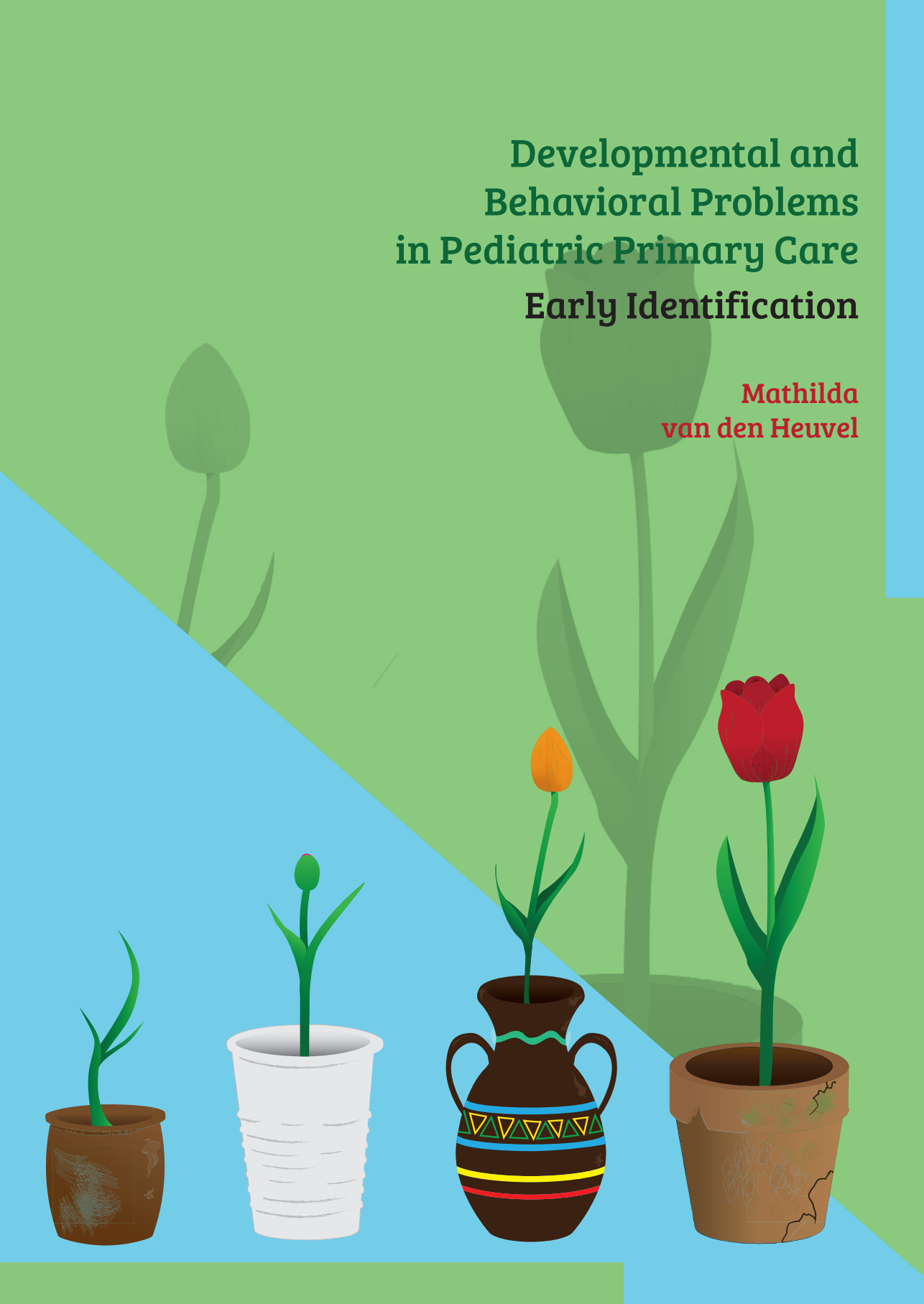
Developmental and Behavioral Problems in Pediatric Primary Care

Early Identification

Mathilda van den Heuvel



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Early Identification

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by

Mathilda van den Heuvel

born on 19 July 1976
in Rhenen

Supervisor
Prof. dr. S.A. Reijneveld

Co-supervisor
Dr. D.E.M.C. Jansen
Dr. B.C.T Flapper

Assessment committee
Prof. dr. A.A.E. Verhagen
Prof. dr. J.B. van Goudoever
Prof. dr. A.M. Oudesluys-Murphy

Paranimfen
Mieke Möller - van den Heuvel
Laura van Steenveldt

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CHAPTER 01

GENERAL INTRODUCTION

This thesis concerns the early identification of developmental and behavioral problems in pediatric primary care. It focuses on the assessment of communication problems in early childhood and on the identification of emotional and behavioral problems by teachers. In this first chapter the broader context of this thesis and its core concepts are described. We will discuss the various concepts of child development and behavior as used in this thesis. The importance of the social environment on early child development will be emphasized. Since studies have been both conducted in the Netherlands and Canada differences between these countries will be highlighted. At the end of this chapter we will discuss the different research questions of our study.

Child development and behavior

Child development and behavior are the central concepts in this thesis. Child development refers to the evolution of capacities in a child, which is the reflection of the maturation of the central nervous system.[1] Major areas of child development are: [1-3]

1. Gross motor: performance of large muscles groups (e.g. running, jumping, climbing stairs)
2. Fine motor: performance of small muscles groups (e.g. building blocks, picking up objects)
3. Language and communication: skills in receptive language (i.e. what the child can understand) and expressive language (i.e. what the child can say) as well as in gestures and other non-verbal communication
4. Social development: attachment, level of cooperative play, empathy
5. Cognitive development: learning & thinking, information processing, problem-solving

Developmental skills are acquired sequentially, with one performance skill (e.g. sitting) acquired after another (e.g. walking).[3] Moreover, development on various domains interacts. For example, the emergence of motor skills also plays an important role in cognitive and language development.[4]

Development and behavior are closely connected in children, but conceptually they are separate.[1] A child's behavior is defined as the style (how a child behaves) and content of his or her actions (what he or she actually does).[1] The *behavior style* of a child is called temperament and is often explained as the "how" of behavior and closely related to a child's personality.[1,5] Temperament is defined as a biologically based individual differences in reactivity and self-regulation, influenced over time by heredity and experience.[6] Each child can be considered to have three main reactive dispositions of temperament: 1) extraversion/ surgency (e.g. positive emotionality, activity, impulsivity), 2) negative affectivity (e.g. sadness, discomfort) and 3) effortful control (e.g. attention shifting, focusing, inhibitory and activational control). The *content of behavior* can be described as child's behavioral adjustment to the environment.[1] This behavioral content may be derived

from or interact with a child's developmental status and individual temperament, but is considered a distinct characteristic of the child.[1]

The outcome of a child's development has been described by Bronfenbrenner's ecological model as the product of the interaction between the child's characteristics (including genetics, temperament, health status) and the environment (including physical, chemical and social circumstances).[1,7] The social environment is considered a fundamental determinant of early child development and, in turn, early child development is a major determinant of health, well-being and learning skills across the life course.[8] Social environments that do not stimulate healthy child development have an ongoing negative impact on a range of social, economic and learning outcomes of a child.[3] From a policy perspective, however, it is not clear how the social environment in early childhood can be supported. In the Chapter 2 of this thesis we have investigated four social determinants of health important in the early years of child development; prenatal care, maternal leave, child health care, and child care and early childhood education. For each of these social determinants we will compare the organization of services and health outcomes in five countries with different redistributive policies, including the Netherlands and Canada.

Developmental and behavioral problems in children: prevalence and consequences

Developmental problems in children include disorders or delays in any of the developmental domains (motor, language, social and cognitive).[1] In the Netherlands it has been estimated that developmental delay affects 5% to 10% of annually born children.[9] A 2001 Statistics Canada report showed a much lower prevalence, i.e. that 1.1% of children aged 0-4 years had a developmental delay.[10] However, recent reports from the United States have indicated a higher prevalence of 13% of children between 9 and 24 months that experience developmental delays.[11]

As a definition of behavioral problems we use in these thesis: problems that children experience in reacting to the environment.[1] We divided behavioral problems in: (1) behavioral / externalizing behavior (e.g. hyperactivity, aggressive and delinquent behavior) (2) emotional / internalizing behavior (e.g. depression, anxiety).[12] In the Netherlands, 11% children (3-18 years) have been estimated to have externalizing behavioral problems and 8% internalizing problems (children 0 -12 years) according to parental ratings on mental health questionnaires.[13,14] In Canada the most recent estimate is that 12.6% of children and youth (between 4 -17 years) experience mental health disorders based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) criteria.[15]

Importantly, the prevalence estimates described above do not take into account that a majority of children will never acquire a specific diagnosis of a developmental or behavioral disorder, but despite this they experience persistent difficulties in behavior, attention,

language or other domains of development impacting their individual potential.[16] In addition, both developmental and behavioral problems often occur in the same child, for example a child with a language delay can have significant behavior problems and a delay in motor performance of a child can have a great impact on his or her psychosocial development.[17,18]

In the USA, speech problems, learning disability, attention deficit/ hyperactivity disorder (ADHD) were reported in 2009 as the top 3 conditions contributing to limitations in children's activities.[19] Both developmental and behavioral problems in early childhood are identified as important precursors for mental health disorders later in life.[20] Prevention of mental health disorders might be possible with early recognition of developmental and behavioral problems in childhood and prompt mental health treatment.[21]

Pediatric Primary Care

Primary care is defined as " the central focus of a country's health system, providing the first level of contact for individuals, family and community, providing universally accessible services as close as possible to where people live and work, and providing the first element of a life-long health process".[22] Primary care is often the main pillar of care for children.[22] Different models are employed in the organization of pediatric primary care; the medical workforce that delivers it, the use of services for urgent or emergency problems, the type of care for children with long-term conditions, and the role of disease prevention and health promotion.[22]

In the Netherlands two major professions provide pediatric primary care; preventive child health specialists (including medical doctors and nurses specialized in preventive child healthcare) and family physicians. For children between 0-4 years preventive child healthcare (PCH) takes place in specific "child health centers". The Dutch PCH is free of charge for all families, regardless of health insurance status and more than 90% of all children regularly visit PCH.[23] The goal of the PCH is to monitor the physical, social, psychological and cognitive development of children and to inform parents about normal development in all these areas. From birth to 4 years Dutch children have 15 routine examinations in child health centers.[24] Traditionally the main focus of these examinations has been on physical development, but in the last years there is more attention for psychosocial problems in children.[25] Acute pediatric care is provided by family physicians at all hours of the day and if necessary these family physicians refer to a pediatrician. In the Netherlands, pediatricians work mainly in hospitals and are responsible for hospitalized pediatric patients and for providing consultation clinics.

In Canada, pediatric primary care is provided by many different professionals; family physicians, pediatricians, nurse practitioners and public health nurses.[26] Access to these professionals is determined by parental preference and/or awareness, geographic location and availability. In Canada six preventive child healthcare visits are recommended in the

first 18 months. In 2009 in Ontario an enhanced 18-month well-baby visit was introduced with a focus on early child development.[27] The 18-month visit is the last regularly scheduled primary care encounter (involving immunizations) before school entry; therefore it was recommended that the focus needed to shift from a well-baby check-up to an assessment of developmental health.[27] Acute pediatric care is offered by family physicians, pediatricians and 'walk-in-clinics" within office hours. For out-of-hours acute pediatric care parents often need to go to "walk-in-clinics" or hospital emergency departments.

Identification of developmental and behavioral problems in pediatric primary care

The importance of screening and surveillance for developmental problems in children is widely recognized by experts.[14,17] In the study of Sheldrick et al. pediatric primary care providers who worked without screening instruments achieved 70% specificity and 54% sensitivity in correctly identifying children having a developmental or behavioral problem.[17] The American Academy of Pediatrics (AAP) recommends using a standardized tool in the screening for developmental delay.[28] A study by Brugman *et al.* conducted in the Netherlands demonstrated that preventive healthcare specialists who worked without screening instruments did not identify psychosocial problems in 43% of children aged 4-15 years with emotional and behavioral problems in the clinical range.[29] For children aged 21 months – 4 years, this was 71%.[30] Vogels et al., de Wolff et al. and Theunissen et al. demonstrated that the use of validated questionnaires can add significantly to the detection of emotional and behavioral problems in PCH.[31-33] Theunissen et al. further showed that work experience and work style determined a substantial part of the variation in detection among preventive child health physicians.[34]

There are a large number of developmental and behavioral screening instruments available. Developmental and behavioral screening instruments have different purposes (general screening tool versus screening for a more specific problem) and use different methods (e.g. parent report versus practitioner administered). In Chapter 3 we will discuss the use of a broad developmental checklist in the early detection of communication problems in pediatric primary care. In Chapter 4 and 5 we will discuss the identification of emotional and behavioral problems by teachers.

Early detection of communication problems

Communication problems are often the first presenting problem in young children with developmental disabilities.[35,36] Children with communication problems have poorer outcomes in reading, spelling, math skills and increased emotional and behavioral difficulties. [37,38] The identification of developmental problems in speech and language acquisition is a core activity of preventive child health care.[39]

In Canada, the Nipissing District Developmental Screen (NDDS) was created as a broad developmental checklist for infants and children for use in pediatric primary care.[40] The Canadian Paediatric Society recommended the NDDS as one of the developmental screening tools that could be used at the 18-month well-baby visit.[27] The NDDS is a parent-completed questionnaire that addresses development in the following areas: fine motor, gross motor, emotional, social, self-help, learning, and thinking and communication.[40] The psychometric properties of the NDDS are not specified and it is currently not known how well the NDDS can detect communication problems at the 18-month developmental surveillance visit.

Therefore, in Chapter 3 of this thesis we compared the 18-month NDDS with a validated questionnaire for detecting communication delays; the Infant Toddler Checklist (ITC). The ITC is a standardized 24-item parent completed questionnaire with normative scores for monthly intervals from 6 -24 months, with both good sensitivity (88.9%) and specificity (88.9%) for detecting global developmental delay and autism spectrum disorder (ASD).[41,42]

Identification of emotional and behavioral problems: the role of teachers

The use of short parental questionnaires in the early identification of emotional and behavioral problems in children has been investigated by Theunissen et al (children 3-4 years) and by Vogels (children 7 -12 years).[31,33,43] Less information is available about the early identification of emotional and behavioral problems by teachers with the use of questionnaires. Multi-informant data are preferable for assessing emotional and behavioral problems in children.[44] Children may display behavioral problems in some contexts (for example at home) but not in other situations (for example with peer interactions).[45] Teachers are well acknowledged informants of children's behavior because they see children on a daily basis in the school environment and have the opportunity to compare behavior of children of similar age every day.[44] Identifying the specific contexts in which children display emotional and behavioral problems and its impact on school functioning, may also facilitate treatment of these problems.[45]

Several questionnaires for teachers have been developed to help identify emotional and behavioral problems in children. The Achenbach Teacher's Report Form (TRF) is often regarded as a gold standard among broadband behavior rating scales for teachers.[46,47] It has questions across eight syndrome scales (Anxious /Depressed, Withdrawn/Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule-breaking Behavior and Aggressive Behavior) and two broadband scales (internalizing and externalizing problems).[46,47] The TRF has been extensively investigated and found to be highly reliable and valid, in all age groups and among many countries and cultures.[47] However, for routine use a major disadvantage is its length, as it includes 113 items.

The Strengths and Difficulties Questionnaire (SDQ) has quickly become one of the most utilized screening instruments because of its brevity and its ability to measure both problem

behavior and competencies.[48-50] The SDQ has a parent, teacher- and adolescent version available. The SDQ consists of 25 items subdivided into four difficulties scales, emotional symptoms, conduct problems, hyperactivity-inattention, peer problems, and a separate fifth strength scale, prosocial behavior. The parent- and adolescent-report versions of the SDQ have been shown to have good psychometric properties.[49,51-57] In contrast, the teacher version of the SDQ (SDQ-T) has not been well investigated in school children in a broad age range.[58-60] It would be ideal for pediatric primary care professionals to use the same, short questionnaire for both parents and teachers to express their concerns about emotional and behavioral problems. In Chapter 4 of this thesis we will assess the reliability and validity of the teacher version of the SDQ-T in a population of school children in the Netherlands.

Identification of emotional and behavioral problems: the role of teachers in children with developmental coordination disorder

Developmental Coordination Disorder (DCD) is a common disorder affecting motor coordination in school-aged children, affecting 6% of all children.[61] Research has shown that motor performance greatly impacts psychosocial development of children.[62] Children with DCD not only show significantly higher internalizing behavior, but also showed higher externalizing behavior compared with peers.[63,64] Up to 50% of children with DCD have been shown also to meet criteria ADHD.[65]

Current evidence on the co-occurrence of DCD and emotional and behavioral problems mainly concerns parent-reported information and rarely includes teacher reports.[62,63,66-69] Since DCD is a common motor problem in school-aged children, more insight is needed in the teacher's identification of emotional and behavioral problems in children with DCD. Although the parent version of the SDQ has been used in children with DCD, it is not known if the teacher version of the SDQ could identify the same emotional and behavioral problems in children with DCD as a more extensive questionnaire like the TRF. In Chapter 5 we will evaluate the teachers' identification of emotional and behavioral problems in children with DCD, using both the TRF and SDQ-T in school children in the Netherlands.

The relation of early childhood temperament and nutrition

Nutrition plays an essential role in growth, development and in the social- and emotional well-being of children.[70,71] Important examples of nutrition related risk factors and health outcomes in young children include prolonged bottle use contributing to iron deficiency and increased screen time and excessive intake of sugar sweetened beverages contributing to obesity.[71,72] Recognizing early signs of nutrition related risk factors could help identifying children who require interventions. In Canada, a Nutrition Screening Tool for Every Preschooler (NutriSTEP) has been developed to assess nutrition risk in preschool children.[70] The NutriSTEP ® includes 17 questions about nutritional risk factors including five domains;

eating behaviors, dietary intake, parental concerns about food and activity, screen time duration and the use of supplements.[70]

An important child factor contributing to his or her nutrition is child temperament.[73,74] Temperament may be related to nutrition by evoking particular responses from caregivers; for example infants who are higher on negative affectivity may be fed more as an attempt to soothe their distress.[75] Additionally children with lower self-regulation may have a difficult time resisting the energy-dense, palatable foods that are prevalent in the current environment.[75]

No studies have investigated the longitudinal influence of child temperament on nutritional risk factors in preschool children. In Chapter 6 we have investigated whether temperament dimensions (negative affectivity, effortful control and surgency) in early childhood are associated with later nutritional risk factors.

Research questions and outline of this thesis:

This thesis aims to contribute to the early detection of developmental and behavioral problems in pediatric primary care by addressing a number of research questions:

1. What is the influence of redistributive polices on early child development services and outcomes?
2. How well does the Nipissing District Developmental Screen (NDDS) identify communication problems in infants?
3. What is the reliability and validity of the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T)?
4. What is the risk of emotional and behavioral problems identified by teachers in children with Developmental Coordination Disorder (DCD) compared with their peers? How well does the SDQ-T perform compared to the TRF in children with DCD?
5. Is temperament (negative affectivity, effortful control and surgency) in early childhood associated with later nutritional risk factors?

In Chapter 2 we describe our examination of the social environment of early child development in countries with different redistributive policies, including the Netherlands and Canada. The objective of this study was to highlight similarities and differences in social and health services between countries and their associations with other health outcomes to inform better early child development policies.

In Chapter 3 we report how well the Nipissing District Developmental Screen (NDDS) identifies communication problems in 18-month infants in Canada. We assessed the diagnostic properties (sensitivity, specificity) and validity (Cohen's kappa) of the 18-month NDDS with the Infant Toddler Checklist (ITC) used as criterion measure.

In Chapter 4 we describe our assessment of the reliability (internal consistency) and validity

(Spearman's correlation, sensitivity and specificity) of the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T) in primary school children in the Netherlands. In these analyses we compared the SDQ-T with the Teacher's Report Form (TRF).
In Chapter 5 we describe the teachers' identification of emotional and behavioral problems in children with Developmental Coordination Disorder (DCD) in the Netherlands. Secondly we explore the performance of the SDQ-T compared with the TRF in children with DCD**.**
In Chapter 6 we report about our study investigating the association between early childhood temperament dimensions (negative affectivity, effortful control and surgency) and the association with later nutritional risk factors in primary care children in Canada.

In Chapter 7 we discuss our findings and give recommendations for further research.

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CHAPTER 02

A COMPARATIVE ANALYSIS OF EARLY CHILD HEALTH AND DEVELOPMENT SERVICES AND OUTCOMES IN COUNTRIES WITH DIFFERENT REDISTRIBUTIVE POLICIES

Meta van den Heuvel, Jessica Hopkins,
Anne Biscaro, Cintha Srikanthan, Andrea Feller,
Sven Bremberg, Nienke Verkuijl,
Boudien Flapper, Elizabeth Lee Ford-Jones,
Robin Williams

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ABSTRACT

Background: The social environment is a fundamental determinant of early child development and, in turn, early child development is a determinant of health, well-being, and learning skills across the life course. Redistributive policies aimed at reducing social inequalities, such as a welfare state and labor market policies, have shown a positive association with selected health indicators. In this study, we investigated the influence of redistributive policies specifically on the social environment of early child development in five countries with different political traditions. The objective of this analysis was to highlight similarities and differences in social and health services between the countries and their associations with other health outcomes that can inform better global early child development policies and improve early child health and development.

Methods: Four social determinants of early child development were selected to provide a cross-section of key time periods in a child's life from prenatal to kindergarten. They included: 1) prenatal care, 2) maternal leave, 3) child health care, and 4) child care and early childhood education. We searched international databases and reports (e.g. Organization for Economic Cooperation and Development, World Bank, and UNICEF) to obtain information about early child development policies, services and outcomes.

Results: Although a comparative analysis cannot claim causation, our analysis suggests that redistributive policies aimed at reducing social inequalities are associated with a positive influence on the social determinants of early child development. Generous redistributive policies are associated with a higher maternal leave allowance and pay and more preventive child healthcare visits. A decreasing trend in infant mortality, low birth weight rate, and under five mortality rate were observed with an increase in redistributive policies. No clear influence of redistributive policies was observed on breastfeeding and immunization rates. In the analysis of child care and early education, the lack of uniform measures of early child development outcomes was apparent.

Conclusions: This paper provides further support for an association between redistributive policies and early child health and development outcomes, along with the organization of early child health and development services.

BACKGROUND

Social determinants play a critical role in health from the time of conception, through pregnancy, to the post-natal period, and beyond.[1] The social environment is a fundamental determinant of early child development (ECD) (generally defined as the period from birth to 4 to 6 years of age) and, in turn, ECD is a determinant of health, well-being and learning skills across the balance of the life course.[1] Healthy early childhood development influences obesity and stunting, mental health, heart disease, competence in literacy and numeracy, criminality, and economic participation.[2] Therefore, targeted social and health investments not only benefit individual children, but have the potential to "lift all children up" on a population scale. A strategy of targeted universalism is especially relevant during times of economic restraint given the need to spend public dollars cost-effectively, but also to minimize the "gap" between rich and poor within countries. Interestingly, there is not a clear relationship between child well-being and gross domestic product (GDP) per capita; suggesting that more than a strong economy is required to promote child health.[3] Navarro *et al*. suggest that another factor contributing to child well-being is a country's redistributive policy.[4] Redistributive policies aimed at reducing social inequalities, such as a welfare state and labor market policies, have been positively associated with selected health indicators, such as infant mortality and life expectancy at birth.[4] Hence, quality, evidence-based ECD policies and services may prove a powerful strategy for rich and poor countries by bridging the gap between economic inputs and child health.[5]

In this study, we investigated the influence of redistributive policies on the social environment of ECD in five countries with different political traditions. We selected four social determinants of health important in the early years of development; prenatal care, maternal leave, child health care, and child care and early childhood education (ECE). For each of these social determinants we conducted a comparative analysis of the relevant services and policies with child health and/or development outcomes. The objective of this analysis was to highlight similarities and differences in social and health services between the countries that can inform better global ECD policies and improve early child health and development.

METHODS

Country selection

Navarro *et al*. have previously described a conceptual framework to identify and study the complex interactions between politics, policy, and public health.[4,6,7] Navarro *et al*.'s method includes identifying countries by political tradition, so that associations between

political tradition (as a proxy for policy) and population health outcomes can be made.[4,6] Navarro *et al*. classify governance by political traditions into 4 party types for the period 1950–2000: 1) social democratic parties, 2) Christian democratic or conservative parties in the Judeo-Christian tradition, 3) liberal parties or conservative parties of a liberal persuasion, and 4) conservative dictatorships.[4] Traditionally, social democratic parties have been most committed to redistributive policies. The social policies of these parties have included policies designed to encourage a high proportion of adult men and women to gain employment, generous social transfers and social services, including family-oriented services.[4] Examples of countries with a tradition of social democratic parties include Sweden, Denmark, Finland, and Norway.[4] Christian democratic parties or conservative parties in the Judeo-Christian tradition have been less committed to redistributive policies than the social democrats. They provide social transfers funded mainly by payroll taxes through social security systems. They do not tend to emphasize family-oriented services such as child care.[4] Examples of countries with Christian democratic or conservative Judeo- Christian political traditions include Italy, the Netherlands, West Germany and France.[4] Liberal or conservative parties of a liberal persuasion have not traditionally had a strong commitment to redistributive policies. They do not provide universal social services. Most social services benefits in these countries are means tested, and public social expenditures are much lower than in the countries governed by social democratic and Christian democratic parties.[4] Examples of countries in this tradition include the United Kingdom, Canada, Ireland, and the United States.[4] Lastly, the conservative dictatorships can be characterized by ultra-conservative or authoritarian (fascist) regimes, which can be generally characterized by low social system support and high income inequality. Although not currently dictatorships, examples of historic conservative dictatorships include Spain, Portugal, and Greece.[4]

Using the method of Navarro *et al*., we selected five countries representing a cross-section of the political traditions during the time period of 1950 to 2000, including countries governed primarily by: 1) social democratic parties (Sweden), 2) Christian democratic parties or conservative parties in the Judeo-Christian tradition (the Netherlands), 3) liberal parties or conservative parties of a liberal persuasion (Canada, the United States), and 4) conservative dictatorships (Cuba). Although Cuba is not an "ultra-conservative" state and is constitutionally identified as a socialist state, the country is governed an authoritarian regime and is generally recognized as a communist state led for many years by a dictator.[8,9] These countries were chosen for several reasons. Firstly, Organization for Economic Co-operation and Development (OECD) countries were desired for availability of data. The OECD compiles data and metadata from member countries to allow for member country comparisons. Secondly, in spite of different political traditions and policies, all of these countries have been recognized as global leaders in different aspects of early childhood

development (e.g., delivery of prenatal and child health care through polyclinics in Cuba, measurement of school readiness in Canada). Thirdly, trends in early childhood outcomes in countries with different political traditions have been observed in international reports, such as UNICEF's report on early childhood services, suggesting that one need not be exhaustive of all countries to observe trends in early childhood outcomes.[10] Lastly, authors have personal experience working in early child health and development in all of the countries, except Cuba, which allows for a more thorough understanding of contextual factors, which is particularly relevant for analysis of indicators which fall outside those typically collected on international surveys.

