Original citation:
Bilgin, Ayten and Wolke, Dieter. (2016) Regulatory problems in very preterm and full-term infants over the first 18-months. Journal of Developmental and Behavioral Pediatrics, 37 (4). pp. 298-305.

Permanent WRAP URL:
http://wrap.warwick.ac.uk/77786

Copyright and reuse:
The Warwick Research Archive Portal (WRAP) makes this work by researchers of the University of Warwick available open access under the following conditions. Copyright © and all moral rights to the version of the paper presented here belong to the individual author(s) and/or other copyright owners. To the extent reasonable and practicable the material made available in WRAP has been checked for eligibility before being made available.

Copies of full items can be used for personal research or study, educational, or not-for-profit purposes without prior permission or charge. Provided that the authors, title and full bibliographic details are credited, a hyperlink and/or URL is given for the original metadata page and the content is not changed in any way.

Publisher’s statement:
© 2016 Licensed under the Creative Commons Attribution-NonCommercial 4.0 International http://creativecommons.org/licenses/by-nc/4.0/

A note on versions:
The version presented here may differ from the published version or, version of record, if you wish to cite this item you are advised to consult the publisher’s version. Please see the ‘permanent WRAP URL’ above for details on accessing the published version and note that access may require a subscription.

For more information, please contact the WRAP Team at: wrap@warwick.ac.uk
Regulatory Problems in Very Preterm and Full-term Infants over the First 18-Months

Ayten Bilgin¹, MSc
Dieter Wolke¹², PhD

Affiliations: ¹Department of Psychology, University of Warwick; ²Division of Mental Health and Wellbeing, Warwick Medical School, University of Warwick, Coventry, UK

Address correspondence to: Dieter Wolke; University of Warwick, Department of Psychology, Coventry CV4 7AL, United Kingdom; telephone number: +44 (0)24 7657 3217; fax number: + 44 (0) 24 7652 4225; email: D.Wolke@warwick.ac.uk

Short Title: Regulatory Problems in Very Preterm and Full-term Infants

Abbreviations: Abbreviations: RP (Regulatory Problem), VP/VLBW (Very Preterm/Very Low Birthweight), FT (Full-term), CNS (Central Nervous System), CI (Confidence Interval), OR (Odds Ratio), RR (Relative Risk), CC (Contingency Coefficient), RDS (Respiratory Distress Syndrome), BPD (Bronchopulmonary Dysplasia), SGA (Small for Gestational Age)

Funding Source: Ayten Bilgin is supported by a PhD scholarship from the Republic of Turkey Ministry of Education.

Financial Disclosure: Ayten Bilgin and Dieter Wolke have no financial relationships relevant to this article to disclose.

Conflict of Interest: Ayten Bilgin and Dieter Wolke have no conflicts of interest to disclose.

Acknowledgements: We would like to thank the researchers who assisted in recruitment and data collection: Tina Gutbrod, Libi Rust, and Karine Edme. We would also like to thank to the participating hospitals (Addenbrookes Hospital, Cambridge; Luton and Dunstable Hospital, Luton; and Queen Elizabeth II Hospital, Welwyn Garden City) and the parents and their children.

Word Count: 2857
Abstract

Objectives: This study is an investigation of differences in regulatory problems (RP; crying, sleeping, feeding) expressed by infants born very preterm (VP; <32 weeks gestation) or with very low birth weight (VLBW; <1500 grams) and infants born at full term (FT) during the first 18 months of life. It investigates the prevalence of single and multiple RPs, their persistence and how early in infancy RPs still found at 18 months of age can be predicted.

Method: This prospective longitudinal study of 73 VP/VLBW and 105 FT infants utilized a standard interview of mothers to assess regulatory problems among the infants at term, 3, 6, and 18 months of age.

Results: Few differences were found between VP/VLBW and FT infants in the first 6 months. At 18 months, VP/VLBW infants had more single sleeping (RR=2.2, CI=1.3 to 3.7), feeding (RR= 1.4, CI= 1.03 to 1.8), and multiple RPs (RR=1.7, CI=1.02 to 2.8) than FT infants. In VP/VLBW infants, RPs as early as 3 months and in FT infants RPs as early as 6 months predicted RPs at 18 months. Those infants who had persistent RPs in the first 6 months of life were more likely to still have RPs at 18 months.

