born preterm might have neurodevelopmental benefits from catch-up growth, whereas healthy infants born at term (either normal weight or low birthweight for gestation) have adverse outcomes related to catch-up growth. This author also stressed that the effects of catch-up growth might differ in different populations. (Singhal 2017) As an example, a systematic review by Martin et al, showed that low birth weight in combination with catch-up growth in infants was associated with a higher body mass and/or abnormal glucose metabolism in the short-term and higher body mass (index) and cholesterol in the longer-term. (Martin et al. 2017) We performed a study in a general urban population, in which most of the children were born at term with an average birthweight (Table 1). It is more likely that catch-up growth in such a generally healthy population should be considered as unfavorable.

In the past years, risk assessments have been progressively developed in different fields of medicine in order to gain awareness among healthcare professionals and patients and to timely screen for health risks that can be prevented. In preventive healthcare and pediatrics, differ-

ent risk assessments have been developed in the past few years, such as a psychosocial risk assessment (Weigl et al. 2017) and the child abuse inventory at emergency rooms. (Schouten et al. 2017, Sittig et al. 2011). In PCHC, the SPARK, an instrument for the early detection of developmental problems in toddlers has been developed by Van Stel et al. (van Stel et al. 2012, Staal et al. 2016) A postnatal risk assessment, such as the postnatal R4U which screens for both medical and non-medical risk factors has, to our knowledge, not previously been developed. To our knowledge, this was the first study to investigate the implementation of such a postnatal risk assessment including its corresponding care pathways in PCHC.

Previous studies have demonstrated that a new protocol or an introduction of a new working process can cause resistance and hesitance of employees during the implementation process. (Safi et al. 2018, Spelten et al. 2019) In general, people are used to the old working methods and value the protocols they are familiar with. Acceptance of new protocols and working methods needs time and effort from employers and supportive staff members. (Spelten et al. 2019) Our study also shows some hesitance and resistance for a new risk assessment in PCHC, although the data show a significant decrease of catch-up growth in the intervention group. The ASE model presented in one of the design studies seems not fully applicable to the professionals in our study. (van Minde et al. 2019) After the study has ended, final implementation of the postnatal R4U will require additional efforts from the PCHC management and the Dutch Youth Center (NCJ) in supporting PCHC professionals.

Strengths and limitations

We consider it a strength of the study that both the effectiveness of the intervention and the professional opinion concerning the instrument were studied. Moreover, we involved four PCHC organizations in three municipalities in the Netherlands, increasing the generalizability of the results. Although we were not able to include the number of children as calculated with the power calculation, the difference between catch-up growth in the intervention and the historical cohort was statistically significant.

An historically controlled study design suffers from changes in healthcare through time. Protocols and healthcare management may have changed in between the two cohorts. Our study may have been affected by the growing awareness of healthy food and improved infant formula. (Harding et al. 2017) However, the National Prevention Agreement including 'Child to Healthy Weight' was initiated in 2018 (Prevention Table 2018), which was after the inclusion period of this study and could not have affected our results.

Another limitation of this study was the missing data retrieved from the PCHC files. Because of missing data our initial sample size was reduced. Still, we were able to perform the analyses and a sensitivity analysis with a matching. This technique is often described to take interparticipant

differences into account (Lui 1988). The missingness of data could be due to underreporting in the PCHC client files for this study or due to a non-uniform work process in different PCHC organizations. Pseudonymized data were transferred through a secure system, automatically transferring data from the PCHC file to the researcher. Hereby data extraction was dependent on a predefined extraction code and data registered elsewhere in the system could have been missed.

Last of all, the questionnaire used in this study was newly developed and not psychometrically tested. In future studies this could be further assessed.

CONCLUSION

This study suggests that the implementation of a novel postnatal risk assessment including corresponding care pathways in PCHC is feasible and effective regarding the prevention of catch-up growth in young children. Widespread implementation could lead to reduction of adverse health outcomes. Implementation of new working methods requires a lot of effort and time, and final results and health outcomes will become visible in the long-run. Future investments should be prioritized to new innovations in PCHC, such as a validation study and potentially an update of the postnatal R4U for certain risk groups (e.g. for children born preterm and SGA), extended consultation time to enable intensified risk assessment and further development for PCHC nurses and physicians.

REFERENCES

Arpi, E. & Ferrari, F. (2013) Preterm birth and behaviour problems in infants and preschool-age children: a review of the recent literature. *Dev Med Child Neurol,* **55**(9), 788-96.

Baptiste-Roberts, K., Nicholson, W.K., Wang, N.Y. & Brancati, F.L. (2012) Gestational diabetes and subsequent growth patterns of offspring: the National Collaborative Perinatal Project. *Matern Child Health J,* **16**(1), 125-32.

Bilic-Kirin, V., Gmajnic, R., Burazin, J., Milicic, V., Buljan, V. & Ivanko, M. (2014) Association between socioeconomic status and obesity in children. *Coll Antropol,* **38**(2), 553-8.

Bocca-Tjeertes, I.F., Kerstjens, J.M., Reijneveld, S.A., Veldman, K., Bos, A.F. & de Winter, A.F. (2014) Growth patterns of large for gestational age children up to age 4 years. *Pediatrics,* **133**(3), e643-9.

Bocca-Tjeertes, I.F., Reijneveld, S.A., Kerstjens, J.M., de Winter, A.F. & Bos, A.F. (2013) Growth in small-for-gestational-age preterm-born children from 0 to 4 years: the role of both prematurity and SGA status. *Neonatology,* **103**(4), 293-9.

Bradley, R.H. & Corwyn, R.F. (2002) Socioeconomic status and child development. *Annu Rev Psychol,* **53**, 371-99.

Centraal Bureau voor de Statistiek (2018) Geboorte; kerncijfers (EN: childbirth, key figures). Centraal Bureau voor de Statistiek,, Den Haag/ Heerlen.

Claris, O., Beltrand, J. & Levy-Marchal, C. (2010) Consequences of intrauterine growth and early neonatal catch-up growth. *Semin Perinatol,* **34**(3), 207-10.

College Bescherming Persoonsgegevens (2013) CBP Richtsnoeren: Beveiliging van Persoonsgegevens.

Crockenberg, S.B. (1981) Infant Irritability, Mother Responsiveness, and Social Support Influences on the Security of Infant-Mother Attachment. *Child Development,* **52**(3, (september 1981)), 857-865.

Delobel-Ayoub, M., Arnaud, C., White-Koning, M., Casper, C., Pierrat, V., Garel, M., Burguet, A., Roze, J.C., Matis, J., Picaud, J.C., Kaminski, M., Larroque, B. & Group, E.S. (2009) Behavioral problems and cognitive performance at 5 years of age after very preterm birth: the EPIPAGE Study. *Pediatrics,* **123**(6), 1485-92.

Dunger, D.B., Ahmed, M.L. & Ong, K.K. (2006) Early and late weight gain and the timing of puberty. *Mol Cell Endocrinol,* **254-255**, 140-5.

Dunnink G , L.-S.W. (2008) Activiteiten Basistakenpakket Jeugdgezondheidszorg 0-19 jaar per Contactmoment.

El Marroun, H., Hudziak, J.J., Tiemeier, H., Creemers, H., Steegers, E.A., Jaddoe, V.W., Hofman, A., Verhulst, F.C., van den Brink, W. & Huizink, A.C. (2011) Intrauterine cannabis exposure leads to more aggressive behavior and attention problems in 18-month-old girls. *Drug Alcohol Depend,* **118**(2-3), 470-4.

El Marroun, H., White, T.J., van der Knaap, N.J., Homberg, J.R., Fernandez, G., Schoemaker, N.K., Jaddoe, V.W., Hofman, A., Verhulst, F.C., Hudziak, J.J., Stricker, B.H. & Tiemeier, H. (2014) Prenatal exposure to selective serotonin reuptake inhibitors and social responsiveness symptoms of autism: population-based study of young children. *Br J Psychiatry,* **205**(2), 95-102.

Enlow, M.B., Blood, E. & Egeland, B. (2013) Sociodemographic risk, developmental competence, and PTSD symptoms in young children exposed to interpersonal trauma in early life. *J Trauma Stress,* **26**(6), 686-94.

G. Dunnink (2010) Standpunt. Bereik van de jeugdgezondheidszorg. RIVM, Bilthoven.

Gaillard, R., Durmus, B., Hofman, A., Mackenbach, J.P., Steegers, E.A. & Jaddoe, V.W. (2013) Risk factors and outcomes of maternal obesity and excessive weight gain during pregnancy. *Obesity (Silver Spring),* **21**(5), 1046-55.

Gershoff, E.T., Aber, J.L., Raver, C.C. & Lennon, M.C. (2007) Income is not enough: incorporating material hardship into models of income associations with parenting and child development. *Child Dev,* **78**(1), 70-95.

Gerver WJM, D.B.B. (2001) *Paediatric Morphometrics: A Reference Manual. ,* University Press Maastricht, Maastricht, The Netherlands.

Harding, J.E., Cormack, B.E., Alexander, T., Alsweiler, J.M. & Bloomfield, F.H. (2017) Advances in nutrition of the newborn infant. *Lancet,* **389**(10079), 1660-1668.

Henrichs, J., Ghassabian, A., Peeters, R.P. & Tiemeier, H. (2013) Maternal hypothyroxinemia and effects on cognitive functioning in childhood: how and why? *Clin Endocrinol (Oxf),* **79**(2), 152-62.

Jordan, I.M., Robert, A., Francart, J., Sann, L. & Putet, G. (2005) Growth in extremely low birth weight infants up to three years. *Biol Neonate,* **88**(1), 57-65.

Kakinami, L., Seguin, L., Lambert, M., Gauvin, L., Nikiema, B. & Paradis, G. (2014) Poverty's latent effect on adiposity during childhood: evidence from a Quebec birth cohort. *J Epidemiol Community Health,* **68**(3), 239-45.

Kerstjens, J.M., de Winter, A.F., Sollie, K.M., Bocca-Tjeertes, I.F., Potijk, M.R., Reijneveld, S.A. & Bos, A.F. (2013) Maternal and pregnancy-related factors associated with developmental delay in moderately preterm-born children. *Obstet Gynecol,* **121**(4), 727-33.

Knudsen, A.K., Skogen, J.C., Ystrom, E., Sivertsen, B., Tell, G.S. & Torgersen, L. (2014) Maternal pre-pregnancy risk drinking and toddler behavior problems: the Norwegian Mother and Child Cohort Study. *Eur Child Adolesc Psychiatry,* **23**(10), 901-11.

Koutra, K., Chatzi, L., Bagkeris, M., Vassilaki, M., Bitsios, P. & Kogevinas, M. (2013) Antenatal and postnatal maternal mental health as determinants of infant neurodevelopment at 18 months of age in a mother-child cohort (Rhea Study) in Crete, Greece. *Soc Psychiatry Psychiatr Epidemiol,* **48**(8), 1335-45.

Kuhle, S., Tong, O.S. & Woolcott, C.G. (2015) Association between caesarean section and childhood obesity: a systematic review and meta-analysis. *Obes Rev,* **16**(4), 295-303.