Data sources and indicators

We searched international databases and reports (e.g., OECD, World Bank, and UNICEF) to obtain information on the policies, services, and outcomes of interest. If the information was not available in international databases, we used national or local data sources, as described below.

Demographic, economic, and inequality data and social support

Data pertaining to countries' demographics and economics (population, population density, immigrants, GDP, tax revenue, and expenditures) were obtained through the OECD's and World Bank's databases (OECD.Stat and World Data Bank, respectively).[11,12] OECD data are obtained from regional- (e.g., Eurostat) or country-level statistical organizations (e.g., Statistics Canada, Statistics Netherlands, Statistics Sweden, National Center for Health Statistics in the United States). Similar to OECD.Stat, the World Data Bank compiles country-level statistical data using information from the statistical systems of member countries. Both databases have made attempts to improve the quality and comparability of data by providing guidance around methodology, sources, and indicator definitions. Data on Cuba are not available in OECD.Stat or the World Data Bank and Cuba does not publicly release statistics for many of the measures of interest. Data on Cuba were obtained from sources in other countries, primarily the United States, which track and monitor indicators of other countries according to standard definitions. For country demographic data, information for Cuba was obtained from the United States Central Intelligence Agency.[9]

The Gini coefficient is a measure of income equality with a score of 0 representing perfect equality and 1 perfect inequality.[13] Data for all countries except Cuba were obtained from OECD.Stat.[11] An extensive search for data on Cuba was conducted. No official government source was found, although an article in "The Economist" provided an estimate.[14] This has been included for interest, but should be interpreted with caution as the source, methodology, and definition were not described and may not be comparable to OECD sources.

Like the Gini coefficient, the Inequality-adjusted Human Development Index (IHDI) also measures inequality at the country-level. While the Gini coefficient measures only income inequality, the IHDI measures the level of human development of people in a society while accounting for inequality.[15] It is made up of 3 dimensions, including health, education, and income.[15] A score of 0 represents perfect inequality and a score of 1 perfect equality. IHDI data were obtained from United Nations Human Development reports which use standardized methodologies to draw information from country-level statistical sources for the index calculation.[15] No data were available for Cuba. Information on health insurance funding was provided by the authors who have personal experience with the included countries.

Social determinants of early child development

Four social determinants of ECD were selected to provide a cross-section of key time periods in a child's life from prenatal to kindergarten.[1] They included: 1) prenatal care, 2) maternal leave, 3) child health care, and 4) child care and ECE. For each determinant, relevant policies and services were identified which could influence early child health and development outcomes. Further information on the services and policies of each social determinant and the corresponding outcomes are described below.

Prenatal care

Prenatal care can provide an effective intervention to improve maternal and child health by supporting positive behavior changes (e.g., smoking cessation) and connecting parents to prenatal and parenting programs.[16,17] During the intra-partum period, health care providers also have the ability to impact on maternal and infant morbidity and mortality, and promote positive practices, such as breastfeeding. Evidence shows that midwife-led care is associated with an increase in spontaneous vaginal birth and the initiation of breastfeeding.[18] As a policy of interest, we compared the prenatal care services in each country. As outcomes of interest for prenatal care, we identified maternal smoking rate, caesarean-section (c-section) rate, infant mortality rate, and low birth weight rate.

Data for policies and outcomes of prenatal care were generally taken from national statistical databases.[19-22] The c-section rate for Cuba was obtained from the World Health Organization, and data for all countries on infant mortality rate and low birth weight rate (<2500 g) were obtained from the OECD and World Bank.[11,12,20] Based on standard definitions, data on c-section rate, infant mortality rate, and low birth weight rate have good comparability. Country comparisons for maternal smoking rate and c-section rate were limited by data availability as data were not always available for the same year.[23-26] Where years of data collection differ, this has been noted in the corresponding tables.

Maternal leave

Maternal leave is recognized as an important component of child health and enabler of breastfeeding and attachment.[10] Breast milk promotes sensory and cognitive development, and protects the infant against infectious and chronic diseases.[27,28] Exclusive breastfeeding reduces infant mortality due to common childhood illnesses, such as diarrhea or pneumonia, and helps for a quicker recovery during illness.[27] These effects can be measured in low and to some extent high-income countries.[29] International experts recommend exclusive breastfeeding up to 6 months of age with continued breastfeeding up to 2 years and beyond.[30,31] For policies related to maternal leave, we included maternal leave allowance, maternal leave pay, and parental leave. As a maternal leave outcome, we identified maternal breastfeeding rates (initiation and sustained).

Data for policies on maternal leave (i.e., maternal leave allowance, maternal leave, and parental leave) were obtained primarily from country-level government sources, with the exception of Cuba's data which were obtained from an academic source.[32-36] Data for maternal leave outcomes were generally taken from statistical databases.[11-37] Information on breastfeeding for Cuba was obtained from UNICEF.[38] Although most countries obtained information on initiation of breastfeeding through routine collection, information on exclusive breastfeeding at 6 months was more difficult to obtain and was taken from a variety of sources, including one-time surveys (Canadian maternity experiences survey, breastfeeding report card in the United States)[19,39], population statistics (Sweden, the Netherlands)[23,37] and UNICEF (Cuba)[38]. Although definitions for exclusive breastfeeding are similar, challenges to comparability arise from different time periods of data collection and methods of sampling populations.

Child health care

Child health care includes acute and preventive care. Beyond moral and professional obligations, the health sector has a unique opportunity to promote healthy child development because of the high levels of interaction with children and their parents during early childhood.[40] In each country, we compared the acute and preventive child health care services and the number of recommended preventive care visits and approximate cost per child per year [United States dollars (USD)]. Outcomes of interest for child health care and services included coverage of preventive visits, childhood immunization coverage rates, and the under 5 years mortality rate.

Data on policies for child health care were obtained through knowledge of the authors working in their respective countries, and through academic sources for Cuba.[41] Outcome data for service coverage was only available for 2 countries (Sweden and the Netherlands).[42,43] However, under 5 years mortality and vaccination coverage data were available for all countries through UNICEF.[44]

Child care and early childhood education

Today's generation of children is the first in which a majority are spending a large part of early childhood in some form of out-of-home child care.[45] Neuroscientific research demonstrates that loving, stable, secure and stimulating relationships with caregivers in the earliest months and years of life are critical for every aspect of a child's development.[45] We compared the ECE and education services and policies in each country. We focused on the organization of child care, pre-school, and kindergarten and looked specifically at age of enrollment, hours of operation, and contribution from parents and government. As outcomes of ECE and education, we included the Child Development Index (CDI), the Early Development Instrument (EDI), and the educational achievement of 15 year-olds.

Child care centers, or daycares, are places where parents can take children for care while they are otherwise occupied (e.g., while at work). There is generally some cost borne by the parent. Child care centers may be formal institutions or home-based. There are no global databases that collect comprehensive information on child care centers; information was obtained from various reports.[42,46-49]

Pre-school or infant education is a formal environment to stimulate child development in multiple domains. Programs may or may not charge parents a fee. Again, no global database containing this information exists, so data were compiled from various reports.[50.51] Kindergarten represents the first formal education level in school. Data on kindergarten start age was obtained from national policy sources. School readiness measures a child's preparedness to perform in multiple domains (e.g., emotional, behavioral, cognitive) in the school environment. There are no globally accepted measures of school readiness, however several different methods have been developed and are used to differing degrees around the world.[52,55] For example, the EDI is an internationally recognized tool which can be used to assess school readiness on a population- level.[56] The instrument evaluates children in 5 key domains of early development: physical, social, emotional, communication, and language and cognitive skills. Children who fall in the lowest 10th percentile for a given domain are deemed "vulnerable" in that area.[57] Data in this area are presented for interest, but comparability is limited by differences in source, method of collection/sampling, and validity of the measures. The CDI is a tool used globally to assess countries' performance on child health, education, and nutrition.[58] Countries are ranked according to their scores based on a child's risk of dying before his/her fifth birthday, of not enrolling in school, and of being underweight.[58] The CDI is measured on a scale of 0 to 100 with a higher number suggesting children are worse off.[58] To consider longer-term outcomes of child care and ECE, the educational achievement of 15 year-olds in reading, math and scientific literacy were reviewed. The OECD conducted a cross-sectional survey of 250,000 students in 41 countries.[45] Students were given a 2-hour test designed by a group of international experts that measured ability in literacy, numeracy, and science as applied to the management of

everyday life.[45] Students were measured on a numerical scale with the OECD average being around 500.[59] Equivalent data for Cuba were not available.

RESULTS

Comparison of countries and redistributive policies

Table 1 shows demographic, economic and inequality data, and social support information for the included countries. With the exception of Cuba, which is a communist country, all included countries have democratically-elected governments. All countries, with the exception of the United States, also provide free health insurance for children. All countries had a similar GDP per head ($39,000-$42,000) with the exception of Cuba which was significantly lower ($9,900).[9,11] Sweden had the highest income distribution and lowest measured inequality (Gini coefficient 0.26, IHDI 0.851) and the United States had the lowest income distribution and highest measured inequality (Gini coefficient 0.38, IHDI 0.771).[11,15] The Gini coefficient for Cuba was included for interest, but was not considered in the analysis as the data source was unknown, so it may not be comparable to OECD Gini coefficient calculations.[14] Additionally, for Cuba, only unadjusted HDI information was available, so it was not directly comparable with other countries. A similar pattern was seen for general fiscal support of families with Sweden contributing the most (3.4%) and the United States the least (0.7%).[11] We were unable to find equivalent data for Cuba. Expenditures on child care and preschool education as a percentage of GDP ranged from 0.2% (Canada) to 1.1% (Sweden).[60] No equivalent data were available for Cuba.

Table 1 Demographic, economic, and inequality data and social support in Sweden, the Netherlands, Canada, the United States, and Cuba

	Sweden	Netherlands
Political tradition (1950–2000)[4]	Social democratic parties	Christian democratic parties or conservative parties in Judeo-Christian tradition
Population, 2011 (millions)[11,12]	9.4	16.7
Population density (people per square kilometer of land), 2010[12]	22.9	492.6
Immigrants (foreign born population), 2009 [11,12]	14.4%	11.1%
GDP (output approach, USD, current prices and PPP*), 2010 (billions)[9,11]	$369.0	$701.0
GDP per capita (US dollars, current prices and PPP), 2010[9,11]	$39,345	$42,218
Gini coefficient level late 2000s, 2010[11,14]	0.26	0.29
IHDI (2011)[15]	0.851	0.846
Tax revenue (taxes on income, profits and capital gains as a% of GDP), 2009[9,11]	46.7%	38.2%
Public expenditures on family as a% of GDP, 2007[11]		
Cash benefits	1.5%	0.6%
Benefits in kind	1.9%	1.4%
Total	3.4%	2.0%
Public expenditure on child care and **early education services as a% of GDP**, 2007[60]	1.1%	0.7%
Health insurance funding	Government	Private, children have free insurance

**Interpret with caution as data source is not verifiable.
***Unadjusted for inequality.
Legend: GDP = Gross Domestic Product; PPP= Purchasing power parity; IHDI = Human Development Index

Canada	United States	Cuba
Liberal parties or conservative parties of a liberal persuasion	Liberal parties or conservative parties of a liberal persuasion	Conservative dictatorship
33.9	313.2	11.3
3.8	33.8	105.8
19.6%	12.7%	0.1%
$1,332.6	$14,447.1	$114.1
$39,049	$46,587	$9,900
0.32	0.38	0.5**
0.829	0.771	0.776***
32.0%	34.3%	75.8%
0.8%	0.1%	No equivalent
0.2%	0.6%	data available
1.0%	0.7%	
0.2%	0.4%	No equivalent data available
Government	Private with some government	Government

Prenatal care

Table 2 shows the policies and outcomes for prenatal care. All countries used midwives and/or physicians for prenatal, intra-partum and post-partum care. However, the degree to which different countries utilized these provider groups varied. For example, the Netherlands almost exclusively used midwives for prenatal care; whereas the percentage of physician- providers in Canada was much higher (92%).[19,61] In the Netherlands and Sweden, where midwives provided the majority of prenatal care, the c-section rate was lowest (15.4% and 17.2%, respectively).[23,26] The c-section rate was highest in the United States (32.9%).[24] The infant mortality rate ranged from 2.4 per 1000 (Sweden) to 6.8 per 1000 (United States).[63,64] Sweden's rate was significantly lower than the next lowest rate of 4.9 per 1000 (the Netherlands) and more than half the rate of Canada, the United States, and Cuba. Low birth weight rates (<2500 g) ranged from 4.2% in Sweden to 8.1% in the United States.[20,65,66]

Maternal leave

Table 3 shows the policies and outcomes for maternal leave. The maternal leave allowance ranged from 12 weeks in the United States to 68 weeks in Sweden.[33,35] The United States was the only country where maternal leave was not paid.[35] The included countries showed breastfeeding initiation rates from 70% (Cuba) to 97.6% (Sweden).[11,38] The Netherlands, United States, and Canada all had breastfeeding initiation rates below 85%.[11,37] Exclusive breastfeeding at 6 months showed a significant decrease from initiation for all countries with a range of 10.4% in Sweden to 26% in Cuba.[23,38] Interestingly, Cuba had the lowest initiation rates, but best maintenance of exclusive breastfeeding at 6 months. The Netherlands also showed a comparatively high 6-month rate of 18%, whereas all of the remaining countries were below 15%.[19,39]

Table 2 Policies and outcomes for prenatal care

Policy	Sweden	Netherlands	Canada	United States	Cuba
Primary providers of prenatal care[19-22]	Midwives and obstetricians	Midwives	Obstetricians and family physicians	Obstetricians	Polyclinics (wide range of professionals available)
Outcome					
Maternal smoking rate (Canada 2007, Sweden and US 2009)[23-25,62]	6.9%	7.6%	10%	12.8%	No equivalent data available
C-section rate (Canada 2006, all others 2009)[19,20,23,24,26]	17.2%	15.4%	26.3%	32.9%	28.5%
Infant mortality rate (2005) (per 1000 live births)[11,12]	2.4	4.9	5.3	6.8	5.3
Low birth weight rate (<2500 g) (2003–2005)[11,12]	4.2%	6.2%	5.9%	8.1%	5.4%

Table 3 Policies and outcomes for maternal leave

Policies	Sweden	Netherlands
Maternal leave allowance[32-36]	480 days (~68 weeks). Might be used by the mother, the father, or mixed (most common)	16 weeks (mandatory 4 weeks prior to due date)
Maternal leave pay[32-36]	78% of income for 390 days Min $3 USD/day Max $130 USD/day	Full salary (no max payment)
Parental leave[32-36]	60 days (10 days paid leave at birth of child); either parent may take unpaid leave at 25% until the child is 8 years	Additional unpaid leave can be taken by either or both parents after delivery based on hours worked in a week until the child is 8 years
Outcomes		
Initiate breastfeeding (having ever breastfed) (2008, Netherlands 2010, Cuba 2006–2010)[11,37,38]	97.6%	75.0%
Exclusive breastfeeding at 6 months (Sweden 2009, Netherlands 2010, Canada 2006, Cuba 2006–2010, US 2011)[19,23,37-39]	10.4%	18.0%

Child health care

Table 4 shows the policies and outcomes for child health care. Recommended preventive child visits (i.e., well baby visits) differed markedly in number and costs between the countries from 6 in the first 18 months in Canada to 20 visits during the same time period in Sweden. In Cuba there was a community-based, family-centered program that integrated health and education services into a single system, prioritizing health, learning, behavior, and life trajectories during prenatal life, infancy, childhood, and adolescence. In this program (*Educa a Tu Hijo*) children received between 104 and 208 stimulation and development monitoring sessions up to the age of 2 years.[41] Only Sweden and the Netherlands systematically tracked their service coverage rate of all preventive child health care visits. The under 5 years mortality rate showed a similar pattern with Sweden having the lowest mortality (3 per 1000 live births) and the United States the highest (8 per 1000 live births).[44] Most countries were doing well in achieving high primary series vaccination uptake rates; Sweden, the Netherlands, the United States, and Cuba were all above 92% for the primary series of diphtheria, tetanus, pertussis, polio, haemophilius influenza B, and measles.[44] However, Canada has fallen to 80% for some vaccines.[44]

Canada	United States	Cuba
15 weeks	12 weeks	1 year
55% of a woman's average insured earnings up to a yearly max of $44,900 if worked 600 insured hours in the 52 weeks prior to delivery	Unpaid	Full salary for 18 weeks (6 weeks before birth and 12 weeks after)
May be used by one parent or shared, but cannot exceed a combined max of 35 week; max payment is $485 per week	Unpaid	Additional 40 weeks leave at 60% pay may be taken by either parent
84.5%	74.2%	70.0%
14.4%	14.8%	26.0%

Table 4 Policy and outcomes for child health care

	Sweden	Netherlands
Policy		
Acute care	General practitioners, pediatricians	Family physicians, pediatricians
Preventive care	Public health nurses, general practitioners, pediatricians	Public health physicians and specialized nurses
Number of recommended preventive care visits and approximate cost per child per year (USD)[41]	20 visits in the first 18 months ($275-1000)	10 visits in the first 18 months ($150)
Outcomes		
Service coverage rate preventive visits (Sweden 2008; Netherlands 2007)[42,43]	99%	95%
Under 5 years mortality per 1000 live births (2010)[44]	3	4
Vaccination coverage (2010)[44]		
DPT1	99%	99%
DPT3	98%	97%
Polio3	98%	97%
Measles	96%	96%
Hib3	98%	97%
Hib3	98%	97%

Legend: DTP = diphtheria, pertussis and tetanus. HIB = Haemophilus Influenza type B vaccine

Child care and early childhood education

Table 5 shows the policies and outcomes for child care and ECE. Childcare and ECE programs and services varied markedly between and within countries; however some common themes emerged, including child day care beginning at birth to 6 months of age and typically continuing until school age, pre-school programs starting at 1–3 years, and compulsory school beginning at 5–7 years. All of the countries had variations on three main types of child care and ECE services, including daycare centers, preschools, and parent–child programs, although these also differed significantly between provinces in countries like Canada.[67] Additionally, very little was known about the quality of different ECE services across the countries. Canada had the best CDI at 0.74 and the United States the worst at 2.86.[58] Despite the investment in early child education in many countries, systematic data

Canada	United States	Cuba
Family physicians, pediatricians, nurse practitioners, emergency physicians	Family physicians, pediatricians, nurse practitioners, emergency physicians	Polyclinics
Family physicians, pediatricians, nurse practitioners, public health nurse	Pediatricians, family physicians, nurse practitioners	Polyclinics
6 recommended and 4 optional in the first 18 months ($140)	8 recommended visits in the first 18 months (costs vary based on health insurance plan co-payments and whether preventive visits are included in the deductible)	Children receive between 104 and 208 stimulation and development monitoring sessions up to the age of 2 years. No data on costs
No equivalent data	No equivalent data	No equivalent data
6	8	6
92%	99%	98%
80%	95%	96%
80%	93%	99%
93%	92%	99%
80%	93%	96%
80%	93%	96%

collection on readiness at school entry was lacking. Canada and the United States collected some school readiness data, such as with the EDI, but data collection was patchy and not analyzed at a country-level. A follow-up of "*Educa a Tu Hijo*", a Cuban program in which all pregnant woman have at least 12 prenatal medical checks and deliver in a maternity clinic or specialized health center, showed that only 13% of participating children reached school age with unsatisfactory development in key domains (motor skills, cognition, social-personal, and personal hygiene).[2] Looking at outcomes in 15 year-olds for reading, mathematics, and science literacy, where the OECD average was 500, all of the countries except for the United States scored above 500.[45] Data were not available for Cuba.

Table 5 Policies and outcomes for child care and early childhood education

	Sweden	Netherlands
Policy		
Child care centres (formal or family-based)[42,46-49]		
Age	1-5 years	3 mos-4 years
Hours of operation	Work days	Working days
Parental contribution	Mainly tax funded, parent fees based on income and number of children	44%
Government contribution	Income-based (up to 100%)	Income based (3.5-100%)
Pre-school[50,51]		
Age	1-5 years	2-4 years
Hours of operation	Work days	3 x ½ day/week
Financing	Mainly tax funded, parent fees based on income and number of children	Municipally funded, may charge a fee to parents
Kindergarten (varies by state or province in Canada and the United States)		
Age may start	6 years	4 years
Compulsory age of start	7 years	5 years
School readiness [2,52,55]	No equivalent data available	No equivalent data available
Child Development Index (CDI) 2005-2010[58]	1.85	0.93
Reading literacy achievement aged 15 (2003)[45]	514	513
Mathematics literacy achievement aged 15 (2003)[45]	509	538
Science literacy achievement aged 15 (2003)[45]	506	524

Legend: MMSR is the Maryland Model for School Readiness. EDI is Early Development Instrument

Canada	United States	Cuba
Birth-6 years	Birth-6 years	6 mos-5 years
Working days	Working days	Working days
Vary widely	Vary widely	Many free
Vary widely	Vary widely	Up to 100%
2-6 years	3-5 years	5 years
2-3 hours/day	Varies	Twice weekly
Tax funded and/or parent fees	Tax funded in some areas and/or parent fees	Government-funded
4 or 5 years	5 years	4-6 years
6 years	5 or 6 years	7 years (Gr. 1)
EDI (% vulnerable) 25% Ontario, 31% British Columbia, 29.1% in Manitoba (not ready 1 or more domains for all)	21 states have no state wide readiness assessments; 6 states publish school readiness data; instruments vary e.g., 17% vulnerable on MMSR in Maryland	13% unsatisfactory development in key domains (motor skills, cognition, social-personal and personal hygiene)
0.74	2.86	2.27
528	495	No equivalent data available
532	483	No equivalent data available
519	491	No equivalent data available

DISCUSSION

This paper compared four social determinants of early child development in five countries with varying redistributive policies. Sweden, the country with the greatest redistributive policies overall showed the best early child health and development outcomes. Countries with the least redistributive policies, like the United States, generally performed poorly in comparison. Although a comparative analysis cannot claim causation, our analysis suggests that redistributive policies aimed at reducing social inequalities are associated with a positive influence on the social determinants of early child development.

In comparing prenatal care services and outcomes, a decreasing trend in infant mortality rate and low birth weight rate was observed with an increase in redistributive policies. Cuba was an exception with an infant mortality rate comparable to Canada and a low birth weight rate second to Sweden. A possible explanation could be the high enrollment in comprehensive programs, such as "*Educa a Tu Hijo*" (discussed above). A higher c-section rate was observed in countries with less redistributive policies. However, this could also be explained by differences in service providers (i.e., more use of midwifery in Sweden and the Netherlands) or the fact that home deliveries in the Netherlands are popular as is the view of pregnancy and delivery as physiological events which should not be unnecessarily medicalized.[68]

Generous redistributive policies were associated with higher maternal leave allowance and pay. Sweden had the highest breastfeeding initiation rate; however the exclusive breastfeeding rate at 6 months was the highest in Cuba and the Netherlands. Recent studies have revealed varied sociodemographic, biomedical, and psychosocial determinants of breastfeeding duration and exclusivity, which may account for these discrepancies.[69]

In the comparison of child health care services, more preventive visits were recommended in countries with greater redistributive policies. Again, Cuba was an outlier with its high number of combined child health and development stimulation visits. No clear association was seen between immunization uptake rates and redistributive policies. This correlation may have been masked because of the small spread in values between the countries or an approach to vaccination policy which occurs irrespective of redistributive policies. A remarkable fact is that only Sweden and the Netherlands keep track of the coverage rate for preventive visits. A high-quality surveillance and monitoring system is critical to determining what support systems are needed for children.[57]

In the analysis of child care and ECE, the lack of uniform measures of early child development outcomes was apparent. As stated by the American Academy of Pediatrics, school readiness is an important outcome for community-based development programs.[70] With the development and implementation of the EDI, Canada is one of the world leaders in measuring the outcomes of early child development with a population-based survey

approach.[57] By expanding and enhancing measures of early child development, countries can more quickly address this important need and evaluate the impact of interventions on population- level outcomes.[57]

Strengths

We used a previously established method of categorizing countries by redistributive political traditions. This allowed for comparison between multiple countries in all of the categories, while keeping the number of countries manageable to allow for meaningful comparisons. Where data were available, they were generally robust and collected consistently across countries (e.g., immunization rates, infant mortality).

