

SUMMARY

This thesis aims to contribute to improvements in the care of children born preterm with a gestation of less than 32 weeks and/or a birth weight below 1500 grams (VLBW). In this thesis, the effects of the Infant Behavioral Assessment and Intervention Program (IBAIP)[®] in VLBW infants, 3 years after the end of the intervention, are presented. In addition, the VLBW children are compared with their term born peers with regard to several aspects of development at 44 months of corrected age (CA).

In the introduction (**Chapter 1**) is described that VLBW infants are at risk of developmental problems. Several risk factors play a role in the origin of developmental problems. However, also protective factors, like responsive parenting, have been described and may be essential for intervention. Several post-discharge early intervention programmes for preterm infants are developed which focus on parent-infant interaction and aim to improve infant development. One of these programmes is the IBAIP. The IBAIP aims to support an infant's self-regulatory competence and developmental functions via responsive parent-infant interactions. The IBAIP utilises the strengths of the infants and parents. The IBAIP interventionist sensitises parents to interpret their infant's neuro-behavioural expressions in order to securely support their infant's interactions with the environment. The IBAIP interventionist helps parents to adjust the intensity, complexity and timing of the sensory information from the environment to their infant's neuro-behavioural needs and to offer co-regulatory support when interacting with their infant. The co-regulatory support involves, for example, help for bringing the hands together when the infant tries to decrease his/her movements in order to focus his/her attention.

A multicentre RCT was undertaken in 2004 in Amsterdam, the Netherlands. Seven hospitals participated and 176 VLBW infants were randomised; 86 infants received the IBAIP

and 90 infants in the control group received standard care. Positive effects of the IBAIP were found for motor, cognitive and behavioural outcomes at 6 months of corrected age (CA). The IBAIP was also found to improve motor development at 24 months CA, and positively influenced cognition in VLBW infants with bronchochopulmonary dysplasia (BPD), and VLBW infants with a combination of low maternal education and abnormal cranial ultrasound and/or BPD at 24 months CA. In order to evaluate whether the positive effects of the IBAIP were sustainable, this cohort was reassessed at 44 months. A comprehensive assessment was collated which could be completed at home. In order to compare the performance of the VLBW children of the RCT with term born children, a comparison group of term born children was formed. The comparison group matched the VLBW group with respect to gender, having a low educated mother, and a mother of non-Dutch origin

Chapter 2 evaluates the effects of the IBAIP in VLBW children at 44 months CA with regard to sensory processing and daily activities. In the follow-up study of the RCT at 44 months CA, the Sensory Profile-Dutch version (SP-NL) and the Pediatric Evaluation of Disability Inventory-Dutch version (PEDI-NL) were administered. At 44 months CA 76 children (88%) of the IBAIP group and 75 children of the control group (83%) participated. In addition, parents of a comparison group of 41 term born peers completed the SP-NL. This group of term born peers was matched with the VLBW groups with respect the following criteria: male gender (50%), low maternal education (36%) and mother of non-Dutch origin (39%).

After adjustments for pre-randomisation differences in perinatal characteristics, the IBAIP group outperformed the control group significantly on two SP-NL domains (oral sensory processing and sensory processing related to endurance/tone) and on the mobility domains of PEDI-NL.

The following subgroups of VLBW infants profited especially from the intervention: infants with BPD, infants with a gestation < 28 weeks, infants with an abnormal cranial ultrasound scan, and boys.

The term-born group outperformed only the control group, on only one domain of SP-NL: sensory processing related to endurance/tone. The control group scored lower on 5 domains and the IBAIP group on 3 domains compared to the PEDI-NL norm.

These results show, 3 years after the end of intervention, that the IBAIP has a sustained effect on motor development: independency in mobility in daily activities was improved.

In **Chapter 3** the IBAIP's effect on executive functioning, behaviour and cognitive skills at 44 months CA is examined. In addition, the VLBW children are compared with their term born peers.

The Visual Attention Task (VAT), Gift delay, Peabody Picture Vocabulary Test-III-NL (PPVT), Visual motor integration tests and 8 items of the Miler assessment for preschoolers were administered. Parents completed the Behavior Rating Inventory of Executive Function-Preschool (BRIEF-P) and the Child Behavior Checklist (CBCL).

At preschool age, 76 (88%) children of the intervention group, 75 (83%) children of the control group and the 41 children of the term comparison group participated. There were no significant differences between the intervention and control group. However, positive effects of the IBAIP were found on the CBCL, CBCL and BRIEF-P, and PPVT in subgroups of VLBW children: VLBW children with BPD, VLBW children with a gestation < 28 weeks and VLBW children born to a low educated mother, respectively. The VLBW children performed significantly worse than their term born peers with respect to executive functioning, visual attention, attention problems and figure-ground perception.

To conclude, the IBAIP did not effect executive functioning, behaviour and cognition in VLBW children at 44 months CA. However, the most vulnerable children had a clinical relevant profit from the IBAIP. VLBW children performed less well than the term born children.

In **Chapter 4** VLBW children are compared with their term born peers on measures of attention at the age of school entry (44 months CA). In addition, the association with educational provision at 5.5 years is explored.