Conclusions: VP/VLBW children are at slightly increased risk for RPs at term and in the second year of life. Clinicians should be aware that RPs that persist across the first 6 months point to increased risk of continuing RPs into toddlerhood in both VP/VLBW and FT infants.

Keywords: preterm birth, regulatory problems, crying, feeding, sleeping, infancy.
INTRODUCTION

Approximately, 20% of full-term healthy infants experience regulatory problems (RPs) defined as excessive crying, sleeping, or feeding problems during the first year of life.\textsuperscript{1,2} These are transient in the majority of cases.\textsuperscript{3} Early RPs may be associated with trajectories of dysregulation into childhood\textsuperscript{4} and subsequent cognitive, behavior and attention problems,\textsuperscript{5-11} especially if crying or feeding problems persist beyond the age of 3 to 4 months.\textsuperscript{1,3,6,12-14} In addition, multiple RPs, i.e. having two or three single RPs at the same time, increases the likelihood of later behavior problems.\textsuperscript{11,13}

There is some suggestion that preterm birth is associated with more RPs in early infancy.\textsuperscript{15-18} Others have not found an association between preterm birth and increased crying or sleeping problems.\textsuperscript{19-21} Feeding problems, on the other hand, have been consistently found to be more frequent after preterm birth.\textsuperscript{15,22-28} Previous studies of preterm populations were usually of small sample size or they just looked at single RPs.\textsuperscript{20,29-31} None, as far as we are aware, examined whether VP/VLBW and FT infants differ in early crying, sleeping and feeding or have multiple RPs more often beyond 6 months of age.

The aims of the current study were: 1) to examine if there is a difference in prevalence of single and multiple RPs among VP/VLBW and FT infants at term, 3 months, 6 months and 18 months of age; 2) to determine whether RPs at 18 months can be predicted by early RPs and whether prediction is enhanced if RPs persist across the first 6 months.
METHODS

Participants

Caretakers of 112 infants who were born VP/VLBW (<32 weeks of gestation or <1500 gr) in three neonatal units were approached during an 18 months period (See Appendix 1 for a detailed description). Seventy six caretakers of 90 VP/VLBW infants participated at the first assessment point at term. Recruitment of full-term children was conducted in the postnatal wards of the same hospitals within 48 hours of birth. One hundred and fifteen FT infants (37-42 weeks gestation), matched for socio-economic status, sex and multiple birth and their caretakers (N=98) were also recruited from the same units (see 32 for a detailed description).

Participants were assessed at term, 3 months, 6 months and 18 months of age corrected for prematurity. Seventeen VP/VLBW and 10 FT infants did not complete the study until 18 months of age. VP/VLBW participants who did not complete the study (N= 17) differed from participants who remained in the study in that they had significantly higher medical risk neonatally ($F(1, 88) = 4.5, P<.05$) and had parents with lower income ($X^2(1,105) = 10.6, P=.005$) (Table 1). Otherwise, those who dropped out did not differ from those who remained in the study on birth weight, rates of SGA and gestational age or maternal education.

The final sample with complete longitudinal data comprised of 73 VP/VLBW (63 caretakers) and 105 FT infants (89 caretakers). VP/VLBW sample included 69 (94.5%) infants below 32 weeks of gestational age and 4 (5.5%) infants above or equal to 32 weeks of gestational age but with birth weight below 1500g. VP/VLBW and FT samples did not differ in terms of gender, multiple births, maternal age, income, and maternal education. VP/VLBW infants were significantly less likely to be breastfed at term ($X^2(1,178) = 9.81, P=.002$) than
FT infants. However, there were no differences in feeding type at 3 months ($X^2(1,177) = 3.31, P= .07$) and 6 months ($X^2(1,167) = .027, P= .87$) (See Table 1).

**Measures**

**Background Measures.** Medical risk was a composite of the following variables:

Neurosensory deficits, rehospitalisation, surgical procedures, and prolonged oxygen dependency assessed from medical notes and interviews at 3 months. Neurosensory deficits were defined as clinically significant deficits in hearing, vision, muscle tone or presence of hydrocephalus. Re-hospitalization was defined as whether the infant was readmitted to the hospital after discharge from the neonatal unit or not. Surgical procedures were defined as whether the infant had any surgery (e.g. for Patent Ductus Arteriosus, Nectorizing Enterocolitis) or not. Lastly, oxygen dependency was defined as oxygen use of more than 21% (1: never, 2: oxygen dependency still at term, 3: oxygen dependency still at 3 months).