Lagendijk, J., Vos, A.A., Bertens, L.C.M., Denktas, S., Bonsel, G.J., Steyerberg, E.W., Been, J.V. & Steegers, E.A.P. (2018) Antenatal non-medical risk assessment and care pathways to improve pregnancy outcomes: a cluster randomised controlled trial. *Eur J Epidemiol.*

Layte, R., Bennett, A., McCrory, C. & Kearney, J. (2014) Social class variation in the predictors of rapid growth in infancy and obesity at age 3 years. *Int J Obes (Lond),* **38**(1), 82-90.

Martin, A., Connelly, A., Bland, R.M. & Reilly, J.J. (2017) Health impact of catch-up growth in low-birth weight infants: systematic review, evidence appraisal, and meta-analysis. *Matern Child Nutr,* **13**(1).

Morinis, J., Carson, C. & Quigley, M.A. (2013) Effect of teenage motherhood on cognitive outcomes in children: a population-based cohort study. *Arch Dis Child,* **98**(12), 959-64.

Niklasson, A. & Albertsson-Wikland, K. (2008) Continuous growth reference from 24th week of gestation to 24 months by gender. *BMC Pediatr,* **8**, 8.

Polk, S., Thornton, R.J., Caulfield, L. & Munoz, A. (2016) Rapid infant weight gain and early childhood obesity in low-income Latinos and non-Latinos. *Public Health Nutr,* **19**(10), 1777-84.

Potijk, M.R., de Winter, A.F., Bos, A.F., Kerstjens, J.M. & Reijneveld, S.A. (2015) Behavioural and emotional problems in moderately preterm children with low socioeconomic status: a population-based study. *Eur Child Adolesc Psychiatry,* **24**(7), 787-95.

Prevention Table, p.b.a.L.M. (2018) National Prevention Agreement. (Sports;, M. o. H. a. ed., pp. 34-45.

Safi, S., Thiessen, T. & Schmailzl, K.J. (2018) Acceptance and Resistance of New Digital Technologies in Medicine: Qualitative Study. *JMIR Res Protoc,* **7**(12), e11072.

Salgin, B., Norris, S.A., Prentice, P., Pettifor, J.M., Richter, L.M., Ong, K.K. & Dunger, D.B. (2015) Even transient rapid infancy weight gain is associated with higher BMI in young adults and earlier menarche. *Int J Obes (Lond),* **39**(6), 939-44.

Schouten, M.C., van Stel, H.F., Verheij, T.J., Houben, M.L., Russel, I.M., Nieuwenhuis, E.E. & van de Putte, E.M. (2017) The Value of a Checklist for Child Abuse in Out-of-Hours Primary Care: To Screen or Not to Screen. *PLoS One,* **12**(1), e0165641.

Singhal, A. (2017) Long-Term Adverse Effects of Early Growth Acceleration or Catch-Up Growth. *Ann Nutr Metab,* **70**(3), 236-240.

Sittig, J.S., Uiterwaal, C.S., Moons, K.G., Nieuwenhuis, E.E. & van de Putte, E.M. (2011) Child abuse inventory at emergency rooms: CHAIN-ER rationale and design. *BMC Pediatr,* **11**, 91.

Spelten, E., Timmis, J., Heald, S. & Duijts, S.F.A. (2019) Rural palliative care to support dying at home can be realised; experiences of family members and nurses with a new model of care. *Aust J Rural Health,* **27**(4), 336-343.

Staal, II, van Stel, H.F., Hermanns, J.M. & Schrijvers, A.J. (2016) Early detection of parenting and developmental problems in young children: Non-randomized comparison of visits to the well-baby clinic with or without a validated interview. *Int J Nurs Stud,* **62**, 1-10.

Taal, H.R., Vd Heijden, A.J., Steegers, E.A., Hofman, A. & Jaddoe, V.W. (2013) Small and large size for gestational age at birth, infant growth, and childhood overweight. *Obesity (Silver Spring),* **21**(6), 1261-8.

Timmermans, S.H., Mommers, M., Gubbels, J.S., Kremers, S.P., Stafleu, A., Stehouwer, C.D., Prins, M.H., Penders, J. & Thijs, C. (2014) Maternal smoking during pregnancy and childhood overweight and fat distribution: the KOALA Birth Cohort Study. *Pediatr Obes,* **9**(1), e14-25.

van Minde, M.R.C., Blanchette, L.M.G., Raat, H., Steegers, E.A.P. & Kroon, M.L.A. (2019) Reducing growth and developmental problems in children: Development of an innovative postnatal risk assessment. *PLoS One,* **14**(6), e0217261.

van Minde, M.R.C., Hulst, S.M., Raat, H., Steegers, E.A.P. & de Kroon, M.L.A. (2018) Postnatal screening and care for non-medical risk factors by preventive child healthcare in deprived and non-deprived neighbourhoods. *BMC Health Serv Res,* **18**(1), 432.

van Minde, M.R.C., Remmerswaal, M., Raat, H., Steegers, E.A.P. & de Kroon, M.L.A. (2020) Innovative postnatal risk assessment in preventive child health Care: A study protocol. *J Adv Nurs*.

van Stel, H.F., Staal, II, Hermanns, J.M. & Schrijvers, A.J. (2012) Validity and reliability of a structured interview for early detection and risk assessment of parenting and developmental problems in young children: a cross-sectional study. *BMC Pediatr,* **12**, 71.

Vellinga, A., Cormican, M., Hanahoe, B., Bennett, K. & Murphy, A.W. (2011) Opt-out as an acceptable method of obtaining consent in medical research: a short report. *BMC Med Res Methodol,* **11**, 40.

Vos, A.A., Posthumus, A.G., Bonsel, G.J., Steegers, E.A. & Denktas, S. (2014) Deprived neighborhoods and adverse perinatal outcome: a systematic review and meta-analysis. *Acta Obstet Gynecol Scand,* **93**(8), 727-40.

Vos, A.A., van Veen, M.J., Birnie, E., Denktas, S., Steegers, E.A. & Bonsel, G.J. (2015a) An instrument for broadened risk assessment in antenatal health care including non-medical issues. *Int J Integr Care,* **15**, e002.

Vos, A.A., van Voorst, S.F., Waelput, A.J., de Jong-Potjer, L.C., Bonsel, G.J., Steegers, E.A. & Denktas, S. (2015b) Effectiveness of score card-based antenatal risk selection, care pathways, and multidisciplinary consultation in the Healthy Pregnancy 4 All study (HP4ALL): study protocol for a cluster randomized controlled trial. *Trials,* **16**, 8.

Waelput, A.J.M., Sijpkens, M.K., Lagendijk, J., van Minde, M.R.C., Raat, H., Ernst-Smelt, H.E., de Kroon, M.L.A., Rosman, A.N., Been, J.V., Bertens, L.C.M. & Steegers, E.A.P. (2017) Geographical differences in perina-

tal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. *BMC Pregnancy Childbirth,* **17**(1), 254.

Weigl, M., Muller, A., Paramythelli, A., Angerer, P. & Petru, R. (2017) Checklist for psychosocial risk evaluation: a prospective evaluation study. *Occup Med (Lond),* **67**(1), 7-12.

Wit, J.M. & Boersma, B. (2002) Catch-up growth: definition, mechanisms, and models. *J Pediatr Endocrinol Metab,* **15 Suppl 5**, 1229-41.

Xiong, X., Wightkin, J., Magnus, J.H., Pridjian, G., Acuna, J.M. & Buekens, P. (2007) Birth weight and infant growth: optimal infant weight gain versus optimal infant weight. *Matern Child Health J,* **11**(1), 57-63.

Zimmerman, E. (2018) Do Infants Born Very Premature and Who Have Very Low Birth Weight Catch Up With Their Full Term Peers in Their Language Abilities by Early School Age? *J Speech Lang Hear Res,* **61**(1), 53-65.

ADDENDUM

Full questionnaire

Table 1. Baseline characteristics (n=58)

Occupation	PCHC nurse	49 (84,5%)	PCHC physician	9 (15,5%)
Education	Basic training	29	Basic training	3
	Extended training	12	Extended training	5
Average age (min-max)	41,8 years (24-60)			
Average working experience (min-max)	12 years (1-35)			
Patient related contact per week (min-max)	3 days (2-5)			
Amount of neonatal contacts a year (min-max)	160 hours (50-900)			

Table 2. Postnatal home visit (n=58)

Planned time	30 minutes	1 (1,7%)
	45 minutes	4 (6,9%)
	60 minutes	38 (65,5%)
	75 minutes	10 (17,2%)
	>75 minutes	5 (8,6%)
Protraction of the consult is taken into consideration	No	26 (44,8%)
	Yes, for every single home visit	20 (34,5%)
	Yes, by means of a timeframe	3 (5,2%)
	Yes, by means of breaks planned in between	3 (5,2%)
How much time do you actually need for a postnatal home visit?	Less than planned	1 (1,7%)
	Just as much as planned	40 (69%)
	More than planned	14 (24,1%)
	Much more than planned	3 (5,2%)
Reason why a home visit takes longer than planned	A lot of problems in a family	14 (24,1%)
	It takes more time to discuss all topics that need to be discussed	1 (1,7%)
	II don't perform postnatal home visits	1 (1,7%)
	Insecurity of the parents, lots of questions	1 (1,7%)

Table 3. Kick-off meeting / training (n=58)

Question	Answer	n (%)
Were you present?	No	6 (10,3%)
	Yes, only the kick-off meeting	7 (12,1%)
	Yes, only the training	2 (3,4%)
	Yes, both	42 (72,4%)
	Missing	1 (1,7%)
The kick-off meeting provided enough information concerning the study/instrument	Disagree	3 (5,2%)
	Neutral	11 (19%)
	Agree	32 (55,2%)
	Totally agree	3 (5,2%)
	Missing	9 (15,5%)
The training provided an addition to my conversation skills	Completely disagree	6 (10,3%)
	Disagree	9 (15,5%)
	Neutral	19 (32,8%)
	Agree	10 (17,2%)
	Missing	14 (24,1%)
The training was provided an addition to my daily practices in PCHC	Completely disagree	1 (1,7%)
	Disagree	3 (5,2%)
	Neutral	12 (20,7%)
	Agree	30 (51,7%)
	Missing	12 (20,7)
Information about the study and the postnatal R4U was easily accessible	Disagree	2 (3,4%)
	Neutral	17 (29,3%)
	Agree	38 (65,5%)
	Missing	1 (1,7%)

Table 4. Risk assessment (n=58)

How often do you encounter families with multiple non-medical risk factors?	Couple of times a year	6 (10,3%)
	Couple of times a month	21 (36,2%)
	Couple of times a week	14 (24,1%)
	Every day	7 (12,1%)
	Multiple times a day	8 (13,8%)
	Missing	2 (3,4%)
Amount of colleagues that pays attention to non-medical risk factors in PCHC daily practice?	Half	2 (3,4%)
	The majority	4 (6,9%)
	Everybody	46 (79,3%)
	I don't know	2 (3,4%)
	Missing	4 (6,9%)
How often do you experience communication problems with clients?	Never	3 (5,2%)
	Couple of times a month	22 (37,9%)
	Couple of times a week	15 (25,9%)
	Every day	9 (15,5%)
	Multiple times a day	3 (5,2%)
	Missing	2 (3,4%)
	Couple of times a month	4 (6,9%)