Limitations

Global databases, such as OECD.Stat and World Data Bank rely on data collected by national statistics. Although these large databases have made increasing strides to standardize indicator definitions, data sources, and collection methodology, inherently, there will be differences between some countries that limit comparability. Additionally, not all policies and outcomes of interest were collected through standardized, country-level sources, making comparability more challenging for some indicators. Due to these limitations, we attempted to choose indicators with objective or widely recognized definitions. Additionally, some data points were missing as statistics were either not publicly available or not collected. Although this was most readily apparent for Cuba, we elected to include the data available, with cautionary notes on interpretation, as Cuba's successes in some areas of early child health and development may serve as case studies for other resource-constrained settings.

Early child health and development is impacted by a web of different social, cultural, economic, genetic, political, and environmental conditions. While redistributive policies and indices, such as the Gini coefficient and IHDI, attempt to capture the complexity of this web, the categorization is inherently incomplete.

Another limitation is that we only included one country from each different political tradition in our analysis. However, if we examine UNICEF's latest report about early childhood services, the same ranking is observed as in our study with the social democratic countries having the best and the liberal countries the worst early childhood outcomes.[10] UNICEF's report proposed 10 internationally applicable benchmarks for early childhood care and education.[10] The report card scores ranged from 1–10, a 10 indicated that all suggested standards were met. The social democratic countries (Sweden, Denmark, Finland and Norway) all scored 8 or higher; the Christian democratic countries (the Netherlands, Germany and Belgium) scored between 4 and 6; and the liberal countries (Canada, Ireland,

and US) scored the lowest, between 1 and 3. An exception was the United Kingdom which also has a liberal government and scored a 5, this is possibly explained by the "Sure Start Program" which offered full day care for children, good quality teacher input to lead the development of learning within the center, and child and family health services for disadvantaged groups.[2] This underscores the statement of Navarro *et al.* that there is a great need for further research to establish the interactions between politics, policy, and health outcomes.[4]

As discussed previously, a comparative analysis allowed for correlation, but not causation. In the East Asian welfare states (South Korea, Japan, Taiwan, Singapore, and Hong Kong), child health seems to be as good as in Scandinavia.[71] The East Asian welfare states are characterized by low social, educational, and health expenditures. Thus, the findings in our study might not be generalizable to countries outside the western tradition.

Future directions

In order to better understand and continue to improve early child health and development, policy makers should consider the following:

- Establish mechanisms to systematically collect, analyze, and respond to early child health and development indicators. This information is essential to ongoing monitoring and improvement of the early child health and social systems;
- Promote redistributive policies aimed at reducing social inequality;
- Use a "health in all" approach to policy development, so that the health and implications of economic and social policies are understood and considered.

CONCLUSIONS

We hope this paper will inform and encourage further discussion between health care professionals, child development specialists, and policy makers. In these economically challenged times, the need for supportive social and health policies for children and families are crucial to improve life course trajectories, not only for individual children, but also for society and human development globally.

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CHAPTER 03

DIAGNOSTIC ACCURACY OF DEVELOPMENTAL SCREENING IN PRIMARY CARE AT THE 18-MONTH HEALTH SUPERVISION VISIT: A CROSS-SECTIONAL STUDY

Meta van den Heuvel, Cornelia M. Borkhoff,
Christine Koroshegyi, Weeda Zabih,
Sijmen A. Reijneveld, Jonathon L. Maguire,
Catherine S. Birken, Patricia C. Parkin

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ABSTRACT

Background: Communication delays are often the first presenting problem in infants with a range of developmental disabilities. Our objective was to assess the validity of the 18-month Nipissing District Developmental Screen (NDDS) with the Infant Toddler Checklist (ITC), a validated tool for detecting expressive language and other communication delays.
Methods: A cross-sectional design was used. Infants, 18-20 months, were recruited during scheduled health supervision visits. Parents completed both the 18-month NDDS and ITC. We assessed criterion validity (diagnostic test properties, overall agreement) for one or more "no" responses (1+NDDS flag) and two or more "no" responses (2+NDDS flag) using the ITC as a criterion measure.

Results: The study included 348 children (mean age 18.6 $\pm$ 0.7 months). The 1+NDDS flag had good sensitivity (94%; 95% CI 70%-100% and 86%; 95% CI 64%-96%), poor specificity (63%; 95% CI 58%-68% and 63%; 95% CI 58%-69%), and fair agreement (0.26) to identify expressive speech and other communication delays, respectively. The 2+NDDS flag had low to fair sensitivity (50%; 95% CI 26%-74% and 73%; 95% CI 50%-88%), good specificity (86%; 95% CI 82%-90% and 88%; 95% CI 84%-92%) and moderate agreement (0.45) to identify expressive speech and other communication delays, respectively.

Interpretation: The low specificity of the 1+NDDS flag may lead to over-diagnosis; the low sensitivity of the 2+NDDS flag may lead to under-diagnosis suggesting that infants who could benefit from early intervention may not be identified. The NDDS does not have adequate characteristics to accurately identify children with a range of communication delays.

INTRODUCTION

Developmental screening in early childhood is recommended by several leading professional organizations, including the Canadian Paediatric Society and the American Academy of Pediatrics.[1-3] In contrast, the recent 2016 evidence-based guidelines from the Canadian Task Force on Preventive Health Care (CTFPHC) recommends against developmental screening using standardized tools.[4] In the province of Ontario, an expert panel recommended an enhanced 18-month well-baby visit which was introduced in 2009.[1] The panel recommended use of standardized tools including the Nipissing District Developmental Screen (NDDS), which is available free of charge and now commonly used. The conflicting recommendations from professional organizations, evidence-based guidelines, and policy makers present a dilemma for primary care practitioners. Several Canadian experts have expressed concerns regarding the CTFPHC recommendation against developmental screening, calling for more research on this topic.[5,6]

Communication delays are often the first presenting problem in young children with a range of developmental disabilities including isolated expressive speech delay, autism spectrum disorders (ASD) and intellectual disability.[7-9] Approximately 20% of toddlers have expressive speech delay, which resolves in about 50% by five years of age.[10] Children with persistent communication delays have poorer outcomes in reading, spelling, math skills and increased emotional and behavioral difficulties.[10,11]

The NDDS is a parent-completed questionnaire that addresses different areas of development including communication.[12] The accuracy of the NDDS in identifying early communication delays has never been investigated. The Infant Toddler Checklist (ITC) was developed for early identification of children who have or are at-risk for developing a communication impairment.[7,13,14] More recently, the ITC was assessed for the accuracy of detecting a range of developmental delays, including language delay, global developmental delay, and ASD.[15-17] The ITC has been shown to be valid, reliable and has good diagnostic test properties.[7,14,16,17] The ITC is freely available and is one of two measures recommended for early detection of ASD in Canada.[18,19]

We speculate that many Canadian primary care practitioners will continue to use standardized developmental screening tools while awaiting further evidence to guide practice. We recently introduced the ITC screening tool into a network of primary care practices whose usual practice is use of the NDDS. Therefore, the primary objective of this study was to assess the validity of the 18-month NDDS compared with the ITC. As parents and clinicians commonly monitor the number of words spoken in early childhood as a measure of language development, our secondary objective was to describe parent responses regarding their 18-month old child from both screening tools.

METHODS

Participants and Setting

A cross-sectional prospective design was used. Infants, 18-20 months, were recruited from January 2012 – to February 2015 on a convenience basis, during scheduled health supervision visits from primary care practices participating in *TARGet Kids!*, a practice-based research network in Toronto, Canada (www.targetkids.ca).[20] There are currently 9 large group practices in this network, each of which has between 3 and 10 practising physicians. Trained research assistants in the practices obtained survey and questionnaire data. The study protocol and cohort profile was recently published. [20]

Children were included if their parents completed both the 18-month NDDS and the ITC. Participant characteristics were collected using a standardized instrument based on the Canadian Health Measures Survey. [21] Exclusion criteria were: children with health conditions affecting growth, acute or chronic conditions (other than asthma), known severe developmental delay, and families unable to communicate in English. All data were entered into a web-based data management system (Medidata Rave ®). Research Ethics Boards approval was obtained from the Hospital for Sick Children and St. Michael's Hospital, Toronto, Canada.

MEASURES

18-month Nipissing District Developmental Screen (NDDS)

The 18-month NDDS is a one page, 17-item parent-completed tool. Each question addresses one or more areas of development: fine motor, gross motor, emotional, social, self-help, learning, thinking, communication.[12] Ten questions address communication. The NDDS is not a standardized tool. Recently, Cairney et al. evaluated the psychometric properties of the NDDS with the Bayley Scales of Infant Development (BSID, 3rd edition).[22] In that study the NDDS had modest test-retest reliability (Spearman's rho = 0.62) and low sensitivities ranging from 29% to 68% and specificities ranging from 58% to 88% to identify developmental delays.[22]

In 2011, the wording of question six: "Does your child say 5 or more words?" was changed to "Does your child say 20 or more words?". The NDDS authors provide a rationale for this change, highlighting the importance of early referral to a speech pathologist in children with a suspected delay and refer to the MacArthur-Bates Communicative Developmental Inventories (MB-CDI).[23,24] We used the 2011 version of the NDDS.

The NDDS takes five minutes to complete. Response options are "yes" or "no". One or more "no" responses (i.e., the child does not demonstrate the behaviour) indicates the need for further assessment and/or referral. This is known as the "one flag" rule (1+NDDS

flag). The "two flag" rule requires a minimum of two "no" responses for referral and/or follow-up (2+NDDS flag). Currently, the instructions of the 18-month NDDS recommend a "one flag" rule to follow-up with the healthcare and/or childcare professional regarding the child's development.[12] We assessed both the "one flag" and "two flag" rule for the NDDS.

Infant Toddler Checklist (ITC)

The ITC is a one page, 24-item parent-completed tool that can be used in primary care.[13,18] The ITC was developed to measure language predictors in order to determine if a communication evaluation is needed.[7,13,14] It is a standardized tool with normative scores for monthly intervals for children 6-24 months of age. The ITC was originally developed, normed and validated in two samples of US infants.[7,25] In two further studies which included infants 12-24 months of age (n=232 and n=915), the ITC was found to have a sensitivity of 87% and 86%, and a specificity of 75% and 83%. [14,16] In a large study in pediatric primary care in the US, the positive predictive value of the ITC was 75% for a range of developmental disorders (ASD, language delay and global development delay).[17]

The ITC takes five minutes to complete and two minutes to score.[7,17] Most questions are answered with a 3-point scale: "not yet", "sometimes", and "often". Scoring produces three composite scores (social, expressive speech, symbolic) and a total score. The total score and each of the three composite scores are dichotomized as "concern/no concern" using the 10th percentile cut-point. It is recommended that a child should be carefully monitored if the expressive speech composite is below the 10th percentile (concern for expressive speech delay) and the ITC should be re-administered again in three months.[13,18] Additionally, it is recommended that a child should be referred for an evaluation if the social composite, symbolic composite or the total score is below the 10th percentile (concern for other communication delay).[13,18]

STATISTICAL ANALYSIS

Means, standard deviations and percentages were calculated to characterize the study participants. If a participant's response to an individual question on the ITC was missing, we replaced it with a response corresponding to the level below the mode for that ITC domain (e.g., If most answers were "often", then we replaced the missing response with "sometimes"). We assessed criterion validity of the 18-month NDDS by calculating diagnostic test properties and overall agreement. For the purpose of our analysis, the ITC was considered a criterion measure. Diagnostic test properties (sensitivity, specificity, positive predictive value, negative predictive value) of the 18-month NDDS compared with the dichotomized scores of the ITC were calculated (with 95% confidence intervals). For most screening tools, a sensitivity of 80% and specificity of 90% are generally recommended.[26]

For developmental screening tools, because of behavioral noncompliance a sensitivity between 70%-80% and a specificity of 80% has been suggested. [27]

Cohen's kappa coefficients were calculated as measure of overall agreement between the NDDS and ITC. Cohen's kappa gives a quantitative assessment of how well two tools agree. Levels of agreement below 0.20, between 0.21-0.40, between 0.41-0.60, and above 0.61 are considered poor, fair, moderate, and good, respectively.[28]

Finally, we described the number of words spoken by 18-month old children according to parent responses on a comparable single question on both the NDDS and ITC calculating proportions. All analyses were performed with IBM SPSS 20.

RESULTS

Participant characteristics

We included 348 children with a mean age of 18.6 months (+ 0.7 months) (Table 1). The NDDS and ITC were completed at the same visit, with no intervention between measures. On the NDDS, 138 (39.7%) children had 1+flag and 54 (15.5%) had 2+flags (Figure 1). On the ITC, 16 (4.6%) children were identified with an expressive speech delay (concern on the expressive speech composite); 22 (6.3%) children were identified with a communication delay needing referral (concern on the social composite, symbolic composite, or total score).

Table 1 Participant characteristics

Characteristic	n = 348 n (%)	
Age (months) mean (± SD)	18.6	(0.7)
Sex, male	192	(55.2)
Maternal education - College / University	328	(94.3)
Nipissing District Developmental Screen		
1+ flag	138	(39.7)
2+ flags	54	(15.5)
Infant Toddler Checklist		
Expressive speech delay[1]	16	(4.6)
Other communication delays[2]	22	(6.3)

[1] **Need to monitor:** expressive speech composite below the 10th percentile
[2] **Need for referral:** social composite, symbolic composite or the total score below the 10th percentile

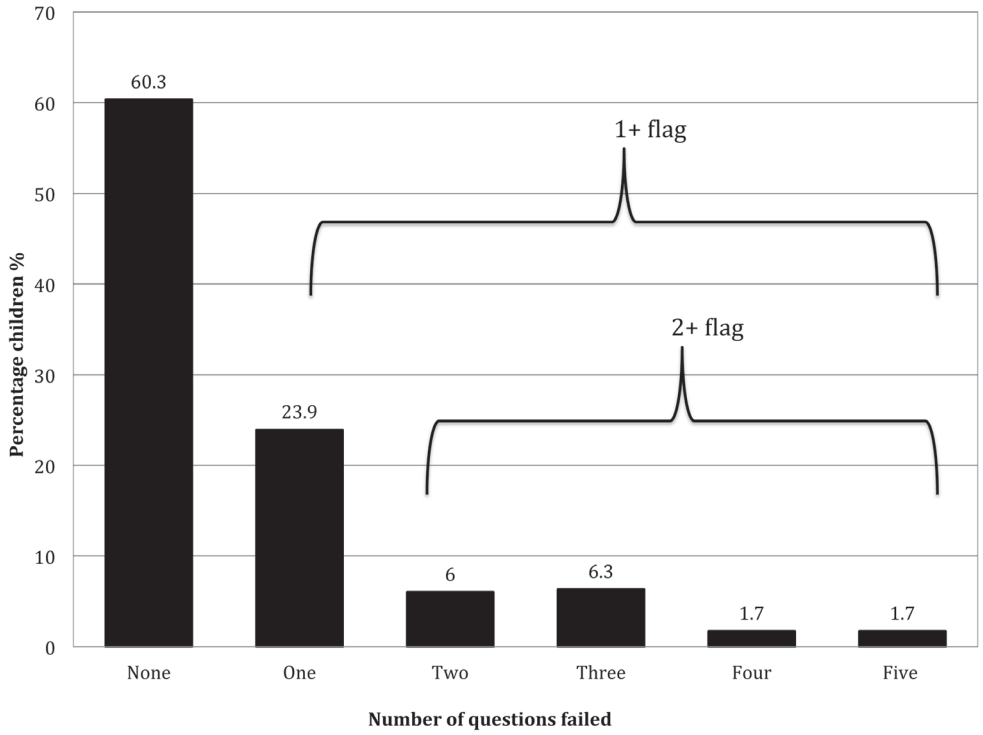

Figure 1 Percentage of children and the total number of questions failed on the 18-month NDDS

Diagnostic test properties of the 18-month NDDS compared with the ITC

To identify children with an expressive speech delay, the 1+NDDS flag was sensitive (94%, 95% CI 70%-100%) but not specific (63%, 95% CI 58%-68%). The 2+NDDS flag reduced the sensitivity (50%, 95% CI 26%-74%) but increased the specificity (86%, 95% CI 82%-90%). To identify children with other communication delays (concerns on the communication composite, symbolic composite or total score), the 1+NDDS flag was sensitive (86%, 95% CI 64%-96%) but not specific (63%, 95% CI 58%-69%). The 2+NDDS flag reduced the sensitivity (73%, 95% CI 50%-88%) but increased the specificity (88%, 95% CI 84%-92%) (Tables 2 and 3).

Table 2 Diagnostic test properties of the +1 NDDS flag compared with the ITC.

1+ NDDS flag	ITC Expressive Speech delay [1]		ITC Other communication delays [2]	
	Yes	No	Yes	No
Positive	15	123	19	119
Negative	1	209	3	207
Sensitivity (%) (95% CI)	94 (70-100)		86 (64-96)	
Specificity (%) (95% CI)	63 (58-68)		63 (58-69)	
PPV (%) (95% CI)	11 (6-17)		14 (9-21)	
NPV (%) (95% CI)	99 (97-100)		99 (96-100)	

[1] **Need to monitor:** expressive speech composite below the 10th percentile
[2] **Need for referral:** social composite, symbolic composite or the total score below the 10th percentile

Table 3 Diagnostic test properties of the +2 NDDS flag compared with the ITC.

2+ NDDS flag	ITC Expressive Speech delay [1]		ITC Other communication delays [2]	
	Yes	No	Yes	No
Positive	8	46	16	38
Negative	8	286	6	288
Sensitivity (%) (95% CI)	50 (26-74)		73 (50-88)	
Specificity (%) (95% CI)	86 (82-90)		88 (84-92)	
PPV (%) (95% CI)	15 (7-28)		30 (18-44)	
NPV (%) (95% CI)	97 (95-99)		98 (95-99)	

[1] **Need to monitor:** expressive speech composite below the 10th percentile
[2] **Need for referral:** social composite, symbolic composite or the total score below the 10th percentile

Overall agreement of the 18-month NDDS with the ITC

The 1+NDDS flag had a fair agreement (Cohen's kappa 0.26) with the need for monitoring or referral for communication delays on the ITC (concerns on any composite or total score). The 2+NDDS flag had a moderate agreement (Cohen's kappa 0.45) with the need for monitoring or referral for communication delays on the ITC (concerns on any composite or total score).

Description of parent responses regarding the number of words spoken

Question 6 of the 18-month NDDS "Does your child speak more than 20 words?" was the

question with the greatest number (n=85, 24.4%) of parents responding "no" (Figure 2). Question 17 on the ITC "About how many different words does your child use meaningfully that you recognize?" identified five (1.3%) children who spoke no words at all, 21 (6.0%) who spoke 1-3 words, 81 (23.3%) who spoke 4-10 words, 134 (38.5%) who spoke 11-30 words and 107 (30.7%) who spoke more than 30 words.

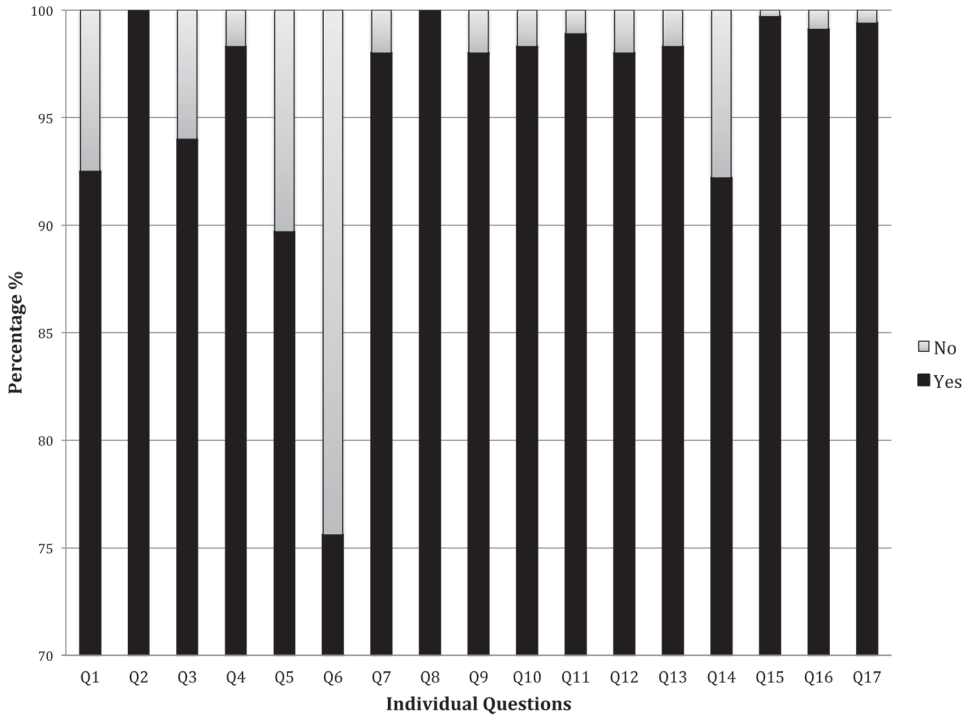

Figure 2 Percentage of parents responding with "no" and "yes" to the 18-month NDDS individual questions

INTERPRETATION

We investigated whether the 18-month NDDS, commonly used by Canadian primary care practitioners, can identify communication delays in early childhood in a primary care setting. Compared with the ITC, the 1+NDDS flag had good sensitivity, poor specificity, and fair agreement, to identify expressive speech delay and other communication delays. Thus, the 1+NDDS flag cut-point may result in a large number of false positives leading to over-diagnosis. The 2+NDDS flag had low to fair sensitivity, good specificity and moderate

agreement, to identify expressive speech delay and other communication delays. Thus, the 2+NDDS flag cut-point may result in a large number of false negatives leading to under-diagnosis. Taken together, these findings suggest that the NDDS, at either cut-point, may not have adequate characteristics to accurately identify children with a range of communication delays.

There is only one study published evaluating the psychometric properties of the NDDS. The authors concluded that the NDDS had poor agreement with the reference standard (BSID 3rd edition,) and recommended not to use the NDDS on its own for the identification of developmental delays.[22] Our findings are consistent with this research. In contrast to the NDDS, the ITC has undergone substantial development and validation over the past two decades. The ITC was recently assessed in 137 US primary care pediatricians at the 12 month visit.[17] Of 10,479 ITCs completed, 1,318 were positive (12.5%).[17] The 10.9 % prevalence of a positive ITC in our study is similar to that of the study in US primary care.[17] In their recent guideline, the CTFPHC recommended against screening using standardized tools in children (1-4 years) with no apparent signs of developmental delay and developmental concerns.[4] However, this recommendation was based on low-quality evidence and studies evaluating the diagnostic properties of the ITC were not included.[29] A systematic review of 11 studies of primary care practitioners who worked without screening tools demonstrated that practitioners achieved poor sensitivity (range 14-54%) in correctly identifying children having a developmental concern, suggesting that sensitive screening tools may be valuable.[30]

In our study, almost a quarter of the 18-month old infants did not speak 20 words or more on the NDDS. Almost a third of the 18-month old infants spoke 10 words or less according to the ITC. Data from "Wordbank", an open database about children's vocabulary growth that archives data from the MB-CDI of more than 5000 children, demonstrates a very wide vocabulary range at 18 months; from 13.9 words (10th percentile) to 269 words (90th percentile).[31] The BSID (3rd edition) indicates that fewer than eight words spoken for a 24-month-old is 1.33 standard deviations below the normative mean.[32] Our data demonstrates that many more parents responded "no" to question 6 than any other question on the 18-month NDDS. This single question accounted for more than 60% of infants with a 1+NDDS flag. As parents commonly monitor their child's vocabulary, parents should be informed about the broad vocabulary range at 18-months to reduce unnecessary concerns identified with the NDDS. Additionally, it is important for child healthcare practitioners to be aware of the fair agreement and low specificity of the 1+NDDS flag for identifying children with expressive speech delay as compared with the ITC.

This study also has some limitations. First, children's communication was not assessed with an independent, standardized measure for comparison such as the MB-CDI or the BSID or clinical evaluation. Second, our study population included only parents who were able to

communicate in English, and therefore results may not generalizable to other populations. Finally, the NDDS is a general development screening tool whereas the ITC was initially developed to target communication delays, so it would be expected that some items (e.g., gross motor) on the NDDS would not correlate with the ITC. However, the majority of questions on the 18-month NDDS address communication and the ITC has a high positive predictive value for detecting global developmental delay, making the comparison of both tools justifiable. Additionally, the authors of the NDDS did not provide independent domains (e.g. "communication domain") therefore a specific validation was not feasible.

CONCLUSION

Our results demonstrate that infants with communication delays will not be adequately identified with the 18-month NDDS. The low specificity of the 1+NDDS flag may lead to over-diagnosis and cause unnecessary concern for parents. The lower sensitivity of the 2+NDDS flag may lead to under-diagnosis suggesting that infants who could benefit from early intervention may not be identified. The NDDS does not have adequate characteristics to accurately identify children with a range of communication delays. With communication delays often being the first presenting problem in young children with a range of developmental disabilities, the ITC may be a more promising screening tool for assessing developmental delay in early childhood. A rigorous research agenda is needed to investigate the use of developmental screening tools in primary care.[5]

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CHAPTER 04

HOW RELIABLE AND VALID IS THE TEACHER VERSION OF THE STRENGTHS AND DIFFICULTIES QUESTIONNAIRE IN PRIMARY SCHOOL CHILDREN?

Meta van den Heuvel , Danielle E.M.C Jansen,
Roy E. Stewart, Bouwien C.M. Smits-Engelsman,
Sijmen A. Reijneveld, Boudien C.T. Flapper

Submitted

ABSTRACT

Introduction: Reporting on emotional and behavioral problems using the Strengths and Difficulties Questionnaire (SDQ) is validated for parents, but not yet for teachers in a broad age range of children. We conducted a cross-sectional study in 4-10 years old school children to investigate if the SDQ-T can be used instead of the validated but lengthy Teacher's Report Form (TRF) to acquire information about emotional and behavioral problems in the school community.