Additionally, Respiratory Distress Syndrome (RDS) and Bronchopulmonary Dysplasia (BPD) were recorded. RDS was recorded based on X-ray evidence at three levels: mild, moderate and severe. BPD was defined as the need for supplemental oxygen use for more than 28 days in addition to chest X-rays of lung changes and coded as a dichotomous variable. Income was divided into 3 groups based on gross family income per annum: 1) 0-£25000, 2) £25000- £40000, 3) >£40000. Maternal education was divided into 3 groups based on years of education: 1) <10 years (not completed), 2) 10 years (basic), and 3) > 10 years (further education).

**Regulatory Problems (RPs).** A standard structured interview about crying, sleeping and feeding problems was conducted at term, 3, 6 and 18 months. Definition of crying, sleeping and feeding problems were derived from the literature (Table 2).
A crying problem was defined by the presence of at least one of three criteria (excessive
duration of crying, difficult to soothe, mother's perception of crying as very
distressing).\textsuperscript{5,7,14,20,35}

Sleeping problems were measured with 3 items at all measurement points. Participants were
considered as having sleeping problems when at least one of the following criteria was
present: a) woke up more than one time per night, b) took longer than 30 minutes to settle
infant to sleep, c) the longest duration without waking up was less than 5 hours.

Feeding problems were measured with 2 summary items at term, 3, 6 and 18 months.
Problems in oral-motor functioning were measured with the following three items: a)
stoppping after a few sucks, b) excessive dribbling/difficulty swallowing, c) gagging/choking
during the feed. Participants were dichotomized into two groups: no oral-motor functioning
problems (0 or 1 problem present) and oral-motor functioning problems (2 or 3 problems
present). Faddy eating/food refusal was measured with one item (fighting against the
bottle/breast) at term, 3 and 6 months. At 18 months, a faddy eating/food refusal scale was
created including the following variables: Eats too little, leaves most of the food offered, poor
appetite, picky eater, slow eater, refuses to eat lumpy food, or even refuses to eat puree
selectively. Internal consistency of this scale was high; .81 for the VP/VLBW and .74 for FT.
Participants were categorized as having faddy eating/food refusal problems if they had 5 or
more problems.

Participants were categorized as having multiple RPs if they had two or three single RPs.

\textbf{Control Variables.} Breastfeeding has previously been found to be related to more frequent
sleeping problems and decreased feeding problems in infancy.\textsuperscript{15,21,36} In preterm infants,
breastfeeding has been reported to increase the duration of crying.\textsuperscript{37} Based on these findings,
mothers were asked about how they fed their infant at term, 3 months and 6 months. They
were divided into two categories: breastfed and not breastfed. The breastfed category included infants who were only partially breastfed. Furthermore, CNS (Central Nervous System) problems have been suggested as influential factors in preterm infant’s sleeping pattern. In order to control for possible impact of CNS problems in preterm infants, brain ultrasound scans were used to measure haemorrhage, ventricular dilatation and parenchymal cysts at term (See Appendix 2 for a detailed description). The type of haemorrhage was coded as following: 0) none, 1) subependymal/choroidal one side, 2) intraventricular one side, 3) parenchymal one side, 4) subependymal/choroidal bilateral, 5) intraventricular bilateral, 6) parenchymal bilateral. Ventricular dilatation was coded as following: 0) no dilation, 1) less than 4mm one side, 2) more than 4mm one side, 3) less than 4mm bilateral, 4) more than 4mm bilateral. Parenchymal cysts were coded as: 0) none, 1) porencephalic cyst one side, 2) cystic leucomalacia one side, 3) porencephalic cyst bilateral, 4) cystic leucomalacia bilateral. All those infants whose early scans were scored ≥1 had repeat scans at a later date. According to the results of final scan (6th scan), infants were divided into two categories: CNS problem present (score ≥1) and not present (score= 0).