Table 5. Knowledge of PCHC professionals on growth and developmental problems in children

Growth	**No**	**Yes**	**Missing**
Smoking	36 (62,1%)	18 (31%)	4 (6,9%)
Drug abuse	40 (69%)	14 (24,1%)	4 (6,9%)
Low income	5 (8,6%)	49 (84,5%)	4 (6,9%)
Relationship problems	18 (31%)	36 (62,1%)	4 (6,9%)
Domestic violence	24 (41,4%)	30 (51,7%)	4 (6,9%)
Overweight status of the mother	2 (3,4%)	52 (89,7%)	4 (6,9%)
Alcohol abuse	32 (55,2%)	22 (37,9%)	4 (6,9%)
Financial problems/ debts	12 (20,7%)	42 (72,4%)	4 (6,9%)
Medicine	17 (29,3)	37 (63,8)	4 (6,9%)
Lack of social support	7 (12,1)	47 (81%)	4 (6,9%)
Housing problems	25 (43,1%)	29 (50%)	4 (6,9%)
Development	**No**	**Yes**	**Missing**
Smoking	12 (19%)	42 (72,4%)	4 (6,9%)
Drug abuse	11 (19%)	43 (74,1%)	4 (6,9%)
Low income	8 (13,8%)	46 (79,3%)	4 (6,9%)
Relationship problems	4 (6,9%)	50 (86,2%)	4 (6,9%)
Domestic violence	5 (8,6%)	49 (84,5%)	4 (6,9%)
Overweight status of the mother	21 (36,2%)	33 (56,9%)	4 (6,9%)
Alcohol abuse	10 (17,2%)	44 (75,9%)	4 (6,9%)
Financial problems/ debts	6 (10,3%)	48 (82,8%)	4 (6,9%)
Medicine	16 (27,6%)	38 (65,5%)	4 (6,9%)
Lack of social support	3 (5,2%)	51 (87,9%)	4 (6,9%)
Housing problems	11 (19%)	43 (74,1%)	4 (6,9%)

Table 6. Risk factor present in which amount of your clients?

	None	Minority	Half	Majority	Everybody	Missing
Smoking	3 (5,2%)	2 (3,4%)	3 (5,2%)	12 (20,7%)	32 (55,2%)	6 (10,3%)
Drug abuse	2 (3,4%)	8 (13,8%)	1 (1,7%)	11 (19%)	30 (51,7%)	6 (10,3%)
Low income	1 (1,7%)	10 (17,2%)	6 (10,3%)	15 (25,9%)	20 (34,5%)	6 (10,3%)
Relationship problems	2 (3,4%)	14 (24,1%)	6 (10,3%)	16 (27,6%)	14 (24,1%)	6 (10,3%)
Domestic violence	5 (8,6%)	26 (44,8%)	3 (5,2%)	7 (12,1%)	11 (19%)	6 (10,3%)
Overweight status of the mother	5 (8,6%)	16 (27,6%)	7 (12,1%)	11 (19%)	13 (22,4%)	6 (10,3%)
Alcohol abuse	3 (5,2%)	9 (15,5%)	1 (1,7%)	9 (15,5%)	30 (51,7%)	6 (10,3%)
Financial problems/ debts	1 (1,7%)	15 (25,9%)	2 (3,4%)	16 (27,6%)	18 (31%)	6 (10,3%)
Medicine	2 (3,4%)	13 (22,4%)	1 (1,7%)	7 (12%)	29 (50%)	6 (10,3%)
Lack of social support	0 (0%)	1 (1,7%)	8 (13,8%)	13 (22,4%)	30 (51,7%)	6 (10,3%)
Housing problems	1 (1,7%)	15 (25,9%)	4 (6,9%)	15 (25,9%)	17 (29,3%)	6 (10,3%)

Table 8. Care pathways: when multiple risk factors are present in a family, what action do you undertake?

N = 58	**No intervention**	**Intervention using a care pathway**	**No care pathway, but monitoring of the situation**	**No care pathway, but an intervention with own resources**	**No care pathway, but an intervention with other care providers**
None of the cases	10 (17,2%)	20 (34,5%)	1 (1,7%)	0 (0%)	1 (1,7%)
Minority of the cases	15 (25,9%)	21 (36,2%)	5 (8,6%)	10 (17,2%)	20 (34,5%)
Half of the cases	5 (8,6%)	7 (12,1%)	11 (19%)	11 (19%)	6 (10,2%)
Majority of the cases	14 (24,1%)	3 (5,2%)	26 (44,8%)	24 (41,4%)	18 (31%)
Everyone	7 (12,1%)	0 (0%)	8 (13,8%)	6 (10,3%)	6 (10,2%)
Missing	7 (12,1%)	7 (12,1%)	7 (12,1%)	7 (12,1%)	7 (12,1%)

Table 9. Non-medical risk factors are present, but no intervention is offered. Why?

Position 1	**Amount (%) n = 58**
1. Client related restraints	32 (55,2%)
2. Care provider related restraints	12 (20,7%)
3. Intervention related restraints	5 (8,6%)
Missing	9 (15,5%)
Position 2	**Amount (%) n = 58**
1. Intervention related restraints	24 (41,4%)
2. Care provider related restraints	16 (27,6%)
3. Client related restraints	9 (15,5%)
Missing	9 (15,5%)
Position 3	**Amount (%) n = 58**
1. Care provider related restraints	21 (36,2%)
2. Intervention related restraints	20 (34,5%)
3. Client related restraints	8 (13,8%)
Missing	9 (15,5%)

Table 10. Consulting other care providers concerning non-medical risk factors

N = 58	Midwivery	Medical obstetrics	GP	Pediatrician	Social work	Maternity care	Psychosocial care	Youth social care	Veilig Thuis	Other
None of the cases	9 (15,5%)	37 (63,8%)	7 (12,1%)	7 (12,1%)	4 (6,9%)	6 (10,3%)	17 (29,3%)	3 (5,2%)	2 (3,4%)	7 (12,1%)
Minority of the cases	35 (60,3%)	11 (19%)	29 (50%)	35 (60,3%)	26 (44,8%)	31 (53,4%)	28 (48,3%)	22 (37,9%)	32 (55,2%)	21 (36,2%)
Half of the cases	1 (1,7%)	0 (0%)	6 (10,3%)	3 (5,2%)	14 (24,1%)	8 (13,8%)	2 (3,4%)	12 (20,7%)	6 (10,3%)	8 (13,8%)
Majority of the cases	4 (6,9%)	1 (1,7%)	7 (12,1%)	4 (6,9%)	5 (8,6%)	4 (6,9%)	2 (3,4%)	12 (20,7%)	9 (15,5%)	12 (20,7%)
Everyone	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1,7%)
Missing	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)	9 (15,5%)

Table 11. How satisfied are you with non-medical risk assessment in current PCHC practice?

	Amount (%)
Very unsatisfied	0 (0)
Unsatisfied	5 (8,6)
Neutral	23 (39,7)
Satisfied	15 (25,9)
Very satisfied	5 (8,6)
Missing	*10 (17,2)*

Table 12. Who should care for families with non-medical risk factors?

	Amount 'yes'(%)
Community midwife	8 (13,8)
Gynecologist/ obstetrician	2 (3,4)
General Practitioner	19 (32,8)
Pediatrician	9 (15,5)
Social work	32 (55,2)
Maternity care	5 (8,6)
PCHC physician	23 (39,7)
PCHC nurse	39 (67,2)
District teams	44 (75,9)
Youth social care	34 (58,6)
Missing	*10 (17,2)*

Table 13. With which care provider would you like to have an intensified collaboration?

	Amount 'yes' (%)
Community midwife	24 (41,4)
Gynecologist/ obstetrician	13 (22,4)
General Practitioner	31 (53,4)
Pediatrician	21 (36,2)
Social work	28 (48,3)
Maternity care	17 (29,3)
PCHC physician	35 (60,3)
PCHC nurse	26 (44,8)
Others	Physiotherapist (1,7), specialized family care (1,7)
Missing	*10 (17,2)*

Table 14. For the first home visit, did you receive a handover from the following care providers?

N = 58	Midwifery	Gynecology	General practitioner	Pediatrics	Maternity care	District teams
None	2 (3,4%)	10 (17,2%)	35 (60,3%)	6 (10,3%)	1 (1,7%)	23 (39,7%)
A minority	8 (13,8%)	16 (27,6%)	12 (20,7%)	28 (48,3%)	5 (8,6%)	22 (37,9%)
Half of the time	8 (13,8%)	5 (8,6%)	0 (0%)	3 (5,2%)	4 (6,9%)	3 (5,2%)
Most	24 (41,4%)	14 (24,1%)	1 (1,7%)	13,8%)	23 (39,7%)	0 (0%)
Everyone	6 (10,3%)	3 (5,2%)	0 (0%)	3 (5,2%)	15 (25,9%)	0 (0%)
Missing	*10 (17,2%)*	*10 (17,2%)*	*10 (17,2%)*	*10 (17,2%)*	*10 (17,2%)*	*10 (17,2%)*

Table 15. If you received a handover(document), did this handover include the following topics?

	Parity	Duration of pregnancy	Previous pregnancy complications	Dramatic events	Smoking	Alcohol consumption
Never	0	0	0	0	1 (1,7)	1 (1,7)
Mostly not	0	0	5 (8,6)	4 (6,9)	4 (6,9)	7 (12,1)
Half of the times	3 (5,2)	0	16 (27,6)	19 (32,8)	17 (29,3)	16 (27,6)
Mostly yes	28 (48,3)	23 (39,7)	16 (27,6)	18 (31)	16 (27,6)	13 (22,4)
Always	16 (27,6%)	24 (41,4)	10 (17,2)	6 (10,3)	9 (15,5)	10 (17,2)
Missing	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*

	Drugs	Complications during pregnancy	Complications during delivery	Complications maternity care period	Birthweight of the baby	Weight of the parents
Never	0	0	0	0	0	35 (60,3)
Mostly not	6 (10,3)	0	0	4 (5,2)	0	11 (19)
Half of the time	17 (29,3)	9 (15,5)	4 (6,9)	11 (19)	0	1 (1,7)
Mostly yes	16 (27,6)	26 (44,8)	28 (48,3)	23 (39,7)	17 (29,3)	0
Always	8 (13,8)	12 (20,7)	15 (25,9)	10 (17,2)	30 (51,7)	0
Missing	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*	*11 (19)*

Table 16. Can you include the following information in the digital PCHC file?

	Yes (%)
Parity	37 (63,8)
Duration of pregnancy	47 (81)
Previous pregnancy complications	45 (77,6)
Dramatic events	47 (81)
Smoking	47 (81)
Alcohol consumption	47 (81)
Drugs	47 (81)
Complications during pregnancy	46 (79,3)
Complications during delivery	46 (79,3)
Complications maternity care period	46 (79,3)
Birthweight of the baby	47 (81)
Weight of the parent(s)	20 (34,5)
Missing	*11 (19)*

Table 17. How often is an antenatal home visit by PCHC conducted?

