# UNDERSTANDING VARIABILITY IN CHILD DEVELOPMENT OUTCOME IN RESOURCE-CONSTRICTED SETTINGS: THE CONTRIBUTION OF THE HOME ENVIRONMENT

**Patricia Kadzo Wekulo**

**B.Ed, M.Ed [Kenyatta University]**

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**The School of Applied Human Sciences**
**College of Humanities**
**University of KwaZulu-Natal**
**Durban, South Africa**

**Supervisor: Prof. Jane Dene Kvalsvig**

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As the candidate’s Supervisor, I agree/do not agree to the submission of this thesis.

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Jane D. Kvalsvig, PhD

DECLARATION

I, Patricia K. Wekulo, declare that:

1. The research reported in this thesis, except where otherwise indicated, is my original research;

2. This thesis has not been submitted for any degree or examination at any other university;

3. This thesis does not contain other persons' data, pictures, graphs or other information, unless specifically acknowledged as being sourced from other persons;

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Signed

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Patricia Kadzo Wekulo

15th February 2015

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DEDICATION

I dedicate this thesis first to God Almighty, who has given me the strength and endurance to complete this journey. And to the 'doctors' in my family who have preceded us to the destination that we must all finally arrive at, Prof. Jay Kitsao and Dr. Joyce Jumwa Asha.

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ABSTRACT

The main purpose of the present study was to establish the manner in which children's home environments (proximal processes) and family household wealth (distal contexts) individually and collectively influence child development, and how these relationships change at different child ages. Based on Bronfenbrenner's bioecological theory, I hypothesized that proximal processes within the home environment would have a stronger impact on child outcomes than the distal factors within the children's contexts. The effects of these factors were explored through two different studies: Sub-Study 1 among a rural school-age population (the School-age Study) and Sub-Study 2 among a rural infant population (the Infant Study). The data in the School-age Study were derived from a larger cross-sectional study examining the development of appropriate methodologies to assess executive functions, motor development and the home environment in 308 school-age children. A prospective follow-up study of approximately 300 mother-infant dyads was conducted as Sub-Study 2. The participants in the Infant Study were drawn from families enrolled in a then ongoing longitudinal study on the neurobehavioural outcomes of children exposed to HIV and malaria. Both studies were conducted at the coast of Kenya, one in the northern, and the other in the southern mainland. As tools to assess child development outcomes were not readily available for the school-age population, existing measures of language skills, motor abilities and the home environment were modified and adapted to make them culturally meaningful, and then validated for this population to establish whether or not they maintained their psychometric properties. Information on child functioning was obtained through interviews with caregivers, direct observations and assessment of children. I used Structural Equation Modelling (SEM) as the main analysis method to examine the relationships among the variables of interest in both studies. For the two groups, the varying strength of the associations between background variables and outcomes demonstrated that there are different causal pathways through which the home environment and family household wealth influence child functioning at different ages. These findings provided partial support for the bioecological theory. This study has made important contributions to the knowledge base by illustrating which aspects within the home environment have the strongest impact on child outcomes. Such information is important to child development researchers working within similar settings. We recommend, based on the findings of the current study, that these aspects be considered when planning interventions to improve future outcomes for children living in resource-constricted settings.

# CHAPTER 1: INTRODUCTION

This thesis is mainly linked to two major projects that were conducted among school-age and infant populations living in similar sociocultural contexts. The main objective of the first project (among school-age children) was to produce a range of reliable, valid and sensitive assessments of motor and cognitive development that were applicable to assessing differential development subsequent to a range of health-related risk factors. These assessments focussed on areas of development and function that remained unexplored through previous studies conducted within this community. Through this first project, we also developed measures of the home environment to provide a more sensitive measure of socio-economic status than has been previously used within this context. The second project among infants investigated the deleterious effects of maternal co-infection on child development. This study obtained information on various aspects of the pre- and perinatal environment through antenatal monitoring, and monitored the neurobehavioural development of children up to the age of 24 months. Multiple assessments during infancy and early childhood allowed for more precise and reliable measurement of developmental change. These assessments were completed using tools that have been modified and validated for populations living in similar contexts.

## Background

The large body of literature in western and non-western settings shows robust relations between the quality and quantity of support and stimulation provided for children at home and child development. Furthermore, there is ample evidence to illustrate the link between family socioeconomic status (SES) and the home environment. Traditional measures of SES such as parental occupation and education or household income levels (Brooks-Gunn, Duncan, Britto, Keating, & Hertzman, 1999; Lempers, Clark-Lempers, & Simons, 1989) are however limited in their capacity to clearly distinguish households in low-income settings. This is occasioned in part by the lack of variability among households characterized by low income and low education levels. And yet research has shown that there are differences in parent-child interactions, even in low SES settings where many households are relatively homogeneous (Ayoub et al., 2009; Hoff-Ginsberg & Tardif, 1995; Hoff, 2003; Raviv, Kessenich, & Morrison, 2004). Numerous research findings suggest that these pathways might be of major importance in determining healthy outcomes (Galler, Harrison, Ramsey, Forde, & Butler, 2000; Santos et al., 2008). Given that they make a significant contribution to the cognitive functioning of young children, it is imperative to take into account the manner in which proximal processes operate within a low-income setting. Establishing the differences in proximal processes within the home environment would therefore enable one to distinguish households from each other.

There is consensus on the factors which promote healthy child development and the association between SES, the home environment and cognitive outcome has been demonstrated time and again (Ayoub et al., 2009; Grantham-McGregor, Powell, Walker, & Himes, 1991).

However, in places where child development is most compromised, the sheer volume of deleterious factors makes it difficult to decide what is primary and what is secondary so that scarce resources can be targeted where they will do the most good. It is important to investigate the contribution of these highly connected factors because early identification of children with developmental and behavioural delays is crucial to the timing and success of interventions.

The purpose of the current study was therefore to shed light on the interrelationships between SES and the quality of the home environment in influencing outcomes in children. I investigated the relative influence of each of these factors on children's outcomes. I sought to analyse the specific pathways that promote resilience in children in resource-poor areas. Longitudinal and cross-sectional study designs were used to illustrate the short- and long-term effects of these factors. The current study will add to the knowledge of how the varying quality of proximal processes in low-income settings shapes children's future development. The findings will inform the setting up of meaningful intervention programmes which ensure that future outcomes for children exposed to multiple risks are not compromised.

## Statement of the Problem

While it is true that many populations in sub-Saharan Africa (SSA) experience extreme poverty, low-income families are not all equally poor. And although there may be no apparent SES differences among households in such settings, variability in the cognitive functioning of poor and non-poor children exists. Certain aspects within the child's immediate home environment seem to create these differences. The most influential of these aspects is the stimulation afforded by the interaction that takes place between a child and his or her parent. Known as proximal processes, these interactions must occur on a fairly regular basis over extended periods of time to be effective. For instance, parental responsiveness to a child's needs in the form of communicative interactions, provision of stimulating play and educational materials and involvement of the child in various joint activities within and outside the home is a powerful influence on the developing child. The current study analyses the differences in the proximal processes within households in a low-income setting, and the manner in which these differences influence the motor and language development of young children. As these processes are presumed to vary as a function of the characteristics of the developing person, of the more remote (distal) environmental contexts, and of the time periods in which they occur, the study will also consider the age and gender of the child, the household wealth available to the family, as well as different time points. This information will add to the knowledge of variations in the strength of proximal processes and compare the most powerful influences on these processes at contrasting ages.

## Research Question and Objectives of the Study

### Research Question

This thesis discusses the research question that factors which are experienced directly by

the child (proximal processes) and those that are found within the child's context (distal factors) vary in the manner in which they individually and collectively influence child development at different ages.

**Objectives of the Study**

The overall objectives of this study were therefore to characterise the home environments of children living in resource-constricted settings and to establish the influence of proximal processes and distal contexts on child developmental outcome. Specifically, the study sought to:

a. Describe the immediate home environment in terms of child-centred materials (e.g. age-appropriate toys and books), behaviours (e.g. parental responsiveness) and activities (e.g. visits outside the home);
b. Examine the association between the more remote environments (distal contexts of family SES) and the proximal processes within the immediate home environment;
c. Investigate the relative contribution of proximal processes and distal contexts to language development in children;
d. Investigate the relative contribution of proximal processes and distal contexts to motor development in children; and,
e. Determine whether or not there are variations in the associations measured across different developmental stages.

**Structure of the Thesis**

The thesis comprises nine chapters. To place the study in context, the background, aims and purpose of this research study are introduced in Chapter 1. Thereafter follows, in Chapter 2, a detailed outline of the theoretical framework employed in the current study, namely, Bronfenbrenner's Bioecological Model of Human Development. The chapter begins with a discussion of the shortcomings of other theories to provide the motivation for choosing Bronfenbrenner's model. The study hypotheses are presented at the end of this chapter. Chapter 3 has three sub-sections namely, study context, tool development and exploration of the analytical framework, and includes a description of the study design, detailing the two sub-studies from which I drew the samples for the current study. The chapter goes on to present details on the study setting, as well as the methods used to collect and analyse data, together with a brief description of the ethical considerations made. The material at the end of this chapter introduces the analytic methods employed in later chapters. In Chapters 4 – 8, the results from each of the sub-studies are presented separately under various titles. Some of these papers have already been published (Paper 3 and Paper 7). I describe in Chapter 4 the influence of various background characteristics on language abilities at school age and during infancy. Chapter 5 provides information on the determinants of variability in motor skills for school-age and infant populations. Chapter 6 describes the home environments of school-age children and

infants. Among the school-age population, I discuss the applicability of a home environment measure derived from an existing tool developed for a Western context. Among infants, I describe the patterns of stability and change in caregiver-infant interactions. This information was obtained through naturalistic observations. In Chapter 7, the results from an exploration of the application of structural equation modelling (SEM) using school-age outcomes are discussed. Chapter 8 compares the results from the SEMs applied on the school-age and infant sub-studies. Chapter 9 concludes with an integrated discussion and conclusions based on the study findings. The key findings are summarised to emphasise the contribution made to the existing body of knowledge. Recommendations for future study are also made.

# CHAPTER 2: THEORETICAL FRAMEWORK

Child development theories help us to understand the nature of child growth in aspects of physical, social, behavioural and cognitive functioning, as well as the influences on these processes. Several theories and models have been put forward, some of them concentrating on atypical development, while others focus on the typically developing child. Piaget's theory is concerned with the capacities of children at different ages; I will therefore briefly discuss its relevance to the current study. And because my study was primarily concerned with the role of environmental influences on the developing child, I briefly discuss other theories that consider contextual perspectives on child development – Vygotsky's Sociocultural Theory, Bandura's Social Learning Theory and the 'Developmental Niche' framework advanced by Super and Harkness. I then outline the limitations of these theories, prior to providing a justification for the choice of Bronfenbrenner's Theory.

## Piaget's Theory of Cognitive Development

According to Piaget, children actively seek out information and adapt it to the knowledge and conceptions of the world that they already have (Piaget, 1973). Thus, children construct their understanding of reality from their own experience. Although the environment nourishes, stimulates and challenges children, it is their responsibility to organise their knowledge into increasingly complex cognitive structures called schemata. Children possess many different schemata, and these change as children develop. For instance, in the newborn, the schemata take the form of innate reflexes and reaction patterns, like sucking. As the child grows and gains experience, the schemata shift from motor activities to mental activities called operations. These operations become increasingly complex with age.

