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An innovative postnatal risk assessment and corresponding care pathways in Preventive Child Healthcare

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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 6 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.

1 | INTRODUCTION

Preconception, prenatal, perinatal and postnatal risk factors affect growth and development. (Arpi & Ferrari, 2013; Baptiste-Roberts et al., 2012; Bocca-Tjeertes et al., 2013, 2014; Delobel-Ayoub et al., 2009; El Marroun et al., 2011, 2014; Gaillard et al., 2013; Henrichs et al., 2013; Kerstjens et al., 2013; Knudsen et al., 2014; Koutra et al., 2013; Kuhle et al., 2015; Morinis et al., 2013; Potijk et al., 2015; Timmermans et al., 2014) These include medical risk factors, such as preterm birth and being born small for gestational age (SGA, birthweight <10th percentile), and non-medical risk factors, such as living in deprivation and social isolation. (Bilic-Kirin et al., 2014; Bradley & Corwyn, 2002; Crockenberg, 1981; Enlow et al., 2013; Gershoff et al., 2007; Kakinami et al., 2014) Children who showed intra-uterine growth retardation (IUGR) as a foetus, or who were born SGA or large for gestational age (LGA, birthweight >90th 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. (Claris et al., 2010; Jordan et al., 2005; Taal et al., 2013; Xiong et al., 2007) Furthermore, being born in a family with a low socioeconomic 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 & Boersma, 2002) There is evidence that 'accelerated' or too fast growth, that is catch-up growth, during critical or sensitive periods in early life has unfavourable 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. (Polk et al., 2016; Taal et al., 2013; Zimmerman, 2018) 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. (Dunger et al., 2006; Salgin et al., 2015) Conversely, catch-up growth has also been studied as a benefit, namely for preterm born children. (Singhal, 2017).

2 | 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 six 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, 2008) The attendance rate is high, with over 95% attendance for all children under the age of four. (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 6 months of life and to evaluate PCHC professional satisfaction with this intervention during the study period.

3 | THE STUDY

3.1 | Aims

This study aimed to evaluate (a) the predictive value of an innovative postnatal risk assessment, the postnatal R4 U, meant to assess the risk of growth and developmental problems in young children and (b) its effectiveness in combination with tailored care pathways.

3.2 | 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 R4 U has been implemented and evaluated. (Lagendijk et al., 2018; Vos, van Veen, et al., 2015; Vos, van Voorst, et al., 2015) 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 R4 U and the design of the study can be found elsewhere. (van Minde et al., 2019, 2020).

This study was conducted in four PCHC organizations within relatively deprived neighbourhoods in three municipalities. (Waelput et al., 2017) Together with local government representatives (i.e. municipal program directors and councillors), 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.

3.3 | Intervention and historical cohort

The effectiveness of the postnatal R4 U 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. 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.

3.4 | Participants

3.4.1 | 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).

3.4.2 | Power calculation

Power calculation resulted in 2,650 children to be included in the intervention cohort until the end of the follow-up period. The 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.

3.4.3 | Professionals

The PCHC professionals involved were PCHC physicians and PCHC nurses. Prior to the start of the study and the implementation of the postnatal R4 U 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 R4 U, a demonstration of the postnatal R4 U 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.

3.5 | Data collection

3.5.1 | 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.

3.5.2 | Children

Risk assessment based on the postnatal R4 U 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 4 weeks of age or the PCHC consultation at 8 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 sufficient time. The postnatal R4 U was integrated in the PCHC digital client files, which enabled the automated transfer of relevant data of the

postnatal R4 U. (Dunger et al., 2006) The postnatal R4 U 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 were collected from the digital client files of the PCHC organizations 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).

3.5.3 | 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 R4 U 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 R4 U, 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 6 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 R4 U, which consisted of 10 questions from the original questionnaire. (Supplement 1: Questionnaire.)

3.5.4 | The intervention

The intervention, which has been developed based on the Intervention Mapping process, consisted of the postnatal R4 U and its corresponding care pathways. (van Minde et al., 2020) The postnatal R4 U 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 (a) psychosocial problems, (b) financial problems, (c) substance abuse including smoking, (d) overweight/obesity, (e) chronical illness of a parent, (f) psychiatric problems, (g) 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).