	Amount (%)
None	21 (36,2)
Minority	24 (41,4)
Half of the time	1 (1,7)
Not applicable	1 (1,7)
Missing	11 (19)

Table 18. How often is a case manager appointed in case of multiple problems?

	Amount (%)
None	8 (13,8)
Minority	10 (17,2)
Half of the time	8 (13,8)
Not applicable	18 (31)
Missing	3 (5,2)
None	11 (19)

Table 19. How are case consultations organized?

	Amount (%)
Separate with different care providers	16 (27,6)
During an existing multidisciplinary consultation	20 (34,5)
There are no case consultations organized	5 (8,6)
In a different manner	6 (10,3)
Missing	11 (19)

Table 20. Who can participate during a case consultation?

	Yes (%)
Gynecologist	10 (17,2)
Pediatrician	15 (25,9)
Clinical midwife	6 (10,3)
Community midwife	17 (29,3)
Lactation consultant	9 (15,5)
General Practitioner	29 (50)
Mental healthcare	17 (29,3)
Child protection services	27 (46,6)
Guardian	25 (43,1)
Clinical residents	9 (15,5)
Clinical nurses	9 (15,5)
Maternity care	15 (25,9)
Youth services	33 (56,9)
District team	39 (67,2)
Social work	30 (51,7)
Physiotherapy	21 (36,2)
Speech therapy	21 (36,2)
Dietician	18 (31)
Specialized care projects (i.e. for teenage moms)	29 (50)
Clients/ parents	31 (53,4)
Other	8 (13,6)
Missing	*11 (19)*

Table 21. Is a periodically planned consultation organized?

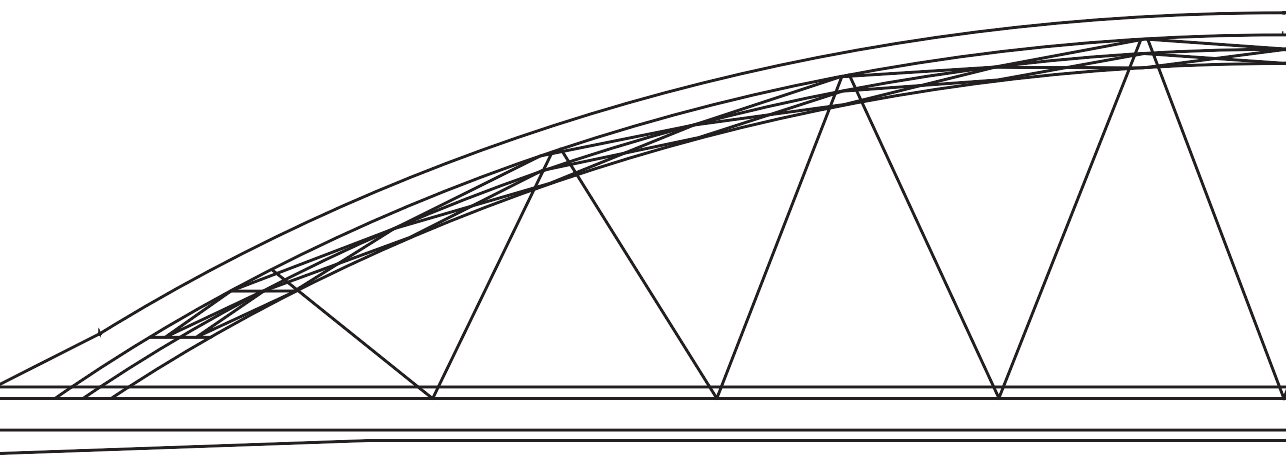
	Yes(%)
Gynecologist	0
Pediatrician	0
Clinical midwife	0
Community midwife	1 (1,7)
Lactation consultant	0
General Practitioner	5 (8,6)
Mental healthcare	2 (3,4)
Child protection services	2 (3,4)
Guardian	1 (1,7)
Maternity care	1 (1,7)
Youth services	12 (20,7)
District team	23 (39,7)
Social work	6 (10,3)
Physiotherapy	4 (6,9)
Speech therapy	5 (8,6)
Dietician	1 (1,7)
Specialized care projects (i.e. for teenage moms)	2 (3,4)
Clients/ parents	5 (8,5)
Other	*11 (19)*

Table 22. How often do you receive feedback after handover?

		Do you feel restricted concerning referral possibilities?
Never	2 (3,4)	1 (1,7)
Mostly not	11 (19)	13 (22,4)
Half of the time	21 (36,2)	27 (46,6)
Mostly yes	11919)	5 (8,6)
Always	2 (3,4)	1 (1,7)
Missing	*11 (19)*	*11 (19)*

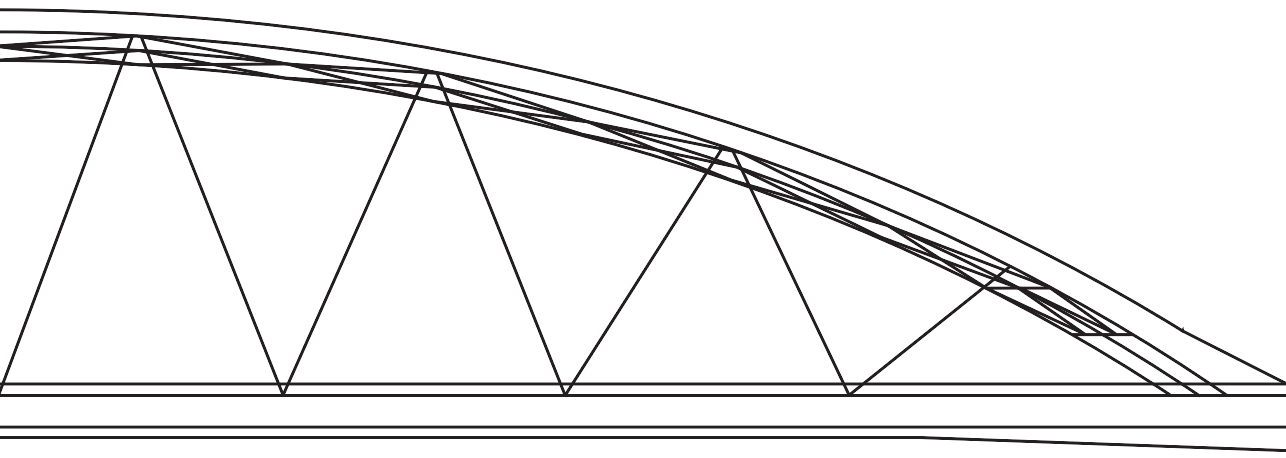
Table 23. Is the current consultation structure a desirable situation?

Is the current consultation structure a desirable situation?	**Amount (%)**
Definitely not	3 (5,2)
No	16 (27,6)
Maybe yes, maybe no	17 (29,3)
Yes	11 (19)
Definitely yes	0 (0)
Missing	*11 (19)*



Chapter 8

General discussion



In this thesis the postnatal care for vulnerable children and their wellbeing are studied, along with an innovative postnatal risk assessment. The overall goal was to address children's health inequities from birth onwards.

SOCIAL DETERMINANTS IN HEALTH

Inequity differs from inequality, whereas the latter refers to social disparity, inequity refers to lack of fairness. (1) To quote the World Health Organization (2008): "Equity is a concept based on the human-rights principles of social justice and fairness. It is an approach that addresses the unfair and avoidable differences among social groups with an aim of achieving more equal outcomes. Health equity is the notion that everyone should have a fair opportunity to attain their full potential and that no one should be disadvantaged from achieving this. Health inequities are the unjust differences in health between persons of different social groups, and can be linked to forms of disadvantage such as poverty, discrimination and lack of access to services or goods. Health inequities are rooted in social injustices that make some population groups more exposed to health risks, and more vulnerable to poor health than other groups. This implies that health inequities are systematic differences in the health status of different population groups. These inequities generate significant social and economic costs both to individuals and societies." (2)

After birth, a child is brought into a household with specific norms, values and socioeconomic status (parental SES), they live in a particular neighborhood with a certain socioeconomic status (neighborhood SES), in a country with its own laws and regulations. These familial norms and values, neighborhood SES and laws and regulations may affect prospects in life, resulting in children being born with unequal opportunities to develop, leading to inequities. Social and economic elements severely impact perinatal and child health, growth, development, school achievements and career opportunities in later life. (3) These inequities which start before conception should be of great political and societal concern.

More awareness and knowledge of the social determinants of health in early life could stimulate policy makers and society to create social and physical environments that diminish health inequities and promote the chances of children to develop and grow to their full potential. This thesis aimed to contribute to this knowledge and to the design of preventive strategies to support health professionals in their care for vulnerable families. In the following paragraphs the context, opportunities and clinical implications of our findings and future research directions are discussed.

CHILD WELLBEING IN THE NETHERLANDS

Neighbourhood and parental SES were shown to affect child and adolescent wellbeing and their wellbeing in later life (**chapter 2** and **5**). This disadvantage starts effectively during foetal development, and even before conception; children born in families with a low SES are more likely to be born preterm or with a low birthweight. (4) These children are more likely to be overweight or obese during childhood and they have a higher risk of developmental, (5-7) behavioural and psychosocial problems. (8-10) As young adults, these children often show weaker work commitment. (11) Even in a high developed country such as the Netherlands, geographical differences in perinatal health and child welfare are present. (12) The differences between neighbourhoods can be attributed to clustering of families with a low familial SES, and to adverse geographical features, including population density and environmental factors, such as air pollution and distance to healthcare. (13-15) Preconception, prenatal, perinatal and postnatal risk factors affect child growth and development (**chapter 2** and **5**). These include medical risk factors, such as preterm birth and being born small for gestational age (SGA, birth-weight <10th percentile), and non-medical risk factors, such as living in deprivation and social isolation (**chapter 2** and **5**). Importantly, the accumulation of multiple risk factors is the main cause of vulnerability and adverse health outcomes. (16)

OPPORTUNITIES OF THE DUTCH PREVENTIVE CHILD HEALTHCARE

Preventive Child Healthcare (PCHC) in the Netherlands is unique in its design and approach; (17) this offers a great opportunity to address inequity from birth onward. Well-baby clinics are accessible for all families free of charge. (18, 19) During the visits to well-baby clinics, nurses and physicians assess the weight, height and development of children from zero until 19 years old. Additionally, the national vaccination program is executed (**chapter 5**). The attendance rate is high, with over 95% attendance for all children under the age of four (**chapter 5**). PCHC professionals encounter vulnerable families quite often, especially those working in deprived neighborhoods (**chapter 3**). Essentially, PCHC professionals consider the care for vulnerable families as their responsibility (**chapter 3**).