Piaget suggested that schemata are modified according to the principles of organisation and adaptation, which continue to operate throughout the life span. Organisation is the predisposition to combine simple physical or psychological structures into more complex systems. Adaptation involves the two complementary processes of assimilation, or fitting new experiences into current cognitive schemata, and accommodation, or adjusting current schemata to fit the new experiences (Piaget, 1971). Most encounters involve both processes; however, a state of disequilibrium arises if the information from the environment is not congruent with a child's prior knowledge.

Piaget divided intellectual development into four unique periods that are indicative of the changes in children's cognitive structures (Piaget, 1973). While all children go through all stages in the same order, though not necessarily at the same age (Singer & Revenson, 1997), earlier stages must be attained before later ones (Richardson, 1998). The sensorimotor period is experienced during the first two years of life. At this stage, which is divided into six sub-stages, the child makes the transition from using reflexes to using internal representation. Between the

age of two and seven years (the preoperational period), the child develops symbolic function, that is, the ability to use symbols such as words, images, and gestures to represent objects and events (Berk, 1997). This period is sub-divided into the earlier (preconceptual) and later (intuitive) stages. During the preconceptual period, children's thinking is limited by animistic thinking; where they attribute lifelike characteristics to inanimate objects, and by egocentricity; an inability to see things from another person's perspective. At the intuitive stage, children are able to use certain mental operations, but they do not seem to be aware of the principles used because they cannot explain them. Children acquire an elementary understanding of the notion of conservation during the preoperational period but their thinking is limited by inability to understand reversibility, the tendency to focus on the end states rather than the process of transformation, and focusing on only one dimension of a problem (centration). During the concrete operational period (6 – 11 years), children acquire the three basic reasoning skills – identity, compensation and reversibility – and can perform most of the tasks that they were unable to master in the preceding stage. In the formal operations period (11 – 12 years), they can use flexible and abstract reasoning, test mental hypotheses and consider multiple possibilities for the solution to a problem (Richardson, 1998; Woolfolk, 2004).

Although Piaget's theory integrates and illuminates a broad spectrum of diverse issues revolving around children's understanding and use of knowledge, and has stimulated an enormous amount of research, it only concentrated on biological influences while overlooking the effects of culture (Edwards, Hopgood, Rosenberg, & Rush, 2000). Research also suggests that the sequence of development may not be invariant as Piaget believed, and may be modified by cultural experiences or the child's environment (Greenfield, 1966). Furthermore, current evidence indicates that infants and children grasp many concepts considerably earlier than Piaget thought (Hood & Willats, 2011; Wood, 2008). In some circumstances, children are often able to learn more advanced concepts with brief instruction. Vygotsky has advanced this notion of assisted learning and has also drawn attention to the importance of the social context in which learning takes place. His theory is briefly discussed below.

**Vygotsky's Sociocultural Theory**

The Sociocultural Theory is based on the work of Lev Vygotsky and its major theme is that social interaction plays a fundamental role in the development of cognition. The theory considers the role of parents, caregivers, peers and the predominant culture in the development of higher order functions in the child. According to Vygotsky, "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first between people (interpsychological) and then inside the child (intrapsychological). This applies equally to voluntary attention, to logical memory, and to the formation of concepts. All the higher order functions originate as actual relationships between individuals (Vygotsky, 1978a)."

A second aspect of the Sociocultural Theory is the idea that the potential of a child's cognitive development is limited to a zone of proximal development (ZPD). The ZPD includes all of the knowledge and skills that a person cannot yet understand or perform on their own yet, but is capable of learning with guidance and social interaction (Briner, 1999). Vygotsky also described the ZPD as the difference between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978b). The ZPD contains two features, subjectivity and scaffolding. Subjectivity is the process through which two individuals who begin a task with different understanding eventually arrive at a shared understanding. Scaffolding refers to a change in the social support offered by for instance, a parent or older sibling, that guides a child in the acquisition of new knowledge and skills based on what the child already knows and is able to do (Vygotsky, 1978a).

The limitation of the Sociocultural Theory is that Vygotsky does not provide a detailed account of procedures or models to assess the ZPD, and only provides a hypothetical example of how this might be applied. Considering that the content and meaning of the zone will change depending on which age period is being studied (Chaiklin, 2003), this lack of a guiding model may result in study findings which cannot be compared across contexts, as each researcher makes his/her own interpretation of what should be (or should not be) included in the model. Complementing Vygotsky's view of the environmental influence on behaviour is Bandura's Theory in which he posits that behaviour also influences the environment in a process called reciprocal determinism. His theory is discussed briefly below.

**Bandura's Social Learning Theory**

The Social Learning Theory analyses behaviour in terms of a process of reciprocal determinism (Bandura, 1977). The term 'reciprocal' refers to mutual action whilst 'determinism' is used to signify the production of effects by events, rather than in the doctrinal sense, that actions are completely determined by a prior sequence of causes independent of the individual. In the social learning view of interaction, behaviour, internal personal factors, and environmental influences all operate as interlocking determinants of each other (Bandura, 1978), as people are not simply reactors to external stimulation in their transactions with the environment. The foundation of Bandura's conception of reciprocal determinism is that (a) personal factors in the form of cognition, affect and biological events, (b) behaviour and, (c) environmental influences create interactions that result in a triadic reciprocality. The relative influence exerted by these three sets of interlocking factors will vary in different individuals and under different circumstances. In some cases, environmental conditions exercise such powerful constraints on behaviour that they emerge as the overriding determinants. At other times, behaviour is the central factor in the interlocking system. In other instances, cognitive factors serve as the predominant influence in the regulatory system. In still other instances, the

development and activation of the three interlocking factors are all highly interdependent (Bandura, 1978). The theory therefore posits that factors such as socioeconomic status, educational and familial structures do not affect human behaviour directly. Instead, they affect it to the degree that they influence people's beliefs, personal standards, emotional states and other self-regulatory influences.

A prominent feature of Bandura's theory is that self-reflection is the most 'distinctly human' capability (Bandura, 1986). Through self-reflection, people make sense of their experiences, explore their own cognitions and self-beliefs, engage in self-evaluation, and alter their thinking and behaviour accordingly. Tied to this are the concepts of self-regulation and self-efficacy. Self-regulation refers to setting goals, evaluating individual performance and adjusting individual behaviour in order to achieve these goals in the context of ongoing feedback. Bandura defines self-efficacy as one's judgement of one's own capability to carry out a course of action successfully.

The major weakness of Bandura's theory is that it ignores some likely biological influences on outcome, such as temperament. Moreover, any of the interlocking factors can be a stimulus, a response or an environmental reinforcer, therefore making it difficult to determine the starting point for analysing relationships among the factors. One cannot therefore easily explain an outcome in terms of the other factors. It is in view of these shortcomings that I considered another theoretical framework, the "Developmental Niche."

**The "Developmental Niche"**

The idea of the "Developmental Niche" combines two important insights that have been gained from cross-cultural research on children and families into a framework for thinking about human development in cultural context (Super & Harkness, 1986). The first concerns regularities in how different parts of a culture work together as a system. In different systems, children learn about what is expected of them through multiple messages in the environment. The second is that parents and children in all times and places face some of the same problems, experience some of the same needs, and seek some of the same rewards and pleasures. Although the experience of each child and of the children in each culture is unique, the overall experience of childhood is constructed around a common story of human development (Super & Harkness, 1994).

The term "niche" is used to describe the combination of features of the environment which a child inhabits. At the centre of the developmental niche is a particular child of a certain sex and age and with certain temperamental and psychological dispositions. By virtue of these and other characteristics, the child will inhabit a cultural "world" that is different from the worlds of other members of the family. This world will change as the child grows and changes.

Three major aspects of a child's culture that shape his or her life make up the developmental niche. The first component is the physical and social settings of everyday life

which include the size and shape of the living space and what kind of company the child keeps. The second component is the customary practices of childcare and child rearing that are normative for families and communities. The psychology of the caretakers, or the cultural ways of thinking and feeling held by parents and other caregivers is the third component. These three components form the immediate micro-environment of the child and are linked in the following manner – parents' cultural belief systems and related emotions underlie the customs of child rearing and validate the organisation of physical and social settings of life for children. The developmental niche thus operates as a system where the three components influence and adapt to each other. A second dynamic of the niche is the various aspects of the larger human ecology such as customs, economic and demographic changes and national or community policies.

Inasmuch as child behaviour is shaped by the environment, parents and caretakers also alter their demands and supports in response to the characteristics of the child. And as the child grows and develop, they learn to cope with, or avoid specific features of the niche. In this sense, the niche also develops in response to the changing child, as well as to the outer influences. Consistency across the three subsystems would therefore seem to forge the strongest effects on child development (Super & Harkness, 2002). However, few studies have been designed to examine the three components of the 'Developmental Niche' concurrently which makes it difficult to replicate the application of the theory. I therefore discuss the components of a related theory, Bronfenbrenner's Bioecological Theory, to illustrate how their application fit within the current study. Although the 'Developmental Niche' aligns well with Bronfenbrenner's Bioecological Theory, its specific focus at the family level makes it somewhat narrower in scope (Wombles, 2010).

**Bronfenbrenner's Bioecological Theory**

The bioecological theory provides a holistic approach for understanding the developmental process within environmental contexts. The theory demonstrates how the interaction between factors within the child and within the immediate environment influences development according to their proximity to the developing child (Bronfenbrenner, 1995). To better understand these issues, the theory is discussed in detail below.

Child development is conceptualized as an interactive process between a person and complex 'layers' of the environment within which that person is found (Bronfenbrenner, 1979); in line with the notion of interdependence reflected in the concept of the four nested systems – the microsystem, mesosystem, the exosystem and the macrosystem. The microsystem refers to all processes that take place within a person's immediate environment. The mesosystem refers to the "linkages and processes taking place between two or more settings containing the developing person." The exosystem "encompasses the linkages and processes taking place between two or more settings, at least one of which does not ordinarily contain the developing person, but in which events occur that influence process within the immediate setting that does

contain that person." The macrosystem "consists of the overarching pattern of micro-, meso- and exosystems characteristic of a given culture, subculture, or other broader social context..." Bronfenbrenner has also defined the chronosystem in terms of the lifespan perspective on development.

The defining properties of the bioecological theory involve the developmental *process* shaped by the characteristics of the *person* and the *context* over *time*. These four components form the basis for Bronfenbrenner's Process-Person-Context-Time (PPCT) model. The PPCT model is an operational research design developed to investigate the propositions of the bioecological theory for human development (Bronfenbrenner, 1995).

The PPCT model can be used to explain how certain characteristics of the child and the child's environment affect how a child grows and develops. It enables the simultaneous investigation of the interaction among several factors. For instance, Dennis (2010) has examined the manner in which contextual (income, maternal depression, mothers' negative parenting) and personal factors (boys' difficult temperament and early aggressive behaviour) served as predictors of outcome (boys' aggressive behaviour) over time (from infancy to school entry). In a program setting, given the complexities and multiple paths through which poverty may influence child outcome, the PPCT model provides an appropriate framework to guide interventions (Eamon, 2001).