Methods: Teachers of 453 children from primary schools were approached. Teachers of 394 children (response rate 86.9%) with a mean age of 7.1 years filled in the SDQ-T (n = 387), the TRF (n= 349) or both (n =342). We assessed reliability by calculating internal consistency and concurrent validity (using correlation coefficients, sensitivity, specificity) of the SDQ-T compared with the TRF.

Results: Internal consistency of the SDQ-T Total Difficulties Score (SDQ-T TDS; Cronbach α=0.80), hyperactivity/ inattention- (α = 0.86) and prosocial behavior (α = 0.81) was very good. Concurrent validity demonstrated a strong correlation of all subscales of the SDQ-T with the corresponding scale on the TRF (range 0.54-0.73), except for peer problems (0.46). Using a SDQ-T TDS cut-off score > 14, the SDQ-T had a good sensitivity (90%) and specificity (94%).

Discussion: The good reliability, validity and brevity of the SDQ-T make it an easily applicable questionnaire for obtaining information about emotional and behavioral problems from teachers in primary school children.

INTRODUCTION

Mental health problems affect 10-20% of children and adolescents worldwide, and may strongly hamper their functioning.[1] Mental health disorders are currently the leading causes of disability in children.[2] Accumulating evidence shows that young children with mental health problems are progressively at risk for a range of negative outcomes. In adulthood these include psychiatric disorders, poor academic achievement and a lower socio-economic status.[2,3] Prevention of these poor outcomes might be possible with early recognition and prompt mental health treatment.[4]

Reliable and valid questionnaires to report mental health problems are available for young children. The parent version of the Strengths and Difficulties Questionnaire (SDQ) has quickly become one of the most utilized screening instruments because of its brevity and its ability to measure both problem behavior and competencies.[5-7] The SDQ includes only 25 items, is freely available and translated in many languages (http://www.sdqinfo.org). Recently, the parent version of the SDQ identified significant mental health concerns in a large sample of children and adolescents screened in pediatric primary care offices.[8]

For clinicians it is important to have multiple informants report on emotional and behavioral problems in children because these problems might be highly situational.[9-11] For example, children can be very hyperactive in the school environment, because of the interaction with their classmates, but not display this behavior in the home environment in a one-on-one situation. Furthermore, for most DSM-V mental health diagnosis in children both parental and teacher information is required, as symptoms must be present in two or more settings (e.g. at home and school) but also there must be clear evidence that the symptoms interfere with or reduce the quality of social or school functioning.[12] Identifying the specific context in which children display emotional and behavioral problems and its impact on school functioning, may also facilitate treatment of these problems.[13] Teachers are well acknowledged informants of children's behavior because they see children on a daily basis in the school environment and have the opportunity to compare behavior of children of similar age every day.[9]

A reliable and valid questionnaire, the Teacher's Report Form (TRF), is available for teachers to assess the extent of a child's emotional and behavioral problems.[14] The TRF is the teacher version of the Achenbach Child Behavior Checklist (CBCL), with the same questions worded differently for teachers. Both questionnaires are often regarded as the gold standard among broadband behavior rating scales. For routine use, a major disadvantage of the TRF is its length, as it includes 113 items. Time and administrative burdens are reported to be important barriers for identifying mental health problems in the school environment.[15] The use of a short, inexpensive, easy accessible questionnaire could facilitate obtaining information from teachers.[21]

The parent- and adolescent-report versions of the SDQ have been shown to have good psychometric properties.[6,10,16-20] In contrast, the validity of the teacher version of the SDQ (SDQ-T) has not been investigated in a broad age range of school children.[10,21] Although a recent review reported the strong psychometric properties of the SDQ-T, in most studies the SDQ-T results have not been compared with a gold standard for teachers, but with a gold standard for parents (e.g. Child Behavior Checklist or the Conner's Parent Symptom Questionnaire).[16,19,22] Studies that did compare the SDQ-T with the TRF have some limitations; they studied a specific age range (children age 5-6 years only) and another study used the TRF-reference data of another population than the one studied.[23-25]

Clinicians are increasingly held accountable to assess mental health problems in their practice and are mandated to collaborate with parents and teachers on these problems.[26] It would be ideal for them to use the same, short, questionnaire for both parents and teachers to express their mental health concerns. The aim of our study was therefore to examine the reliability and validity of the SDQ-T with the TRF as a gold standard, in 4-10 years old children in primary school children.

METHODS

Participants and Procedure

We obtained data using a two-step procedure. In the first step directors of all 70 regular primary schools in the middle and eastern regions of the Netherlands were contacted and asked if they were interested to participate in the study. Seventeen schools consented to have teachers participate in the study (24.3%). Reasons for schools not to participate were time constraints or participation in other studies.

In the second step, information about the study was sent to all parents, and 1664 parents signed informed consent (response rate 40.3%). Since the TRF is a long questionnaire and time consuming for teachers to fill in, only 5 children per class were randomly chosen to participate in our study. This led to the inclusion of teachers and parents of 453 children. Of these, 22 (4.9%) of the children were lost to follow-up and 37 (8.2) had incomplete data.

We obtained data on child and family background characteristics; i.e. age, gender, ethnic background (country of origin of parents) and educational level (highest completed grade) of parents. Teachers of 394 children (response 86.9%) filled in the SDQ-T (n = 387), the TRF (n= 349) or both questionnaires (n =342). Figure 1 describes the data collection process. This study was approved by the ethics committee of the Radboud University Nijmegen, in the Netherlands.

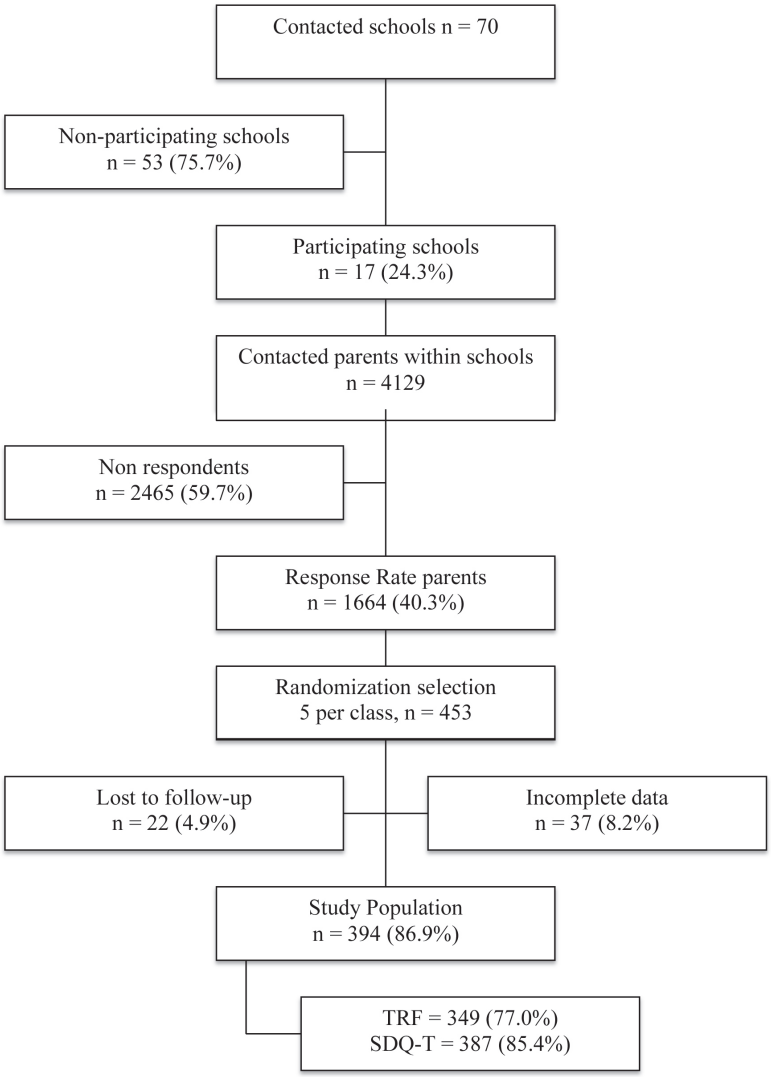

Figure 1 Flow chart for data collection

MEASUREMENTS

Strengths and Difficulties Questionnaire

The SDQ consists of 25 items subdivided into four difficulties scales, emotional symptoms, conduct problems, inattention-hyperactivity, peer problems, and a separate fifth strength scale, prosocial behavior.[7] All subscales had five questions each. An impact supplement inquires further about the existence, chronicity, and distress of problems, social- and learning impairment, and burden to others, these items can be summed to generate an "impact score". [7] Each item has to be scored on a 3-point scale with 0 = 'not true', 1 = 'somewhat true' and 2 = 'certainly true'. An example of a question in the inattention-hyperactivity subscale is: "Restless, overactive, cannot stay still for long". We used the Dutch teacher version of the SDQ 4 -16 years including the impact supplement.[19] The SDQ-T Total Difficulties Score (SDQ-T TDS) was calculated by aggregating the scores for the emotional symptoms, conduct problems, hyperactivity-inattention, and peer problems subscales (range 0-40). We dichotomized the SDQ-T TDS according to Goodman's recommendation to define the highest 10% in a clinical range.[5] In the present study population the clinical cut-off score for the SDQ-T TDS was found to be 14.

Teacher's Report Form

The TRF has 113 items across eight syndrome scales (Anxious/Depressed, Withdrawn/Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule-breaking Behavior and Aggressive Behavior) and two broadband scales (internalizing and externalizing problems).[14] Teachers have to indicate on 3-point scales the extent to which each item applies: 0='not', 1 ='sometimes', or 2 = 'often'. An example question of the Attention Problems scale is " Can't concentrate, can't pay attention for long". We used the validated Dutch version of the TRF.[27] We computed the scores on the syndrome- and broadband scales, and the total problems scale. The total problem scale (TRF TPS) was dichotomized according to the Dutch cut-off score for the subclinical and clinical range.[27]

ANALYSIS

All analyses were performed with IBM SPSS 20. First we described the background characteristics of our study population. Second, we examined the reliability, i.e. the extent to which items produce similar scores, of the SDQ-T. We therefore examined the scale structure of the SDQ-T by calculating internal consistencies. Standardized Cronbach's alpha coefficients (α) were computed for the SDQ scales (emotional symptoms, conduct problems, hyperactivity / inattention, peer problems, prosocial behavior) impact score and total difficulties score. Cronbach's $\alpha = 0.70$ and below are generally considered as low, values between $\alpha = 0.70$ and $\alpha = 0.80$ as acceptable, and values above $\alpha = 0.80$ as good.[28]

Third, we assessed the concurrent validity, by determining the degree to which SDQ-T outcomes concurred with those on the TRF. We expected correlations between the SDQ scales and the TRF scales that rated similar problems. The emotional subscale of the SDQ-T was expected to correlate with the Internalizing broadband scale of the TRF. The conduct problem scale of the SDQ-T was expected to correlate with the Aggressive Behavior and Externalizing broadband scale of the TRF. The hyperactivity / inattention subscale of the SDQ-T was expected to correlate with both the Attention Problem and Externalizing scale of the TRF. The peer problem subscale of the SDQ-T was expected to correlate with the Social Problem scale of the TRF. The SDQ-T prosocial subscale, which includes questions about strengths, was thought to have a negative correlation with all problem scales of the TRF. Because of the non-normal distribution of both the SDQ-T and TRF concurrent validity was assessed using Spearman's correlation of the SDQ-T with the TRF. Correlations below 0.30 are considered as small, correlations between 0.30 and 0.50 as medium, and correlations above 0.50 as strong.[28]

We computed sensitivity (the proportion of children with emotional and behavioral problems who are correctly identified with the SDQ-T), specificity (the proportion of children without emotional and behavioral problems who are correctly identified without problems with the SDQ-T) and positive predictive value (the probability that children with a clinical SDQ-TDS truly have emotional and behavioral problems) with the TRF-TPS used as criterion. We further calculated the Area Under the Receiver Operator characteristic Curve (AUC) that integrates sensitivity and specificity across the various cut-offs of the dichotomized SDQ-T TDS. A value of the AUC of 1 reflects perfect accuracy of the SDQ-T to discriminate between children with- and without emotional and behavioral problems, and a value of 0.5 the absence of capacity to discriminate.

RESULTS

Background characteristics

The characteristics of the study population are presented in Table 1. The study population consisted of 202 boys (51.3%) and 192 girls (48.7%), with a mean age of 7.1 years (range 4.0 – 10.8 years). Most parents had medium (secondary vocational education) or higher educational (university or higher vocational education) level (Table 1). The SDQ-T mean scores and the clinical cut-off scores (p90) scores in the total sample and stratified by gender and age are presented in Table 2.

Table 1 Social and demographic background of study population

	Number (%)
Gender	
Boys	202 (51.3)
Girls	192 (48.7)
Age of the child	
4-5 year	126 (32.0)
6-7 years	124 (31.5)
8-10 years	144 (35.6)
Ethnic background	
Dutch	373 (94.7)
Non-Dutch	5 (1.4)
Education Father	
Lower education	79 (20.0)
Medium education	140 (35.5)
Higher education	141 (35.8)
Education Mother	
Lower education	73 (18.5)
Medium education	179 (45.4)
Higher education	113 (28.7)

Missing data: ethnic background n =16, education father n =34, education mother n=29
Lower education: no education, primary education or pre-vocational education; Medium education: secondary vocational education; Higher education; university or higher vocational education.

Table 2 Mean scores, standard deviations (SD) and clinical cut-off scores (p90)* for the Teacher SDQ

	Complete N =387		Boys N=199		Girls N=188		4-5 years N=122		6-7 years N =124		8-10 years N =141	
	Mean (SD)	P90	Mean (SD)	P90	Mean (SD)	P90	Mean (SD)	P90	Mean (SD)	P90	Mean (SD)	P90
Emotional Symptoms	1.3 (1.9)	4	1.1 (1.6)	4	1.5 (2.1)	4	1.2 (1.7)	4	1.2 (1.9)	4	1.4 (1.9)	4
Conduct Problems	0.7 (1.3)	2	1.0 (1.5)	3	0.5 (1.1)	2	0.9 (1.6)	3	0.6 (1.1)	2	0.7 (1.3)	2
Hyperactivity / Inattention Problems	2.7 (2.8)	7	3.5 (3.0)	8	1.8 (2.3)	5	2.9 (2.9)	8	2.8 (2.8)	7	2.5 (2.7)	8
Peer Problems	1.2 (1.6)	4	1.4 (1.7)	4	1.0 (1.4)	3	1.2 (1.6)	3	1.1 (1.5)	4	1.3 (1.7)	4
Prosocial Behavior	8.0 (2.3)	10	7.2 (2.4)	10	8.8 (1.8)	10	7.5 (2.5)	10	8.3 (2.1)	10	8.2 (2.0)	10
Total Difficulties Score	5.9 (5.2)	14	7.1 (5.5)	15	4.7 (4.6)	11	6.2 (5.7)	15	5.7 (4.8)	13	5.8 (5.0)	15
Impact score	0.4 (0.9)	2	0.6 (1.1)	3	0.2 (0.6)	1	0.4 (1.0)	1	0.5 (1.0)	2	0.3 (0.8)	1

*p90 score = 90th percentile score recommended for clinical use[15]

Reliability and Concurrent Validity of the SDQ-T

In Table 3 the internal consistency of the SDQ-T is presented. Especially the hyperactivity / inattention, prosocial and total difficulties scales of the SDQ-T all had Cronbach's α of 0.80 or above 0.80. The Cronbach's α were low for conduct (0.64) and peer problems (0.60) and the impact score (0.48).

Table 3 Internal consistency of the SDQ-T

SDQ-T subscales	Cronbach's α
Emotional Symptoms	0.73
Conduct Problems	0.64
Hyperactivity / Inattention	0.86
Peer Problems	0.60
Prosocial Behaviour	0.81
Total Difficulties	0.80
Impact Score	0.48

Missing data on the impact score n=12

As demonstrated in Table 4, concurrent validity was shown by a strong (> 0.5) and significant correlation of all subscales of the SDQ-T with the corresponding scale on the TRF except for peer problems. The peer problem scale showed an acceptable significant correlation of 0.46. The prosocial subscale did have a negative correlation with both Internalizing (-0.16) and Externalizing (-0.43) broadband scale of the TRF. The highest correlation (0.73) was found between the SDQ-T TDS and TRF TPS.

Table 4 Concurrent validity (correlation coefficient with the TRF) of the teacher SDQ

TRF	Anxious Depressed	Withdrawn / Depressed	Somatic Complaints	Social Problems	Thought Problems	Attention Problems	Rule-breaking Behavior	Aggressive Behavior	Internalizing Problems	Externalizing Problems	Total Problem Score
SDQ-T											
Emotional Symptoms	0.52**	0.44**	0.26**	0.44**	0.36**	0.26**	-0.05	0.003	**0.54****	0.28	0.40**
Conduct Problems	0.10	0.02	-0.01	0.23**	0.17**	0.31**	0.42**	**0.59****	0.05	**0.57****	0.42**
Hyperactivity/ Inattention	0.12	0.12	0.01	0.33**	0.27**	**0.67****	0.33**	0.52**	0.10	**0.51****	0.59**
Peer Problems	0.39**	0.38**	0.10	**0.46****	0.36**	0.32**	0.15**	0.26**	0.38**	0.24**	0.44**
Prosocial Behavior	-0.14**	-0.22**	-0.03	-0.24**	-0.16**	-0.33**	-0.32**	-0.40**	-0.16**	-0.43**	-0.43**
Total Difficulties	0.41**	0.36**	0.14**	0.55**	0.42**	0.65**	0.32**	0.51**	0.38**	0.51**	**0.73****

**Significant at 0.01 level (Spearman's correlation coefficient). Corresponding scales are printed in bold SDQ-T: Teacher version of the Strengths and Difficulties Questionnaire. TRF: Teacher's Report Form. The TRF Internalizing Problems broadband scale consists of the Anxious/Depressed, Withdrawn/Depressed and Somatic Complaints syndrome scales. The TRF Externalizing Problems broadband scale consists of the Rule-Breaking Behavior and Aggressive Behavior syndrome scales.

Using a SDQ-T cut-off score > 14, the SDQ-T had a good sensitivity 90% (95% confidence interval (CI) = 0.86-0.94), specificity 94% (95% CI = 0.92-0.94) and a positive predictive value (PPV) of 0.30 (95% CI = 0.26-0.34). The area under the curve (AUC) using the TRF TPS as criterion was 0.95 (95% CI = 0.89-1.00).

DISCUSSION

Our study demonstrated that the SDQ-T is a reliable and valid instrument for identifying emotional and behavioral problems by teachers in a broad age range of school children. The results of this study contribute to the literature about the validity of the SDQ-T in 4-10 year old children. The good psychometric properties and brevity of the SDQ-T make it an easily applicable alternative for the TRF to obtain information about emotional and behavioral problems from teachers on primary school children.

Our findings on the reliability revealed a very good internal consistency of the SDQ-T TDS (α =0.80) and of the subscales hyperactivity / inattention and prosocial problems (α = 0.86 and α = 0.81 respectively). A low reliability of some subscales of the SDQ-T in our study (conduct problems (α =0.64), peer problems (α =0.60) and the impact score (α =0.48), has been reported in two other studies and in studies of the parent version of the SDQ (SDQ-P).[10,23,24] Theunissen *et. al.* (2013) concluded in their study of SDQ-P in preschool children (3-4 years) that the low internal consistency of the SDQ subscales does not justify the use of these subscales to decide on a specific need of individual children for further attention regarding these problems.[29] This can be concluded for the subscales of the SDQ-T as well. However an exception could possibly be made for the hyperactivity / inattention problem scale of the SDQ-T; this subscale demonstrated both the highest reliability (0.86) and highest validity (0.67) in our study. These findings are consistent with the study of Posserud et al (2013) that demonstrated high sensitivity of the SDQ for Attention Deficit Hyperactivity Disorder.[30]

Concurrent validity of all subscales, except the peer problems scale, of the SDQ-T with the corresponding scale on the TRF (range 0.54-0.73) was good. Our correlation results were comparable with the results found by the study of Mieloo et al in 5-year old children (correlation range: 0.43-0.76).[23] The relatively low correlation between the peer problems scale with the corresponding TRF social problem scale, was also reported in the study of Mieloo (2012) and Van Leeuwen (2006).[23,24] An explanation might be that teachers are considered outsiders to the peer group of children and use an adult perspective to interpret children's social interactions, which decreases the degree of consistency across various scales.[10]

The p90 scores for the teacher report of the SDQ in the 5-year old children in the study of Mieloo et al were remarkably lower than the 4-5 year old p90 scores in our study (p90

score SDQ-T TDS 11 versus p90 score SDQ-T TDS 15 respectively).[23] One reason for this difference could be that we included also 4-year-old children in our analysis in this age group. The clinical cut-off point for scoring the SDQ-T TDS in 2-4 years old children in United Kingdom was also 15. [31]

The sensitivity and specificity of the SDQ-T are slightly higher than found for the SDQ-P.[29,32] In our study the cut-off score of the SDQ-T was higher than the SDQ-P cut-off score measured in Dutch parents.[32] This was also reported in a large Danish study.[18] One explanation could be that teachers may be influenced by some sort of "halo-effect" which means that children exhibiting problem behavior in one area are more likely to be rated as problematic in other areas as well, due to the impact of one class of behavior on the perception of another one.[18,33]

Strengths and Limitations

The current study is, to our knowledge, the first to assess the concurrent validity of the SDQ-T compared to the TRF as a gold standard in a large community sample of 4-10 year old school children. This study did not assess construct validity of the teacher version of the SDQ since multiple other studies already identified evidence for a five-factor model of the SDQ-T.[10,23-25] A limitation is the relatively low response rate for informed consent by schools and parents. No data was collected to objectively measure if the schools that refused to participate in our study were in any way different than the schools that chose to participate in our study. A second limitation is that children from immigrant origin and parents with lower vocational education were underrepresented in this study. This may have led to an underestimation of the prevalence of clinical SDQ and TRF scores but it is unlikely that this has significantly influenced the correlation of the SDQ-T with the TRF.[19] A third limitation is the possible clustering of student evaluations by classroom and thus by teacher. However, each teacher assessed only 5 children, largely reducing the potential influence of this. A final limitation is that although the TRF is one of the best instruments available, it cannot be regarded as the ultimate gold standard, because that position is reserved for clinical diagnosis.[34] Because of complexity and high costs, structured clinical interviews such as the Diagnostic Interview Schedule for Children were not used as criterion.

IMPLICATIONS

The SDQ-T is a reliable and valid instrument for identifying emotional and behavioral problems in primary school children. The brevity of the SDQ-T makes it an easily applicable questionnaire for obtaining information about emotional and behavioral problems on primary school children from teachers. Obtaining teacher's SDQ ratings in addition to parental information is valuable for clinicians because this provides data on emotional and

behavioral problems in children in a second setting, and can be of help in the management of mental health problems in these children.[13,35] The SDQ-T TDS may highly add to the identification of emotional and behavioral problems in the school setting in these children.

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CHAPTER 05

IDENTIFICATION OF EMOTIONAL AND BEHAVIORAL PROBLEMS BY TEACHERS IN CHILDREN WITH DEVELOPMENTAL COORDINATION DISORDER IN THE SCHOOL COMMUNITY

Meta van den Heuvel, Danielle E.M.C. Jansen,
Sijmen A. Reijneveld, Boudien C.T. Flapper,
Bouwien C.M. Smits-Engelsman

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ABSTRACT

Current evidence on the co-occurrence of Developmental Coordination Disorder (DCD) and psychosocial problems mainly concerns parent-reported information, but rarely includes teacher information. The aim of this study was (1) To investigate the teachers' identification of emotional and behavioral problems in children with DCD and (2) To examine the performance of the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T) compared with the Teacher Report Form (TRF) in children with DCD**.** We assessed primary school children (202 boys, 200 girls, range 4 – 10.8 years, mean age 7.2 years) for DCD following the DSM IV-TR criteria. Emotional and behavioral problems were measured with the TRF (n = 327) and the SDQ-T (n = 361). DCD was established in 23 (5.7%) children, 16 boys and 7 girls (mean age 7.0 years). Children with DCD had a higher proportion of clinical scores on both the TRF Total Problem Scale (TRF TPS) and SDQ-T Total Difficulties Score (SDQ-T TDS). Children with DCD had increased odds on the TRF domains Thought (odds ratio, OR: 5.39), Externalizing (OR: 4.12) and Internalizing (OR: 4.42) problems, and on all SDQ-T-domains and Total Difficulties score (OR: 7.30). In the DCD group the SDQ-T TDS correlated strongly (Spearman's rho 0.80) with the TRF TPS and demonstrated a moderate agreement (Cohen's Kappa 0.53). In conclusion, teachers identified significantly more emotional and behavioral problems in children with DCD compared with their peers. The SDQ-T showed moderate agreement with the TRF in identifying emotional and behavioral problems in children with DCD.