REFLECTION ON OBTAINED RESULTS

Dutch neighborhoods with a lower SES inhabit more children in families living on welfare and inhabit more delinquent and unemployed youth (**chapter 2**). In these deprived neighborhoods PCHC professionals encounter vulnerable families more often and experience more communi-

cation problems with their clients than their colleagues working in non-deprived neighborhoods (**chapter 3**). A large amount of PCHC professionals felt the need for a structured postnatal risk assessment, including intensified collaboration with district teams, general practitioners and community midwives (**chapter 3**), which might be specifically useful in deprived neighborhoods. In addition, to improve care for vulnerable families a qualitative research study with community midwifes, maternity care assistants and PCHC nurses, revealed that the handover in primary care needed improvement; digitized data transfer is preferred, and more peer agreements between partner organizations in neighborhoods need to be drafted (**chapter 4**).

Subsequently, the postnatal Rotterdam Reproductive Risk Reduction checklist (R4U) was designed, evaluated and implemented using the Intervention Mapping process (**chapter 5**). Intervention Mapping is a six-step protocol that guides the design of multilevel health promotion interventions and implementation strategies. (20) The postnatal R4U was drafted after a scoping review of the literature and focus group meetings to assess expert opinion (**chapter 5**).

During the evaluation study, we used catch-up growth as the primary outcome measure in a historically controlled study design (**chapter 7**). Catch-up growth was defined as more than 0.67 SDS weight for height gain in the first six months of life. (21) Children in the intervention cohort with the postnatal R4U and corresponding care pathways showed significantly less often catch-up growth in the first six months of life than children in the historical cohort (**chapter 7**). Furthermore, our study showed some hesitance and resistance from the PCHC professionals during the design and implementation of the postnatal R4U (**chapter 3** and **chapter 7**). Most professionals thought that the care including the postnatal R4U and the corresponding care pathways was not superior to their standard care (**chapter 7**). The study results indicate that a definite need is felt by professionals to improve risk selection shortly after birth in order to reduce inequities from birth onward, which may be specifically useful in low SES neighborhoods. This risk selection with related care pathways also has been shown to be effective. However, implementation in preventive child health care of such a risk selection instrument has not yet turned out to be self-evident, implying that impeding and facilitating factors have not yet been addressed sufficiently. In the future, it seems important that PCHC professionals will be more engaged, involved and facilitated from the start of studies executed in the well-baby clinics they work in.

Methodological considerations

The studies described in this thesis have been conducted as part of the Healthy Pregnancy 4 All-2 program. (12) The program focused on creating a continuum for risk selection and tailored care pathways from preconception and antenatal care towards postpartum care, early childhood care, as well as interconception care. (12) During this study we were able to design, implement and execute an innovative postnatal risk assessment along with its corresponding

care pathways. One of the strengths of this study was the joint collaboration of the government, municipal health services, university, healthcare providers and various stakeholders, such as municipal officials and child healthcare managers. This approach was lengthy, and also exceptional in the Netherlands. A few methodological considerations will be discussed in the next paragraphs.

Health behavior model

We used the 'Attitude- Social influences- Self efficacy' (ASE-) model to predict subsequent behavior, specifically the intention to implement and execute the postnatal R4U and corresponding care pathways was of interest. (22) This model has been successfully applied in several studies to explain various aspects of health behavior. (23, 24) However, the ASE model probably did not include all elements needed to guarantee a successful implementation in the PCHC setting, resulting in low adherence to the study (**chapter 7**). We tried to improve adherence to the study by frequent visits by the researchers to the well-baby clinics, group training and implementation of prolonged consultations (**chapter 5**). Despite our efforts, professional satisfaction was limited (**chapter 7**). Future studies should also focus on engaging the PCHC professionals involved during the conceptualization and the design of the study.

Information bias

We used self-reported questionnaires to assess professional satisfaction and interviews to assess handover strategies, which could have led to information bias from measurement error. There are two types of information bias, namely recall bias and misclassification. (25) Recall bias could have occurred as data regarding current practices in postnatal risk screening and handover in primary care were collected by questionnaires retrospectively. Almost all professionals who participated in our studies were employed in their field of expertise at that time and had worked with clients in the month prior to our study (**chapter 3**, **5** and **7**).

Missing data

Missing data occurred in our dataset, due to either no registration of the data by PCHC professionals or technical issues during the transferring or scripting process (**chapter 7**). Imputation of missing data was not possible because missing data on the variables concerned was over 90% (**chapter 7**). Imputing data where most variables are missing, results in an outcome that is not reliable.

Missing data occurs in almost all research. (26) Missing data can reduce the statistical power of a study, leading to invalid conclusions. (26) There are three types of missing data, according to the mechanisms of missingness: (26) 1) Missing completely at random (MCAR) is defined as when the probability that the data are missing is not related to either the specific value which is supposed to be obtained; 2) Missing at random (MAR) is defined as when the probability that the data is missing depends on the set of observed responses, but is not related to the specific

missing values which is expected to be obtained; 3) If the characters of the data do not meet those of MCAR or MAR, then they fall into the category of missing not at random (MNAR). (26) In the variables containing missing values, the missing values exceeded more than 50% even up to values of 90% (**chapter 7**). This raised the suggestion that the values might be MNAR, and this implies that the variables are not eligible for imputation (**chapter 7**). We presumed that imputation would make our results less reliable and less generalizable. Missing data did prevent us to correct for confounding, however, the variables used for our primary outcome measure contained no missing data (**chapter 7**). Alternatively, we performed a sensitivity analysis using a logistic regression model and matching (**chapter 7**).

FUTURE PERSPECTIVES AND RECOMMENDATIONS

This thesis provides several recommendations which have been allocated and explicated per field.

Recommendations for the local government

Local governments should be aware of differences in neighborhood socioeconomic status (SES) and the effects on child wellbeing (**chapter 2**). Therefore, local governments should strive to improve equity between neighborhoods. This can be achieved by supporting families with a low socio-economic status, e.g. by offering free sport facilities and supporting sport participation (**chapter 2**). Neighborhood playgrounds could be made safer and more child friendly. (27) Not every municipality has a structured organized meeting for primary obstetric care professionals and PCHC (**chapter 4**). Based on the study results described in this thesis it is recommended that local governments should endorse and facilitate community midwives, maternity care and PCHC to organize structured meetings in order to improve prenatal and postnatal collaboration between these healthcare professionals (**chapter 4**). To enhance handover in primary care, a digitized handover is preferred (**chapter 4**). Local and national governments should collaborate in designing and facilitating a national digital client file to be used by all professionals in healthcare organizations and hospitals (**chapter 4**).

Recommendations for PCHC organizations

Handover and collaboration with obstetric care, maternity care and pediatricians could be facilitated by involving PCHC in the 'obstetric collaborative network' (in Dutch: Verloskundig Samenwerkingsverband: (VSV)) , a local or regional meeting between obstetric care professionals (**chapter 4**). This implies that PCHC organizations should push for collaboration with the 'obstetric collaborative network' in their region and thus enable their nurses and physicians to join the network meetings (**chapter 4**). In addition, implementation of the postnatal R4U is feasible and effective in reducing growth disturbances in young children (**chapter 7**). Future

investments should be prioritized to new innovations in PCHC, such as an update of the postnatal R4U for certain risk groups (e.g. for children born preterm and with a low birthweight) and offering training and facilities to PCHC nurses and physicians (**chapter 7**). The Dutch Youth Center and the management of PCHC organizations could conjoint efforts to promote structured postnatal risk assessment in PCHC (**chapter 7**), to further evaluate and validate the found effects of the implementation of the postnatal R4U, and to compare the postnatal R4U with other postnatal instruments (**chapter 7**).

Recommendations for clinical practice

Awareness of the existence of vulnerable families and risk factors involved, especially in low SES neighborhoods, is present among PCHC professionals (**chapter 3**). However, efforts should be taken to intensify collaboration with other healthcare professionals to improve care for these vulnerable families (**chapter 3**). Professionals working in obstetric healthcare, maternity care and PCHC must be encouraged to collaborate on a structural basis (**chapter 4**). A warm handover to other healthcare professionals ought to occur more often in order to improve collaboration and quality of care (**chapter 4**). The above could be conditions for the health insurance companies when drawing agreements with midwives and hospitals. The postnatal R4U seems to be an effective tool to screen for vulnerable children and families and can have a surplus value in PCHC (**chapter 7**). Further research is needed to develop and finally implement guidelines for PCHC to cover the issues addressed in this thesis, whereas municipalities should offer substantial financing to extend the consultation time for screening methods at the well-baby clinics.

Recommendations for future research

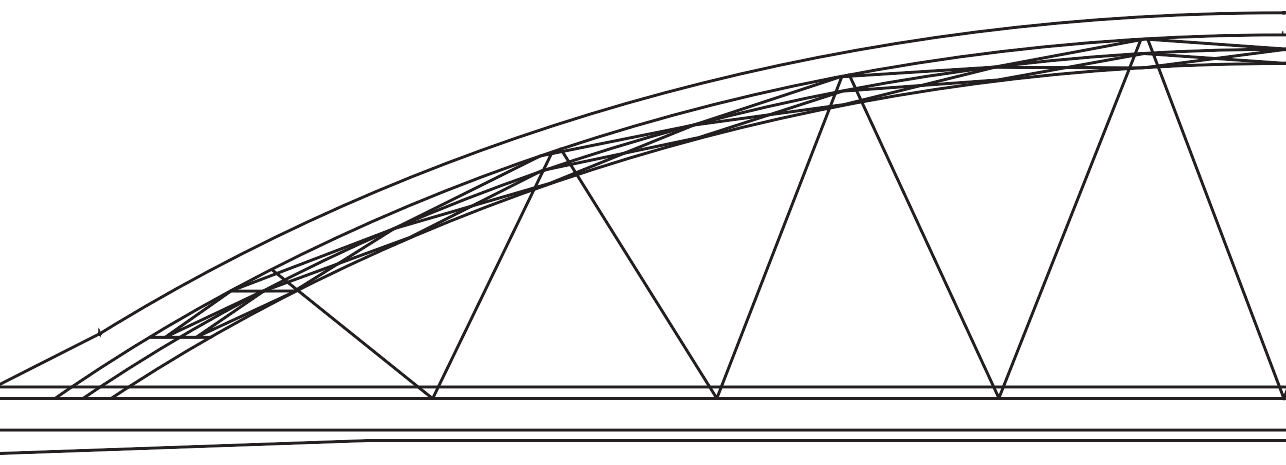
Although using historical data possibly increases the risk of missing data (**chapter 7**), a historically controlled study is a feasible alternative study design, without risk of contamination bias between the intervention and control group (**chapter 6** and **7**). Our study showed that the opt-out methodology could be considered in future research, when all preconditions are met (**chapter 6** and **7**). The methods we applied may also be an advantage in new public health studies.