The current study examined the relationships among the proximal processes within the home environment, the person characteristics of age and gender, the context of family SES and their effects on the language and motor development in children over time. First, individual developmental outcomes were related to proximal processes (the provision of stimulating experiences within the home environment) as antecedent factors. Second, these processes varied depending on the context within which they occurred. Third, these processes changed with time because of maturational changes within the individual. Figure 1 is a diagrammatic representation of the application of the PPCT model within the current study.

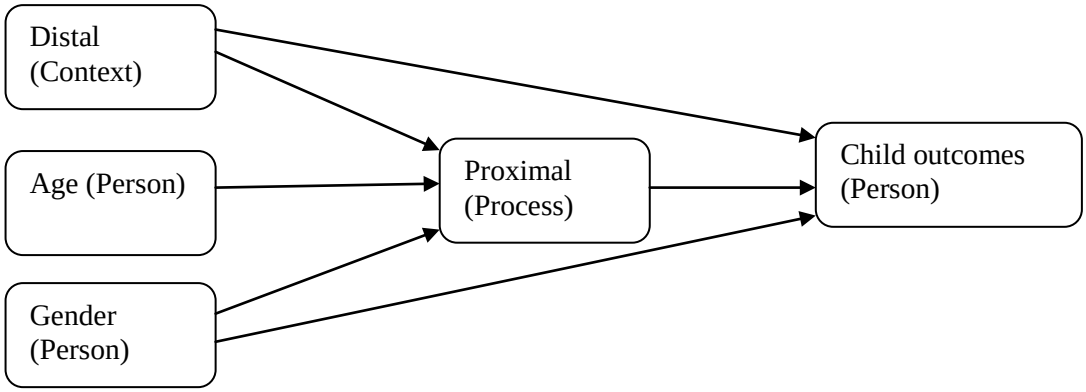



*Figure 1.* Diagrammatic representation of the PPCT model

**Process**

In the PPCT model, proximal processes are "progressively more complex reciprocal interactions between an active, evolving bio-psychological organism and the person, objects and symbols in its immediate external environment"... "which must occur on a fairly regular basis over extended periods of time" (Bronfenbrenner, 1995, p. 620). These processes, which Bronfenbrenner considered the "primary engines of development" (Bronfenbrenner & Morris, 2006) are the day to day experiences, interactions and relationships of children with the persons, objects or symbols in their immediate environments. They impact child development directly to produce positive (competencies) or negative (dysfunctions) outcomes (Bronfenbrenner & Evans, 2000). In the current study, the process element looks at the levels of parental warmth and responsiveness toward their children. It also examines an important proximal process – the manner in which parents facilitate the provision of materials and experiences for teaching and stimulation for their children within the home environment. Proximal processes were measured by assessing the quality of the home environment using cultural and linguistic adaptations of measures of the home environment.

**Person**

Person characteristics shape developmental environments and the proximal processes that take place within those environments (Bronfenbrenner & Morris, 2006). For example, mothers are the primary caregivers for young children but as they grow older, this role is 'shared' between older siblings and peers as children spend more time with them. In this sense, the age of the child determines how the mother interacts with the child. Person characteristics can also encourage or hinder interactional processes with the environment (Bronfenbrenner, 1992). For instance, children's gender may affect their socialization processes due to the different expectations of the behaviour of girls and boys. In the current study, the person element looked at the child's demographic personal (age and gender) and developmental (scores on language and motor tests) characteristics. This information was obtained through a structured interview and developmental assessment tests.

**Context**

Context is the environment in which development takes place. This environment ranges from micro to macro levels. The microsystem in which proximal processes take place, is encompassed by increasingly larger systems, such as communities or cultures. Contexts influence the proximal processes that occur within them. These contexts include the physical and social settings of the developing person, and they are considered distal to the child. Distal contexts, which may comprise SES variables such as income, education and occupation, are the structures which characterize the wider environment of the child. They provide an index of a family's socio-economic situation. Distal contexts impact child development through their influence on proximal processes. In the current study, information on family SES was obtained

through a structured interview.

**Time**

Examination over time is necessary in order to identify patterns of relationships among variables that contribute to behavioural development (Bronfenbrenner, 1995; Bronfenbrenner & Morris, 2006). This is because development can only take place over time. An important component of the current study is that in the Infant Study, the children were followed up over a period of one year and we examined the pattern of change in developmental outcomes over time. This enabled us to determine whether developmental outcomes followed expected trends. A theoretical limitation of the School-age Study is that since data were collected cross-sectionally, the fourth aspect of the PPCT model, time, was tested across age groups rather than tracking within-person changes over time. Cross-sectional studies are limited by their assessment of a situation at only one time point, which means that improvements or any changes over time are not captured.

The primary focus of the current study was to examine the outcomes of children that were influenced by the process of provision of stimulating experiences within the context of available household wealth. The model is appropriate to the current study because it integrates individual, relational and contextual processes over time (Bronfenbrenner & Morris, 1998). One of the strengths of this theory therefore is that it includes both environmental and biological factors as contexts for the understanding of human development (Bubolz & Sontag, 1993). Inasmuch as the theory is relevant across several contexts, some cultural norms in traditional African societies, such as the expectation that children should not interact directly with adults, may hinder its application. In defining proximal processes, it may be necessary to consider cultural norms which may define what is, and what is not acceptable behaviour for members of the community under study. For instance, in the cultural setting of the current study, it may not be customary for fathers to interact with their children at younger ages (before they start walking), as their care is left specifically to the mother, or to female members of the family. Also, in collectivist societies, children raised by multiple caregivers may not experience meaningful reciprocal relationships with a single significant other on a regular basis. Related to this is the difficulty in defining the persons within the proximity of the child, which then presents problems in delineating the child's immediate environment.

## Hypotheses

The study hypotheses are as follows:

- The hypothesis for specific objective b) is that there is a direct association between distal contexts and proximal processes;
- The hypothesis for specific objective c) is that, in resource-constricted settings, proximal processes have a stronger influence on child language development than distal contexts;

· The hypothesis for specific objective d) is that, in resource-constricted settings, proximal processes have a stronger influence on child motor development than distal contexts;

· The hypothesis for specific objective e) is that, the relative contribution of proximal processes and distal contexts to child outcome is more discernible among older children who display a wider range of skills than among younger children.

# CHAPTER 3: RESEARCH METHODOLOGY

## Research Design/Approach

The design for this study entailed the use of findings from two different studies. Sub-Study 1 was conducted among a school-age population. The data in this study were derived from a larger cross-sectional study examining the development of appropriate methodologies to assess executive functions, motor development and the home environment in school-age children in a rural district of Kenya. The data for this study were collected between 2003 and 2004.

A prospective follow-up study of approximately 300 mother-infant dyads living in a rural area was conducted as Sub-Study 2. The participants in this study were drawn from families enrolled in a then ongoing longitudinal study on the neurobehavioural outcomes of children exposed to HIV and malaria. Quantitative and qualitative research approaches were used.

## Study Context

### Sub-Study 1 – School-age Study

**Study setting.** The study was conducted at the Kenya Medical Research Institute's Centre for Geographic Medicine Research (KEMRI/CGMR-C) in Kilifi District at the Coast Province in Kenya. The district comprises two main population structures, with the area bordering a major tarmac road between two towns characterised by higher population densities (approximately 288 persons per square kilometre). The hinterland (approximately 27 persons per square kilometre) is more sparsely populated. Over 80% of the district's inhabitants belong to the majority ethnic group, which comprises nine sub-groups with similar dialects closely related to Kiswahili, the lingua franca and country's national language. Approximately 50% of the labour force is engaged in subsistence farming mainly growing maize, cassava and cowpeas. A few engage in livestock farming of cattle, sheep and goats. Coconuts, cashew nuts and mangoes are the main cash crops. The majority of the population (66.8%) experiences absolute poverty, manifest as limited access to basic needs, and an inability to meet the minimum cost of food and non-food items essential to sustain life (Kahuthu, Muchoki, & Nyaga, 2005a). The district is a food deficit region relying on trade with other districts to meet the food gap – however, income-generating opportunities are few and unsustainable (FAO Kenya, 2007). Malnutrition remains rampant due to variability in crop production; and high illiteracy levels increase the population's vulnerability to food insecurity (Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010).

Geographic, economic and socio-cultural barriers, such as unpredictable weather patterns, low levels of education and land ownership, aggravate poverty levels. High poverty levels are also associated with school drop-out, deteriorating health conditions and poor literacy levels (Kahuthu et al., 2005a). Primary school enrolment rates within the District were low at

66.5% (Kahuthu et al., 2005a). Even though the proportion of females in the general population is higher (100:95), there are more males (57.5%) than females in primary school. At the time of the study, the District had 230 primary schools with a total enrolment of 137, 958 (75,582 males and 62,376 females) children. At primary school however, the dropout rate is 8% and the majority of dropouts are boys. The average literacy level in the district is 44.9% (District Planning Team, 2000), which compares poorly with the national rate of 83.9% (UNESCO Institute for Statistics, 2011). About 21% of the population has never attended school, with the greater proportion being women.

Family structure is largely collectivist, with extended families including members of several generations, living together in homesteads comprising four to ten mud-walled thatched houses. More recently, brick-walled and iron-roofed houses have become more common. Children of school-going age spend a lot of time outdoors. Boys have more unstructured time than girls do and most of their time is spent unsupervised outside the household. They thus have more opportunities for social play with same-sex peers (Awiti, 2011; Wenger, 1989). Girls on the other hand spend more time with older females within the homestead engaged in chores such as looking after infants and toddlers (Wenger, 1989). It is not unusual for a child growing up in this context to learn three different languages – their mother tongue, Kiswahili the national language and English, the language of instruction in elementary schools.

**Sampling and sample characteristics.** Children aged between 8 and 10 years were recruited from the catchment area of five local schools distributed across neighbourhoods in the district ranging from sparsely populated (64 persons/sq.km compared to the district average of 114 persons/sq.km) to densely populated (325persons/sq.km) semi-urban areas. At the time of the study, these schools had a total population of 2,755 children. Children in school and out of school were selected into the study through stratified sampling. We recruited a total of 308 children representing diverse geographical areas, and there were equal numbers of boys and girls in each of the three age bands – 8, 9 and 10 years – in the sample. Additional child-level characteristics included length of school experience and nutritional status (defined by the presence or absence of growth retardation). Where available, birth records were used to confirm age. In cases where records were not available, the child's age was estimated by using major local or national events that occurred around the time of the child's birth. School exposure was defined as each year of enrolment from nursery class.

**Inclusion criteria.** In order to be included in the main study, children had to speak one of the local dialects or Kiswahili, *the lingua franca* and national language, as their first language; be resident within the study area; and, demonstrate physical ability to perform the tasks. Their parents also had to be willing to give consent for their children to participate in the study. To determine if children met the study criteria, children and parents were asked which language they used most commonly at home. Parents were also asked if they lived in their own

houses and how long they anticipated being resident within the study area. The Ten Questions Questionnaire (TQQ: Mung'ala-Odera et al., 2004) and observations by the assessment team were used to establish any visual, auditory and motor impairment, as well as any other serious health problems in children. When the parent was not able to determine if the child had any impairments (visual, auditory or motor) or in cases where only milder concerns were reported, testing was attempted. Children who were found to be physically unable to perform the tasks, due to severe limitations in physical and global mental functioning, were excluded.