Statistical Analyses

Data were analysed with SPSS (IBM, version 21.0). One way ANOVA and chi-square test (X²) were used to compare the dropouts and non-dropouts. Chi-square test was also used to compare the RPs of VP/VLBW and full-term groups at each time point. Contingency coefficients were computed as indices of the associations of RPs across measurement points. Binominal logistic regression was used to estimate the odds ratio of having RPs at 18 months. All analyses except for differences in frequencies at 18 months were adjusted for breastfeeding. Furthermore, analyses for VP/VLBW infants were adjusted for CNS problems. Statistical significance was defined as P<.05.
In the data analysis regulatory problems were considered as transient if they were present only at one measurement point (term, 3 months, or 6 months) in the first 6 months. If regulatory problems were present at two or three measurement points during the first 6 months, they were considered as persistent regulatory problems. VP/VLBW infants were assessed at term, 3, 6 and 18 months corrected for prematurity and controls at chronological age.

**RESULTS**

**Differences between very preterm and full-term infants at term, 3 months, 6 months, and 18 months**

Frequencies of single and multiple RPs are shown in Table 3.

There were little differences in RPs between VP/VLBW and FT infants. At term, VP/VLBW had slightly higher risk ratios of having crying, feeding or multiple regulatory problems than FT. At 3 months and 6 months, there were no significant differences between groups. At 18 months, VP/VLBW had more often single sleeping, feeding, and multiple RPs (See Table 3).

The impact of having lung disease (RDS, BPD) on RPs was further investigated in VP/VBW infants. Chi-square analysis revealed no significant differences between those who suffered from lung disease and who did not in RPs at all measurement points. Additionally, the impact of being SGA (Small for Gestational Age) was investigated. Results revealed no differences at any measurement point between those who were SGA and those who were AGA (Appropriate for Gestational Age). Furthermore, VP/VLBW infants who were SGA did not differ from full-term infants.
How Early Can We Predict Crying, Sleeping, and Feeding Problems at 18 Months?

Figure 1 illustrates the contingency coefficients between the 3 early measurement points and 18 months outcome for crying, sleeping and feeding RP in VP/VLBW and FT.

For FT infants, the contingency coefficient between early RPs and 18 months sleeping, feeding, and multiple RPs increased with age (i.e. 6 months had the highest correlation). This pattern was not evident for VP/VLBW infants for crying, sleeping and multiple RPs, where the highest correlation with 18 months was already found at 3 months. Only for feeding RPs, VP/VLBW infants followed the same association pattern as FT infants.

**Associations between Persistence of RPs until 6 Months and RPs at 18 Months**

In VP/VLBW infants, having either transient (i.e. at one measurement point) (OR= 3.3, CI= 1.2 to 5.8) or persistent RP (OR=4.2, CI= 1.4 to 12.9) in the first 6 months was associated with sleeping RP at 18 months. Furthermore, having persistent RPs at 3 measurement points (OR= 3.9, CI= 1.3 to 6.1) was significantly related to multiple RPs at 18 months in VP/VLBW infants.

In FT infants, having persistent RPs during the first 6 months of life (OR= 3.4, CI= 1.2 to 3.9) was also associated with sleeping RP at 18 months (Supplemental Table 1). Moreover, having persistent RP (OR= 3.5, CI= 1.2 to 5.9) was associated with multiple RPs at 18 months.

**DISCUSSION**

This study investigated early regulatory problems (crying, sleeping, and feeding) in VP/VLBW infants in comparison to FT infants during the first 18 months. Our findings indicate few differences between VP/VLBW and FT infants in the first 6 months of life but emerging differences in sleeping, feeding or multiple RPs at 18 months. For predicting 18
months RPs, associations were emerging slightly earlier (i.e. at 3 months) in VP/VLBW infants for crying, sleeping and multiple RPs than full term children. Moreover, persistence of any RP across the first 6 months increased the odds of having multiple RPs or sleeping RPs in both VP/VLBW and FT infants.

The prevalence of single and multiple RPs was similar to previous reports during the first 18 months of life. However, crying RPs in FT infants at 3 months (17.1%) was found to be lower than in one previous study (29%). Furthermore, in VP/VLBW infants, the prevalence of sleeping RPs at 18 months was 34% which was somewhat higher than the rates reported in previous studies (approximately 15%).

There were few differences between VP/VLBW and FT infants in sleeping, feeding or multiple RPs in the first 6 months but they emerged at 18 months. This is consistent with previous findings of no differences in crying patterns and durations between preterm and full-term infants before 3 months. Some differences were found in feeding skills, between VP/VLBW and FT infants both early at term when sucking coordination is important and after 6 months of age when processing of solids is required. Consistent with previous research, no differences in sleeping patterns between very preterm and full-term infants during the first 6 months of life was found. However, our finding that very preterm infants had increased odds of sleeping problems at 18 months contradicts findings of other studies. Higher sleeping problems in VL/VLBW infants might reflect insecure or disorganised attachment which has been shown to increase sleeping problems in full-term infants and has been found to be more frequent in VP/VLBW toddlers.