Our study findings gave new insights but also led to more research questions. We concluded that collaboration between professionals in primary obstetric care and PCHC ought to be improved, and therefore it is recommended to study how this can be realized (**chapter 4**). Future research should also focus on new innovations in PCHC, such as an update of the postnatal R4U for certain risk groups; additionally, prediction modelling could be applied to reduce the amount of risk factors to be assessed (**chapter 7**). Furthermore, the predictive value of the postnatal R4U for neurodevelopmental outcomes still needs to be assessed, since these are highly predictive for societal participation in later life. (11, 28)

REFERENCES

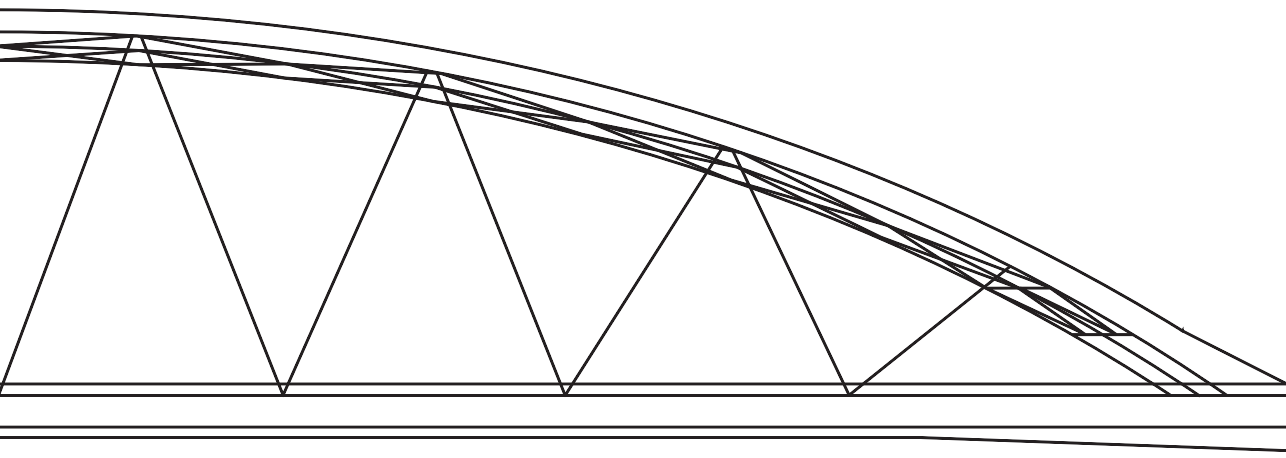
1. Braveman P. Health disparities and health equity: concepts and measurement. . *Annu Rev Public Health* 2006;2006;27:167-94 doi: 10.1146/annurev.publhealth.27.021405.102103. PMID: 16533114.
2. Hosseinpoor AR BN, Schlotheuber A. . Promoting health equity: WHO health inequality monitoring at global and national levels. . *Glob Health Action* 2015;Sep 18;8:29034. doi: 10.3402/gha.v8.29034. PMID: 26387506; PMCID: PMC4576419.
3. Bradley RH, Corwyn RF. Socioeconomic status and child development. *Annu Rev Psychol* 2002;53:371-99.
4. Denktas S, Poeran J, van Voorst SF, et al. Design and outline of the Healthy Pregnancy 4 All study. *BMC Pregnancy Childbirth* 2014;14:253.
5. Schjolberg S, Eadie P, Zachrisson HD, et al. Predicting language development at age 18 months: data from the Norwegian Mother and Child Cohort Study. *J Dev Behav Pediatr* 2011;32(5):375-83.
6. Rijlaarsdam J, Stevens GW, van der Ende J, et al. Economic disadvantage and young children's emotional and behavioral problems: mechanisms of risk. *J Abnorm Child Psychol* 2013;41(1):125-37.
7. Rijlaarsdam J, Tiemeier H, Hofman A, et al. Home environments of infants: relations with child development through age 3. *J Epidemiol Community Health* 2013;67(1):14-20.
8. Rothon C, Goodwin L, Stansfeld S. Family social support, community "social capital" and adolescents' mental health and educational outcomes: a longitudinal study in England. *Soc Psychiatry Psychiatr Epidemiol* 2012;47(5):697-709.
9. Anderson LR. Adolescent mental health and behavioural problems, and intergenerational social mobility: A decomposition of health selection effects. *Soc Sci Med* 2018;197:153-60.
10. Chzhen Y, Moor I, Pickett W, et al. International trends in 'bottom-end' inequality in adolescent physical activity and nutrition: HBSC study 2002-2014. *Eur J Public Health* 2018
11. Nieuwenhuis J, Yu R, Branje S, et al. Neighbourhood Poverty, Work Commitment and Unemployment in Early Adulthood: A Longitudinal Study into the Moderating Effect of Personality. *PLoS One* 2016;11(12):e0167830.
12. Waelput AJM, Sijpkens MK, Lagendijk J, et al. Geographical differences in perinatal health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. *BMC Pregnancy Childbirth* 2017;17(1):254.
13. Scholmerich VL, Erdem O, Borsboom G, et al. The association of neighborhood social capital and ethnic (minority) density with pregnancy outcomes in the Netherlands. *PLoS One* 2014;9(5):e95873.
14. Westergaard N, Gehring U, Slama R, et al. Ambient air pollution and low birth weight - are some women more vulnerable than others? *Environ Int* 2017;104:146-54.
15. Ravelli P, Hakuta K, Simpson T. Achieving health equity through oral health value-based care: a funder's perspective. *J Public Health Dent* 2020;80 Suppl 2:S80-S82.
16. Timmermans S BG, Steegers-Theunissen RP, Mackenbach JP, Steyerberg EW, Raat H, Verbrugh HA, Tiemeier HW, Hofman A, Birnie E, Looman CW, Jaddoe VW, Steegers EA. . Individual accumulation of heterogeneous risks explains perinatal inequalities within deprived neighbourhoods. . *Eur J Epidemiol* 2011;Feb;26(2):165-80. doi: 10.1007/s10654-010-9542-5. Epub 2011 Jan 4. PMID: 21203801; PMCID: PMC3043261.
17. Jacobusse G, van Buuren S, Verkerk PH. An interval scale for development of children aged 0-2 years. *Stat Med* 2006;25(13):2272-83.
18. van der Pal SM, Heerdink N, Kamphuis M, et al. [Dutch Preventive Youth Health Care Service guideline on children born too early and/or too small for gestational age] in Dutch: JGZ-richtlijn 'Te vroeg en/of small for gestational age (SGA) geboren kinderen'. *Ned Tijdschr Geneeskd* 2014;158:A6745.

19. Postma S. JGZ-richtlijn Vroegsignalering van psychosociale problemen: RIVM, 2008.
20. Garba RM, Gadanya MA. The role of intervention mapping in designing disease prevention interventions: A systematic review of the literature. *PLoS One* 2017;12(3):e0174438.
21. Jordan IM, Robert A, Francart J, et al. Growth in extremely low birth weight infants up to three years. *Biol Neonate* 2005;88(1):57-65.
22. H. de Vries MD, P. Kuhlman,. Self-efficacy: third factor besides attitude and subjective norm as a predictor of behavioral intentions. *Health Educ Res,* 1988;3:273-82.
23. H. de Vries EB, G. Kok, M. Dijkstra,. The impact of social influences in the context of attitude, self-efficacy, intention and previous behaviour as predictors of smoking onset. *J Appl Soc Psychol,* 1995;25:237-57.
24. J. Brug LL, H. de Vries,. Psychosocial determinants of fruit and vegetable consumption. *Appetite* 1995;25:285-96.
25. Tripepi G, Jager KJ, Dekker FW, et al. Selection bias and information bias in clinical research. *Nephron Clin Pract* 2010;115(2):c94-9.
26. Kang H. The prevention and handling of the missing data. *Korean J Anesthesiol* 2013;64(5):402-6. doi: 10.4097/kjae.2013.64.5.402 [published Online First: 2013/06/07]
27. Parent N GM, Brussoni M, Almas A, Oberle E. . Social determinants of playing outdoors in the neighbourhood: family characteristics, trust in neighbours and daily outdoor play in early childhood. *Can J Public Health* 2021;Feb;112(1):120-127. doi: 10.17269/s41997-020-00355-w. Epub 2020 Aug 5. PMID: 32757122; PMCID: PMC7851233.
28. Leventhal T, Brooks-Gunn J. The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychol Bull* 2000;126(2):309-37.



Chapter 9

Summary / samenvatting



SUMMARY

Geographical related health inequalities and inequities are of huge societal concern, especially when it comes to perinatal health and child welfare. Preventive Child Healthcare (PCHC) in the Netherlands has a unique opportunity to address vulnerable families. In this thesis the aim was to design, implement and study the effectiveness of a postnatal risk assessment in PCHC, as well as to study handover from obstetric care to PCHC and finally, to reduce child growth and developmental problems, particularly in families with a low socio-economic status.

In part 1, we studied the associations between living in a deprived neighborhoods and social indicators of child wellbeing, the way in which screening for non-medical risk factors in PCHC prior to the study with the postnatal risk assessment, the postnatal R4U, was carried out, and the handover between obstetric care and PCHC.

The results of aggregated data from 3565 neighborhoods in 390 municipalities in the Netherlands are presented in **chapter 2**. Longitudinal data on neighbourhood SES scores and social indicators of child wellbeing were used to perform repeated measurements, with one year measurement intervals, over a period of 11 years. Neighbourhood SES was associated with the proportion of 'children living in families on welfare', 'delinquent youth' and 'unemployed youth', after adjustment for year, population size, and clustering within neighborhoods and within a municipality.

In **chapter 3** we assessed current practices in postnatal risk screening and care for non-medical risk factors and the collaboration with other healthcare professionals, in both deprived and non-deprived neighborhoods in the Netherlands. Eight out of ten invited PCHC organizations, from different areas in the Netherlands, participated in this study, where 370 physicians and nurses were employed. Data was collected between June and September 2016. Most of the respondents performed screening for non-medical risk factors in at least 50% of their consultations. PCHC professionals working in deprived neighborhoods encountered significantly more often families with non-medical risk factors and experienced significantly more communication problems than their colleagues working in non-deprived neighborhoods. 48.2% of the respondents were satisfied with the current form of postnatal risk screening in their organization, whereas 41.2% felt a need for a structured postnatal risk assessment.

Chapter 4 contains recommendations for the process of handover of information by primary midwifery care and maternity care to the PCHC in the Netherlands. A qualitative research through semi-structured interviews was conducted. Community midwives, maternity care nurses and PCHC nurses from three municipalities in the Netherlands participated. A total of 18 semi-structured interviews took place from February to April 2017. All those interviewed

emphasized the importance of good information transfer in order to provide optimum care, especially when problems within the family are present. In order to improve care, a large number of healthcare professionals preferred a fully digitized handover of information, providing the privacy of the client is warranted and the system works efficiently. To provide high quality care, it is considered desirable that healthcare workers get to know each other and more peer agreements are prepared. The 'obstetric collaborative network' or another structured meeting was considered most suitable for the exchange between obstetric care and PCHC.

Part 2 entails the design of the postnatal risk assessment, the postnatal R4U, and the design of the postnatal risk assessment study, where the postnatal R4U was implemented and its effectiveness was studied.