INTRODUCTION

Developmental coordination disorder (DCD) is a common disorder affecting motor coordination in school-aged children.[1,2] Current prevalence estimates for DCD range from 2-20%, with 5 to 6% being the most frequently quoted percentage in the literature.[2,3] DCD causes restrictions in motor activities of daily living (such as sports, play and self-care skills) and/or in academic achievement.[4]

Motor performance has a great impact on the psychosocial development of children, which may explain the co-morbidity between DCD and various psychosocial problems.[5-12] In children (6-12 years) with DCD, several studies reported significantly higher levels of depression, withdrawn behavior and anxiety than typically developing children.[7-9,13,14] Children with DCD (6-11 years) not only show significantly higher internalizing behavior, but also showed higher externalizing behavior compared with peers.[8,9] Up to 50% of children (7 years old) with DCD have been shown also to meet criteria for Attention Deficit/ Hyperactivity Disorder (ADHD) [1] and the majority of children with ADHD have motor deficits.[15] It is important to recognize double diagnoses of DCD and behavioral problems since both diagnoses affect children's daily functioning and these children are at risk for poorer adult psychosocial functioning.[16] There is only limited research on emotional and behavioral difficulties in pre-school children with motor problems.[17] The recent study of Kind-Dowling *et al.* (2015) demonstrated that children (mean age 4 years, 11 months) with motor difficulties (Movement Assessment Battery for Children - Second edition: MABC-2 ≤ 16th percentile) had more externalizing behaviors in the form of increased aggression as well as increased withdrawn behavior.[18]

Current evidence on the co-occurrence of DCD and psychosocial problems mainly concerns parent-reported information, but rarely includes teacher reports.[7,9,10,13,14] Only two, somewhat outdated, studies presented teacher-reported information on psychosocial problems in children with DCD.[1,19] In the first study teachers identified moderate to severe symptoms of ADHD in approximately half of the children with DCD in a school population.[1] However, their method to obtain information about psychosocial problems, a structured teacher interview and multiple teacher questionnaires, is not feasible for routine use due to time and financial constraints.[1] The second study showed that in a sample of hyperactive children (n=47), the comorbidity of hyperactivity as reported by the teacher (using the Conners Teacher Rating Scale) and clumsiness as determined by the MABC (<5th percentile) ranged from 35-55% depending on the sampling source (school, hospital or support group).[19] A study in a school population using a concise and feasible teacher questionnaire is lacking.

Reasons to include teachers as informants are first that teachers see children on a daily basis in the school environment and have the opportunity to compare behavior of children of similar age every day. Next, it is important to have multiple informants reporting on

emotional and behavioral problems in children.[20,21] For most DSM mental health diagnosis in children both parental and teacher information are required, as symptoms must be present in two or more settings (e.g. at home and school) and there must be clear evidence that the symptoms interfere with or reduce the quality of social or school functioning.[22] Moreover, detection and prompt treatment of emotional and behavioral problems in children with DCD may alleviate some of the risk of poor future mental health outcomes.[10,12]

Reliable and valid questionnaires for the detection of emotional and behavioral problems in children are available for teachers.[23,24] The Teacher's Report Form (TRF) is the teacher version of the Achenbach Child Behavior Checklist (CBCL), with the same questions worded differently for teachers. The TRF is a well-validated instrument to assess the extent of a child's emotional and behavioral problems.[24] However, for routine use in a school population, a major disadvantage of this questionnaire is its length of 113 items. The Strengths and Difficulties Questionnaire (SDQ) might be a better option. The parental version has gained popularity because it includes only 25 items, and is freely available. The teacher version of the SDQ (SDQ-T) has good psychometric properties and a good construct validity of the SDQ-T when compared with the subscales of the TRF was found in the general population.[20,25,26]

Although the parent version of the SDQ has been used in children with DCD, it is not known if the SDQ could identify the same emotional and behavioral problems in children with DCD as more extensive questionnaires like the CBCL and TRF.[10] The aim of this study was to investigate (1) teachers' identification of emotional and behavioral problems in children with Developmental Coordination Disorder (DCD) and (2) the performance of SDQ-T compared with the TRF in children with DCD.

METHOD

Participants and Procedure

A cross-sectional study was performed in which data was collected on 402 children (202 boys, 200 girls, range 4 – 10.8 years, mean age 7.2 year (SD1.9)). We obtained data using a two-step procedure (Figure 1). In the first step, directors of 70 regular primary schools in the middle and eastern region of the Netherlands were contacted and asked if they were interested to participate in the study. Seventeen schools consented to have teachers participate in the study (24.3%).

In the second step, if the school was willing to participate, information about the study was sent to all the parents; 1664 parents signed informed consent (response rate 40.3%). Per class, every fifth child on the alphabetic student list was randomly selected for motor evaluation. Parents and teachers of 453 children were approached to participate in our study. Four hundred twenty nine (94.7%) children were assessed with the Movement

Assessment Battery for Children - Second edition (MABC-2) by experienced physiotherapists with at least 4 years' experience who were trained in the administration of the test.[27,28] The children who were not identified with DCD were allocated to the reference group. Twenty-seven children were excluded because they had a learning disability. Figure 1 describes the data collection process. The study was approved by the local medical ethics committee (Radboud University Nijmegen).

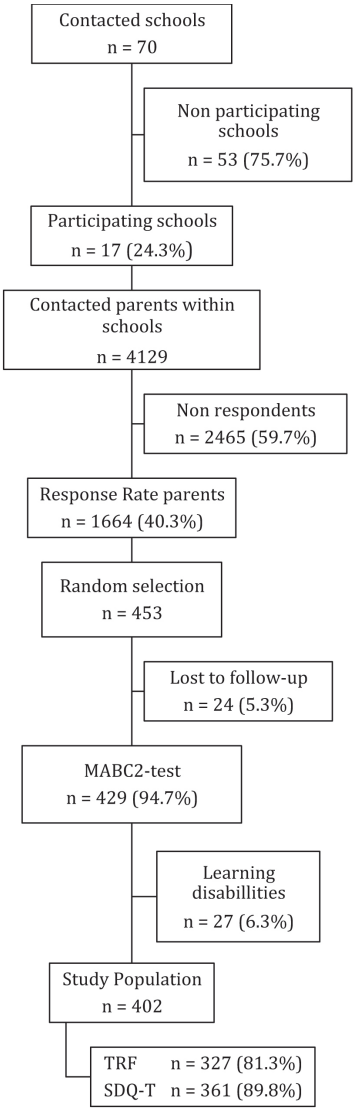

Figure 1 Flow diagram for data collection

MEASURES

Exposure variable: DCD

Children were defined as having DCD if they met all 4 DSM IV-TR criteria for DCD: poor motor coordination (criterion A), which causes functional limitations in activities of daily living or academic achievement (criterion B), not caused by a general medical condition nor severe mental retardation (criterion C and D).[22] The second edition of the Movement ABC (MABC-2) was used to identify marked impairment in motor coordination (DSM criterion A).[28] It contains three age-bands, each consisting of eight items that measure manual dexterity (three items), aiming and catching (two items) and balance (three items). We used the 5th percentile cut-off of the Dutch norm sample for the MABC-2 to define children with DCD.[27] With this, we adhered to the recommendation of the 2006 Leeds Consensus Statement.[29] Children who were tested positive were only classified as having DCD if their parents also reported problems in motor control in a parent questionnaire (DSM criterion B). This parent questionnaire was constructed based on important themes identified in the DCD literature by one of the authors (BSE). Problems in motor control were assessed by questions asking about problems in motor development in the past or future, and if children had help from occupational therapy or physiotherapy. Furthermore questions asked specifically about medical conditions, learning- and behavioral problems, other developmental concerns and pediatric follow-up.

Only children in regular primary education without reported learning disabilities were included, as a validation for IQ in the normal range (DSM criterion D).[30] In addition, pediatric physiotherapists excluded any children with known cerebral palsy or medical conditions causing coordination problems (DSM criterion C).

Outcome variable: Emotional and Behavioral Problems

Emotional and behavioral problems were measured with the Teacher's Report Form (TRF) and the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T). The TRF is a parallel form of the Child Behavior Check List (CBCL) and consist of 8 syndrome scales (Anxious/Depressed, Withdrawn/Depressed, Somatic Complaints, Social Problems, Thought Problems, Attention Problems, Rule-breaking Behavior and Aggressive Behavior) and two broadband scales (Internalizing and Externalizing problems). Teachers had to indicate on a 3-point scale the extent to which each item applies: 0='not', 1 ='sometimes', or 2 = 'often'. A higher score indicates more emotional and behavioral problems. Teachers completed the TRF in n=327 (81.3%) children. We computed the scores of the syndrome scales, the Internalizing and Externalizing problems broadband scales, and the Total Problems Scale (TPS). For the TRF we used the standard Dutch cut-off for the borderline clinical range.[24] The TPS and the syndrome- and broadband scales of the TRF were dichotomized using the borderline clinical cut-off values.

The SDQ-T consists of 25 items subdivided into four difficulties scales, emotional symptoms, conduct problems, inattention-hyperactivity and peer problems, and a separate fifth strength scale, prosocial behavior. All subscales have five questions. Each item has to be scored on a 3-point scale with 0 = 'not true', 1 = 'somewhat true' and 2 = 'certainly true'. A higher score indicates more emotional and behavioral problems. Teachers completed the SDQ-T in n =361 (89.8%) children. The SDQ Total Difficulties Score (TDS) was calculated as the sum of the scores for the emotional symptoms; conduct problems, hyperactivity-inattention, and peer problems subscales (range 0-40). For the calculation of the SDQ-T TDS and syndrome scales cut-off scores we followed Goodman's recommendations to define the highest 10% in a clinical range which was 14 in the present study.[31]

Finally, we obtained data on child and family background characteristics; i.e. age, gender, ethnic background (country of origin of parents) and parental educational level (highest completed grade).

STATISTICAL ANALYSIS

All analyses were performed with IBM SPSS 20. First, we described the background and motor characteristics of our study population. Secondly, we investigated differences in background and emotional and behavioral problems between the DCD- and the reference group. Because of the skewed distribution we used the Mann Whitney U test for continuous variables. Fisher exact test was used for categorical variables. Thirdly, we assessed the associations between DCD and emotional and behavioral problems, using dichotomized SDQ-T and TRF scales and calculated odds ratios (OR). Logistic regression was used to account for gender, age and maternal education differences.

In order to examine the performance of the SDQ-T compared with the TRF we assessed the validity of the SDQ-T in the DCD group by calculating sensitivity and specificity indices, using the TRF TPS as criterion. Cohen's kappa and Spearman correlation coefficient are presented as measures of concordance between the SDQ-T TDS and the TRF TPS in the DCD group.

RESULTS

Descriptive characteristics

DCD was diagnosed in 23 (5.7%) children, 16 boys (69.6%) and 7 girls (30.4%). The reference group consisted of 379 (94.3%) children without DCD. 8 (34.8%) children in the DCD group and 111 (29.3%) children in the reference group were in the age range 4 to 6 years. The mean Total Test Score of the MABC-2 in the DCD group was 49.6 (SD 10.4) versus 78.8 (SD 11.2) in the reference group (Table 1 $p<0.001$). There was a greater percentage of boys in the DCD group compared to the reference group (69.6% vs 49.1%; p=.044). Mean age and

other background characteristics were comparable for the DCD- and the reference group (Table 1).

Table 1 Background characteristics of the sample, split into Developmental Coordination Disorder (DCD) and reference group

	DCD n = 23	Reference Group n = 379	p-value
Gender			
Boys	16 (69.6%)	186 (49.1%)	0.044
Girls	7 (30.4%)	193 (50.9%)	
MABC-2 (mean, SD)			
Manual Dexterity	6.6 (2.5)	10.7 (2.9)	
Aiming and Catching	8.4 (2.9)	10.8 (2.9)	
Balance	5.2 (2.6)	10.6 (3.1)	
Total Test Score	49.6 (10.4)	78.8 (11.2)	<0.001
Age of the child (years)			
Mean (range)	7.0 (4.3 -10.3)	7.2 (4.0-10.8)	0.531
Ethnic background			
Dutch	23 (100%)	373 (98.4%)	1.000
Non-Dutch	0	4 (1.0%)	
Education Father			
Lower vocational	5 (21.7%)	80 (21.1%)	0.253
Higher vocational	9 (39.1%)	144 (38.0%)	
University / higher professional	9 (39.1%)	141 (37.2%)	
Education Mother			
Lower vocational	4 (17.4%)	73 (19.3%)	0.455
Higher vocational	12 (52.2%	182 (48.0%)	
University / higher professional	7 (30.4%)	118 (31.1%)	

Missing data from Reference Group; ethnic background n =2 (0.5%), education father n= 14 (3.7%), education mother n=6 (1.6%)

Differences in emotional and behavioral problems between the DCD- and the reference group.

There was a significant difference in the proportion of clinical TRF TPS in the DCD group (n = 3, 15%) versus the reference group (n = 7, 2.3%) (Table 2). Furthermore we identified a significant higher proportion of children with a clinical SDQ TDS (n = 8, 36 %) in the DCD group versus the reference group (n=25, 7.4%) (Table 2).

Children with DCD scored significantly higher on all of the TRF syndrome scales, except for Somatic Complaints, Rule-Breaking- and Aggressive Behavior. They scored significantly higher on Internalizing- but not on Externalizing problems.

Children with DCD scored significantly higher on all of the difficulties scales of the SDQ-T (Table 3).

Table 2 Proportion of clinical scores of the TRF Total Problem Score and SDQ Total Difficulties Score, split into Developmental Coordination Disorder (DCD) and reference group

	DCD	Reference Group	p-value*
TRF-TPS[1]			0.006
Normal	15 (75%)	289 (94.1%)	
Borderline	2 (10%)	11 (3.6%)	
Clinical	3 (15%)	7 (2.3%)	
SDQ-T TDS[2]			<0.001
Normal	12 (54.5%)	284 (83.3%)	
Borderline	2 (9.1%)	30 (8.8%)	
Clinical	8 (36.4%)	25 (7.4%)	

[1]Teacher's Report Form Total Problem Score (TRF TPS). [2]Teacher version Strengths and Difficulties Questionnaire Total Difficulties Score (SDQ-T TDS). *Fisher exact test was used to calculate p-values

Table 3 Mean scores of the Teacher's Report Form (TRF) and the teacher version of Strengths and Difficulties Questionnaire (SDQ-T) in children with Developmental Coordination Disorder (DCD) and reference group

	DCD (SD)	Reference Group (SD)	p-value*
TRF	*n=20*	*n=307*	
Anxious / Depressed	55.7 (7.1)	52.3 (4.5)	**0.010**
Withdrawn / Depressed	55.7 (6.9)	52.5 (4.7)	**0.003**
Somatic Complaints	51.2 (4.0)	51.4 (3.7)	0.623
Social Problems	57.2 (6.6)	52.8 (4.8)	**0.001**
Thought Problems	56.4 (7.9)	51.9 (5.4)	**<0.001**
Attention Problems	55.6 (5.8)	51.8 (4.0)	**<0.001**
Rule-breaking Behavior	51.9 (4.1)	51.1 (2.8)	0.215
Aggressive Behavior	54.8 (5.9)	52.3 (4.5)	0.057
Total Problems	53.2 (8.9)	45.3 (9.0)	**<0.001**
Externalizing Problems	50.8 (9.3)	47.1 (7.7)	0.083
Internalizing Problems	52.2 (10.9)	45.9 (8.7)	**0.009**
SDQ-T	*n=22*	*n=339*	
Emotional Problems	2.2 (2.0)	1.2 (1.8)	**0.004**
Conduct Problems	1.3 (1.5)	0.7 (1.3)	**0.030**
Hyperactivity / Inattention Problems	4.2 (3.6)	2.5 (2.7)	**0.025**
Peer Problems	2.5 (1.8)	1.0 (1.5)	**<0.001**
Prosocial Behavior	6.7 (3.0)	8.1 (2.1)	**0.021**
Total Difficulties	10.2 (6.6)	5.5 (4.9)	**0.001**
Impact Score	0.3 (0.8)	1.2 (1.6)	**<0.001**

*Group differences were tested with the Mann Whitney U test

Risk of emotional and behavioral problems in children with DCD

The odds for having Thought-, Externalizing- and Internalizing problems among children with DCD were significantly higher compared with their peers, also after adjustment for gender, age and maternal education. In addition, children with DCD had a 4-fold increased risk on the TRF-TPS compared with their typically developing counterparts (Table 4).

Children with DCD had increased odds on all domains of the SDQ-T, Total- and Impact Score; this was also true after adjustment for gender, age and maternal education (Table 4).

Table 4 Odds of emotional and behavioral problems in children with Developmental Coordination Disorder (DCD) compared to their peers: odds ratios (OR) and 95% confidence intervals (CI).

	Unadjusted		Adjusted[3]	
	OR (95% CI)	p-value	OR (95% CI)	p-value
TRF[1]				
Syndrome Scale				
Anxious / Depressed	3.18 (0.35-22.2)	0.302	2.35 (0.25-22.2)	0.457
Withdrawn / Depressed	5.33 (0.53-53.7)	0.156	9.98 (0.70-143.3)	0.091
Somatic Complaints	2.26 (0.26-19.3)	0.458	2.58 (0.28-23.7)	0.401
Social Problems	2.64 (0.30-23.0)	0.380	1.75 (0.19-16.0)	0.622
Thought Problems	5.23 (1.5-17.7)	**0.008**	5.39 (1.50-19.1)	**0.009**
Attention Problems	5.57 (1.1-29.6)	**0.044**	4.88 (0.85-28.2)	0.077
Rule-breaking Behavior*	0.00 (0.00-0.00)	0.999	0.00 (0.00-0.00)	0.998
Aggressive Behavior	1.74 (0.21-14.4)	0.609	1.89 (0.20-17.5)	0.575
Total Problems	5.35 (1.7-16.4)	**0.003**	4.26 (1.3-13.8)	**0.016**
Broadband Scale				
Externalizing Problems	4.78 (1.6-14.5)	**0.006**	4.12 (1.27-13.3)	**0.018**
Internalizing Problems	4.63 (1.6-13.1)	**0.004**	4.42 (1.5-12.8)	**0.006**
SDQ-T[2]				
Emotional Problems	3.05 (1.0-9.8)	0.060	3.35 (1.0-11.1)	**0.048**
Conduct Problems	3.54 (1.2-10.4)	**0.021**	3.73 (1.2-11.7)	**0.024**
Hyperactivity / Inattention Problems	4.81 (1.9-12.2)	**0.001**	4.60 (1.7-12.4)	**0.002**
Peer Problems	3.27 (1.1-9.5)	**0.030**	3.03 (1.0-9.1)	**0.048**
Prosocial Behavior	3.14 (1.3-7.6)	**0.011**	2.97 (1.1-7.8)	**0.028**
Total Difficulties	7.18 (2.8-18.7)	**<0.001**	7.30 (2.7-19.7)	**<0.001**
Impact Score	5.38 (2.0-14.4)	**0.001**	5.12 (1.8-14.7)	**0.002**

[1]Teacher's Report Form (TRF) [2] Teacher version Strengths and Difficulties Questionnaire (SDQ-T) *Only 1 child had a borderline clinical score on the Rule-breaking Behavior Scale of the TRF
[3] Adjusted for gender, age, maternal education

Validity of the SDQ-T

The SDQ-T TDS had a strong correlation (Spearman's rho 0.80) with the TRF TPS in children with DCD. We demonstrated a moderate agreement (Cohen's Kappa 0.53) between the SDQ-T TDS and the TRF TPS in the DCD group. Using the borderline clinical TRF TPS as criterion, the SDQ-T, when defining the highest 10% in a clinical range, had a good sensitivity of 0.80 (95% Confidence Interval = 0.62-0.98) and a good specificity of 0.80 (95% CI = 0.62-0.98) in the DCD group. The area under the curve (AUC) in the DCD group was 0.85 (95%CI = 0.66-1.00).

DISCUSSION

This study showed that teachers identified significantly more emotional and behavioral problems in children with DCD compared to children without DCD in the school community. Children with DCD had higher mean scores and a higher proportion of clinical scores of both the TRF and the SDQ-T. In addition the children in the DCD group had an increased risk for having emotional and behavioral problems compared to their peers. The SDQ-T correlated strongly with the TRF and demonstrated satisfactory sensitivity and specificity in children with DCD.

Our finding that teachers observed more emotional and behavioral problems in children with DCD is in agreement with what has been seen in parental report of psychosocial problems in children with DCD.[8-10] In the study by Tseng *et al.* parents scored significantly higher mean scores on all eight subscales of the CBCL, except the subscale of Somatic Complaints.[8] In our study mean scores of both the TRF and the SDQ-T fell within the normal range, which implicates that not all children with DCD experienced clinically significant emotional and behavioral problems.

Teachers identified an increased risk of borderline clinical Internalizing and Externalizing problems in children with DCD. This is in line with other studies in which parents reported a relationship between children with motor coordination problems and internalizing problems, especially depression and anxiety.[13,14,32]

Children with DCD were identified with a 7-fold higher risk of a clinical SDQ-T TDS. This increased risk is higher than the study of Lingam *et al.* in which parents identified children with probable DCD with a 4-fold increased risk of a clinical SDQ TDS.[10] One explanation could be that we used more strict criteria to define DCD in our study. Alternatively, teachers may have been influenced by some sort of "halo-effect" which in the literature is referred to as the impact of one class of behavior on the perception of another. This means that children exhibiting problems in one area are more likely to be rated as problematic in other areas as well.[33]

The risk for Attention Problems in children with DCD was more outspoken in the SDQ-T ratings than in the TRF-ratings. A possible explanation for this difference could be the high sensitivity of the SDQ for ADHD symptoms, which was demonstrated in the study of Posserud et al.[34] In the study of Kadesjo et al. teachers identified moderate to severe symptoms of ADHD in approximately half of the children with DCD in a school population.[1] The high incidence of ADHD in children with DCD makes it likely that the SDQ-T identified hyperactivity- inattention problems accurately in the DCD group.

DCD should not be generally diagnosed before the age of five years.[30] However there is emerging evidence that preschool children (3 -6 years) with motor problems have an increased risk of social emotional problems.[17,18] Additionally, in the Netherlands all children of four years and older are going to school, therefore we chose to include also younger children (4-6) in our study.

This study is the first study that used both the TRF and SDQ-T to investigate teacher reported emotional and behavioral problems in children with DCD in the school community. Strengths of our study are that we used teacher data that add to our current knowledge derived from parental data. Additionally, we included teacher reported emotional and behavioral problems in very young children with DCD. Moreover, DCD was diagnosed according to strictly operationalized criteria for DCD and all children were examined with the MABC-2.[7,29] Dutch norms could be used for both motor and behavioral measures. Since we included children with mild movement difficulties in the reference group, our results will not have overestimated the differences in mental health problems between the DCD and the reference group.

Our study also has some limitations. First the number of children with DCD was small, which is explained by the community-based nature of our study. Because of the use of the Leeds criteria for DCD in our sample, the percentage of children with DCD would never be higher than 5%. This limited number of children with DCD in our community sample led to broad confidence intervals for ORs. In addition this could have led to possible overestimation of the sensitivity and specificity of the SDQ-T in the DCD group.[35] A second limitation is the low response rate of the schools and of the parents to participate in the study. It is unlikely that this has affected the associations between two teacher-report measures, but it may have affected the rates of emotional and behavioral problems. Furthermore we did not account for any double diagnosis in this study. A third limitation was that in this study no mental health interviews or mental health assessments of children with DCD were performed. However based on the literature, the TRF can be used as a good criterion for the early detection of mental health problems by professionals.[36] Finally, the current study presented cross-sectional data and therefore cannot imply causality. Studies explaining the increased risk for emotional and behavioral difficulties in DCD are still few and further research is needed to explore these relationships including causal pathways.[14]

CONCLUSIONS

In the current study teacher ratings indicated a higher risk of emotional and behavioral problems in children with DCD compared with children without DCD. Teachers can make a valuable contribution to the identification of emotional and behavioral problems in children with DCD in the community. Because of its shortness and good validity in this study, the SDQ-T could be used to support this, though these findings require confirmation.

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CHAPTER 06

THE CONCURRENT AND LONGITUDINAL ASSOCIATIONS OF TEMPERAMENT AND NUTRITIONAL RISK FACTORS IN EARLY CHILDHOOD.

Meta van den Heuvel, Yang Chen,
Kawsari Abdullah, Jonathon L. Maguire,
Patricia C. Parkin, Catherine S. Birken

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ABSTRACT

Background: Early childhood temperament is increasingly recognized as an important attribute that may impact screen time use, outdoor play and childhood obesity. The relationship between temperament and nutrition in preschool children is less clear.

Objective: To investigate if temperament dimensions (negative affectivity, effortful control and surgency) in early childhood are associated with nutritional risk factors.

Methods: 678 children were followed (mean age at baseline visit 3.1 years; mean time to follow-up 16.5 months). Parents reported on child temperament and nutritional risk factors during regularly scheduled well-child clinic visits.

Results: A mixed effect model demonstrated a significant association between higher negative affectivity (1.03; 95% CI 0.69 to 1.37) and higher effortful control (-0.88; 95%CI -1.27 to -0.49) on concurrent nutritional risk, independent of covariates. Multivariate linear regression analysis identified that higher effortful control, and not negative affectivity, was significantly associated with a decrease in nutritional risk (-0.67; 95%CI -1.10 to -0.24) over time, independent of covariates. There was no relationship identified between surgency and nutritional risk.

Conclusion: Three year old children with higher effortful control had reduced nutritional risk at 5 years of age. Future nutritional risk prevention strategies may benefit from interventions to increase effortful control in early childhood.