Having any RP that persisted from term to 6 months increased the odds of having sleeping RPs or multiple RPs in both VP/VLBW and FT infants. Persistence of RPs has been repeatedly found to predict later behavior problems. Our findings support the
significance of persistence of RPs for predicting sleeping and multiple RPs in both VP/VLBW and FT infants in the toddler years. However, there were also some differences between full term and VP/VLBW infants in predicting 18 months RPs. In FT infants, regulatory problems at 18 months were mainly related to persistent regulatory problems at two or three measurement points in the first 6 months. Previous research showed that single or transient regulatory problems are less likely to lead to later adverse behaviour indicating early behavior adaptation in the first 6 months of life. In contrast, persistent or multiple problems experienced in the first 6 months have been consistently reported to increase the risk of later RPs or adverse outcomes in infants. This study suggests that VP/VLBW infants may be more susceptible to develop long term multiple problems and this is predicted at an earlier age. Single or multiple regulatory problems at term and 3 months already predicted 18 months sleeping and multiple regulatory problems in VP/VLBW but less so in FT infants. Similar findings have been recently reported in a longitudinal study of crying problems of preterm infants in Finland.

In contrast, single crying or feeding RPs at 18 months were not predicted by early persistent RPs in both groups. Thus crying and feeding RPs were poorly predicted by early child behavior. Mother-infant interaction problems, maternal stress and maternal anxiety have been suggested as critical factors in developing crying and feeding problems. Future research may take into account the impact of maternal mental health and/or mother-infant interaction in alleviating or leading to crying and feeding problems.

**Strengths and Limitations**

The strength of this study is the detailed definition of crying, sleeping and feeding problems. Most previous studies either used one or two indicators of the problems. Furthermore, to our
knowledge this is the first study to measure all three regulatory problems (crying, sleeping and feeding) in both very preterm and full-term infants during the first 18 months of life. Moreover, this study controlled for the impact of breastfeeding and CNS problems on regulatory problems. In addition, this study had a matched sample on the number of twins to control for parenting effects in VP/VLBW infants and controls equally.

There are also limitations. Regulatory problems were assessed with a standard interview using mothers as data source. Using diaries or observational methods would have provided more objective information than parental interviews; however, they are prone to lower and selective participation rates. Furthermore, our sample included 4 infants with equal or above 32 weeks of gestational age but with a very low birth weight. We included these infants in our study for two reasons: a) exclusion did not change our findings and b) other studies report on very preterm and very low birth weight (VP/VLBW) sample combined.

Conclusions

VP/VLBW infants are only at slightly increased risk for experiencing more regulatory problems at term and in the second year of life than healthy full term children. In particular, persistent regulatory problems in the first 6 months forebode increased sleeping and multiple RPs at 18 months in both VP/VLBW and full term children. Clinicians should be aware that persistency of crying, sleeping or feeding problems in the first 6 months and their co-occurrence increase the risk of long-lasting problems which might still have an impact on parents a year later.
References

1. Wake M, Morton-Allen E, Poulakis Z, Hiscock H, Gallagher S, Oberklaid F. Prevalence, stability, and outcomes of cry-fuss and sleep problems in the first 2 years of life: prospective community-based study. *Pediatrics.* 2006;117(3):836-842.

2. von Kries R, Kalies H, Papousek M. Excessive crying beyond 3 months may herald other features of multiple regulatory problems. *Arch Pediatr Adolesc Med.* 2006;160(5):508-511.

3. Schmid G, Schreier A, Meyer R, Wolke D. A prospective study on the persistence of infant crying, sleeping and feeding problems and preschool behaviour. *Acta Paediatr.* 2010;99(2):286-290.

4. Winsper C, Wolke D. Infant and toddler crying, sleeping and feeding problems and trajectories of dysregulated behavior across childhood. *J Abnorm Child Psychol.* 2014;42(5):831-843.

5. Wolke D, Rizzo P, Woods S. Persistent infant crying and hyperactivity problems in middle childhood. *Pediatrics.* 2002;109(6):1054-1060.