**Ethical considerations.** The Kenya Medical Research Institute's National Ethics Review Committee (KEMRI/NERC) provided ethical clearance for the study. Permission to visit schools was obtained from the District Education Office. We explained the purpose of the study to the head teachers of selected schools and then sought their permission to recruit children. We also held meetings with community leaders, elders and parents (or guardians) of selected pupils to explain the purpose of the study. After each meeting, a screening questionnaire was administered to establish if selected children met the study's eligibility criteria. We presented information on the study to parents in the language with which they were most familiar. We then obtained written informed consent for their children's participation. All the selected children assented to their participation in the study. The study was also authorized by the Ethics Committee of the Faculty of Humanities, Development and Social Sciences (HDSS) at the University of KwaZulu-Natal (UKZN).

**Sub-Study 2 – Infant Study**

**Study setting.** The study was conducted in Msambweni District, a rural location in the Coast Province of Kenya. The inhabitants of the District belong primarily to the Digo sub-tribe of the Mijikenda ethnic group. The main languages spoken are Kidigo and Kiswahili. From the existing literature, we infer that the community within which the current study was completed is a collectivist society with an interdependent sociocultural orientation (Nsamenang & Lamb, 1994).

The population is characterised by low education and low income levels. Although there are currently efforts to reverse the trend, low enrolment and high dropout rates in schools, particularly for girls, are aggravated by traditional early marriages and use of child labour. The wide and increasing non-schooling gap results in an overwhelmingly large non-literate population. Adult literacy levels are at approximately 44.9%, with lower levels among women.

The minority of the productive labour force aged 15-64 is largely engaged in agriculture-related activities on family farms or involved in trading and informal employment. More than fifty percent of the households live below absolute poverty levels and are not able to attain the recommended daily food energy intake. The major causes of poverty in the district include poor infrastructure development, inadequate agricultural production due to land tenure problems, poor and undeveloped agricultural marketing and wildlife menace. A large proportion of the

population lives over 5 kilometres to the nearest health facility and accessibility of health services is low. The cost of health care services also is also a barrier to access.

The majority of families in Msambweni live in homesteads which comprise several members of the extended family. The pattern of child-care is such that younger children spend a lot of time with their older siblings and relatives.

**Sampling procedures.** Approximately, between 120 and 140 women deliver at the hospital every month. Recruitment into the current study was completed through the main longitudinal study mentioned at the beginning of this chapter. During the antenatal visits, a presentation outlining the main aims of the study was made to mothers at the clinic. After the presentation, those who agreed to be part of the study were invited to a separate room where the purpose of the study was explained in more detail. After establishing that they met specific eligibility criteria, the mothers were recruited into the study. The current study included all the women who were part of the main study, and whose offspring were assessed at any or all of the three time points, at 12, 18 and 24 months.

**Sample size estimation.** With multiple levels of analyses, the estimation of sample size was determined by multiple considerations. With an anticipated retention of 80% (prior experience in this study area indicated that 70-80% of the women recruited would deliver at the hospital [King, personal communication, 2007]), the study was able to detect effect sizes on the order of .5 or smaller. Effects of .5 are considered 'medium-sized' (J. Cohen, 1988). From preliminary data, the differences in means between exposed and unexposed children on the psychomotor scales of the KDI translate to an effect size of .49 with exposed children performing at a level 7% lower than their unexposed peers. The total sample size calculated for the main study was therefore 538 children.

**Inclusion criteria.** The eligibility criteria for infants and mothers in this study were: (for infants) singleton; having no significant congenital abnormalities; (for mothers) maternal age of at least 15 years of age; anticipated residence of three years; ability to communicate in the local dialect or the national language; and, consent for mothers and their infants to participate in the study.

**Ethical considerations.** Ethical approval for the Infant Study was initially obtained from the KEMRI/NERC. The study was also authorized by the Ethics Committee of the Faculty of Humanities, Development and Social Sciences (HDSS) at the University of KwaZulu-Natal (UKZN). Information about the project was initially disseminated through a series of meetings with community leaders in which members of the study team provided oral descriptions of the nature and purpose of the study. Informed consent procedures were designed to ensure that families (especially children's primary caregivers) were familiar with what was expected from them prior to providing consent. Participants were informed that their participation was voluntary and that they were free to withdraw from the study at any time, without fear,

prejudice or any loss of benefits. Risks related to child assessment were minimised by employing assessors who were well trained in work with children and families, and who were knowledgeable of ways to reduce test-related anxiety. These assessors were also sensitised to ways of dealing with parent and child concerns about testing. At the beginning of the interview and assessment sessions, the content and purpose of the session were outlined again. Assent, demonstrated by participation without visible distress (e.g. crying or hiding behind the caregiver) was sought from infants who were within sight of a family member at all times. If the child exhibited distress during the session, appropriate comforters (such as cuddling, singing, or a drink) were offered, preferably by the accompanying caregiver. In other instances, a short break was taken. The session was discontinued if the child remained in distress for longer than 15-20 minutes. No invasive procedures were used. All information collected was coded without personal identifiers and was kept confidential. Both consent and study procedures were carried out in private.

## Data Collection Procedures

Parental report, observation and child performance measures were used to gather the required information. Measures of the home environment and child developmental outcomes were administered once in the School-age Study and at 3 time points – at 12, 18 and 24 months – in the Infant Study. Trained child development assessors conducted the assessments and interviews. Information on child gender, age and household wealth was obtained through interviews with parents.

### School-age Study

**Test administration.** A battery of tests of neuropsychological functioning was administered among the school-age population. Apart from the language and motor tests which are described in detail under the section on tool development, the battery included other modified tests as follows:

a) The Tower of London (P. Anderson, Anderson, & Lajoie, 1996) is a non-verbal test of executive function that measures problem-solving and planning ability. The test makes use of three coloured balls which can be placed onto three wooden pegs of varying heights. The child is required to match a pattern presented on a stimulus card in a prescribed number of moves, while adhering to specified rules;

b) Dots (Fletcher, 1985) is a test of verbal memory where the child is required to point at a special dot on a sheet. The examiner progressively points at a series of one up to eight special dots from a series of designs;

c) The Self-Ordered Pointing Test (SOPT; Petrides & Milner, 1982) assesses verbal/visual selective reminding in terms of the capacity to initiate a sequence of responses, retain the responses and monitor the consequences of behaviour. The child is shown three series of six, eight, ten and twelve pictures each presented three times. The

positions of the pictures differ on each page and the child is required to point at one picture on each page without pointing at the same one twice;

d) The Verbal List Learning (Delis, Kramer, Kaplan, & Ober, 1989) is a test of learning and working memory. The test consists of five serial verbal presentations of a 15-item word list composed of items semantically related to four common categories. Following each presentation, the child is asked to recall as many items as they can in any order. A second list of different items is read out once;

e) The Coloured Progressive Matrices (CPM; Raven, Court, & Raven, 1998) is a non-verbal test of reasoning. The 36-item test comprises a matrix of abstract patterns in a multiple choice format which the child is required to complete by selecting the appropriate missing symbol from a set of six alternatives;

f) The Contingency Naming Test (CNT; P. Anderson, Anderson, Northam, & Taylor, 2000) is a test of executive function designed to assess response inhibition, attentional shift and cognitive flexibility. The child is taught a set of rules to name nine drawings consisting of a large outer coloured shape and a smaller inner coloured shape displayed in a single series;

g) The Score test (Manly, Robertson, Anderson, & Nimmo-Smith, 1999) is a test of auditory sustained and selective attention in which the child is required to place beads on one of two plates only after a special sound is heard on a cassette tape; and,

h) The People Search (Connolly & Grantham-McGregor, 1993; Connolly & Pharoah, 1993) is a test of visual sustained and selective attention. A stimulus sheet comprising complete and incomplete stick figures is presented. The child is required to cross out all the complete figures as quickly as possible.

All the tests in the School-age Study were administered at a school near the child's home. Each child was tested individually in a quiet area within sight of other children, and in familiar surroundings to minimise test anxiety. Observations by the assessors suggested that none of the children was unduly anxious during the test sessions.

**Home environment measure.** The quality and quantity of support available in the home environment for emotional, social and cognitive development of the child was assessed through a caregiver interview. Caregivers (most frequently, mothers) were asked to talk about each item as it related to the target child and family. The interviews were administered in a conversational manner with the child's principal caregiver, and in the presence of the child. The caregivers' responses were recorded as written notes on the interview sheet.

All the HOME interviews were carried out outside children's homes, as it is uncommon for visitors to be invited into the house. At the end of the interview, the caregiver was asked for permission to escort the interviewer to see the living conditions inside the family home.

**Sociodemographic information.** Birth records were used, where available, to confirm

the child's date of birth. In the cases where records were not available, the procedure outlined by Kitsao-Wekulo and colleagues (2012) was followed. Mothers were asked to recall local or national events that occurred around the time of their children's birth. For the purposes of this study, an age variable in 6-month increments was created.

School exposure was measured as the number of complete years that the child had attended school. Household-level characteristics comprised an index of household resources that divided the sample into three approximately equal groups from the least wealthy to the most wealthy (Level 1, Level 2 and Level 3). The constituent items comprising the wealth index score were developed through a review of indicators of socioeconomic status (SES) made in the study population as well as a local investigation of household characteristics associated with educational outcome (Holding & Katana, internal report). It was calculated by summing the values assigned to each of six SES variables obtained through parental interview: parental education and occupation (mothers and fathers separately); ownership of small livestock; and, types of windows in the child's dwelling place. Education groupings were calculated on the basis that primary education takes 8 years to complete, post-primary education takes between 9 and 12 years to complete while a tertiary education certificate is obtained after more than 12 years of education, thus: '0' = no education; '1' = <8 years of education; '2' = 8 years of education; '3' = 9-12 years of education; and, '4' = >12 years of education. Parental occupation was denoted thus: '0' = not known/deceased; '1' = unemployed/housewife; '2' = subsistence farmer; '3' = unskilled/petty trader; '4' = semi-skilled; and, '5' = skilled. The number of livestock was coded as '0' = none, '1' = <5, and '2' = 5+ while the type of windows (a proxy for housing quality among homesteads characterised mainly by grass-thatched mud-walled dwellings) was coded '0' = none; '1' = open; '2' = small; '3' = wooden; '4' = wire; and '5' = glass.

**Other measures.** We measured children's heights to the nearest centimetre using a stadiometer. The child was asked to remove his/her shoes, place the legs together and stand with his/her back and head against the board. The child was instructed to stand up straight and look straight ahead. The moveable headpiece was then brought onto the uppermost point of the head with sufficient pressure to compress the hair. One assessor was designated to take the reading, while another recorded the measurement to the nearest 0.1cm. Two readings were taken for each child.

Height-for-age indices to determine nutritional risk were calculated using WHO AnthroPlus (World Health Organization, 2009). Growth retardation was defined as height that was more than 2 standard deviations below levels predicted for age according to the World Health Organization reference curves for school-aged children (World Health Organization, 2007).