One hundred and fifty-one VLBW children of 44 months CA and 41 healthy term born peers were assessed. Attention was explored using six measures. The children performed the Visual Attention Task of the Developmental neuropsychological assessment and the Gift delay test. The parents completed the Attention problems domain of the Child Behavior Checklist (CBCL-AP), the Inhibit domain of the Behavior Rating Inventory of Executive Function (BRIEF-preschool version), and the Inattention/Distractibility scale of the Dutch Sensory Profile (SP-NL). The assessor completed the attention domain within the Behavior During Testing (BDT-AD) of the Miller assessment for preschoolers. Mean scores and abnormal scores were calculated.

VLBW children performed significantly worse than their term born peers on all attention measures except for the SP-NL. Significantly more abnormal scores were found in the VLBW group than in the term group on the CBCL-AP and the BDT-AD. Abnormal scores on the BDT-AD and the SP-NL were significantly associated with lower levels of participation in the curricula of mainstream education at 5.5 years CA.

The results presented in this chapter confirm that VLBW children perform less well on attention measures than their term born peers at 44 months CA. The results of the BDT-AD are associated with later functioning in school. This may therefore be a valuable tool for

identifying children in need of intervention at preschool age. Further studies on this attention measurement are suggested.

Chapter 5 presents the results of an evaluation of the levels of independence in VLBW children in daily activities at the age of school entry. In addition, risk factors for disability in daily activities are explored.

The Dutch Pediatric Evaluation of Disability Inventory (PEDI-NL) was used to detect disability in daily activities in 143 VLBW children without cerebral palsy (CP) at 44 months CA. Disability in daily activity was defined as a score below 2 SD on a domain of the PEDI-NL.

Data was utilised from the psychomotor-developmental index (PDI) and the mental developmental index (MDI) of the Bayley Scales of Infant Development II (BSID II) at 24 months CA, together with data relating to perinatal and socio-economic status.

Disability in daily activities was found in 27 (19%) VLBW children without CP. High frequencies of disability were found on the mobility domain (in 19 (13%) children) and on the social functioning domain (in 12 (8%) children). The multiple logistic regression analyses showed that low BSID II outcomes ($< 2SD$) were risk factors for disability in the mobility domain, but not for disability in the social functioning domain. The predictive value of the BSID II outcomes is moderate, 46% of the VLBW children with a low PDI and 44% with a low MDI developed a disability in the mobility domain.

This study found a higher frequency of disability in daily activities in VLBW preschoolers compared to their term born peers at the age of school entry. Prediction of disability in daily activity is limited. Therefore, an assessment of a VLBW child's performance of daily activities is recommended before school entry.

In **Chapter 6** the frequency of multiple developmental difficulties between VLBW children and those born full term is examined. In VLBW children the association between multiple developmental difficulties assessed at 44 months CA and educational provision, at 5.5 years CA, was also investigated. 'Educational provision' refers to the curriculum, school placement and the level of learning support.

There were 143 VLBW children, without cerebral palsy (CP), and 41 term-born peers assessed at 44 months CA. The assessment included 6 measures of development: word comprehension, visual motor integration, visual perception, motor co-ordination, executive functioning and behaviour. Educational provision was determined at 5.5 years CA. A mildly abnormal score (score <1 SD) was considered to indicate developmental difficulty. Scores from the six measures of development were analysed to determine the difficulty frequency and the presence of multiple difficulties (>1 difficulty score) in each child. This study found that at 44 months CA, VLBW children had significantly more difficulty with motor co-ordination than their term-born peers: 26% versus 10% ($p=.029$). In addition, 27% of the VLBW children had multiple difficulties compared to 10% in the term-born group ($p=.01$). Multiple logistic regression analyses showed that of the difficulties, impaired motor co-ordination was most strongly associated with the requirement for learning support two years later. Regression analyses showed that the presence of multiple difficulties was significantly associated with the need for learning support (Odds Ratio of 3.4 (95% CI 1.5–7.8)). These results show that the presence of multiple difficulties in a VLBW child of preschool age can impact the child's educational provision two years later.

Chapter 7 presents a general discussion of the main findings, the strengths and limitations of the studies, suggestions for clinical practice and suggestions for further research.

The IBAIP improved motor development in VLBW infants up to 44 months CA. However, the IBAIP did not improve executive functioning, behaviour and cognitive skills. Subgroups of extra vulnerable VLBW infants profited especially from the IBAIP. Being of VLBW, at 44 months CA, results in lower levels of independence in daily activities, less favourable executive functioning, attention difficulties and, more often, multiple developmental difficulties.

The following clinical implications of the results presented in this thesis were formulated. In order to stimulate development in all domains, preventive intervention may be extended across early childhood, aimed at the developmental issues for that specific age. It is recommended to assess daily activities in VLBW children before they enter school. With respect to attention, it is suggested to observe systematically the attention during testing as these observations are associated with later educational provision. We recommend for the follow-up of VLBW children at preschool age a comprehensive assessment with a focus on multiple mildly abnormal scores. Given that certain areas such as word comprehension develop rapidly at preschool age, it would seem appropriate to consider starting school at the corrected age of 4 years rather than at the uncorrected age of 4 years.

Several suggestions for further study are formulated. Complementary support to improve daily activities, executive functioning, attention and level of preschool skills in VLBW children needs to be developed and evaluated to determine the effectiveness. It is suggested to further research the effect of the early intervention in VLBW infants with BPD and infants with a gestation < 28 weeks. Establishing the reliability and validity of the BDT-AD in VLBW children seems valuable. It is proposed to study the benefits of allied health interventions for the VLBW children with developmental difficulties. In addition, it is suggested to evaluate the effects of preschool programmes in VLBW children with developmental delay(s).