6. Wolke D, Schmid G, Schreier A, Meyer R. Crying and feeding problems in infancy and cognitive outcome in preschool children born at risk: a prospective population study. *J Dev Behav Pediatr.* 2009;30(3):226-238.

7. Degangi GA, Porges SW, Sickel RZ, Greenspan SI. Four-year follow-up of a sample of regulatory disordered infants. *Inf Mental Hlth J.* 1993;14(4):330-343.

8. DeSantis A, Coster W, Bigsby R, Lester B. Colic and fussing in infancy, and sensory processing at 3 to 8 years of age. *Inf Mental Hlth J.* 2004;25(6):522-539.

9. Rautava P, Lehtonen L, Helenius H, Sillanpaa M. Infantile colic: child and family three years later. *Pediatrics.* 1995;96(1 Pt 1):43-47.
10. Forsyth BWC, Canny PF. Perceptions of Vulnerability 3½ Years After Problems of Feeding and Crying Behavior in Early Infancy. *Pediatrics.* 1991;88(4):757-763.

11. Hemmi MH, Wolke D, Schneider S. Associations between problems with crying, sleeping and/or feeding in infancy and long-term behavioural outcomes in childhood: a meta-analysis. *Arch Dis Child.* 2011;96(7):622-629.

12. Papoušek M, von Hofacker N. Persistent crying and parenting: Search for a butterfly in a dynamic system. *Early Dev Parenting.* 1995;4(4):209-224.

13. Hyde R, O’Callaghan MJ, Bor W, Williams GM, Najman JM. Long-term Outcomes of Infant Behavioral Dysregulation. *Pediatrics.* 2012.

14. St. James-Roberts I, Conroy S, Wilsher C. Stability and outcome of persistent infant crying. *Inf Behav Dev.* 1998;21(3):411-435.

15. Schmid G, Schreier A, Meyer R, Wolke D. Predictors of crying, feeding and sleeping problems: a prospective study. *Child Care Hlth Dev.* 2011;37(4):493-502.

16. Ferrari F, Grosoli MV, Fontana G, Cavazzuti GB. Neurobehavioural comparison of low-risk preterm and fullterm infants at term conceptional age. *Dev Med Child Neurol.* 1983;25(4):450-458.

17. Korja R, Maunu J, Kirjavainen J, et al. Mother-infant interaction is influenced by the amount of holding in preterm infants. *Early Hum Dev.* 2008;84(4):257-267.

18. Korja R, Huhtala M, Maunu J, et al. Preterm Infant’s Early Crying Associated With Child’s Behavioral Problems and Parents’ Stress. *Pediatrics.* 2014.

19. Maunu J, Kirjavainen J, Korja R, et al. Relation of prematurity and brain injury to crying behavior in infancy. *Pediatrics.* 2006;118(1):e57-65.

20. Barr RG, Chen S, Hopkins B, Westra T. Crying patterns in preterm infants. *Dev Med Child Neurol.* 1996;38(4):345-355.
21. Wolke D, Sohne B, Riegel K, Ohrt B, Osterlund K. An epidemiologic longitudinal study of sleeping problems and feeding experience of preterm and term children in southern Finland: comparison with a southern German population sample. *J Pediatr.* 1998;133(2):224-231.

22. Bertoncelli N, Cuomo, G. et al. Oral Feeding Competences of Healthy Preterm Infants: A Review. *Int J Pediatr.* 2012;2012:5.

23. Cerro N, Zeunert S, Simmer KN, Daniels LA. Eating behaviour of children 1.5-3.5 years born preterm: parents' perceptions. *J Paediatr Child Hlth.* 2002;38(1):72-78.

24. Samara M, Johnson S, Lamberts K, Marlow N, Wolke D. Eating problems at age 6 years in a whole population sample of extremely preterm children. *Dev Med Child Neurol.* 2010;52(2):e16-e22.

25. Gewolb IH, Vice FL. Maturational changes in the rhythms, patterning, and coordination of respiration and swallow during feeding in preterm and term infants. *Dev Med Child Neurol.* 2006;48(7):589-594.

26. Schädler G, Süss-Burghart H, Toschke A, von Voss H, von Kries R. Feeding disorders in ex-prematures: causes - response to therapy - long term outcome. *Eur J Pediatr.* 2007;166(8):803-808.