**Infant Study**

**Test administration.** The assessments and interviews in the Infant Study took place at the district hospital or at the child's home. Assessments of children's motor and language development were conducted individually using the tools and procedures described under the section on tool development. All the visits were made at predetermined times.

**Home environment measures.** The interview on the home environment was completed at the district hospital. Home visits to selected households were made at agreed times by the researcher to make naturalistic observations of a child's typical day and the environment in which they live.

**Socio-demographic information.** Information on maternal age, marital status, area of residence, parental education and occupation and living arrangements was obtained from caregivers using a structured questionnaire. However, we were not certain of the veracity of the information on age as many women did not have written records of their birth. We therefore used a grouping variable to place mothers into three groups based upon the convention to assign categories of older and younger mothers. The maternal age variable was designated thus: '0' = less than 20 years; '1' = between 20 and 34 years; and, '2'= 35 years and older.

Conventional western terminologies of single/married and widowed were found unsuitable due to ambiguous definitions of marital status within this community. An index to define support provided by a partner was thus used to designate presence or absence of support; '1'= reports presence of a partner who provides support, and '0' = no partner or partner does not provide support.

Parental education was defined using an index to establish functional literacy. Seven or less years of formal education, corresponding to incomplete primary education was equivalent to no functional literacy = '0'; less than complete secondary education equivalent to between 8 and 11 years of education = '1', and '2' = 12 or more years of education.

An index of occupation to estimate both the level and regularity of income was used to categorise families into four occupation levels. No income was denoted as '0'. Those who had low income (less than Kshs. 5000) on irregular basis were categorised as Level 1. Level 2 included those with regular income levels ranging between 5,000 and 15,000 while Level 3 was those with regular income higher than 15,000.

Home ownership, denoted as '0' = tenant/squatter, '1' = shared house (with other members of the extended family) and '2' = own house (only members of the nuclear family) was based on the family's living arrangements.

**Other measures.** Information on children's dates of birth was obtained from hospital records at delivery. Children's length and weight information was obtained to determine the presence of underweight, wasting and growth retardation. Recumbent length was used for infants and children of less than two years of age. The length of infants was measured using a

calibrated length board with a fixed headpiece and a movable foot piece perpendicular to the surface of the table. The mother/caregiver was asked to remove the child's shoes and clothes apart from light underclothing. The infant was placed on his/her back in the centre of the board lying flat against the surface and with the eyes looking up, both legs fully extended, toes pointing upward and feet flat against the foot piece. The length measurement was taken by one trained assessor and recorded by another to the nearest 0.1 cm. A stadiometer was used for children who were able to stand unassisted.

To measure weight, the infant was placed on a digital SECA scale and the reading was taken to the nearest 10g. Weight readings were taken three times and recorded when the results were consistent to one decimal place. Weight-for-age, weight-for-height and height-for-age indices were determined using WHO Anthro (World Health Organization, 2010) and those that were more 2 standard deviations below the World Health Organisation child growth standards median (WHO Multicentre Growth Reference Study Group, 2006) were indicators of undernutrition.

## Tool Development

In this section, I provide information about the development of the measures of the home environment, language skills and motor abilities for both the School-age and the Infant Studies. The process of tool development for the school-age population was completed during the current study while that for the infant population was completed through previous studies conducted among infants living within a similar context.

### School-age Study

**Home environment measure.** We followed the systematic test adaptation procedure recommended by Holding and others (2009) to adapt and modify an existing measure of the home environment. This process is described in detail below.

***Item pool modification.*** All the items of the original MC-HOME Inventory were translated into Kiswahili, the *lingua franca* of the region, using the descriptions provided in the original manual. We made use of conceptual translations because some words or phrases could not be translated directly. At each stage of translation, we grouped items into sets and then evaluated them through an iterative process where each set was presented to different respondents.

Initial interviews were conducted with three willing parents to establish the clarity and face validity of the items. A focus group discussion was also held with eight mothers of school-age children to establish their understanding of item content and if the items would be answered without hesitation. Their responses suggested that some of the items needed further clarification. Our own observations made during data collection pointed to the perceptual richness of the environs of the household. We therefore incorporated an additional item as an indicator of environmental stimulation.

After this process, some of the original content was retained while other items were modified to take into account the cultural milieu of the study. The Kiswahili version was evaluated for clarity and then back translated by a panel of professionals (a psychologist, a community paediatric nurse and two teachers) with detailed knowledge of the cultural and linguistic context.

***Training of interviewers.*** Prior to the main study, the Principal Investigator trained three interviewers to administer the MC-HOME Inventory. For the purpose of this study, the interviewers were referred to as the home 'Visitors.' The interviewers were first familiarised with the content and structure of the MC-HOME Inventory. They were provided with information on how 6-10 year old children develop and important influences on their development. The interviewers were also instructed on interviewing techniques.

Practical training began with the Principal Investigator observing each 'Visitor' administering the Inventory. She provided feedback to ensure that the 'Visitors' understood interview procedures. The 'Visitors' then conducted mock interviews with selected caregivers, while being observed by a trained member of the assessment team. One source of homogeneity in responding was the tendency for interviewees in this community to simply agree with the interviewer. Developing the skills of potential interviewers to elicit responses in a more conversational method was identified as a way of circumventing this problem and obtaining more informative responses. An interview guide with additional prompts and probes was therefore developed and used during the interview to maintain the flow of the conversation. More specific examples of relevant activities were included to facilitate coding of each item. This guide was modified and updated with relevant information throughout the one-month training period. During the training process, the interviewers recorded their observations and caregiver responses to interview questions. They then used this information to rate the interviews.

***Piloting phase.*** After final selection and refinement of items, further piloting took place in the homes of seven children randomly identified from a census database of the study area population available at the Kenya Medical Research Institute. The purpose of these interviews was to evaluate the acceptability of the interview procedure, clarity of the modified items, feasibility of completing the observational items, and variability in responses.

In the initial analysis of pilot data, more than one-third of the items demonstrated a lack of variability, suggesting the need to investigate alternative indicators of inter-household variability. The scoring procedure was expanded to a 3-point rating scale (not at all = 0, sometimes = 1, most of the time = 2) and tested on 15 literate parents. Descriptive analysis of the total scores and responses to individual items indicated that this method yielded greater response variability. This version of the MC-HOME Inventory was then administered to 24 respondents. Across these participants, 94% of the items received multiple ratings.

**Vocabulary measure.** A local version of the Kilifi Naming Test (KNT) was used to assess language abilities in school-age children. The process of the construction of the confrontation naming test followed a 4-step systematic adaptation procedure outlined by Holding and colleagues (2009) and is described below. The validation of the KNT is described in detail in Chapter 4.

***Step 1 – Construct definition.*** An extensive review of existing literature did not reveal any studies reporting the concept of confrontation naming within the sub-Saharan African context. We therefore obtained a simple definition – the ability of children to name common words depicted through pictures presented to them – from a reference book.

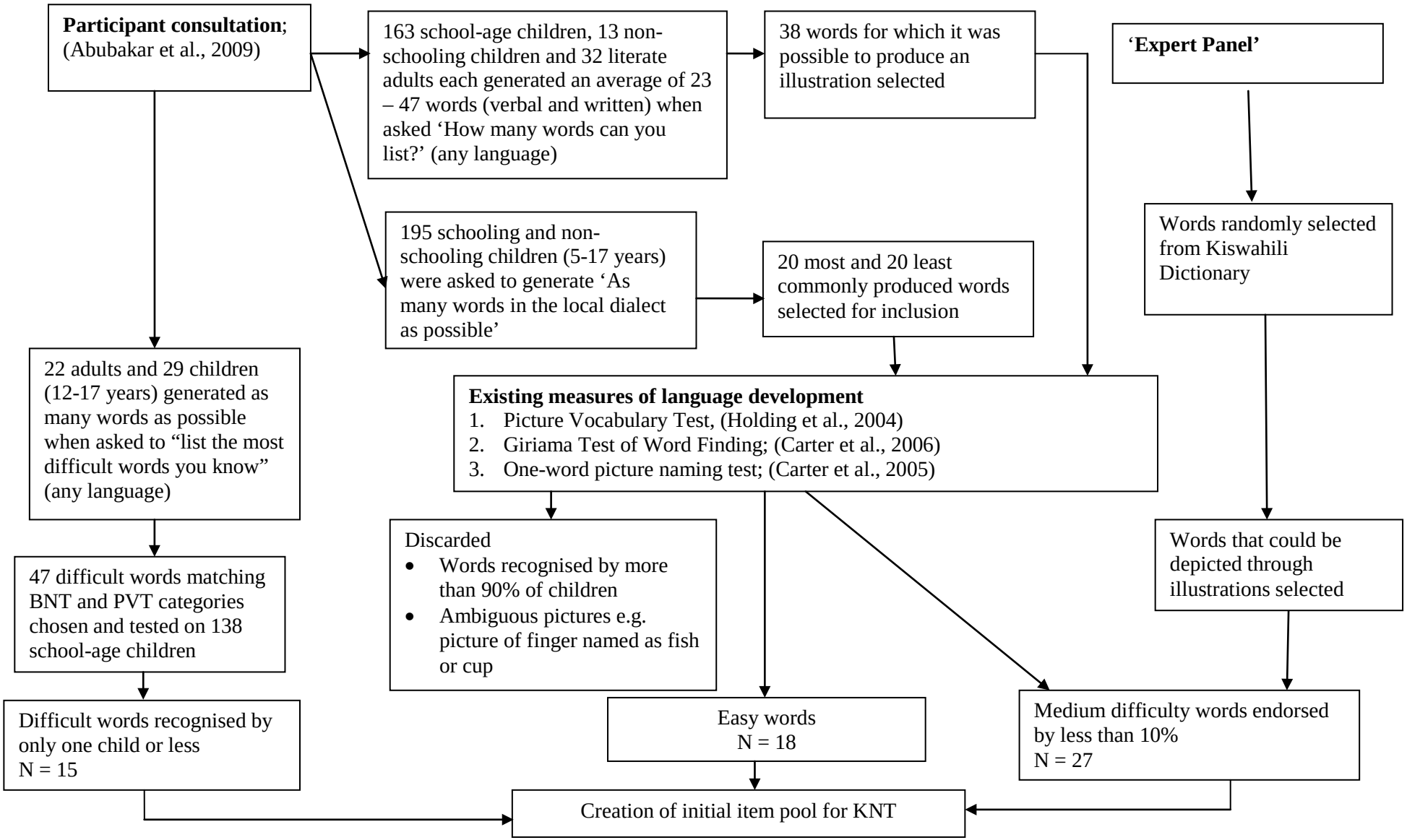
***Step 2 – Item pool creation.*** Figure 2 summarises the procedures followed in creating the item pool.

***Step 3 – Developing the procedure and training examiners.*** In the next stage, we formulated semantic stimulus cues. These were phrases used to prompt the respondent to produce a correct response if they were not able to name a picture accurately. The appropriateness and utility of these stimulus cues was then tested on a group of children by presenting the pictures first, with and then, without stimulus cues. Some of the stimulus cues were reworded to improve clarity. In most cases, the frequency of correct responses was higher when the items were presented with stimulus cues.

Four assessors with a background in education were trained in administration and scoring of the KNT. This training ensured that all assessors consistently administered the test in a standardised manner. All the assessors practiced administering the tests among themselves and with non-study children before the actual data collection process began.