INTRODUCTION

Nutrition plays an essential role in growth and development, academic success and in the social- and emotional well-being of children.[1,2] Important examples of nutrition related risk factors and health outcomes in young children include prolonged bottle use contributing to iron deficiency and increased screen time and excessive intake of sugar sweetened beverages contributing to obesity.[2,3] Nutritional risk has been defined as "the presence of risk factors that can lead to impaired nutritional status". [4]

Many child-, family- and social factors and their complex interactions influence child nutrition.[5] Temperament has been defined as biologically based individual differences in reactivity and self-regulation, influenced over time by heredity and experience.[6] Each child has 3 main reactive dispositions of temperament: 1) negative affectivity (e.g. sadness, discomfort), 2) effortful control (e.g. attention shifting, focusing, inhibitory, activational control) 3) extraversion/ surgency (e.g. positive emotionality, activity, impulsivity).[7]

A recent workshop conducted by the National Institute of Health identified the need for studies that address how individual differences in early temperament contribute to obesity.[8] Emerging evidence suggests that high negative reactivity may be an early risk factor for childhood obesity.[9-12] Other studies also identified associations between low effortful control, high negative affectivity and more television viewing and reduced outdoor play in young children.[13,14] Additionally, a recent study by Leung et al (2015) in low-income preschoolers revealed that high levels of surgency predicted more food responsiveness and enjoyment of food leading to a higher concurrent Body Mass Index (BMI).[15] Only one study investigated the relationship between temperament and food-intake directly. They concluded that both internalizing (anxious, dependent) and externalizing (hyperactive, aggressive) temperament in 18-month old children were risk factors for consuming more sweet drinks and foods at 3 and 7 years.[16] In addition, somewhat contradictory to the study of Leung et al, this study also reported that high surgent (active, sociable) 18-month old infants were more likely to consume a healthy diet with higher intake of fruits and vegetables daily at 3 and 7 years. However this study was limited by assessment of temperament at only one time point (18 months) and used a non-validated measure of temperament.[16]

The present study tested the hypothesis that in early childhood higher negative affectivity and lower effortful control are associated with an increased nutritional risk and an unhealthy dietary intake over time. Furthermore, because of this somewhat contradictory evidence that children with high surgency were both at risk of high BMI, and yet had a higher fruit and vegetable intake, our study aimed to add to the literature and examined the impact of temperament on later dietary intake.

METHODS

Study Design and Setting

This was a longitudinal cohort study of children, aged 3-5 years, recruited during scheduled well-child clinic visits from primary care practices participating in *TARGet Kids!*.[17] *TARGet Kids!* is a community-based primary care research network in Toronto, Canada. The study protocol, including recruitment procedures, has recently been published. [17]

At each annually scheduled well-child clinic visit standardized questionnaires were completed by parents and anthropometric measures, including height and weight, were collected by research assistants using standardized measures and procedures.[17] Children were included if they had a minimum of two assessments of both temperament and nutritional risk. Exclusion criteria included children with health conditions affecting growth (e.g. cystic fibrosis), any acute or chronic conditions (other than asthma and high functioning autism), children with severe developmental delay and families who were unable to communicate in English. All data generated from *TARGet Kids!* were entered into a web-based data management system (Medidata Rave ®). Ethics approval for the study was obtained from Research Ethics Boards of the Hospital for Sick Children and St. Michael's Hospital, Toronto, Canada.

MEASURES

Nutritional Risk

The primary outcome was nutritional risk, as measured by the total score of the Nutrition Screening Tool for Every Pre- schooler (NutriSTEP ®).[1] The NutriSTEP ® was developed for children ages 3-5 years of age, and has been validated in multicultural Canadian children by registered dieticians using a detailed history and 3-day dietary recall.[1] The NutriSTEP ® includes 17 questions about nutritional risk factors including five domains; eating behaviors, dietary intake, parental concerns about food and activity (including food security), screen time duration and the use of supplements. Each question has 2-5 response options. Examples of questions include "My child is not hungry at meal times because he /she drinks all day", "My child eats meals while watching TV" (response options: always, most of the time, sometimes, rarely, never).

We calculated the Total NutriSTEP® score by aggregating the score of each question.[1] Higher total NutriSTEP® scores represent more nutritional risk factors and a greater nutritional risk (range of scores 0-68).[1] We used the continuous Total NutriSTEP® score as main outcome. For a secondary analysis, we dichotomized the Total NutriSTEP ® score in two groups: high (Total NutriSTEP ® score > 20) and low (Total NutriSTEP ® score ≤ 20). In the clinical setting, the above-mentioned cut points are used; for children that have a Total

NutriSTEP ® score > 20 recommendations should be made to change the child's eating and activity habits.[1]

Unhealthy dietary intake was determined from the dietary intake domain score of the NutriSTEP® which included 6 questions about the intake of vegetables, fruit, grain, milk, meat or meat alternatives and 'fast food'.[1] Higher scores of the dietary intake domain represent an unhealthier dietary intake (range of scores 0-24). [1]

Child Temperament Measure

Temperament was measured using the parent reported very short form of the Child Behavior Questionnaire (CBQ-VSF) for children 3 - 7 years. [7] The CBQ-VSF includes 36 items and provides a comprehensive assessment of temperamental behavior patterns and has demonstrated satisfactory internal consistency, criterion validity and longitudinal stability.[7,18] Parents were asked to rate their child on a 7-point scale ranging from 1 (extremely untrue of your child) to 7 (extremely true of your child). For each child, the VSF-CBQ produced a summary score of each of the three separate temperament domains: Negative Affectivity, Effortful Control and Surgency. A child with a high level of negative affectivity has typically a lowered mood, is angry, fearful and very difficult to soothe. [7] Children with a high level of effortful control have the capacity to suppress inappropriate responses, have better self-regulation and can maintain focus on task-related activities. [7] Children with high surgency levels are impulsive, enjoy situations with high stimulus intensity and do not show discomfort in social situations. [7]

Covariates

Relevant parental and family characteristics were assessed with a standardized survey instrument developed for *TARGet Kids!*, based on the Canadian Community Health Survey.[19] Neighborhood income was measured using median neighborhood income from census data. The height and weight of children and their parents were measured using established protocols, and BMI was standardized to z-score BMI (zBMIs) using the World Health Organization growth standards.[20] Parent BMI refers to the BMI of the parent who attended the clinic visit. In our study 85.5% was maternal BMI and 17.4% paternal BMI and in 91.3% the same parent attended all visits.

A number of child, parent and household characteristics may also contribute to the relationship between temperament and nutritional risk. For example mothers with a university education and older mothers have been shown to have more positive toddler feeding practices.[21] The following clinically important covariates that we identified from literature were included in all adjusted analysis models: child factors (age, sex, z-BMI), parent factors (maternal education, maternal age and parent BMI) and household factors (neighborhood income).[2,16,21]

STATISTICAL ANALYSIS

We calculated means, standard deviations and percentages to characterize the study population, each of the three domains of temperament (Negative Affectivity, Surgency, Effortful Control and Surgency), nutritional risk (Total NutriSTEP® score) and unhealthy dietary intake (dietary domain score NutriSTEP®) at the baseline clinic visit and at follow-up visits.

For the cross-sectional analysis we tested the overall association between the three temperament domains and the Total NutriSTEP® score. The analysis included all temperament domains and the Total NutriSTEP® score at all three clinic visits simultaneously (T1, T2, T3) adjusted for covariates above (Figure 1). We used a mixed effect model to accommodate the correlation within subjects. We performed the same analysis with the dietary intake domain score of the NutriSTEP® as an outcome. A secondary cross-sectional analysis was performed using mixed effect logistic regression analysis with the dichotomized Total NutriSTEP® score as outcome.

For the longitudinal analysis we used multivariate linear regression model with correlated error structures to examine the effect of the three temperament domains on changes in Total NutriSTEP® score over time accounting for within-subject level correlations, while adjusting for the previous Total NutriSTEP® score and covariates. The multivariate linear regression model used the change in Total NutriSTEP ® score (between preceding visits) as dependent variable and the three temperament domains at the previous visit as main explanatory variables. For example, for the first follow-up visit (T2) we used previous temperament and Total NutriSTEP® score from the baseline visit (T1) (Figure 1). The same analysis was performed for the secondary outcome, using the dietary intake domain score of the NutriSTEP®.

In all models we tested for interactions between age and the three temperament domains; we planned a-priori to perform a stratified analysis by age groups if any significant interactions were identified. Additionally we hypothesized that the impact of negative affect could be different depending on the child's effortful control, and we tested for this interaction in the longitudinal model. It is unclear if child z-BMI is a true confounder of the relationship between temperament and nutritional risk, and therefore we performed a sensitivity analysis without child z-BMI.[5,9] Figure 1 presents a schematic representation of our statistical analysis. Data was analyzed using R version 3.0.3. [22]

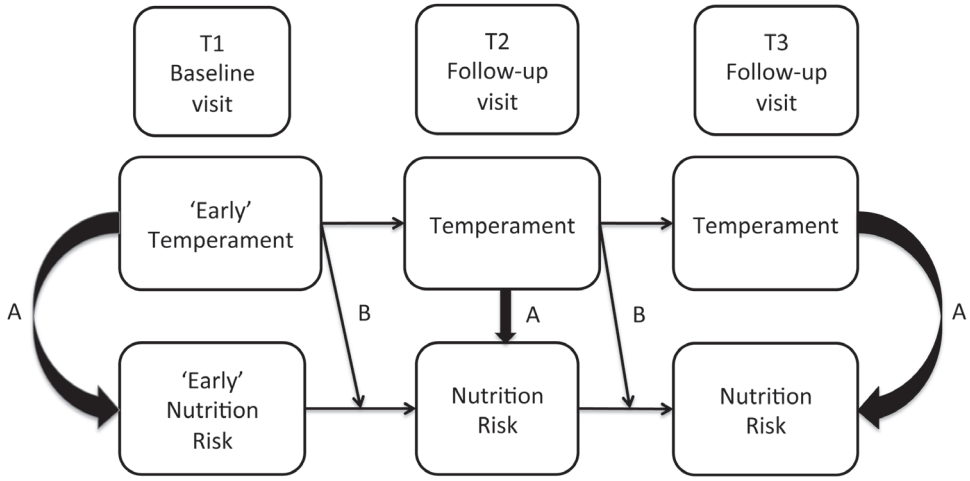

Figure 1 Schematic representation of statistical analysis

Legend:
A: Cross-sectional mixed effect model to test the overall associations of temperament on nutritional risk at all three time points simultaneously.
B: Longitudinal multivariate linear regression model to test the effect of the previous temperament domains on changes in nutritional risk (Total NutriSTEP® score) at follow-up visits

T1 = baseline well-child clinic visit, T2 = follow-up well-child clinic visit, T3 = follow-up well-child clinic visit

RESULTS

678 children met inclusion criteria. All children had at least two clinic visits and 135 children had three clinic visits. The mean follow-up time was 16.5 months. Child, parent and household characteristics are presented in table 1.

Table 1 Baseline characteristics

	All children	Children with 2 clinic visits	Children with 3 clinic visits
Child characteristics			
Number of children	678	543	135
Boys (n,%)	336 (49.6)	270 (49.7)	66 (48.9)
Age, months (SD)	38.1 ± 2.3	37.7 ± 2.9	37.3 ± 1.9
z-BMI (SD) (kg/m2)[1]	0.27 ± 1.0	0.22 ± 0.98	0.48 ± 1.0
Negative Affectivity	3.7 ± 0.8	3.7 ± 0.8	3.6 ± 0.8
Effortful Control	5.4 ± 0.7	5.4 ± 0.7	5.4 ± 0.7
Surgency	4.5 ± 0.8	4.5 ± 0.8	4.6 ± 0.8
Total NutriSTEP ® score	13.7 ± 6.2[3]	13.9 ± 6.4	13.1 ± 5.3
Dietary Intake domain score	6.7 ± 3.2[4]	6.7 ± 3.2	6.7 ± 3.0
Parent & Household characteristics			
Age of mother, years (SD)	36.1 ± 4.4	33.0 ± 4.5	32.7 ± 3.7
Parent BMI (SD) (kg/m2)[1,2]	25.0 ± 4.5	25.0 ± 4.4	24.8 ± 4.9
Neighborhood income (SD) (1000 CAD)	63.6 ± 30.5	62.8 ± 30.9	66.3 ± 28.9
Maternal education (n, %)			
Public school	4 (0.6)	4 (0.8)	0
High school	40 (5.9)	32 (6.1)	8 (6.2)
College / University	615 (90.7)	493 (93.2)	122 (93.9)

[1] Using WHO Child Growth Standards [20]
[2] Parent BMI refers to the BMI of the parent who attended the clinic visit.
[3] Percentiles of the Total NutriSTEP ® score at baseline: 5th percentile 5; 25th percentile 9, 75th percentile 17, 95th percentile 25
[4] Percentiles of the Dietary Intake domain score at baseline: 5th percentile 2; 25th percentile 4; 75th percentile 9, 95th percentile 12
Abbreviations: BMI = Body Mass Index, CAD= Canadian Dollar. Missing data z-BMI n = 8, age of mother n=39, parent BMI n = 82, neighborhood income n = 56, maternal education n=17

Cross-sectional overall association between temperament and nutritional risk (see Figure 1)

Mixed effect modeling demonstrated that higher negative affectivity was associated with an increased Total NutriSTEP® score adjusted for covariates (adjusted *B* estimate 1.03; 95% CI 0.69 to 1.37). In contrast, higher effortful control was associated with a decreased Total NutriSTEP® score (adjusted *B* -0.88; 95%CI -1.27 to -0.49). No association was identified between surgency and the Total NutriSTEP® score (Table 2).

The overall association between the temperament domains and unhealthy dietary intake demonstrated similar, but smaller effects, for both higher negative affectivity (adjusted *B* 0.31; 95% -0.12 to 0.50) and higher effortful control (adjusted *B* -0.66; 95% -0.80 to -0.44) (Table 2).

Logistic regression analysis of the dichotomized measure of the Total NutriSTEP® score identified that children with higher negative affectivity had an increased odds of nutritional risk (high vs. low: OR 1.58; 95%CI 1.11 to 2.27). In contrast, higher effortful control was associated with a reduced nutritional risk (high vs. low: OR 0.34; 95%CI 0.22 to 0.53). No association between surgency and nutritional risk was identified.

Longitudinal effect of the three early temperament domains on changes in nutritional risk and unhealthy dietary intake (see Figure 1)

Table 2 presents the multivariate linear association between temperament and the change in nutritional risk at follow-up, adjusted for the previous Total NutriSTEP® score. Each one point higher effortful control at the previous clinic visit was associated with a significant reduction in the Total NutriSTEP ® score (adjusted *B* -0.67; 95%CI -1.06 to -0.28) at follow-up visits, independent of covariates. No significant associations were observed between either negative affectivity or surgency and a change in Total NutriSTEP ® score over time.

A similar result was demonstrated when examining the change in unhealthy dietary intake (Table 2). Each one point higher effortful control at the previous visit was associated with a healthier dietary intake (reduced NutriSTEP ® dietary intake domain score) at follow up (adjusted *B* -0.53; 95%CI -0.79 to -0.26), independent of covariates. No longitudinal relationship was identified between either negative affectivity or surgency and a change in unhealthy dietary intake.

No interactions between age and temperament were identified (data not shown). No interactions between effortful control and negative affect were identified (data not shown). No differences in results were identified when performing the analysis without child z-BMI (data available upon request).

Table 2 Concurrent and longitudinal associations between temperament and nutritional risk and unhealthy dietary intake

	Nutritional Risk				Unhealthy Dietary Intake			
	Unadjusted analysis		Adjusted analysis[3]		Unadjusted analysis		Adjusted analysis[3]	
	B (95% CI)	p-value	*B* (95% CI)	p-value	*B* (95% CI)	p-value	*B* (95% CI)	p-value
Cross sectional analysis[1]								
Effortful Control	-0.93 (-1.32: -0.55)	<0.001	-0.88 (-1.27: -0.49)	<0.001	-0.65 (-0.87: -0.43)	<0.001	-0.66 (-0.89: -0.44)	<0.001
Negative Affectivity	1.07 (0.74: 1.40)	<0.001	1.03 (0.69: 1.37)	<0.001	0.36 (0.17: 0.55)	<0.001	0.31 (0.12: 0.50)	0.002
Surgency	-0.20 (-0.56: 0.16)	0.28	-0.23 (-0.60: 0.13)	0.21	-0.01 (-0.21: 0.20)	0.93	-0.01(-0.22: 0.19)	0.90
Longitudinal analysis[2]								
Effortful Control	-0.62 (-1.10: -0.24)	0.001	-0.67 (-1.06: -0.28)	<0.001	-0.48 (-0.75: -0.22)	<0.001	-0.53 (-0.79: -0.26)	<0.001
Negative Affectivity	0.18 (-0.17: 0.52)	0.32	0.19 (-0.16: 0.54)	0.29	-0.08 (-0.32: 0.16)	0.51	-0.08 (-0.32: 0.16)	0.49
Surgency	0.11 (-0.23: 0.44)	0.54	0.04 (-0.30: 0.38)	0.81	-0.12 (-0.35: 0.11)	0.32	-0.14 (-0.3: 0.10)	0.26

[1] For the cross sectional analysis a mixed effect model was used.
[2] For the longitudinal analysis a multivariate linear regression model was used
[3] Adjusted for: age, sex, child z-BMI, maternal age, parent BMI, neighborhood income, maternal education
B-Coefficients are estimates for change in Total NutriSTEP ® score and dietary intake domain score associated with 1 point change in temperament.

DISCUSSION

This study identified both a concurrent and longitudinal protective effect of higher effortful control on nutritional risk and dietary intake in early childhood. Children at age three who had higher effortful control had reduced nutritional risk and a reported healthier dietary intake at age five. Children with higher negative affectivity had a 1.6 times higher odds and children with higher effortful control a 0.3 times reduced odds of concurrent nutritional risk. This is the first study that examined temperament and nutritional risk factors longitudinally in early childhood. We used data from a large prospective cohort of children recruited from primary care settings and adjusted for important potential confounders.

Contrary to our hypothesis, higher negative affectivity was not associated with a change in nutritional risk over time. A mixed picture of the relation between greater negative affectivity and weight related outcomes of children were also reported in a recent review.[9] One explanation could be that negative affectivity in preschool children has been associated with both emotional overeating as well as food avoidant eating behaviors such as food fussiness and less enjoyment of food, which can lead to mixed effects on nutritional risk over time.[23] Another explanation for finding only a concurrent effect of negative affectivity could be differences in parenting style. In the study of Leung *et al*, low-income preschoolers who experienced emotion regulation difficulties were more likely to have tantrums over being denied food, but less likely to eat in the absence of hunger.[24] In other words, the negative behavior itself may not be problematic for developing obesity; rather the caregivers' responses might be.[9]

There are several possible mechanisms that might explain the concurrent and longitudinal association between higher effortful control and lower nutritional risk and healthier dietary intake. Firstly, children with higher effortful control may have a better ability to focus their attention on their own satiety responses, which could result in less concurrent excessive dietary intake.[24] Secondly, children with higher effortful control may be able to better redirect their emotions and behaviors. This may result in less parental use of food or screen time over time to soothe their children.[24,25] Finally, in adults it has been demonstrated that stress can lead to a shift in preference from healthy foods to foods with high-added sugar and fats.[26] Children with higher effortful control may have an improved ability to regulate their emotions and can better cope with stress over time, which could result in a lower preference for an unhealthy dietary intake.[27,28]

This study did not identify a concurrent or longitudinal relationship between surgency and nutritional risk factors and dietary intake. Children with high surgency have a high approach motivation and they may therefore learn more quickly to enjoy fruits and vegetables.[16] In contrast Leung et al identified that low-income preschoolers with higher surgency were more inclined to overeat in response to external cues and to eat in the

absence of hunger.[15,24] Surgency could also shape parenting behavior; parents may feed children with more surgent behavior more often.[16] In our study, the relationship between surgency and nutritional risk factors could be absent because of differences in parenting behavior and possibly because of the inclusion of both the eating of fruits and vegetables and eating of 'fast food' in the dietary intake NutriSTEP ® sub score.

Limitations of our study include the lack of measurement of parenting style. Parenting style could have a mediating influence on the development of temperament and nutritional risk factors in preschool children.[9] Not all children had three clinic visits, however there were no significant differences between the two groups, except for zBMI for which we adjusted our analysis. Also, the parent that attended the clinic visit was not always the same parent. However both maternal and paternal BMI are established as independent risk factors for obesity in young children.[29]

Furthermore our study relied on parent report of temperament and nutritional risk, which could have lead to ascertainment bias. Our study was conducted with a large group of children in primary care offices, and therefore direct observation was not feasible. However, both the NutriSTEP ® and the CBQ-VSF have demonstrated strong measurement properties when validated against direct observation.[1,7] Although there is theoretical support to investigate the relationship between temperament and nutritional risk (including dietary intake), there was no theoretical base for a relationship between temperament and food security. Our study may have also been limited by a relatively low nutritional risk profile, and our demographic data revealed high parental education. The results may therefore not be generalizable to other populations.

Results from this study contribute to the growing recognition of temperament as an important early childhood behavioral risk factor in child nutritional outcomes. This study used a longitudinal design and although causation cannot be directly inferred, it represents a stronger design than previous studies. Results from this study suggests that early childhood temperament impacts later nutritional risk providing evidence that preventive strategies for decreasing nutritional risk factors in preschool children might consider approaches to address temperament. While temperament of individuals tend to be relatively stable over time, there is evidence that links between early temperament and child outcomes are malleable and that self-regulation can be improved with interventions promoting sensitive, responsive parenting.[9] Future research should explore parenting style as a mediating factor in relationship between temperament and nutritional risk in preschool children.

In summary, this study demonstrated a concurrent and longitudinal protective effect of high effortful control on nutritional risk factors in preschool children. New nutritional risk prevention strategies might consider programming to increase effortful control as opposed to decreasing negative affectivity in preschool children.[9,30]

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CHAPTER 07

GENERAL DISCUSSION

The main aim of this thesis was to investigate the early identification of developmental and behavioral problems in pediatric primary care. We first explored the influence of redistributive policies on the social environment of early child development. Second, we focused on the assessment of communication problems in early childhood and on the identification of emotional and behavioral problems by teachers. At last, the relation between early childhood temperament and nutritional risk factors was investigated. In this chapter the main findings from this thesis are reported and discussed. Additionally, methodological issues and implications for pediatric primary care practice and research will be addressed.

FINDINGS PER RESEARCH QUESTION

In this paragraph we summarize our findings per research question.

1. *What is the influence of redistributive policies on early child development services and outcomes?*

We have investigated country scores on four social determinants of health important in the early years of child development: prenatal care, maternal leave, child health care, and child care and early childhood education. For each of these social determinants we have compared the organization of services and health outcomes in five countries with different redistributive policies, including the Netherlands and Canada. More redistributive policies were associated with better organization of early child health services such as higher maternal leave allowances and more preventive child healthcare visits. Child health outcomes that were associated with generous redistributive policies included lower rates of infant mortality, low birth weight rate and under-five mortality. Importantly, our comparative analysis demonstrated correlation but cannot claim causation.

2. *How well does the Nipissing District Developmental Screen (NDDS) identify communication problems in infants?*

In this study our primary objective was to assess the validity of the 18-month NDDS using the Infant Toddler Checklist (ITC) as a criterion measure. One or more “no” responses on the 18-month NDDS (i.e., the child does not demonstrate a behavior) indicate a need for further developmental assessment and/or referral. This is known as the “one flag” rule (1+NDDS flag). Previously, a minimum of two “no” responses (“two flag” rule) was recommended for a referral and/or follow-up of the child’s development (2+NDDS flag). Compared with the ITC, the 1+NDDS flag had modest to good sensitivity and poor specificity to identify expressive speech delay and other communication delays. The 2+NDDS flag had low to fair sensitivity and good specificity to identify expressive speech delay and other communication delays.

These results indicated that the NDDS does not have adequate psychometric characteristics to validly identify children with a range of communication delays.

3. *What is the reliability and validity of the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T)?*

We evaluated the reliability of the SDQ-T and its validity using the Teacher's Report Form (TRF) as a gold standard. Internal consistencies of the SDQ-T Total Difficulties Score, and the Hyperactivity/ Inattention and Prosocial behavior domain scores were very good. Good concurrent validity was demonstrated by strong correlations of all subscales of the SDQ-T with the corresponding scales of the TRF, except for peer problems. Using a SDQ-T cut-off score > 14, the SDQ-T had a good sensitivity and specificity. Our study shows a mostly good reliability and validity of the SDQ-T in 4 -10 year old children.

4. *What is the rate of teacher-reported emotional and behavioral problems in children with Developmental Coordination Disorder (DCD) compared with their peers? How well does the SDQ-T perform compared to the TRF in children with DCD?*

Teachers reported significantly more emotional and behavioral problems in children (aged 4 -10 years) with DCD than in their peers without DCD. Children with DCD had increased odds of problems on the TRF domains Thought, Externalizing and Internalizing problems, and on all SDQ-T-domains and Total Difficulties scale. In the DCD group, the SDQ-T scores correlated strongly and showed moderate agreement with the TRF scores. The brevity and good validity of the SDQ-T make it an ideal questionnaire to identify emotional and behavioral problems by teachers in children with DCD.

5. *Is temperament (negative affectivity, effortful control and surgency) in early childhood associated with nutritional risk factors?*

Each child has three main reactive dispositions of temperament: 1) negative affectivity (e.g. sadness, discomfort), 2) effortful control (e.g. attention shifting, focusing, inhibitory and activational control) and 3) extraversion/ surgency (e.g. positive emotionality, activity, impulsivity). In our study, children with higher negative affectivity had higher odds of concurrent nutritional risk, but higher negative affectivity was not associated with a change in nutritional risk over time. Furthermore our study demonstrated both a concurrent and longitudinal protective effect of higher effortful control on nutritional risk in early childhood. Children at age three who had higher effortful control had a reduced nutritional risk at age five. We found no relationship between surgency and nutritional risk. Results from this study contribute to the growing recognition of temperament as an important early childhood behavioral risk factor in child nutritional outcomes.

DISCUSSION OF THE MAIN FINDINGS

In this paragraph the main findings of our study will be discussed.

Child development; the social environment

In Chapter 2, we selected four social determinants to explore the social environment of early child development important in the early years. These determinants were (1) prenatal care, (2) maternal leave, (3) child health care, and (4) early childhood education. They were compared between five countries with different political traditions, as classified by Navarro *et al*.[1] In our study countries with political traditions of generous redistributive policies had a better organization of early child development services such as higher maternal leave allowances and more preventive child healthcare visits. Generous redistributive policies were also associated with improved child health outcomes; a decreasing trend in low birth weight rate, infant mortality, and under-five mortality rate were observed with an increase in redistributive policies.