27. Wrotniak BH, Stettler N, Medoff-Cooper B. The relationship between birth weight and feeding maturation in preterm infants. *Acta Paediatr.* 2009;98(2):286-290.

28. Mathisen B, Worrall L, O'callaghan M, Wall C, Shepherd RW. Feeding Problems and Dysphagia in Six-Month-Old Extremely Low Birth Weight Infants. *Int J Speech Lang Pathol.* 2000;2(1):9-17.

29. Anders TF, Keener M. Developmental course of nighttime sleep-wake patterns in full-term and premature infants during the first year of life. I. *Sleep.* 1985;8(3):173-192.
30. Lau C, Smith EO, Schanler RJ. Coordination of suck-swallow and swallow respiration in preterm infants. *Acta Paediatr*. 2003;92(6):721-727.

31. Lau C, Sheena HR, Shulman RJ, Schanler RJ. Oral feeding in low birth weight infants. *J Pediatr*. 1997;130(4):561-569.

32. Wolke D, Eryigit-Madzwamuse S, Gutbrod T. Very preterm/very low birthweight infants’ attachment: infant and maternal characteristics. *Arch Dis Child Fetal Neonatal Ed*. 2013.

33. Northway WH, Jr., Rosan RC, Porter DY. Pulmonary disease following respirator therapy of hyaline-membrane disease. Bronchopulmonary dysplasia. *N Engl J Med*. 1967;276(7):357-368.

34. Ehrenkranz RA, Walsh MC, Vohr BR, et al. Validation of the National Institutes of Health consensus definition of bronchopulmonary dysplasia. *Pediatrics*. 2005;116(6):1353-1360.

35. Wolke D, Meyer, R., Ohrt, B., & Riegel, K. Comorbidity of feeding and crying problems with sleeping problems in infancy: Concurrent and predictive associations. *Early Dev Parenting*. 1995;4(4):191-207.

36. Thunstrom M. Severe sleep problems among infants in a normal population in Sweden: prevalence, severity and correlates. *Acta Paediatr*. 1999;88(12):1356-1363.

37. Thomas KA. Differential effects of breast- and formula-feeding on preterm infants' sleep-wake patterns. *J Obstet Gynecol Neonatal Nurs*. 2000;29(2):145-152.

38. Doussard-Rossevelt J, Porges SW, McClenny BD. Behavioral sleep states in very low birth weight preterm neonates: relation to neonatal health and vagal maturation. *J Pediatr Psychol*. 1996;21(6):785-802.
39. Hofacker Nv, Papoušek M. Disorders of excessive crying, feeding, and sleeping: The Munich Interdisciplinary Research and Intervention Program. *Inf Mental Hlth J.* 1998;19(2):180-201.

40. Richman N. A community survey of characteristics of one- to two- year-olds with sleep disruptions. *J Am Acad Child Psychiatry.* 1981;20(2):281-291.

41. St James-Roberts I. Persistent infant crying. *Arch Dis Child.* 1991;66(5):653-655.

42. Wolke D, Meyer R, Ohrt B, Riegel K. The incidence of sleeping problems in preterm and fullterm infants discharged from neonatal special care units: an epidemiological longitudinal study. *J Child Psychol Psychiatry.* 1995;36(2):203-223.

43. Shinya Y, Kawai M, Niwa F, Myowa-Yamakoshi M. Preterm birth is associated with an increased fundamental frequency of spontaneous crying in human infants at term-equivalent age. *Biol Letters.* 2014;10(8).

44. Lau C, Smith EO. A Novel Approach to Assess Oral Feeding Skills of Preterm Infants. *Neonatology.* 2011;100(1):64-70.

45. Pridham K, Steward D, Thoyre S, Brown R, Brown L. Feeding skill performance in premature infants during the first year. *Early Hum Dev.* 2007;83(5):293-305.

46. Migraine A, Nicklaus S, Parnet P, et al. Effect of preterm birth and birth weight on eating behavior at 2 y of age. *Am J Clin Nutr.* 2013;97(6):1270-1277.

47. Shimada M, Takahashi K, Segawa M, Higurashi M, Samejim M, Horiuchi K. Emerging and entraining patterns of the sleep-wake rhythm in preterm and term infants. *Brain Dev.* 1999;21(7):468-473.