***Step 4 – Evaluation of adapted schedule.*** Sixty items were tested on 75 children and then ordered according to frequency of correct responses. These items, which constituted the initial version of the KNT, were then tested on the first 100 children in the study. Fifteen items were taken out of the list after they were found to be too easy. Slightly more difficult items (N = 19) were then tested on 16 children. The items that were discarded from the original list were replaced with sixteen of these difficult items. The final version of the KNT had 61 words ordered according to their difficulty level (see Figure 2). The names of the objects range in difficulty from simple, high frequency words (easy) to rare words with low frequency (difficult) of occurrence.

*Figure 2.* Steps in creation of the item pool for the Kilifi Naming Test



**Tests of motor skills.** A battery of motor tests adapted from the Movement - Assessment Battery for Children (Movement-ABC; Henderson & Sugden, 1992) was used to assess motor functioning of school-age children. We followed the 4-step adaptation procedure described earlier and the details of this process are presented below.

***Step 1: Construct definition.*** The focus of the battery was tasks that measured balance and co-ordination, as these skills reflect planning of movements that may be more reflective of an underlying executive function component of motor proficiency. We therefore defined motor proficiency as the specific abilities measured by tests of balance, bilateral co-ordination, upper limb co-ordination, visual-motor control and upper limb speed and dexterity (Sherrill, 1993).

***Step 2: Item pool creation.*** Some tests were modelled after those in the Movement-ABC, a battery of motor tasks designed for children ages 5-12 years. Apart from the fact that it takes a short time to administer, the most important advantages of the Movement-ABC compared with other available tests are its cross-culturally applicability, simplicity of instruction and demonstration and the ease with which trainers can be trained in administration (Cools, De Martelaer, Samaey, & Andries, 2009). Additional tests in the battery, such as the Bolt Board, were conceptualised and designed by the investigation team.

***Step 3: Developing the procedure.*** We produced a manual of instructions for the newly created tests and modified existing items and procedures to suit the cultural norms and practices of the study context. Instructions were formulated in the local language. Tasks were chosen on the basis that their requirements were familiar to children and that they were similar to activities that children regularly engaged in. The appropriateness of the procedures was pilot-tested on groups of between 10 and 20 children. Some of the instructions were rewritten to improve clarity.

We initially piloted the following tests: fine motor tests included the Bolt Board, Peg Board and Bead Threading Tests; tests of dynamic balance included Hopping in Squares, Jumping in Squares (with two feet together), Jumping and Clapping, and the Ball Balance; Static balance tests included Standing on One Leg, One Board Balance and Two Board Balance. We established the ceiling and floor effects on each test. Very easy items on which 30% or more of the children made no errors like Jumping in Squares were dropped. Very difficult items on which 20% or more of the children were unable to reach the first level (e.g. for some children with wide feet, the requirement to balance on two ridged boards on the Two Board Balance test was impossible to achieve) were dropped. The Standing on One Leg Test, in which one leg was held off the ground, was modified as the Stork Balance Test as assessors were not able to establish the angle at which the free leg was held especially for girls wearing long skirts.

The process of pilot testing continued until there was no further need for modifications and children were deemed to have understood the test requirements. In this manner, the

frequency of modifications made was a determining factor in the total number of children on which the tests were pilot-tested. Four assessors with professional backgrounds in education (varying from diploma to degree level) were trained in administration and scoring of the gross and fine motor tests. Training included participation in the initial development of instructions for test administration and selection of the tests, as well as direct instruction and practice in administration procedures.

***Step 4: Evaluation of modified tests.*** Once the content and format of the assessment tasks were established, extensive practice sessions in which assessors administered tests to 30 non-study children under the close supervision of the PI, enhanced standardisation in the administration procedure. These non-study children were divided into three groups of 10 each comprising 5 younger (7-8 years) and 5 older (10-11 years) school-going and non-schooling children. A set of tests within the three categories – fine motor, static and dynamic balance – was administered to each group.

***Final battery.*** The final battery of motor tests comprised 8 tests, five tests of gross motor abilities covering static and dynamic balance – and three timed tests of manual dexterity to assess eye-hand coordination.

*Stork Balance Test.* This was a test of static balance. The test was administered by asking the child to stand on one leg with the hands on the hips. The second non-standing foot rests on the knee. The child completed the task first on the preferred leg, then on the non-preferred leg with the eyes open and eyes closed. A second trial on each leg was administered if any errors were made within 30 seconds on the first trial. Errors included placing the non-standing foot on the ground and removing the hands from the hips. The trial with the highest time was noted. Percentile cut-offs for the entire sample were calculated and scores ranging from '0' (complete failure) to '3' (complete pass) were awarded based on the highest time achieved. To provide a continuous score, the scores across the four conditions were summed.

*Ball Balance Test.* In this test of static balance, the child was asked to walk along the outline of the perimeter of a rectangle marked with a rope placed on the ground. This task was completed by using an outstretched arm to balance a tennis ball on a square board. If the ball dropped up to 10 times on the first trial, or if the child made any of the following errors (does not resume walking from the point of drop, supports the ball with the free hand or places the thumb on the upper surface of the board), a second trial was administered. If the ball was dropped up to 10 times again on the second trial, a third trial was administered with the arm bent. The child's score was calculated according to the number of ball drops on each trial.

*Hopping in Squares Test.* This test in which the child hopped in five squares marked on the ground with a rope was a test of dynamic balance. The task was completed first on the preferred leg then on the non-preferred leg. Errors were recorded if the child stepped onto the rope, made two hops in one square or hopped outside the square. An acceptable landing was

defined as coming down on one foot with the sole of the foot meeting the ground within the last square. If the child was successful on the first trial, a score of '2' were awarded for each of the three aspects (no errors, five correct hops and acceptable landing), and for each leg separately. If the first trial was not completed accurately, a second trial was administered. Each of the three aspects was scored '1' if success was achieved on the second trial. The child scored '0' if s/he did not achieve success on all three aspects. The total score was calculated by summing the scores for errors, hops and landing for both legs.

*Jumping and Clapping Test.* This test was administered to assess dynamic balance. The child was asked to jump as high up in the air as possible and to clap hands while their feet were in the air. The number of claps for each of three trials was recorded. The child's score was the highest number of correct claps.

*One Board Balance Test.* In another test of static balance, the child was asked to balance on a ridged board, first with the preferred leg (then with the non-preferred leg) on the board and the other in the air while being timed. A second trial was administered if any errors occurred within the 30-second time limit. As with the Stork Balance Test, percentile cut-offs based on the highest time achieved on each leg were calculated. Scores ranging from '0' (complete failure) to '3' (complete pass) were awarded and summed to derive a continuous total test score.

For the timed fine motor tests, the assessor first demonstrated the correct procedure for completion and then allowed the child a practice trial. When the child demonstrated that they had understood the task requirements, the assessor gave the instruction 'Do this test as quickly as you can without making any mistakes' and then began to time the test.

*Bolt Board Test.* This was a test of manual dexterity. The child was presented with a board of nuts on which were screwed 20 bolts in four rows of five. There were red-coloured bolts on two rows on one side and blue-coloured ones on the other. Beginning with the preferred hand, the child was required to unscrew a bolt from the same side, turn it upside down and screw it back on to the nut. The same process was followed using the non-preferred hand with the bolts on the other side. Alternating between the right and left hand, the bolts were unscrewed and screwed until all 10 on each side had been turned over. Three 60-second trials were administered. The number of bolts completed across the three trials was recorded. The child's score was derived from the total number of bolts manipulated correctly.

*Bead Threading.* In a second test of manual dexterity, the child was required to thread as many beads as possible onto a shoelace within 30 seconds. The child's score was the mean number of beads threaded across three trials.

*Pegboard Test.* The third test of manual dexterity required the child to insert as many pegs as possible into the holes of a pegboard within 25 seconds. This test was completed first with the preferred hand, then with non-preferred hand and lastly with both hands together. Three trials were administered and an average score was calculated for each condition. The

child's overall score was the mean number of pegs across the three conditions.

**Infant Study**

**Home environment measure.** Information on the home environment of infants was obtained through the use of an adapted version of the Infant Toddler version of the Home Observation for Measurement of the Environment (IT-HOME). The process of modifying and adapting the IT-HOME for use in rural contexts has been described by Holding and colleagues (2011) and is summarised below.

***Adaptation of the IT-HOME.*** A total of 425 children aged 6-35 months, living in both rural and urban settings at the Kenyan coast, were involved in this cross-sectional validation study. The study followed a four-stage process of test adaptation developed through extensive experience: construct definition; preparation of the item pool; developing the administration procedure; and, evaluation of the adapted schedule. Information on local beliefs and customs relating to child stimulation and support was obtained through focus group discussions and direct observations of infants and young children. Translations and back-translations of the IT-HOME were carried out using a Panel Approach. Culturally appropriate modifications were made, and the language and content in the final draft were evaluated for semantic clarity by a professional translator.

In the next stage, field workers were trained on proper administration and scoring procedures, and this process was continued until the trainees attained 90% agreement on scoring with the trainer. A review of the responses obtained during the training process indicated that very few items of the IT-HOME showed adequate variability when the binary scoring system was used. The detailed written responses on the record sheets were used to develop a three-point coding scheme representing various levels of regularity. However, a significant number of items (n = 26) from the original IT-HOME measure showed limited variability, even with the new coding scheme, and these were excluded from the final schedule. Two more items were excluded because of negative item-to-total correlations and ambiguity in scoring. The remaining 17 items had a modest internal consistency reliability level ($\alpha = .63$) and the measure demonstrated a theoretically meaningful relationship with antecedent and child outcome variables, providing partial evidence for convergent validity.

**Vocabulary measure.** An adapted version of the MacArthur-Bates Communicative Development Inventory (CDI: Fenson et al., 1993) was used to assess vocabulary development in infants. The process of modification and adaptation to fit the cultural context of the current study has been described by Alcock and colleagues (Alcock et al., 2014), and is summarised below.

***Adaptation of the CDIs.*** Parents of children aged 6 – 36 months in rural and urban settings at the Kenyan coast were recruited into a study designed to develop and validate an interview format of the CDI for two related Bantu languages, Kiswahili and Kigiriama. Words

taken from the original measure were translated into the two languages. Unsuitable vocabulary (e.g. 'snow') and grammatical items (the use of suffixes that do not exist in Bantu languages) were replaced. Construction of the new forms was carried out concurrently in the two languages – the translated equivalent of any word known by children learning one language was included in the other questionnaire. Substitute items were drawn from parental interviews and recordings of the free speech of children in the target communities. Parents reported that a number of words were produced by children at various ages. The proportion of children who understood (or understood and produced) the words on the list at each age was collated. In this manner, 100 words were included in the short form of the questionnaire for younger children and two parallel short forms, each with 100 words, were created for older children.

The adapted measure requires the parent to endorse items that the child understands or produces, supplemented by observational items. The CDI words were read out to parents because we did not assume that all parents were literate. Like the original, the adapted version has two versions: for younger (8-15 months) and older (16-30 months) children. Parents of older children were asked if their children were combining words into sentences and were asked for examples if they answered in the affirmative. The adapted version of the CDI has high internal consistency reliability levels ($\alpha = .9$) and it has been validated against parental reports of child development and functioning (Pearson's $r = .47$ - $.68$; $p<.05$).