3.5.5 | Catch-up growth

Catch-up growth was defined as >0.67 SDS weight for height in the first 6 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 & Albertsson-Wikland, 2008).

3.6 | Data analysis

3.6.1 | 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 6 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, 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).

3.6.2 | Professionals

Comparative statistics were used, that is 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 $p < 0.05$.

3.6.3 | 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.

3.7 | Results/findings

3.7.1 | 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.

Table 1.

3.7.2 | 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 were 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.

3.7.3 | 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 R4 U 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%, $p < 0.001$). The 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 children in the historical cohort had no birthweight registered. The 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: $p < 0.0001$). (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 6 months of life compared to the historical cohort was 0.957 (0.938–0.976) for the intervention cohort, which was statistically significant.

3.7.4 | Professionals

Table 2 shows the opinions of 74 (82%) of the PCHC nurses and physicians after 6 months working with the postnatal R4 U. The most important findings were that 47.3% found the postnatal R4 U easy to work with, 43.2% disagreed that with the postnatal R4 U it was easier to address certain topics to parents and 50% disagreed that it was easier to refer patients to other healthcare professionals, using the postnatal R4 U. Only 20% agreed that care for vulnerable families was, in their opinion, quicker organized with the help of the postnatal R4 U 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 R4 U. Concerning the question whether the total score of the postnatal R4 U corresponded with their own judgement they were more positive; 50% was neutral and 36.5% agreed.

Table 2.

3.8 | Discussion

3.8.1 | Findings of this study

This study showed that the structured postnatal risk assessment, the postnatal R4 U, together with its corresponding care pathways

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)
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

significantly decreased the odds of catch-up growth in the first 6 months of life. In contrast, PCHC professional satisfaction with the instrument was less evident.

3.8.2 | 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

TABLE 2 PCHC professional opinion on working with the postnatal R4 U risk assessment (n = 74)

	Completely agree	Agree	Neutral	Disagree	Completely disagree	Total
I find it easy to work with the postnatal R4 U, 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 R4 U, 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 R4 U, 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 R4 U, 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 R4 U, n(%)	0 (0)	1 (1.4)	21 (28.4)	42 (50)	10 (13.5)	74 (100)
The postnatal R4 U 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 R4 U, 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)

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 unfavourable.

In the past years, risk assessments have been progressively developed in different fields of medicine to gain awareness among healthcare professionals and patients and to timely screen for health risks that can be prevented. In preventive healthcare and paediatrics, different 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. (Staal et al., 2016; van Stel et al., 2012) A postnatal risk assessment, such as the postnatal R4 U 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 in 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, the final implementation of the postnatal R4 U will require additional efforts from the PCHC management and the Dutch Youth Center (NCJ) in supporting PCHC professionals.

4 | 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.

5 | 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 in 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 R4 U 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.

DATA AND MATERIAL AVAILABILITY STATEMENT

The data that support the findings of this study are available from the PCHC organizations participating in this study. However, restrictions apply to the availability of these data, which were used under license for this study, and thus are not publicly available. Data are only available from the authors upon reasonable request and with permission of the participating PCHC organizations.

CONFLICT OF INTEREST
The authors report no conflicts of interest.

AUTHORS' CONTRIBUTIONS
ES conceived the HP4All and HP4All2 program. MM and MK were responsible for the study design. ES, HR and JL participated in the design of the study. MM and JL drafted the data analysis plan and MM performed the data analysis. MM has drafted the first version of the manuscript. All authors have contributed to the final version of the manuscript and approved the final version for publication.

ETHICAL STATEMENT
The study was reviewed by the Daily Board of the Medical Ethics Committee Erasmus MC in the Netherlands (MEC-2015–697). As a result of this review, the Board declared that the rules laid down in the Medical Research Involving Human Subjects Act (also known by its Dutch abbreviation WMO) do not apply to the study. An opt-out methodology was applied to this study.

PEER REVIEW
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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of the article at the publisher's website.

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