48. Mirmiran M, Maas YG, Ariagno RL. Development of fetal and neonatal sleep and circadian rhythms. *Sleep Med Rev.* 2003;7(4):321-334.
49. Iglowstein I, Latal Hajnal B, Molinari L, Largo RH, Jenni OG. Sleep behaviour in preterm children from birth to age 10 years: a longitudinal study. *Acta Paediatr*. 2006;95(12):1691-1693.

50. McNamara P, Belsky, J., & Fearon, P. Infant sleep disorders and attachment: Sleep problems in infants with insecure-resistant versus insecure-avoidant attachments to mother. *Sleep Hypnosis*. 2003;5(1):7-16.

51. Papousek M, von Hofacker N. Persistent crying in early infancy: a non-trivial condition of risk for the developing mother-infant relationship. *Child Care Hlth Dev*. 1998;24(5):395-424.

52. Stifter CA, Braungart J. Infant colic: A transient condition with no apparent effects. *J Appl Dev Psychol*. 1992;13(4):447-462.

53. Scher A, Zukerman S, Epstein R. Persistent night waking and settling difficulties across the first year: early precursors of later behavioural problems? *J Reprod Infant Psychol*. 2005;23(1):77-88.

54. Rao M, Brenner R, Schisterman E, Vik T, Mills J. Long term cognitive development in children with prolonged crying. *Arch Dis Child*. 2004;89(11):989-992.

55. Sidor A, Fischer C, Eickhorst A, Cierpka M. Influence of early regulatory problems in infants on their development at 12 months: a longitudinal study in a high-risk sample. *Child Adolesc Psychiatry Mental Hlth*. 2013;7:35-35.

56. Lester BM, Boukydis CF, Garcia-Coll CT, et al. Developmental outcome as a function of the goodness of fit between the infant's cry characteristics and the mother's perception of her infant's cry. *Pediatrics*. 1995;95(4):516-521.

57. Maxted AE, Dickstein S, Miller-Loncar C, et al. Infant colic and maternal depression. *Inf Mental Hlth J*. 2005;26(1):56-68.
58. Fujiwara T, Barr RG, Brant R, Barr M. Infant distress at five weeks of age and
caregiver frustration. J Pediatr. 2011;159(3):425-430.e421-422.
59. McDonough SC, Rosenblum K, Devoe E, Gahagan S, Sameroff A. Parent concerns
about infant regulatory problems: Excessive crying, sleep problems, and feeding
difficulties. Inf Behav Dev. 1998;21, Supplement(0):565.
60. Miller-Loncar C, Bigsby R, High P, Wallach M, Lester B. Infant colic and feeding
difficulties. Arch Dis Child. 2004;89(10):908-912.
61. Wurmser H, Rieger M, Domogalla C, et al. Association between life stress during
pregnancy and infant crying in the first six months postpartum: a prospective
longitudinal study. Early Hum Dev. 2006;82(5):341-349.
62. Barr RG, Kramer MS, Boisjoly C, McVey-White L, Pless IB. Parental diary of infant
cry and fuss behaviour. Arch Dis Child. 1988;63(4):380-387.
63. Aarnoudse-Moens CSH, Weisglas-Kuperus N, van Goudoever JB, Oosterlaan J.
Meta-Analysis of Neurobehavioral Outcomes in Very Preterm and/or Very Low Birth
Weight Children. Pediatrics. 2009;124(2):717-728.
64. Geldof CJ, Oosterlaan J, Vuijk PJ, de Vries MJ, Kok JH, van Wassenaer-Leemhuis
AG. Visual sensory and perceptive functioning in 5-year-old very preterm/very-low-
birthweight children. Dev Med Child Neurol. 2014;56(9):862-868.
65. Reijneveld SA, de Kleine MJ, van Baar AL, et al. Behavioural and emotional
problems in very preterm and very low birthweight infants at age 5 years. Arch Dis
Child Fetal Neonatal Ed. 2006;91(6):F423-428.
66. Degangi GA, Breinbauer, C., Doussard-Roosevelt, J., Porges, S., & Greenspan, S.
Prediction of childhood problems at 3 years in children experience disorders of
regulation in infancy. Inf Mental Hlth J. 2000;21(3):156-175.
67. Dahl M, Sundelin C. Early feeding problems in an affluent society. I. Categories and clinical signs. *Acta Paediatr Scand*. 1986;75(3):370-379.
Figure Legends

**Figure 1.** Associations between RPs at early months (term, 3 months, 6 months) and 18 months