The design of the postnatal R4U, according to the six steps of the Intervention Mapping process, is presented in **chapter 5**. Step 1: review of the literature and focus group discussions; Step 2: identification of program objectives on how to develop and implement a risk assessment in PCHC daily practice; Step 3: application of the ASE model to initiate behavioral change in the target group; Step 4: development of the postnatal R4U and corresponding care pathways; Step 5: design of the program adoption and implementation in four PCHC organizations; Step 6: planning program evaluation by a questionnaire and an evaluation meeting. Subsequently in 2015, the 41 item postnatal R4U (the postnatal Rotterdam Reproduction Risk Reduction checklist) was developed and implemented in four PCHC organizations.

In **chapter 6** the rationale and design of a postnatal risk assessment study, is presented. This study aimed to evaluate: (a) the predictive value of an innovative postnatal risk assessment, meant to assess the risk of growth and developmental problems in young children; and (b) its effectiveness in combination with tailored care pathways. It concerns a historically controlled study design and was designed as part of the Healthy Pregnancy 4 All-2 study program. We hypothesized that child growth and developmental problems would be reduced in the intervention cohort due to the implementation of the postnatal risk assessment and corresponding care pathways. The study was approved in August 2016. Data to determine the predictive value of the risk assessment and its effectiveness in combination with its corresponding care pathways would be collected by Preventive Child Health Care nurses and physicians in four Preventive Child Health Care organizations in three municipalities with adverse perinatal outcomes.

Part 3 includes **chapter 7** where the results of the postnatal risk assessment study (chapter 6) were described. Participants enrolled from September 2016 until December 2017. The historical cohort existed of children born in previous years from 2008 until 2016. The outcome measure was defined as catch-up growth, i.e. more than 0.67 standard deviation score weight for height increase in the first 6 months of life. PCHC professionals' opinions were assessed with a digital

survey. After the inclusion period, 1,953 children were included in the intervention cohort and 7,436 children in the historical cohort. Catch-up growth was significantly less common in the intervention cohort (p-value: < 0,001). A regression sensitivity analysis, using matching, showed an odds ratio in favor of the intervention cohort. In the survey, 74 PCHC physicians and nurses participated; most of them were neutral concerning the benefits of the postnatal R4U.

In the general discussion of this thesis health inequalities and health inequities for vulnerable children are discussed, as well as child wellbeing in the Netherlands and opportunities for PCHC. Lastly, we discuss reflections on obtained results and future perspectives and recommendations are presented.

SAMENVATTING

Geografisch gerelateerde gezondheidsverschillen en ongelijkheden zijn van groot maatschappelijk belang, vooral als het gaat om perinatale gezondheid en kinderwelzijn. De jeugdgezondheidszorg (JGZ) in Nederland heeft een unieke kans om kwetsbare gezinnen te signaleren. Het doel van dit proefschrift was het ontwikkelen, implementeren en analyseren van de effectiviteit van een postnatale risicosignalering in de JGZ, evenals het bestuderen van de overdracht van verloskundige- en kraamzorg naar de JGZ en ten slotte het verminderen van groei- en ontwikkelingsproblemen bij jonge kinderen, met name in gezinnen met een lage sociaaleconomische status.

In deel I bestudeerden we de associaties tussen wonen in achterstandswijken en sociale indicatoren van kinderwelzijn, de manier waarop screening op niet-medische risicofactoren inde JGZ plaatsvond voorafgaand aan de studie met de postnatale R4U, en de overdracht tussen verloskundige- en kraamzorg naar de JGZ.

De resultaten van geaggregeerde gegevens van 3565 buurten in 390 gemeenten in Nederland worden gepresenteerd in **hoofdstuk 2**. Longitudinale gegevens over Sociaaleconomische Status (SES)-scores van buurten en sociale indicatoren van kinderwelzijn werden gebruikt om herhaalde metingen uit te voeren, met meetintervallen van een jaar, over een periode van 11 jaar. Postcode SES werd geassocieerd met het aandeel 'kinderen in gezinnen met een bijstandsuitkering', 'delinquente jongeren' en 'werkloze jongeren', na correctie voor jaartal, bevolkingsomvang en clustering binnen buurten en binnen een gemeente.

In **hoofdstuk 3** evalueerden we manier van postnatale risicoscreening en zorg voor niet-medische risicofactoren en de samenwerking met andere zorgprofessionals, zowel in achterstandswijken als in achterstandswijken in Nederland vóór de aanvang van de studie. Acht van de tien uitgenodigde JGZ organisaties, afkomstig uit verschillende gebieden in Nederland, namen deel aan dit onderzoek, waarbij 370 artsen en verpleegkundigen werkzaam waren. De gegevens zijn verzameld tussen juni en september 2016. De meeste respondenten hebben in ten minste 50% van hun consulten gescreend op niet-medische risicofactoren. JGZ medewerkers die in achterstandswijken werken, kwamen significant vaker gezinnen met niet-medische risicofactoren tegen en ondervonden significant meer communicatieproblemen dan hun collega's die in niet-achterstandswijken werkten. 48,2% van de respondenten was tevreden over de huidige vorm van postnatale risicoscreening in hun organisatie, terwijl 41,2% behoefte had aan een gestructureerde postnatale risicosignalering.

Hoofdstuk 4 bevat aanbevelingen voor het proces van informatieoverdracht door de eerstelijns verloskundige zorg en kraamzorg aan de JGZ in Nederland. Er is kwalitatief onderzoek gedaan

door middel van semigestructureerde interviews. Eerstelijns verloskundigen, kraamverzorgenden en jeugdverpleegkundigen uit drie gemeenten in Nederland deden mee aan het onderzoek. Van februari tot april 2017 hebben in totaal 18 semigestructureerde interviews plaatsgevonden. Alle geïnterviewden benadrukten het belang van een goede informatieoverdracht om optimale zorg te kunnen bieden, zeker als er problemen zijn binnen het gezin. Om de zorg te verbeteren gaf een groot aantal zorgprofessionals de voorkeur aan een volledig gedigitaliseerde informatieoverdracht, waarbij de privacy van de cliënt gewaarborgd is en het systeem efficiënt werkt. Om kwalitatief goede zorg te kunnen leveren wordt het wenselijk geacht dat zorgmedewerkers elkaar leren kennen en worden er zo meer collegiale afspraken gemaakt. Voor de uitwisseling tussen verloskundige zorg, kraamzorg en JGZ werd het 'Verloskundig Samenwerkingverband' of een andere gestructureerde bijeenkomst het meest geschikt geacht.

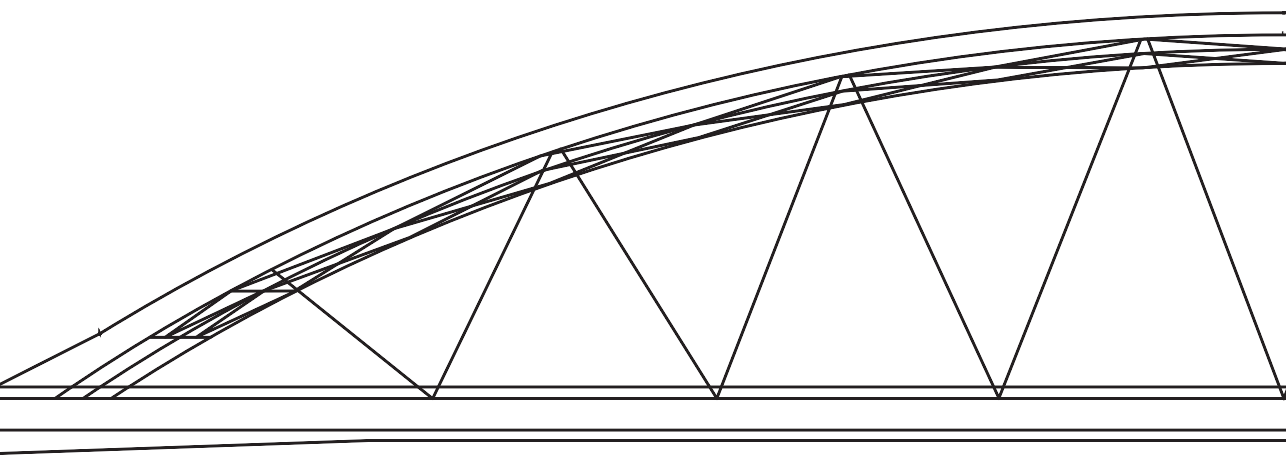
Deel 2 omvat de opzet van de postnatale risicosignalering, de postnatale R4U, en de opzet van de postnatale risicosignaleringsstudie, waarbij de postnatale R4U is geïmplementeerd en de effectiviteit ervan is onderzocht.

Het ontwerp van de postnatale R4U, volgens de zes stappen van het 'Intervention Mapping-proces', wordt gepresenteerd in **hoofdstuk 5**. Stap 1: literatuuronderzoek en focusgroep discussies; Stap 2: identificatie van programmadoelstellingen voor het ontwikkelen en implementeren van een risicobeoordeling in de dagelijkse praktijk van de JGZ; Stap 3: toepassing van het ASE-model om gedragsverandering in de doelgroep te initiëren; Stap 4: ontwikkeling van de postnatale R4U en bijbehorende zorgpaden; Stap 5: ontwerp van de acceptatie en implementatie van het programma in vier JGZ organisaties; Stap 6: programma-evaluatie plannen door middel van een vragenlijst en een evaluatiegesprek. Vervolgens is in 2015 de 41 item postnatale R4U (de postnatale Rotterdam Reproduction Risk Reduction checklist) ontwikkeld en geïmplementeerd in vier JGZ organisaties.

In **hoofdstuk 6** wordt de grondgedachte en het ontwerp van een postnatale risicosignaleringsstudie gepresenteerd. Deze studie was gericht op het evalueren van: (a) de voorspellende waarde van een innovatieve postnatale risicosignalering, bedoeld om het risico op groei- en ontwikkelingsproblemen bij jonge kinderen te voorspellen; en (b) de doeltreffendheid ervan in combinatie met zorgpaden op maat. Het betreft een historisch gecontroleerd onderzoeksdesign en is ontworpen als onderdeel van het Healthy Pregnancy 4 All-2 programma. Onze hypothese was dat de groei- en ontwikkelingsproblemen van kinderen zouden worden verminderd in het interventiecohort als gevolg van de implementatie van de postnatale R4u en de bijbehorende zorgpaden. Het onderzoek is in augustus 2016 goedgekeurd. Gegevens om de voorspellende waarde van de risicobeoordeling en de effectiviteit ervan in combinatie met de bijbehorende zorgpaden, zouden worden verzameld door jeugdverpleegkundigen en jeugdartsen van consultatiebureaus in vier JGZ organisaties in drie gemeenten met nadelige perinatale uitkomsten.