In this thesis studies have been conducted both in the Netherlands and in Canada. In Navarro's classification in the period 1950-2000 the Netherlands has mainly had a Christian Democratic political tradition, with redistributive policies funded by payroll taxes through social security systems.[1] Canada has had a history of a more conservative political tradition in the same period, with no strong commitment to redistributive policies. In our comparison of early childhood services between the Netherlands and Canada we identified a striking difference in organization of pediatric primary care between the two countries. The Netherlands has had a long history of preventive child health care provided by specialized child health centers and had in our study, next to Sweden, the highest number of preventive care visits in early childhood (10 visits in the first 18 months). Importantly, the Netherlands is, next to Sweden, the only country that monitors the coverage rate for preventive child health care visits. In contrast, various healthcare providers offer pediatric primary care in Canada and there is no system in place to monitor preventive health care visits in individual children.

Another important finding in our analysis was a lack of uniform measures of the quality of early childhood education services and child development outcomes in the various countries. Recent data from the UNICEF Innocenti Report Card 11 "Child well-being in rich countries" included participation in early childhood education for the first time in the overall picture of children's well-being.[2] In that report, the Netherlands had one of the highest preschool enrolment rates (99%) and it was the only country that ranked among the top five in all dimensions of child well-being (material well-being, health and safety, education behaviors and risks and housing and environment).[2] In contrast to the Netherlands, Canada was in the overall UNICEF league somewhere "stuck in the middle".[3] No Canadian data was

provided for the participation in early childhood education before the start of compulsory education, however a recent report estimated this at 62% (which would put Canada at the bottom of that league table).[4] The large size of Canada, its remote and scattered communities, the large immigrant population and the longstanding poorer health status of their Indigenous people may be among factors that impede an improvement of Canada's position.[5] The Chairs of the 16 Departments of Paediatrics at Canadian medical schools emphasized the importance of a vigorous child health advocacy strategy that included the promotion of a social security net in Canada in order to improve the social environment of disadvantaged children.[5]

Developmental problems; early identification of communication problems

We found that the Canadian NDDS, compared to the ITC, did not adequately identify children with a range of communication delays. This confirms recent findings of Cairney et al. who compared the NDDS with the Bayles Scales of Infant Development (BSID, 3rd edition).[6] They found that the NDDS had poor to moderate sensitivity and specificity using the BSID as criterion. The authors concluded that the NDDS should not be used on its own for the identification of developmental delay in community or population-based settings.[6] Our study results well align with this conclusion and the use of the NDDS in pediatric primary care as a developmental or communication screening instrument cannot be supported. The NDDS was originally not designed as a developmental screening tool, but as a short tool to promote a conversation about child development between health care providers and caregivers. In our study we did not examine if the use of the NDDS resulted in a more detailed discussion of general developmental concerns with caregivers.

Universal screening for developmental delay in children is still debated in the literature. A recent guideline "Recommendations on screening for developmental delay" from the Canadian Task Force on Preventive Health Care stated that there is no evidence from randomized controlled trials (RCTs) that screening for (any) developmental delay improves health outcomes in children.[7] The Task Force recommended against screening for developmental delay using standardized tools in children aged one to four years with no apparent signs of developmental delay and whose parents and clinicians have no concerns about development.[7] It is important to recognize that this guideline made a clear distinction between population based screening at one time point or developmental surveillance, which is defined as the monitoring of a child's development at each clinical encounter.[7] In the Netherlands the systematic surveillance of physical, psychosocial and cognitive development of children and youth is one of the main tasks of the preventive healthcare for children.[8] In Canada, developmental surveillance defined as the ongoing monitoring of development, identification of risk factors, and the response to parental concerns is also considered to be part of standard clinical care for children.[9]

An important limitation of the Canadian guideline is that it only focused on the screening of developmental problems and it did not include the screening of behavioral problems in this age group. The SDQ has been identified as a valid tool for the identification of emotional and behavioral problems in preschool children.[10,11] There is also evidence that early identification and treatment of these emotional and behavioral problems can prevent poor outcomes in preschool children.[12]

Early identification of behavioral problems; the role of teachers

In two studies we demonstrated the good reliability of the SDQ-T and its validity if compared with the TRF. The first study was conducted in 4-10 year old community school children and the second study included 4-10 year old children with DCD. Both studies demonstrated that teachers could make a valuable contribution to the identification of emotional and behavioral problems in children in the school community.

Our findings on the added value of teachers' ratings confirm that obtaining information from teachers in addition to parental information is highly valuable. Teachers provide information on emotional and behavioral problems in children in a second setting, which may also be of help in the management of these problems in children.[13,14] However, collecting teacher ratings of children's emotional and behavioral problems also provides some challenges.[15] Teachers who will participate in screening for emotional and emotional problems will need adequate training regarding these problems in children.[16,17] Also, in practice it is not feasible for most teachers to fill in an SDQ for each child in their class. That probably implies that a teacher version of the SDQ cannot be used routinely for all children. Currently the Dutch guideline "psychosocial problems" in the Dutch preventive healthcare is under revision, and at this time it is not clear in what way the teacher version of the SDQ will be used in the Dutch preventive healthcare.

The relation of early childhood temperament and nutritional risk

Nutrition plays an essential role in growth and development, in academic success and in the social and emotional well-being of children. Our study investigated if a child's early temperament is associated with nutritional risk factors over time. We demonstrated both a concurrent and longitudinal protective effect of higher effortful control on nutritional risk in early childhood. Children at age three who had higher effortful control had reduced nutritional risk at age five. Children with higher negative affectivity had higher odds of concurrent nutritional risk but higher negative affectivity was not associated with a change in nutritional risk over time.

Our results showed that early childhood temperament has an impact on later nutritional risk. This contributes to the growing recognition of temperament as an important early childhood behavioral risk factor in child nutritional outcomes.[18-20] Preventive strategies to

decrease nutritional risk factors in preschool children might therefore consider approaches to address temperament. While temperament of individuals tends to be relatively stable over time, there is evidence that links between early temperament and child outcomes are malleable and that self-regulation can be improved with interventions that promote sensitive, responsive parenting.[20] Because of the longitudinal protective effect of higher effortful control new nutrition prevention strategies in preschool children might consider programming to increase effortful control as opposed to decreasing negative affectivity. [20]

METHODOLOGICAL CONSIDERATIONS

Sample

Our study was conducted in relatively large Dutch and Canadian pediatric community populations. Both Dutch studies took place in a school population of 4-10 year old children. A limitation of this school population sample concerned the relatively low response rates by schools and parents. We could not assess if the schools that refused to participate in our study differed in any respect from the schools that chose to participate in our study. A second limitation was that children from immigrant origin and parents with lower vocational education were underrepresented in this Dutch population. This small share of immigrants may be due to the fact that the schools were located in the middle and eastern regions of the Netherlands.[21] An additional factor may be that immigrant parents refused to participate in our study.

The community-based nature of our study in the Netherlands resulted also in a relatively small number of children with DCD. Prevalence rates of DCD, based on the strict Leeds criteria for DCD that we used, will seldom lead to more than 5% of children with DCD in a community-based cohort.[22] This limited number of children with DCD in our community sample led to broad confidence intervals for ORs of emotional and behavioral problems. Additionally, this also could have led to some overestimation of the sensitivity and specificity of the SDQ-T in the DCD group.[23]

In Canada, children were included from a large community based primary care research network in Toronto, Canada (*TARGet Kids!*). [24] *TARGet Kids!* is the only child health research network embedded in primary care practices in Canada. A limitation of the *TARGet Kids!* study population was that parents with a relatively high parental education level were overrepresented. Regarding ethnicity, in the complete *TARGet Kids!* study population a majority of people with an European background (66.8%) was included.[24]

Quality of data

In our first study we explored the social environment of early child development in different countries. We searched international databases and reports to obtain information

on policies, services and outcomes of interest. Global databases, such as Organisation for Economic Co-operation and Development (OECD.Stat) and World Data Bank rely on data collected by national statistics. Although these large databases have made increasing strides to standardize indicator definitions, data sources, and collection methodology, inherently, there will be differences between countries that limit comparability.

In three studies we examined the validity of existing questionnaires and compared them to a gold standard. The choice of the gold standards in our studies could be criticized. In Chapter 3, the criterion validity of the NDDS with the ITC was investigated. The goal of our study was to compare two short developmental screening instruments that can be used in primary pediatric care. Therefore we did not assess communication with an independent, standardized measure such as the MacArthur-Bates Communicative Developmental Inventories (MB-CDI) or the Bayley Scales of Infant Development (BSID). The ITC is a standardized screening questionnaire and well validated in multiple studies.[25-27] The NDDS is not standardized and at the time of our study the psychometric properties of the NDDS had not yet been published.

In Chapters 4 and 5 the validity of the SDQ-T was assessed using the TRF as gold standard. Strength of these studies was that we were able to use Dutch norms for both questionnaires. Although the TRF is one of the best instruments available, it cannot be regarded as the ultimate gold standard, because that position is reserved for clinical diagnosis.[28] Because of complexity and high costs, structured clinical interviews such as the Diagnostic Interview Schedule for Children were not used as criterion. Based on the literature however, the TRF can be considered to be a good criterion for the early detection of mental health problems by professionals. [29]

In Chapter 6 we explored the concurrent and longitudinal relation of temperament and nutrition risk. Both the Nutrition Screening Tool for Every Pre-schooler (NutriSTEP®) and the very short form of the Child Behavior Questionnaire (CBQ-VSF) are parent reported which could have led to ascertainment bias. However, both questionnaires have demonstrated strong measurement properties when validated against direct observation.[30,31]

Causality

An important limitation in our comparative analysis of early child health and development services and outcomes is that this analysis only allowed for correlation, not for causation. A web of different social, cultural, economic, genetic, political, and environmental conditions influences early child development and could not be captured completely in our study.[32] Our study examining the identification of emotional and behavioral problems by teachers in children with DCD presented only cross-sectional data and therefore does not allow causal inferences. Studies explaining the increased risk for emotional and behavioral difficulties in DCD are still scarce.[33] Specifically, the considerable overlap between DCD and Attention

Deficit/Hyperactivity Disorder (ADHD) has been subject to debate in literature with studies arguing that DCD could be one facet of broader syndrome including learning difficulties and attention deficits and studies suggesting that DCD and ADHD are distinct disorders. [33,34]

In our study on the relation between temperament and nutritional risk in early childhood a limitation was the lack of measurement of parenting style. In literature, both emotional development and the development of healthy eating behaviors in children are thought to be dependent on responsive parenting behaviors, in other words on parenting behaviors that reflect reciprocity between child and caregiver.[35] In contrast to a direct association another possibility could be that parenting style has a mediating influence on the development of nutritional risk factors. For example, it is reported that parents use food to sooth their 'fussy' (i.e. high in negative affectivity) infants. [36]

Generalizability

The results of the studies conducted in the school population in the Netherlands (Chapter 4 and 5) are likely generalizable to other school populations in the Netherlands and possibly to other Western European school populations as well. In our school population, children from immigrant origin and parents with lower vocational education were underrepresented. This may have led to an underestimation of the prevalence of clinical SDQ and TRF scores as previous studies show rates of emotional and behavioral problems to be somewhat higher among children from low-SES families and among Moroccan and Turkish children.[37] However, it is unlikely that this has significantly influenced the correlation between the SDQ-T with the TRF. Anyhow, these results need to be confirmed in other groups of children, including children with a non-Western European background.

The results of the studies conducted in the pediatric research group *TARGet Kids!* in Canada (Chapter 3 and 6) are likely to be generalizable to other pediatric primary care populations in Canada and other European populations. Parents are only included in the *TARGet Kids!* population if they are able to communicate in English. Therefore our results may not hold for immigrant populations who don't speak English. This is especially an important limitation in our study investigating communication in 18-months old children. Language development is inextricably integrated with culture. [38]

In our study examining the influence of temperament on nutritional risk the majority of parents had a relatively high education level (>90% college level). Confirmation of our findings is therefore needed in in a low-income population.

IMPLICATIONS

Implications for policy and pediatric practice

Our study reported that redistributive policies aimed at reducing social inequalities were associated with a positive influence on the social determinants of early child development. Our study adds to the literature that mandates governments to increase their redistributive policies as a means to improve early child development outcomes and services. [2] For both policy makers and researchers, a population linked administrative database, including information about early child development and the social environment, would provide a powerful resource in obtaining longitudinal data on large populations over the life-course. [9] In Sweden, Western Australia and in Ontario the Institute for Clinical and Evaluative Sciences (ICES) the linkage of administrative records from multiple sources to create a longitudinal data set is well established.[39] However, in order to improve child development outcomes on both an individual and population level, mechanisms should be developed to systematically collect, analyze, and respond to universally accepted early child development indicators.

Based on our results of the poor psychometric properties of the 18-month NDDS, we would not advise primary care practitioners to use the 18-month NDDS to identify children with communication delays. The ITC has been validated and studied in a large pediatric population and might be a more promising screening tool for the early identification of communication and other developmental delays in primary pediatric care. [25-27]

This thesis reported on the good reliability and validity of the SDQ-T with the TRF in 4 -10 year old children in the Netherlands. Pediatric primary care providers are increasingly held accountable to assess emotional and behavioral problems in their practice and are mandated to collaborate with parents and teachers on these problems.[40] The use of the SDQ-T to identify teacher reported emotional and behavioral problems can be supported in the general school population and also in children with DCD. The SDQ-T TDS may highly add to the identification of emotional behavioral problems in the school setting.

In Canada, specifically in large urban cities, there has been experience with obtaining information from teachers directly in the school environment in “school-based health clinics”. [41] In these school-based health clinics, family physicians and pediatricians collaborate with teachers and other school staff. These clinics were designed to improve access to developmental and medical services, especially for economically disadvantaged and new immigrant families. A feasibility study demonstrated that one in five children were diagnosed with a new mental health disorder in these school based health clinics.[41] The SDQ-T could be of value for the clinicians working in these clinics. The brevity, good validity, free accessibility, the availability in many languages, and cultural acceptability of the SDQ-T would make it an ideal questionnaire in this setting to obtain information from teachers.

Implications for research

Based on our finding of poor psychometric properties of the NDDS we concluded that the NDDS is not suitable to identify children with a range of communication delays. Because of its good psychometric properties and substantial validation over the past decades the ITC is a more promising instrument to detect early communication delays in pediatric primary care.[25-27] A recent systematic review that investigated the screening for speech and language delays in children 5 years or younger did not find any well-conducted trials that addressed the question whether early screening and subsequent treatment of speech and language delays lead to improved outcomes.[42] Therefore, evidence from randomized controlled trials is needed to decide whether screening for communication delays with the ITC and subsequent early treatment should be implemented.

Our study demonstrated a strong correlation and moderate agreement of the SDQ-T with the TRF in children with DCD. Future studies should explore the use of the SDQ-T in children with DCD in a larger community-based population. In addition, further research is needed to explore the relationship between DCD and emotional and behavioral difficulties further, including causal pathways.

Our study regarding the influence of early childhood temperament on later nutritional risk was one of the first studies that demonstrated the longitudinal protective effect of effortful control. The study population included an overrepresentation of parents with a higher education. Confirmation of our findings is therefore needed in other populations. Future research should explore the relationship between temperament and nutritional risk in families with a lower socioeconomic status. Since temperament and parenting style are thought to have a bidirectional relationship additional research should also explore if parenting style mediates the association between temperament and nutritional risk. Ultimately, intervention studies are required that evaluate if prevention strategies to increase effortful control will lead to a decrease in nutritional risk in preschool children.

FUTURE PERSPECTIVES

As the understanding deepens and expands regarding the profound influence of social factors on developmental process through multiple gene-environment interactions, the long-standing role of pediatric care providers to promote the bio-psycho-social well-being of all children also must evolve.[43,44]

Social pediatrics is the pediatric subspecialty that focuses on the child's health, development and behavior within the child's social, environmental and political context. In the Netherlands, social pediatrics has been a subspecialty since 1974, and four universities offer this training. The focus of social pediatrics in the Netherlands has been on the identification and management of psychosocial problems in children at risk e.g. children

experiencing abuse, children with chronic diseases and / or developmental concerns and children living in poverty. Essential in the work of a social pediatrician in the Netherlands is the participation in multidisciplinary teams inside the hospital, as well as outside with community partners.

In Canada, developmental-behavioral pediatrics is the subspecialty that focuses on childhood neurodevelopmental (e.g. autism spectrum disorder, attention deficit hyperactivity disorder) and neuro-rehabilitation disorders (e.g. cerebral palsy) and partly overlaps with social pediatrics in the Netherlands. Social pediatrics in Canada is the subspecialty that focuses on the social determinants of health as critical mediators of health especially applied to disadvantaged and vulnerable children and their families. The Chairs of Departments of Paediatrics at Canadian medical schools advocated for the importance of social pediatrics in curriculum development. [5] However, social pediatrics is not recognized as a separate subspecialty by all universities, though multiple opportunities exist for students and residents to explore social pediatrics in many universities in Canada.[43-46]

Pediatric medicine is a discipline of subspecialties and one could argue that pediatricians with a focus on child health, development and behavior in relation to the social environment, working both in a hospital and in a community setting (e.g. in public health, mental health centers, government institutions) are highly needed. These paediatricians can help to design new science-based multidisciplinary strategies to promote optimal child development.

CONCLUSION

In this thesis the importance of redistributive policies on the social environment of early child development was demonstrated. For the early identification of communication problems the 18-month NDDS showed not to have adequate diagnostic properties. For the early identification of behavioral problems, the SDQ-T demonstrated good reliability and validity in a pediatric community population and also in children with DCD. Our last study provided evidence that child temperament influenced nutritional risk factors in early childhood.

Pediatric primary care providers need to identify developmental and behavioral problems early and monitor the social environment of children. New, creative strategies, including multidisciplinary collaborations locally and globally are urgently needed to address the social, behavioral, and economic determinants of lifelong disparities in order to promote optimal child development.[47]

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APPENDICES

SUMMARY

This thesis focuses on the early identification of developmental and behavioral problems in pediatric primary care. We first explored the influence of redistributive policies on the social environment of early child development. Second, we focused on the assessment of communication problems in early childhood and on the identification of emotional and behavioral problems by teachers. At last, the relation between early childhood temperament and nutritional risk factors was investigated.

INTRODUCTION

Chapter 1 describes the various concepts of child development and behaviour and the importance of the social environment on child development outcomes. In this thesis, studies have been conducted both in the Netherlands and Canada therefore we discussed the prevalence of developmental and behavioral problems and the organization of pediatric primary care in both countries. The importance of screening and surveillance for developmental problems in children is widely recognized and there are a large number of instruments available for the use in pediatric primary care. For assessing emotional and behavioural problems in children information from multiple informants is preferable. However less research is available about the early identification of emotional and behavioral problems by teachers with the use of questionnaires.

Research questions and main findings per chapter:

1. *What is the influence of redistributive policies on early child development services and outcomes?*

In Chapter 2 of this thesis we describe the investigation of four social determinants of health important in the early years of child development; prenatal care, maternal leave, child health care, and child care and early childhood education. For each of these social determinants we have compared the organization of services and health outcomes in five countries with different redistributive policies, including the Netherlands and Canada. We used international databases and reports to obtain information on policies, services and outcomes of interest.

In our study countries with political traditions with generous redistributive policies had a better organization of early child development services such as higher maternal leave allowances and more preventive child healthcare visits. Generous redistributive policies were also associated with improved child health outcomes; a decreasing trend in low birth weight rate, infant mortality, and under-five mortality rate was observed with an increase in redistributive policies. A remarkable finding in our study was the lack of uniform

measures of the quality of early child care services and child development outcomes in the included countries. Our comparative analysis only allowed for correlation not for causation.

In conclusion, this paper provided further support for an association between redistributive policies and early child health and development outcomes, along with the organization of early child health and development services.

2. How well does the Nipissing District Developmental Screen (NDDS) identify communication problems in infants?

In the study reported in Chapter 3, our main objective was to assess the validity of the 18-month NDDS compared with the Infant Toddler Checklist. Communication delays are often the first presenting problem in young children with a range of developmental disabilities including isolated expressive speech delay, autism spectrum disorders (ASD) and intellectual disability. The NDDS is a parent-completed questionnaire that addresses different areas of development including communication. One or more "no" responses on the 18-month NDDS (i.e., the child does not demonstrate the behaviour) indicates the need for further developmental assessment and/or referral. This is known as the "one flag" rule (1+NDDS flag). Previously, a minimum of two "no" responses ("two flag" rule) was recommended for a referral and/or follow-up of the child's development (2+NDDS flag). The NDDS is currently one of the most widely used developmental screening tools in Ontario, however the accuracy of the NDDS in identifying early communication delays has never been investigated.

The Infant Toddler Checklist (ITC) was originally developed for early identification of children who have or are at-risk for developing communication impairment. It is a standardized questionnaire, validated for detecting expressive language and other communication delays.

We calculated diagnostic test properties (sensitivity, specificity, positive predictive value, negative predictive value) of the 18-month NDDS compared with the ITC. Our study included 348 children (mean age 18.6 $\pm$ 0.7 months). Compared with the ITC, the 1+NDDS flag had good sensitivity and poor specificity to identify expressive speech delay and other communication delays. The 2+NDDS flag had low to fair sensitivity and good specificity to identify expressive speech delay and other communication delays. Our results indicated that the NDDS does not have adequate psychometric characteristics to validly identify children with a range of communication delays.

3. What is the reliability and validity of the teacher version of the Strengths and Difficulties Questionnaire (SDQ-T)?

In Chapter 4 we describe the investigation of the reliability of the SDQ-T and its validity using the Teacher's Report Form (TRF) as a gold standard. A reliable and valid questionnaire,

the Teacher's Report Form (TRF), is available for teachers to assess the extent of a child's emotional and behavioral problems. The TRF is often regarded as the gold standard among broadband behavior rating scales. For routine use, a major disadvantage of the TRF is its length, as it includes 113 items. The SDQ is a short questionnaire that also can be used to detect emotional and behavioral problems in children. The SDQ is free of charge (www.sdq.org) available in many languages and has versions for parents, children and teachers. Obtaining teacher's SDQ ratings in addition to parental information is valuable for clinicians because this provides data on emotional and behavioral problems in children in a second setting, and can be of help in the management of these problems in children.

We conducted a cross-sectional study in 4-10 years old school children to investigate if the SDQ-T can be used instead of the validated Teacher's Report Form (TRF) to acquire information about emotional and behavioral problems in the school community. Teachers of 394 children (response rate 86.9%) with a mean age of 7.1 years (age range 4 - 10 years) filled in the SDQ-T (n = 387), the TRF (n= 349) or both (n =342). Internal consistency of the SDQ-T Total Difficulties Score (SDQ-T TDS; Cronbach α=0.80), hyperactivity/ inattention- (α = 0.86) and prosocial behavior (α = 0.81) was very good. Concurrent validity demonstrated a strong correlation of all subscales of the SDQ-T with the corresponding scale on the TRF (range 0.54-0.73), except for peer problems (0.46). Using a SDQ-T TDS cut-off score > 14, the SDQ-T had a good sensitivity (90%) and specificity (94%).

We concluded that the SDQ-T is a reliable and valid instrument for identifying emotional and behavioral problems in primary school children. The brevity of the SDQ-T makes it an easily applicable questionnaire for obtaining information about emotional and behavioral problems on primary school children from teachers. The SDQ-T TDS may highly add to the identification of emotional and behavioral problems in the school setting in these children.

4. *What is the rate of teacher-reported emotional and behavioural problems in children with Developmental Coordination Disorder (DCD) compared with their peers? How well does the SDQ-T perform compared to the TRF in children with DCD?*

In Chapter 5 the investigation of the teacher's identification of emotional and behavioral problems in children with DCD is reported. DCD is a common disorder affecting motor coordination in school-aged children. Motor performance has a great impact on the psychosocial development of children, which may explain the co-morbidity between DCD and various psychosocial problems. Current evidence on the co-occurrence of DCD and psychosocial problems mainly concerns parent-reported information, but rarely includes teacher reports.

We performed a cross-sectional study in which data was collected on 402 children (202 boys, 200 girls, range 4-19.8 years, mean age 7.2 years (SD 1.9). Children were defined as having DCD if they met all 4 DSM IV-TR criteria for DCD: poor motor coordination (criterion

A), which causes functional limitations in activities of daily living or academic achievement (criterion B), not caused by a general medical condition nor severe mental retardation (criterion C and D). Emotional and behavioural problems were measured with the TRF (n = 327) and the SDQ-T (n = 361). DCD was established in 23 (5.7%) children, 16 boys and 7 girls (mean age 7.0 years). Children with DCD had a higher proportion of clinical scores on both the TRF Total Problem Scale (TRF TPS) and SDQ-T Total Difficulties Score (SDQ-T TDS). Children with DCD had increased odds on the TRF domains Thought (odds ratio, OR: 5.39), Externalizing (OR: 4.12) and Internalizing (OR: 4.42) problems, and on all SDQ-T-domains and Total Difficulties score (OR: 7.30).

Our second aim was to investigate the performance of the SDQ-T compared with the TRF in children with DCD. In the DCD group the SDQ-T TDS correlated strongly (Spearman's rho 0.80) with the TRF TPS and demonstrated a moderate agreement (Cohen's Kappa 0.53). Using the borderline clinical TRF TPS as criterion, the SDQ-T had a good sensitivity of 0.80 (95% Confidence Interval = 0.62-0.98) and a good specificity of 0.80 (95% CI = 0.62-0.98) in the DCD group.

We concluded that teacher ratings indicated a higher risk of emotional and behavioral problems in children with DCD compared with children without DCD. Teachers can make a valuable contribution to the identification of emotional and behavioral problems in children with DCD in the community. Because of its shortness and good validity in this study, the SDQ-T could be used to support this, though these findings require confirmation in other studies.