**Test of motor skills.** The Kilifi Developmental Inventory (KDI) Psychomotor Scales for infants, a locally developed and validated measure was used in the Infant Study. The process of development and validation as described by Abubakar and colleagues (2008) is summarised below.

***Development and validation of the KDI.*** The KDI is an extension of the Kilifi Developmental Checklist (KDC: Abubakar et al., 2007), an assessment previously applied in studies of early adverse health experiences. Items on the KDC which focused largely on the assessment of psychomotor performance in children aged 9 to 60 months, were derived from multiple sources. Items were selected on the basis of ease of scoring, demonstrated variability and cultural meaningfulness. Performance on the KDC was audited in order to select suitable items, and those items which had not been successfully completed by at least one child under 36 months of age were excluded. The remaining items were supplemented with tasks suitable for younger children (6-12 months). Further modifications included simplifying the original KDC three-point scale (0, cannot do the task; 1, emerging skill; 2, established skill) to a dichotomous scale (0, cannot perform the task; 1, can perform the task) to reduce potential ambiguity in scoring. A detailed instruction manual to ensure standardisation of the administration procedure which also included templates for construction of standardised test materials, was produced. As part of the training process, assessors were taught to recognise the developmental progression of items and to assign the appropriate score to all items on the KDI. In this manner, children who

accomplished more complex items were automatically awarded scores on the simpler ones, regardless of age.

In order to evaluate the psychometric properties and applicability of the newly derived KDI, children aged between 6 and 35 months were involved in a study to monitor psychomotor development in two sites at the Kenyan coast. The measure provides an assessment of locomotor and fine motor function as well as a composite score of psychomotor development. An assessor initially provides instructions and demonstrations for the child to model. The scale consists of 69 items, scored from observation of children's performance on a range of activities. Locomotor items assess the child's movement in space, static and dynamic balance, and motor coordination. Items include ball handling and reaching skills, mobility in various positions (prone, supine and standing) and development in climbing, and jumping. Eye-hand coordination assesses the child's ability to manipulate objects and to coordinate fine motor movement. Items include manipulation of coins, bead threading and block building. A summated score is calculated for the two functional areas, locomotor skills and eye-hand co-ordination. The KDI has high reliability levels ($\alpha$ = .76 - .86) and has been validated against parental reports of child development and functioning in an infant population living in a low-income setting (Pearson's $r$ = .42 - .62; $p < .05$). The sensitivity of the measure to early brain insult and to variation in performance has also been established.

Measures of language development (CDI), psychomotor development (KDI) and the home environment (IT-HOME) have been validated through earlier studies conducted among infants living in contexts similar to the one of the current study. These measures could therefore be used with confidence to track the developmental outcomes of infants involved in a nutrition intervention study (INSTAPA).

## Exploring the Analytic Framework

### Modelling the Indices

In order to test the appropriateness of the model proposed in Figure 1, I set out to investigate the impact of nutritional status as a mediator in the association between background variables and child outcomes. Area of residence, school attendance and household wealth were conceptualised as context variables while gender and age were person variables. Following the model presented in an earlier study within a similar context (Abubakar, van de Vijver, et al., 2008), we examined how the relationship between antecedent factors (background characteristics) and child outcomes (language skills and motor abilities) was mediated through nutritional status. We used the data collected for the School-age Study for this exploratory analysis.

The procedure of analysis by the SEM approach required multiple steps. First, according to Tate (1998), valid causal inference in SEM requires correct specification of the structural equations as SEM begins with the design of a model to be estimated (Hoyle, 1995).

Thus, model specification involves formulating a statement about a set of parameters. The purpose of a linear structural equation model is to provide a meaningful and parsimonious explanation for observed relationships within a set of measured variables (MacCallum, 1995). Second, the assumptions for the SEM approach were examined by the preliminary analysis of data to determine whether they were appropriate. Additionally, correlations among variables were examined to reduce multicollinearity problems (Tate, 1998). Then, the fully hypothesised model including the measurement model was specified, and measurement model fit was assessed in order to test the fully hypothesised model. The full model was tested by examining the model fit indices and path coefficients for all direct and indirect paths hypothesised in the model. Lastly, the overall model fit including all direct and indirect paths was tested. If the hypothesised model was unacceptable based on goodness-of-fit statistics, these processes were repeated with model revisions until a good model fit was presented. The desired outcome in these post hoc modifications was to find the best-fitted and most parsimonious model.

**Model Structure**

The assessment of the validity of the SEM assumptions was conducted using Bentler and Chou's (1987) recommendations. They identify 10 statistical assumptions for consideration: independence of observations, identical distributions, simple random sampling, functional form, distribution of variables, covariance structures, large sample size, identified model, a priori structural hypotheses, and no parameters on boundary. Among these assumptions, three required more attention than the others: independence of observations; distribution of variables; and, large sample size.

**Independence.** The bivariate correlations between variables were examined to check whether there were any multicollinearity issues. None of the correlations were above the typical recommended cut-off point of .70 (Tate, 1998).

**Distribution of variables.** The distributions for all the variables were normally shaped. However, in the event that they were skewed, they could have been included in the analysis because (a) 'maximum likelihood estimates are still consistent with nonnormal distributions and (b) the overall test and standard errors of estimates are reasonably robust to moderate violations of normality' (Tate, 1998).

**Sample size.** The School-age Study had an overall sample size of 308. This was above the recommended sample size of 200 (Tate, 1998). Any number above 200 provides sufficient statistical power for data analysis (Garver & Mentzer, 1999; Hoelter, 1983).

**Assessing Model Fit**

To assess the SEM results, various fit criteria were examined.

**Chi-square statistic.** The overall test of the model fit was evaluated using the most common index, the chi-square statistic. Smaller values of the chi-square statistic reflect better model fit and a chi-square value of zero, which would result from a value of the fitting function

equal to zero, indicates a perfect fit (Hoyle, 1995). In this case, we want to fail to reject the null hypotheses (indicating that the model fits the data). Significance values, or p-values should be high, or greater than at least .001 as it indicates that the observed model is not significantly different from what was expected. Thus, non-significance means that there is no considerable difference between the actual and predicted matrices (Hair, Anderson, Tatham, & Black, 1998). However, because the chi-square is highly sensitive to sample size, especially if the observations are greater than 200, it is necessary to also evaluate the ratio of chi-square to the degrees of freedom for the model (Jöreskog & Sörbom, 1993). Kline (2005) suggests a ratio of 3 or less as a small chi-square value relative to its degree of freedom is indicative of good fit.

**Incremental and absolute fit indices.** To overcome the sensitivity of the chi-square to sample size, alternative goodness-of-fit indices are incremental and absolute fit indices (Lei & Wu, 2007). Incremental fit indices measure the increase in fit relative to a baseline model and include the comparative fit index (CFI: Bentler, 1990) and the non-normed fit index (NNFI) also known as the Tucker-Lewis index (TLI: Tucker & Lewis, 1973). Absolute fit indices measure the extent to which the specified model of interest reproduces the sample covariance matrix (Lei & Wu, 2007). Examples include the Root Mean Square Error of Approximation (RMSEA: Steiger & Lind, 1980). It is generally recommended that multiple indices be considered simultaneously. The following global fit indices were therefore used to assess overall model fit in the current study:

1. Root Mean Square Error of Approximation (RMSEA): Values of .05 and less are interpreted as reflecting a close fit of the model to the data, while values of up to .08 represent acceptable fit. The RMSEA index measures the discrepancy between the observed and estimated covariance matrices per degree of freedom (Steiger, 1990).
2. Nonnormed Fit Index (NNFI) also known as the Tucker-Lewis Index (TLI): Values of .9 or larger are assumed to represent acceptable fit. This index compares a proposed model's fit to a nested baseline or null model. It also measures parsimony by assessing the degrees of freedom from the proposed model to the degrees of freedom of the null model. This index is highly recommended because it seems resilient against variations in sample size (Garver & Mentzer, 1999).
3. Comparative Fit Index (CFI): Values of .9 or greater are viewed as representing acceptable fit.

Besides the goodness-of-fit indices, the causal paths were also evaluated for statistical significance and strength using the standardised path coefficients. Statistical significance was based on alpha of 0.05; the rejection of the null hypothesis means that the structural coefficient is not zero (Bentler, 2002). In addition, Chin (1995) suggests that standardised paths should be at least 0.20 and ideally above 0.30 in order to be considered meaningful for discussion.

The results of this exploratory analysis are presented in Chapter 7.

**Data Manipulation**

All record forms were checked for incomplete or erroneous entries. Data were double-entered in Epi Info and stored in Microsoft Access for translation to SPSS for analysis.

Analysis of the home environment measure focused on responses to items relating to the quantity of parental support for child development. To establish consistency among raters, I used the Kappa statistic. The observed agreement for the raters across all the items for the school-age measure of the home environment ranged from 0.69 to 0.99, with a mean of 93.4%. Kappas ranged from 0.38 to 0.99 and the overall interrater reliability was found to be Kappa = 0.87, 95% *CI* (0.838, 0.893). The Kappa coefficients of all the 60 items are presented in Appendix K.

Item level analysis was used to determine variability in responses. A descriptive analysis of the responses revealed that five items (Items 8, 10, 14, 17 and 39) were endorsed at levels of >95% at any one of the three ratings. These five items were excluded from further analysis based upon extremely infrequent or frequent endorsement (Clark & Watson, 1995).

Correlational analysis was carried out to determine the strength of the relationship between distal and proximal factors. Stepwise regression was used to examine the relative contribution of the different variables in shaping cognitive outcomes.

Structural Equation Modelling (SEM), specifically path analysis, was used to evaluate causal pathways. SEM is a method that requires a large sample, specifically a minimum of either (a) 100 – 200 participants (Kline, 2005) or (b) an n:v ratio of at least 10:1 or 15:1, where n represents the sample size and v signifies the number of variables (Tate, 1998; Thompson, 2000). The sample size in Sub-Studies 1 and 2 fulfilled both criteria. A strength of this procedure is that, because all the relevant paths can be tested, SEM can identify indirect, direct and total causal effects of the variables of interest (Klem, 2000; Tate, 1998).

The hypothesised model for this study is presented in Figure 1. In the model, I surmised that the distal context of household wealth and person variables of age and gender would directly and indirectly (through the proximal processes within the home environment) influence the person variables of language and motor outcomes.

A thematic framework based on themes and sub-themes generated from the naturalistic observations was used to analyse the qualitative data collected.

CHAPTER 4: LANGUAGE DEVELOPMENT IN CHILDREN

## Paper 1: Vocabulary Acquisition in School-age Children: Development and Application of the Kilifi Naming Test

### Introduction

Few studies report the measurement of expressive vocabulary in school-age children in resource-constrained settings. Furthermore, only a small number of locally developed standardised norm-referenced measures of language functions have been published for use with the multiple language groups of sub-Saharan Africa (SSA). This makes it difficult to detect language and communication problems especially among school-age children who may be wrongly diagnosed as having a general learning disability. Our current understanding of influences on vocabulary acquisition is generally limited to those linguistic and cultural contexts where standardised tests of vocabulary are available.