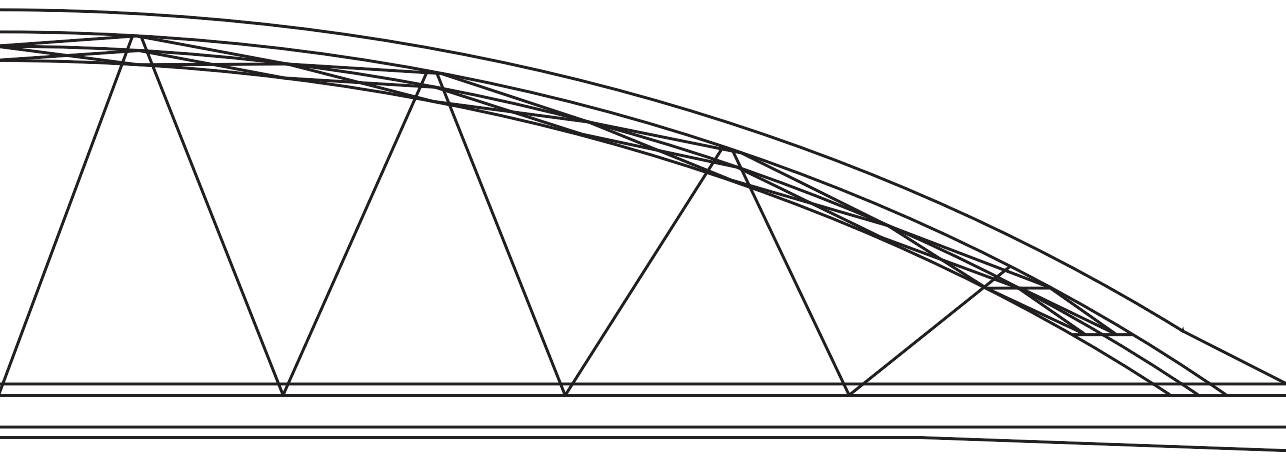
Deel 3 bevat **hoofdstuk 7** waarin de resultaten van de postnatale risicosignaleringsstudie (hoofdstuk 6) worden beschreven. De inclusieperiode liep van september 2016 tot december 2017. Het historische cohort bestond uit kinderen geboren in voorgaande jaren van 2008 tot 2016. De uitkomstmaat werd gedefinieerd als inhaalgroei, d.w.z. meer dan 0,67 standaarddeviatiescore gewicht voor lengtetoename in de eerste 6 maanden van het leven. De meningen van JGZ medewerkers zijn bestudeerd met een digitale enquête. Na de inclusieperiode werden 1.953 kinderen opgenomen in het interventiecohort en 7.436 kinderen in het historische cohort. Inhaalgroei kwam significant minder vaak voor in het interventiecohort (p-waarde: < 0,001). Een regressiegevoeligheidsanalyse, waarbij gebruik werd gemaakt van matching, toonde een odds ratio in het voordeel van het interventiecohort. Aan het vragenlijstonderzoek namen 74 jeugdartsen en jeugdverpleegkundigen deel; de meeste van hen waren neutraal over de voordelen van de postnatale R4U.

In de algemene discussie van dit proefschrift worden gezondheidsverschillen voor kwetsbare kinderen en -gezinnen besproken, evenals kinderwelzijn in Nederland en de kansen voor de JGZ. Ten slotte wordt gereflecteerd op behaalde resultaten en worden toekomstperspectieven en aanbevelingen besproken.



Addendum

Authors and affiliations
Bibliography
PhD Portfolio
Acknowledgments / dankwoord
About the author



AUTHORS AND AFFILIATIONS

Department of Obstetrics and Gynecology, Division of Obstetrics and Prenatal Medicine, Erasmus University Medical Center, Rotterdam, The Netherlands

Eric A.P. Steegers, Marlou L.A. de Kroon, Jacqueline Lagendijk, Meertien K. Sijpkens, Loes, C.M. Bertens, Danielle van Veen-Belle, Hiske E. Ernst-Smelt, Ageeth N. Rosman, Marianne Remmerswaal, Suzan M. Hulst.

Department of Public Health, Division Youth, Erasmus University Medical Center, Rotterdam, The Netherlands

Hein Raat, Marlou L.A. de Kroon

Department of Health Sciences, University Medical Centre Groningen, Groningen, The Netherlands

Marlou L.A. de Kroon

Department of Social Development, Municipality of the city of Rotterdam, Rotterdam, The Netherlands

Lyne M.G. Blanchette

BIBLIOGRAPHY

van Minde MRC, Hulst SM, Raat H, Steegers EAP, de Kroon MLA. Postnatal screening and care for non-medical risk factors by preventive child healthcare in deprived and non-deprived neighbourhoods. BMC Health Serv Res. 2018 Jun 8;18(1):432. doi: 10.1186/s12913-018-3243-2. PMID: 29884178; PMCID: PMC5994004.

van Minde MRC, Blanchette LMG, Raat H, Steegers EAP, Kroon MLA. Reducing growth and developmental problems in children: Development of an innovative postnatal risk assessment. PLoS One. 2019 Jun 5;14(6):e0217261. doi: 10.1371/journal.pone.0217261. Erratum in: PLoS One. 2019 Oct 15;14(10):e0224160. PMID: 31166964; PMCID: PMC6550373.

van Minde MRC, van Veen-Belle DW, Ernst-Smelt HE, Rosman AN, Raat H, Steegers EAP, de Kroon MLA. Handover of care and of information by community midwives, maternity care assistants and Preventive Child Healthcare professionals, a qualitative study. Midwifery. 2019 Nov;78:25-31. doi: 10.1016/j.midw.2019.07.012. Epub 2019 Jul 15. PMID: 31349181.

van Minde MRC, Remmerswaal M, Raat H, Steegers EAP, de Kroon MLA. Innovative postnatal risk assessment in preventive child health Care: A study protocol. J Adv Nurs. 2020 Dec;76(12):3654-3661. doi: 10.1111/jan.14547. Epub 2020 Sep 30. PMID: 32996632.

van Minde MRC, de Kroon MLA, Sijpkens MK, Raat H, Steegers EAP, Bertens LCM. Associations between Socio-Economic Status and Unfavorable Social Indicators of Child Wellbeing; a Neighbourhood Level Data Design. Int J Environ Res Public Health. 2021 Dec 1;18(23):12661. doi: 10.3390/ijerph182312661. PMID: 34886386; PMCID: PMC8657207.

Van Minde MRC, Lagendijk J, Raat H, Steegers EAP, de Kroon MLA. An innovative postnatal risk assessment and corresponding care pathways in Preventive Child Healthcare. J Adv Nurs. 2022 Mar;78(3):739-749. doi: 10.1111/jan.15003. Epub 2021 Sep 30. PMID: 34590735; PMCID: PMC9293120.

Other

Sijpkens MK, Lagendijk J, **van Minde MRC**, de Kroon MLA, Bertens LCM, Rosman AN, Steegers EAP. Integrating interconception care in preventive child health care services: The Healthy Pregnancy 4 All program. PLoS One. 2019 Nov 6;14(11):e0224427. doi: 10.1371/journal.pone.0224427. PMID: 31693703; PMCID: PMC6834275.

Waelput AJM, Sijpkens MK, Lagendijk J, **van Minde MRC**, Raat H, Ernst-Smelt HE, de Kroon MLA, Rosman AN, Been JV, Bertens LCM, Steegers EAP. Geographical differences in perinatal

health and child welfare in the Netherlands: rationale for the healthy pregnancy 4 all-2 program. BMC Pregnancy Childbirth. 2017 Aug 1;17(1):254. doi: 10.1186/s12884-017-1425-2. PMID: 28764640; PMCID: PMC5540512.

van Minde MRC, Koopman-van Gemert AWMM, Rombout-de Weerd S. The role of fibrinogen in massive postpartum haemorrhage, a case report. Case Rep Womens Health. 2015 Apr 11;6:4-5. doi: 10.1016/j.crwh.2015.02.002. PMID: 29629305; PMCID: PMC5886002.

Oomen MW, Bakx R, **van Minden M**, van Rijn RR, Peters M, Heij HA. Implementation of laparoscopic splenectomy in children and the incidence of portal vein thrombosis diagnosed by ultrasonography. J Pediatr Surg. 2013 Nov;48(11):2276-80. doi: 10.1016/j.jpedsurg.2013.03.078. PMID: 24210199.

PHD PORTFOLIO

Erasmus MC Department	Obstetrics & Gynaecology
Research School	Netherlands Institute of Health Sciences (NIHES)
PhD period	February 2015 – May 2018
Promotor(s)	Prof. dr. E.A.P. Steegers
	Prof. dr. H. Raat
Co-promotor	Prof. dr. M.L.A. de Kroon

1. PhD training	Year	Workload (ECTS)
General and specific courses		
e-Brok (Basiscursus Regelgeving Klinisch Onderzoek)	2017	1.0
Center for Patient-Oriented research (CPO) course, Erasmus MC	2015	0.3
Integrity in Science, Erasmus MC	2015	0.3
Biomedical English Writing and Communication, Erasmus MC	2016	3.0
Biostatistical Methods I, NIHES	2016	5.7
Markers and Prediction Research, NIHES	2016	0.7
Repeated measurements, NIHES	2017	0.9
Logistic Regression, NIHE	2017	1.4
Markers and Prediction Research, NIHES	2017	0.9
International conferences		
9th European Public Health Conference, Vienna, Austria: *poster presentation*	2016	1.0
10th World Congress Developmental Origins of Health and Disease (DOHaD), Rotterdam, the Netherlands: *poster presentation*	2017	1.0
10th European Public Health Conference, Stockholm, Sweden: *workshop presentation, poster presentation*	2017	1.0
National conferences		
SCEM Congres Jonge Zwangerschap	2015	0.2
NIHS Perinatale Risicofactoren, Leiden	2015	0.2
4th Symposium Urban Perinatal Health, Rotterdam: *oral presentation*	2017	0.2

Seminars, workshops and research meetings

Rivas/Careyn Inspiratiedag: *workshop presentation*	2015	0.2
Workshop media contact for researchers, Erasmus MC	2016	0.1
Erasmus MC PhD day	2016	0.2
Weekly and biweekly obstetric research meetings of the Department of Obstetrics and Gynaecology, Erasmus MC	2015-2018	5.0
Biweekly statistics meetings of the Department of Public Health, youth section, Erasmus MC	2015	1.0
Biweekly youth section meeting of the Department of Public Health, Erasmus MC	2015-2018	3.0
Quarterly research meeting of the Department of Public Health, Erasmus MC	2015-2018	0,5
Annual RGOC award meeting: 'Wladimiroff symposium'	2015-2018	0,3

Reports a and other writing

Contributed to writing of the report for the Dutch Ministry of Health on Healthy Pregnancy 4 All-2

2. Teaching	Year	Workload (ECTS)

Lecturing

Minor mistery of creation, for medical students, NIHES	2016	0.5
Maternal and Child Health, for medical students, NIHES	2017	0.5

Tutoring/training

Training PCHC professionals on postnatal risk assessment and care pathways (within the HP4All-2 program) - 90 PCHC physicians and nurses for a 3 hour training	2016	4.0

Supervising Master's theses

Supervising master thesis of Suzan Hulst, medical student, Erasmus MC. Title: *'Screening and care for (non-)medical risk factors in PCHC, a baseline survey'*	2016	2.0
Supervising master thesis of Yaela Bosman, medical student, Erasmus MC. Title: *'Birth outcomes and growth trajectories in children, until the age of two years old'*	2017	2.0