5. *Is temperament (negative affectivity, effortful control and surgency) in early childhood associated with nutritional risk factors?*

In Chapter 6 we report the exploration of the relationship between a child's early temperament and nutritional risk factors. Early childhood temperament is increasingly recognized as an important attribute that may impact screen time use, outdoor play and childhood obesity. Temperament is defined as a child's behavior style. It determines how children react to new situations and how they regulate their emotions. Every child has three main types of temperament. A child with a high level of negative affectivity has typically a lowered mood, is angry, fearful and very difficult to soothe. Children with a high level of effortful control have the capacity to suppress inappropriate responses, have better self-regulation and can maintain focus on task-related activities. Children with high surgency levels are impulsive, enjoy situations with high stimulus intensity and do not show discomfort in social situations.

In our study we measured nutritional risk factors with Nutrition Screening Tool for Every Pre-schooler (NutriSTEP®). The NutriSTEP® is a short questionnaire, developed and tested in a multicultural Canadian population. The NutriSTEP® includes questions about: eating

behaviours, dietary intake, parental concerns about food and activity, screen time duration and the use of nutrition supplements. We followed 678 children (aged 3 -5 years) over a mean period of 16 months.

Our results demonstrated that higher negative affectivity was associated with a concurrent increased nutritional risk (1.03; 95% CI 0.69 to 1.37) but not with a change in nutritional risk over time. Higher effortful control was associated with both a concurrent decrease in nutritional risk (-0.88; 95%CI -1.27 to -0.49) and also with a decrease in nutritional risk over time (-0.67; 95%CI -1.10 to -0.24). There was no relationship identified between surgency and nutritional risk.

Results from this study contribute to the growing recognition of temperament as an important early childhood behavioral risk factor in child nutritional outcomes. Three-year-old children with higher effortful control had reduced nutritional risk at five years of age. Future nutritional risk prevention strategies may benefit from interventions to increase effortful control in early childhood.

DISCUSSION AND IMPLICATIONS

In Chapter 7 the main findings from this thesis were reported and discussed. Methodological issues and implications for pediatric primary care practice, policy and research were addressed.

Our findings support the use of redistributive policies to reduce social inequalities in order to improve early child health and development services and outcomes. Based on our results of the poor psychometric properties of the 18-month NDDS, we would not advise primary care practitioners to use the 18-month NDDS to identify children with communication delays. The use of the SDQ-T to identify teacher reported emotional and behavioural problems could be supported in the general school population and also in children with DCD.

A limitation of our study sample in the Dutch school population was that children from immigrant origin and parents with lower vocational education were underrepresented. The generalizability of our school study results needs further investigation in other groups of children, including children with a non-Western European background. In the pediatric community population in Canada, the majority of the parents had a relatively high education level and parents were only included if they were able to communicate in English. Therefore results of the studies conducted in Canada might not be generalizable to low income populations and immigrant populations who don’t speak English.

The most important policy, practice and research implications that were discussed in Chapter 7 were:

1. Policy makers should develop mechanisms to systematically collect, analyze and respond to universally accepted early child development indicators in order to improve child development outcomes.
2. The NDDS is not suitable to identify children with a range of communication delays. The ITC has been validated and studied in a large pediatric population and might be a more promising screening tool for the early identification of communication delays. More evidence is needed to investigate whether screening for communication delays with the ITC and subsequent early treatment will result in improved child outcomes over time.
3. The use of the SDQ-T can be supported to obtain information about emotional and behavioral problems from teachers. However, in practice it is not feasible for teachers to fill in an SDQ for each child in their class. More research is needed how to use the SDQ-T on a population level.
4. Further research is needed to identify causal pathways to explain the relationship between emotional and behavioral difficulties and DCD.
5. New studies examining should examine the relationship between temperament and nutritional risk in low-income populations. Further research should also explore if parenting style mediates the relation between temperament and nutritional risk.

At the end of Chapter 7 future perspectives were discussed including the role of pediatric care providers to promote the bio-psycho-social well-being of all children. A short description is provided about social pediatrics, the subspecialty that focuses on the child's health, development and behaviour within the child's social, environmental and political context. New creative strategies, including multidisciplinary collaborations locally and globally are urgently needed to address the social, behavioral, and economic determinants of lifelong disparities in order to promote optimal child development.

APPENDICES

SAMENVATTING

Dit proefschrift richt zich op de vroege herkenning van ontwikkelings- en gedragsproblemen in de eerstelijnsgezondheidszorg voor kinderen. Ten eerste hebben we onderzocht welke invloed herverdelend beleid van de overheid heeft op de sociale omgeving waarin het jonge kind zich ontwikkelt. Ten tweede hebben we de vroegopsporing onderzocht in de eerstelijnsgezondheidszorg van communicatie problemen bij jonge kinderen, en de herkenning door leerkrachten van emotionele- en gedragsproblemen bij schoolgaande kinderen. Tot slot onderzochten we de relatie tussen temperament en voedings- en beweeggedrag in jonge kinderen.

INLEIDING

Hoofdstuk 1 beschrijft de verschillende modellen over de ontwikkeling en gedrag van een kind en het belang van de sociale omgeving waarin het jonge kind zich ontwikkelt. Dit proefschrift omvat studies die zowel in Nederland als in Canada zijn uitgevoerd. Daarom wordt eerst de prevalentie van ontwikkelings-en gedragsproblemen en de organisatie van eerstelijnsgezondheidszorg voor kinderen in beide landen beschreven. Het belang van screening en surveillance van ontwikkelingsproblemen bij kinderen wordt algemeen erkend en er is een groot aantal instrumenten beschikbaar om de ontwikkeling van kinderen in eerstelijnsgezondheidszorg te monitoren. Voor de beoordeling van emotionele- en gedragsproblemen in kinderen is het wenselijk om de mening van meerdere personen uit de omgeving van het kind te verkrijgen. Er is weinig onderzoek beschikbaar over de vroegopsporing van emotionele en gedragsmatige problemen door leerkrachten met behulp van vragenlijsten.

Onderzoeksvragen en de belangrijkste bevindingen per hoofdstuk:

1. *Wat is de invloed van een herverdelend beleid op de organisatie van voorzieningen voor jonge kinderen en hun gezondheidsuitkomsten ?*

Hoofdstuk 2 van dit proefschrift beschrijft onderzoek naar vier sociale determinanten die belangrijk zijn in de eerste jaren van de ontwikkeling van een kind: prenatale zorg, zwangerschaps- en ouderschapsverlof, gezondheidszorg, en kinderopvang en vroegschoolse educatie. Voor elk van deze sociale determinanten hebben we de organisatie van voorzieningen en gezondheidsuitkomsten onderzocht in vijf landen met een verschillend herverdelingsbeleid, waaronder Nederland en Canada. Deze informatie verkregen we uit internationale databases en rapporten.

In onze studie waren voorzieningen en zorg voor jonge kinderen beter georganiseerd in landen met een genereus herverdelingsbeleid, zoals bijvoorbeeld een hogere toelage tijdens zwangerschapsverlof voor moeders en meer preventieve gezondheidszorg voor kinderen.

Een genereus herverdelingsbeleid hing ook samen met betere gezondheidsuitkomsten bij jonge kinderen: we zagen een tendens naar een lager percentage kinderen met een laag geboorte gewicht, en een lagere sterfte onder zuigelingen en kinderen onder vijf jaar. Opvallend was het gebrek aan gestandaardiseerde uitkomstmaten om de kwaliteit van kinderopvang en vroegschoolse educatie te meten in de landen die we hebben onderzocht. Met onze vergelijkende studie konden we alleen een samenhang aantonen tussen herverdelingsbeleid en de verschillende uitkomstmaten en geen causale verbanden. Concluderend ondersteunt onze studie de samenhang tussen herverdelend beleid en de organisatie van voorzieningen en gezondheids- en ontwikkelingsuitkomsten in jonge kinderen.

2. *Hoe goed herkent de Nipissing District Developmental Screen (NDDS) communicatie problemen in jonge kinderen?*

In de Hoofdstuk 3 beschreven studie was ons belangrijkste doel om de validiteit van de 18-maands versie van de NDDS te bepalen in vergelijking met de Infant Toddler Checklist (ITC). Communicatieproblemen zijn vaak een vroeg signaal van allerlei soorten ontwikkelingsproblematiek zoals bijvoorbeeld autisme, een geïsoleerde spraak-taal achterstand en een algemene ontwikkelingsachterstand. De NDDS is een vragenlijst die ouders invullen met verschillende vragen over de ontwikkeling van het kind, waaronder vragen over communicatie. Als ouders één of meer vragen met “nee” beantwoorden (wat betekent dat het kind het gevraagde gedrag nog niet kan) dan moet de ontwikkeling van het kind verder gevolgd worden of het kind moet doorverwezen worden. Dit staat bekend als de “’één vlag” regel (1+NDDS). In een eerdere versie van de NDDS was een minimum van twee “nee” antwoorden (“twee vlaggen” regel) nodig om de ontwikkeling van het kind verder te volgen of het kind door te verwijzen (2+ NDDS). Tegenwoordig is de NDDS een van de meest gebruikte ontwikkelingsvragenlijsten in Ontario, Canada, hoewel de kwaliteit van de NDDS voor het herkennen van vroege communicatie problemen niet is onderzocht.

De ITC is oorspronkelijk ontwikkeld om vroegtijdig kinderen met, of kinderen met een risico op, communicatie problemen te herkennen. Het is een gestandaardiseerde vragenlijst voor ouders die gevalideerd is om expressieve taal problemen en andere communicatie problemen op te sporen.

In onze studie hebben wij de diagnostische test eigenschappen (sensitiviteit, specificiteit, positief voorspellende waarde, negatief voorspellende waarde) van de 18-maands versie van de NDDS met de ITC vergeleken. Wij hebben 348 kinderen (gemiddelde leeftijd 18,6 + 0,7maanden) geïncludeerd. Vergeleken met de ITC had de 1+NDDS een redelijk goede sensitiviteit en een slechte specificiteit om expressieve taal en andere communicatie problemen op te sporen. De 2+ NDDS had een matige sensitiviteit en een goede specificiteit om expressieve taal en andere communicatie problemen op te sporen. Onze

resultaten laten zien dat de NDDS geen goede psychometrische eigenschappen heeft om kinderen met verschillende taal- en communicatieproblemen op te sporen in de eerstelijnsgezondheidszorg voor kinderen.

3. *Wat is de betrouwbaarheid en validiteit van de leerkracht versie van de Strengths and Difficulties Questionnaire (SDQ-T)?*

Hoofdstuk 4 beschrijft ons onderzoek naar de betrouwbaarheid en validiteit van de SDQ-T met de Teacher's Report Form (TRF) als gouden standaard. De TRF is een veel gebruikt en goed gevalideerd meetinstrument voor leerkrachten om emotionele- en gedragsproblemen op te sporen, maar heeft als nadeel dat de lijst bestaat uit 113 vragen. De SDQ is een korte vragenlijst die ook gebruikt kan worden bij de opsporing van emotionele- en gedragsproblemen in kinderen. De SDQ is gratis beschikbaar in veel talen (www.sdq.org) en heeft een versie voor zowel ouders, kinderen en leerkrachten. Grote voordelen van de SDQ zijn dat deze uit maar 25 vragen bestaat, en zoals de titel al impliceert, niet alleen naar problemen vraagt maar ook naar de sterke kanten van een kind. In de praktijk is het belangrijk om naast informatie van ouders, ook informatie van leerkrachten over emotionele- en gedragsproblemen te krijgen.

Wij hebben een dwarsdoorsnede onderzoek uitgevoerd onder 4-10 jaar oude schoolgaande kinderen, om te onderzoeken of de SDQ-T ook gebruikt kan worden in plaats van de TRF om informatie over emotionele- en gedragsproblemen te verkrijgen. Leerkrachten van 394 leerlingen (respons 86,9%) met een gemiddelde leeftijd van 7,1 jaar (leeftijd variërend van 4 tot 10 jaar) vulden zowel de SDQ-T (n=387), de TRF (n=349), of allebei (n =342) in.

De interne consistentie van de SDQ-T schalen Totale Problemen (SDQ-T TPS; Cronbach α=0,80), hyperactiviteit / aandachtproblematiek (α = 0,86) en prosociaal gedrag (α = 0,81) was erg goed. We vonden een sterke correlatie tussen alle sub-schalen van de SDQ-T en de bijbehorende schaal van de TRF (variërend van 0,54-0,73), behalve voor problemen met leeftijdsgenoten (0,46). De SDQ-T had een goede sensitiviteit (90%) en specificiteit (94%) bij gebruik van een afkapwaarde voor de SDQ-T TPS van > 14.

Concluderend is de SDQ-T een betrouwbaar en valide instrument om emotionele- en gedragsproblemen bij schoolkinderen op te sporen. Omdat de SDQ-T een korte vragenlijst is, kan deze gemakkelijk worden gebruikt om informatie van leerkrachten over emotionele- en gedragsproblemen in school kinderen te krijgen. Het gebruik van de SDQ-T TPS kan een belangrijke bijdrage leveren aan de vroege opsporing van emotionele- en gedragsproblemen in de schoolsituatie.

4. *Wat is proportie van emotionele- en gedragsproblemen in kinderen met Developmental Coordination Disorder (DCD) vergeleken met hun leeftijdsgenoten gerapporteerd door leerkrachten? Hoe goed presteert de SDQ-T vergeleken met de TRF in kinderen met DCD?*

In Hoofdstuk 5 hebben we de resultaten van de opsporing van emotionele- en gedragsproblemen door leerkrachten in kinderen met DCD beschreven. DCD is een veel voorkomende stoornis in de ontwikkeling van coördinatie van bewegingen in schoolgaande kinderen. De motorische prestaties van kinderen hebben een grote invloed op hun psychosociale ontwikkeling . Dit verklaart mogelijk de comorbiditeit tussen DCD en verschillende psychosociale problemen. De huidige kennis over het tegelijk optreden van DCD en psychosociale problemen is voornamelijk gebaseerd op rapportage van ouders en maar zelden op informatie van leerkrachten.

Wij hebben een dwarsdoorsnede onderzoek uitgevoerd waarin we 402 kinderen (202 jongens, 200 meisjes, leeftijd variërend 4-9,8 jaar, gemiddelde leeftijd 7,2 jaar) hebben geïncludeerd. Bij kinderen werd DCD vastgesteld als zij aan alle vier DSM-IV-TR (Diagnostic and Statistical Manual of Mental Disorders, vierde editie, gereviseerd) criteria voldeden: slechte motorische coördinatie (criteria A), die voor functionele beperkingen in het dagelijks leven of in academisch presteren zorgt (criteria B), en die niet veroorzaakt wordt door een andere medische aandoening en/of ernstige mentale retardatie (criteria C en D). Emotionele en gedragsproblemen werden vastgesteld met behulp van de TRF (n=327) en de SDQ-T (n=361).

DCD werd vastgesteld in 23 (5,7%) van de kinderen, 16 jongens en 7 meisjes (gemiddelde leeftijd 7,0 jaar). Kinderen met DCD hadden vaker een verhoogde score op de TRF subschalen Denk Problemen (odds ratio, OR: 5,39), Externaliserend gedrag (OR: 4,12) en Internaliserend gedrag (OR: 4,42) en op alle SDQ-T subschalen en Totale Probleem Schaal (OR: 7,30).

Onze tweede doel was om de prestaties van de SDQ-T te vergelijken met de TRF in kinderen met DCD. In de DCD groep hing de SDQ-T Totale Probleem Score sterk samen (Spearman's rho 0,80) met de TRF Totale Probleem Score (TRF-TPS) en was er een matig goede overeenkomst (Cohen's Kappa 0,53) tussen de twee vragenlijsten. In de DCD groep had de SDQ-T een goede sensitiviteit (0,80; 95% betrouwbaarheid interval: 0,62 tot 0,98) en een goede specificiteit (0,80; 95% betrouwbaarheid interval: 0,62 tot 0,98) bij gebruik van de borderline-klinische grens van de TRF TPS als criterium.

Onze conclusie uit dit onderzoek is dat leerkrachten vaker emotionele- en gedragsproblemen bij kinderen met DCD vaststelden dan bij hun leeftijdsgenoten zonder DCD. Leerkrachten kunnen een belangrijke bijdrage leveren aan het vaststellen van deze problemen bij kinderen met DCD op school. Omdat de SDQ-T korter is dan de TRF en een goede validiteit heeft zou de SDQ-T hiervoor gebruikt kunnen worden. Hoewel dit ook in andere studies bevestigd zal moeten worden.

5. *Hangt temperament van het jonge kind (negatieve emotionaliteit, extraversie en bewuste controle) samen met voedings- en beweeggedrag?*

In Hoofdstuk 6 beschrijven wij de samenhang tussen het temperament van jonge kinderen en voedings- en beweeggedrag. Temperament in jonge kinderen wordt steeds meer erkend als een kenmerk dat mogelijk beeldschermtijd, buitenspeeltijd en obesitas in kinderen beïnvloedt. Temperament wordt gedefinieerd als de gedragsstijl van het kind. Het bepaalt hoe kinderen reageren in nieuwe situaties en hun emoties reguleren. Elk kind heeft drie belangrijke temperament factoren: (1) negatieve emotionaliteit (boosheid, frustratie), (2) extraversie (activiteit, impulsiviteit), en (3) bewuste controle (concentratie, aandacht verplaatsen).

In onze studie hebben we voedings- en beweeggedrag gemeten met de Nutrition Screening Tool for Every Pre-schooler (NutriSTEP®). De NutriSTEP® is een korte vragenlijst die is ontwikkeld en getest in een multiculturele populatie van Canadese kinderen. De vragen in de NutriSTEP® gaan onder andere over: het dieet en eetgedrag van het kind, zorgen van ouders over voeding en beweging, de duur van beeldschermtijd op een dag en het gebruik van voedingssupplementen. Een lagere score op de NutriSTEP® duidt op een beter voedings- en beweeggedrag van het kind. We hebben 678 kinderen (leeftijd 3 tot 5 jaar) gevolgd gedurende gemiddeld 16 maanden. We vonden dat kinderen met meer negatieve emotionaliteit tegelijkertijd een slechter voedings- en beweeggedrag hadden (1,03; 95% betrouwbaarheid interval: 0,69 tot 1,37). Maar meer negatieve emotionaliteit hing niet samen met een verandering in dit gedrag over de tijd. In tegendeel kinderen met meer bewuste controle hadden tegelijkertijd een beter voedings- en beweeggedrag (-0,88; 95% betrouwbaarheid interval: -1,27 tot -0,49) en bij het volgen van het kind over tijd verbeterde dit gedrag nog meer (-0,67; 95% betrouwbaarheid interval: -1,10 tot -0,24). We konden geen samenhang vaststellen tussen extraversie en voedings- en beweeggedrag in jonge kinderen.

De resultaten van deze studie dragen bij aan de groeiende erkenning van temperament als belangrijke gedragsrisicofactor in de voedingsuitkomsten van jonge kinderen. Drie jaar oude kinderen met meer bewuste controle hadden een beter voedings- en beweeggedrag op de leeftijd van vijf jaar. Het kan nuttig zijn voor toekomstige voedingspreventie strategieën om methoden te ontwikkelingen die de bewuste controle in jonge kinderen versterken.

DISCUSSIE EN IMPLICATIES

In Hoofdstuk 7 worden de belangrijkste bevindingen van dit proefschrift samengevat en besproken. Daarbij gaan we ook in op methodologische kwesties en implicaties voor de eerstelijnsgezondheidszorg voor kinderen, en de implicaties voor beleid en onderzoek.

Onze resultaten ondersteunen het inzetten van herverdelend beleid om sociale ongelijkheid te verminderen en zo de gezondheids- en ontwikkelingsuitkomsten van jonge kinderen te verbeteren. Omdat de 18-maands versie van de NDDS geen goede psychometrische eigenschappen heeft, kunnen we deze vragenlijst niet aanbevelen voor gebruik in de eerstelijnsgezondheidszorg voor kinderen. Op basis van onze resultaten kunnen we het gebruik van de SDQ-T om emotionele- en gedragsproblemen op te sporen bij schoolkinderen en kinderen met DCD wel ondersteunen.

Een beperking van onze studies onder Nederlandse schoolkinderen was dat kinderen van immigranten en kinderen van ouders met lager beroepsonderwijs minder deelnamen. De generaliseerbaarheid van onze bevindingen moet daarom verder onderzocht worden, via onderzoek in andere groepen kinderen, waaronder kinderen met een niet-Westerse achtergrond. In de Canadese studies hadden ouders een relatief hoop opleidingsniveau en konden kinderen alleen deelnemen als hun ouders in het Engels konden communiceren. Daarom kunnen de resultaten van deze studies niet gegeneraliseerd worden naar populaties met een laag inkomen en naar immigranten populaties die geen Engels spreken.

De meest belangrijke implicaties van ons onderzoek voor praktijk, beleid en onderzoek zijn:

1. Beleidsmakers moeten methoden ontwikkelen om systematisch indicatoren te verzamelen van de ontwikkeling van jonge kinderen en deze te analyseren, om zo de ontwikkeling van jonge kinderen te verbeteren.
2. De NDDS is niet geschikt om kinderen met verschillende communicatie problemen op te sporen. De ITC is gevalideerd en onderzocht in een grote groep kinderen en zou daarom veelbelovend kunnen zijn om vroege communicatie problemen op te sporen. Meer onderzoek is nodig om te bepalen of screening op communicatie problemen met de ITC en de daarop volgende behandeling ook zal resulteren in verbeterde ontwikkelingsuitkomsten in kinderen.
3. De bevindingen van ons validiteitsonderzoek ondersteunen het gebruik van de SDQ-T om informatie te verkrijgen over emotionele en gedragsmatige problemen van de leerkracht. In de praktijk is het echter niet mogelijk voor leerkrachten om een SDQ voor ieder school kind in te vullen. Meer onderzoek is nodig om te kijken hoe de SDQ-T op populatie niveau gebruikt kan worden.
4. Meer onderzoek is nodig om causale verbanden tussen emotionele- en gedragsproblemen te verklaren in kinderen met DCD.
5. De relatie tussen temperament en voedings- en beweeggedrag in kinderen van ouders met een laag inkomen moet verder onderzocht worden. Verder onderzoek is ook nodig naar de samenhang tussen temperament en voedings- en beweeggedrag in kinderen en naar de rol van de opvoedstijl van ouders daarbij.

Aan het einde van Hoofdstuk 7 bespraken we het toekomstperspectief, met name de rol van zorgverleners voor kinderen in het meer gebruiken van het “bio-psycho-sociale” model bij alle kinderen. Het hoofdstuk bevat ook een korte beschrijving van sociale kindergeneeskunde, het sub-specialisme dat zich bezighoudt met de gezondheid, de ontwikkeling, en het gedrag van het kind binnen de sociale-, ecologische-, en politieke context waarin het kind zich bevindt. Innovatieve strategieën met multidisciplinaire samenwerkingsverbanden, zowel lokaal en internationaal, zijn hard nodig om de sociale, economische, en gedragsmatige determinanten van levenslange ongelijkheden aan te pakken, en te zogen dat alle kinderen zich optimaal kunnen ontwikkelen.

APPENDICES

CURRICULUM VITAE /
LIST OF PUBLICATIONS

CURRICULUM VITAE

Mathilda van den Heuvel was born on July 19th 1976 in Rhenen, the Netherlands. She completed secondary school at the “Veluws College” in Apeldoorn in 1994. She received her Master Degree in Medical Sciences in 1998 and became a Doctor of Medicine in 2001 at the University of Amsterdam. In 2009 she completed her training in pediatrics at the Academic Medical Center of Amsterdam. She graduated from her social pediatric fellowship at the University Medical Center Groningen in 2014. In 2013, she emigrated with her family to Toronto, Canada. Currently, she is an assistant professor in the Department of Paediatrics at the University of Toronto. Clinically, she works as an Academic Pediatrician in both the Hospital for Sick Children and St. Michael’s Hospital in Toronto. Her main interests are developmental and behavioural problems in young children and the social environment in which these problems take place.

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DANKWOORD /
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DANKWOORD

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APPENDICES

LIST OF ABBREVIATIONS

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ADHD	Attention Deficit Hyperactivity Disorder
ASD	Autism Spectrum Disorder
AUC	Area Under the Receiver Operator characteristics Curve
BMI	Body Mass Index
BSID	Bayley Scales of Infant Development
CBCL	Child Behavior Checklist
CBQ-VSF	Very short form of the Child Behavior Questionnaire
CDI	Child Development Index
CTFPHC	Canadian Task Force on Preventive Health Care
DCD	Developmental Coordination Disorder
DSM	Statistical Manual of Mental Disorders
ECD	Early child development
ECE	Early childhood education
EDI	Early Development Instrument
GDP	Gross domestic product
IHDI	Inequality-adjusted Human Development Index
ITC	Infant Toddler Checklist
MABC	Movement Assessment Battery for Children
MB-CDI	MacArthur-Bates Communicative Developmental Inventories
NDDS	Nipissing District Developmental Screen
NPV	Negative Predictive Value
NutriSTEP	Nutrition Screening Tool for Every Preschooler
OECD	Organization for Economic Co-operation and Development
OR	Odds ratio
PCH	Preventive child healthcare
PPV	Positive Predictive Value
SDQ	Strengths and Difficulties Questionnaire
SDQ-P	Parent version Strengths and Difficulties Questionnaire
SDQ-T	Teacher version of the Strengths and Difficulties Questionnaire
SDQ-T TDS	SDQ-T Total Difficulties Score
TRF	Teacher's Report Form
TRF-TPS	TRF Total Problem Scale

APPENDICES

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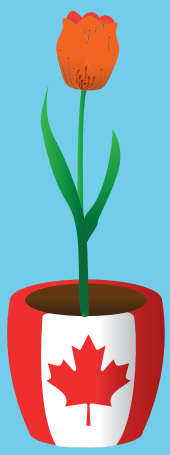
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