Vocabulary acquisition is incremental in nature (Laufer & Goldstein, 2004) and words that are encountered more frequently are learned more quickly (Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991). For a child, the progressive and continual acquisition of new vocabulary is important for the development of communication skills (Smith, Cowie, & Blades, 2003). Assessing vocabulary enables us to identify children with potential literacy problems such as reading comprehension as the two are highly related (Sénéchal, Ouellette, & Rodney, 2006).

The multi-directional interactions between biological (internal) factors and environmental (external) inputs, couched within Bronfenbrenner's bioecological model (Bronfenbrenner, 1995), have a strong influence on children's vocabulary acquisition (Hart & Risley, 1995; Hoff, 2003) even among socioeconomically disadvantaged populations (Apiwattanalunggarn & Luster, 2005; Hamadani et al., 2010; Weizman & Snow, 2001). Internal (i.e. child attributes) and external (i.e. features of the home environment) factors, including gender, age, nutritional status, school exposure, availability of household resources and neighbourhood of residence may underlie the substantial variability observed in vocabulary acquisition among children. An examination of these factors will shed light on the potential causes of differences in vocabulary acquisition.

Several study findings attest to the fact that children show vast improvements in vocabulary acquisition with increasing age (Basilio, Puccini, Silva, & Pedromónico, 2005; Bates, Dale, & Thal, 1995). Considerable variations are thus recorded across children, even those of the same age.

The research has not clearly established if gender differences occur at certain ages or may be attributed to innate biological differences or external environmental and social factors (Bornstein, Hahn, & Haynes, 2004; Burman, Bitan, & Booth, 2008; Leaper, 2002; Maccoby,

1980). However, the reported differences between boys and girls tend to be small, inconsistent (Hyde & Linn, 1988) and not always significant.

With regard to poor nutritional status, its negative effects include a shortened attention span, reduced capacity (Sigman, Neumann, Carter, et al., 1989) and little energy to learn (Brown & Pollitt, 1996) resulting in lower scores on various outcomes, including vocabulary tests. Unfortunately, these effects usually begin early in a child's life and the resultant disadvantages are long-lasting (Grantham-McGregor et al., 2007; Mendez & Adair, 1999). Poor nutritional status affects a significant proportion of children living in resource-poor settings and because of its persistent effects, it becomes very important to prevent it early on in a child's life.

Larger socioeconomic structures such as the neighbourhoods in which children live influence children's outcomes indirectly through various proximal social contexts such as families and schools (Bronfenbrenner, 1979; Leventhal & Brooks-Gunn, 2000; Sampson, Morenoff, & Gannon-Rowley, 2002). This association varies by the extent of neighbourhood advantage (Dupéré, Leventhal, Crosnoe, & Dion, 2010) so children living in neighbourhoods with more resources are likely to have better outcomes.

At the family level, socioeconomic status (SES) affects the manner in which adults use language with their children. The number of different words and the total number of words spoken during these interactions will determine the size of a child's vocabulary (Hart & Risley, 1995; Weizman & Snow, 2001). Parents with more socioeconomic resources at their disposal more frequently talk with the aim of eliciting conversation, use longer sentences and a richer vocabulary than those with less (Hoff-Ginsberg, 1991; Hoff, 2003). On the other hand, poorly educated parents living in crowded homes are less verbally responsive to their children, use less diverse language and their speech more frequently serves the function of directing the child's behaviour (Evans, Maxwell, & Hart, 1999; Hoff, Laursen, & Tardif, 2002). Not surprisingly, poorer outcomes have been reported for children living in homes with fewer resources at their disposal (Hart & Risley, 1995) as children in homes where they are exposed to fewer words develop smaller vocabularies. Substantial differences in vocabulary size among school-age children are reported, with estimates ranging from 6,000 to 14,000 words (Weizman & Snow, 2001). The growing body of evidence linking early vocabulary development and subsequent successful acquisition of reading and writing skills (Sylva, Melhuish, Sammons, & Siraj-Blatchford, 2000) underlies the importance of meaningful interactions between parents and their children.

By the time they get to school, most of the words that children encounter in their everyday conversations are already in their vocabulary repertoires (Cunningham & Stanovich, 1998; Hayes & Ahrens, 1988). Children may however pick up new words through incidental exposure; for example, during their play sessions in school, they may hear new words whose

use in context enable them to deduce their meanings (Connor, Morrison, & Slominski, 2006; Miller & Gildea, 1987) without any explicit training or feedback (Bloom, 2000). Although some studies in Western settings suggest that additional years in school do not have a measurable impact on vocabulary growth in children especially during the early school years (Cantalini, 1987; Chall, Jacobs, & Baldwin, 1990; Christian, Morrison, Frazier, & Massetti, 2000; Skibbe, Connor, Morrison, & Jewkes, 2011), other studies have shown that since language is a socially-mediated process, teachers provide children with opportunities for vocabulary learning through their daily oral language discourse (Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002). Teacher input may therefore have a strong impact on vocabulary growth in children as teachers provide high quality language modelling at school (Penno, Wilkinson, & Moore, 2002). This may be especially true in resource-constricted settings where the provision of education is not universal, and children not in school may not benefit from a similar influence from their parents at home.

To assess expressive vocabulary, we chose to use confrontation naming which is sensitive to brain injury (R. W. Cheung, Cheung, & Chan, 2004; Jordan & Ashton, 1996). Furthermore, the measures used tap cognitive skills such as encoding and retrieval. Expressive vocabulary tests show strong relationships with other aspects of oral language and therefore more accurately reflect emergent literacy (Malvern & Richards, 1997). Such measures can thus serve as proxies for reading comprehension specifically and academic achievement more generally (R. C. Anderson & Freebody, 1981; Beck, McKeown, & Kucan, 2002; Cunningham & Stanovich, 1998; Dickinson & Tabors, 2001).

We considered confrontation naming a suitable approach because compared to younger children, most school-age children possess naming abilities and are able to verbalise their responses. Whereas receptive vocabulary tests do not require reading, writing or speaking during assessment, they are more costly and complex to produce and require more time to administer than expressive vocabulary tests. This, coupled with the problem of providing sufficient drawings recognisable to the children in the current study, provided the impetus for developing a confrontation naming test for this age group. Also, the requirement to choose from a selection of available items bears little relation to the way language is used in most real-life situations (Luo & Zhang, 2011). This may make the test format more susceptible to guessing and impulsive responding than tests requiring an open-answer format (Luo & Zhang, 2011). A similar response bias where children picked a picture from the same position was observed in the administration of a picture vocabulary test of comprehension designed for children aged 5 to 9 years in the same setting as the current study (Holding et al., 2004). Furthermore, at this age children have appropriate levels of comprehension and concentration making such a method more sensitive (Clacherty & Kushlik, 2004). This procedure therefore provides a more direct assessment of vocabulary skills than would be obtained using parental

reports or observation of communicative interactions.

There have been studies on language development in children in the sub-Saharan African setting; however, they are few in number, have mostly utilised small sample sizes (Carter et al., 2006; Carter et al., 2005) or have relied on 'Western' instruments to measure child outcome (Msellati et al., 1993; van Rie, Mupuala, & Dow, 2008). In relation to the latter point, Alcock and colleagues (2007) have noted that the problem with using instruments not specifically developed for the population under study may result in data that suggest language delay or demonstrate lack of sensitivity to individual differences in the population of interest. Whilst some earlier studies have compared the rates of development of speech among different language groups (Demuth, 1990; Suzman, 1987), others have focussed on the influence of illness, nutritional supplementation and various environmental factors on various aspects of language functioning in children. And although other studies have reported the adaptation and use of measures of comprehension vocabulary among infants, pre-school and school-age children living in resource-constricted settings (Bortz, 1995; Holding et al., 2004; Pakendorf & Alant, 1997; Sigman, Neumann, Carter, et al., 1989), some of the measures were limited by their lack of sensitivity to brain injury at younger ages. As far as the literature search has revealed, we are not aware of any efforts to create a standardised assessment of expressive vocabulary for school-age populations in SSA.

In designing a vocabulary measure for rural school-aged children, context-specific cultural and language differences present translation difficulties. Hence it would not be valid to apply any of the available published measures, such as the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983). This study is unique in that assessment of expressive vocabulary among a school-age population has not been previously conducted in this setting. Considering how varied and complex language is, our study did not however seek to distinguish language delays and disorders; rather, we were more interested in describing variability in vocabulary acquisition as an important element of global cognitive functioning. Our primary purpose was to identify a list of words that would be useful in creating a measure of vocabulary development in a rural community of school-age children. Secondary aims were to establish the psychometric properties of the measure, examine sources of variability in vocabulary acquisition, and investigate associations between children's vocabulary scores and performance on measures of non-verbal reasoning and educational achievement.

## Method

The details of the study setting and sample are presented in Chapter 3.

### Study Setting

The study was conducted in Kilifi District, Kenya.

### Study Sample

The sample consisted of 308 boys and girls.

**Procedures**

**Test design.** In designing the test, we had a number of objectives – that the test would be: simple and quick to administer; require no specialised equipment; and, elicit clear, responses that are easy to record. We therefore developed a test similar to the BNT in terms of structure, administration and scoring that would be appropriate for school-age children (eight years and above). Different versions of the BNT have been widely used to investigate naming or word retrieval (Kim & Na, 2007; Miotto, Sato, Lucia, Camargo, & Scaff, 2010; Storms, Saerens, & Deyn, 2004). The BNT also provided an appropriate framework for length, and was used to suggest possible categories of words.

The KNT was developed following the 4-step systematic test adaptation procedure outlined by Holding and colleagues (2009). We first defined the construct after which we created the item pool. We then developed the procedure for administering the test and four assessors were trained in administration and scoring. In the fourth and final step, we evaluated the adapted schedule to ensure that the test was appropriate for the age for which it was intended. The details of this process are presented in Chapter 3.

In the KNT, the child is asked to spontaneously give one-word responses when presented with a black and white line drawing of a familiar object. All children were tested individually in a quiet room. Participants were administered the items in a standard order beginning with item 1. No time limits were imposed for responding. If a child provided the correct response, i.e. the name of the item written on the record sheet, the assessor recorded 'C' on the record sheet. A stimulus cue was provided when no response was given, the child stated that s/he did not know the name or the item was incorrectly perceived (e.g., if the child misperceived a saucepan as a cup, s/he would be given the cue that the item was used "for cooking"). If provision of a stimulus cue did not result in a correct answer, the word that the child provided was recorded verbatim as a non-target word response. If a child failed to correctly name any objects on six consecutive trials, the test was discontinued. Several children met the criteria for discontinuation. The test took between 10 and 20 minutes to administer. All responses were scored according to the standard single-word scoring key presented in the BNT response booklet. Multiple possible names for an item would make it difficult to score an item reliably so we developed a list of acceptable answers to score the test in order to reduce ambiguity in scoring. Credit was given for a correct answer even if it was in another language. All scoring was checked by the assessor who administered the test and by a second assessor. Any disagreements were resolved through discussions. A score of '1' was awarded for all correct responses. The final score was calculated by summing the number of spontaneously correct items and the number of correct items following a stimulus cue. The maximum possible score was 61.

**Test administration.** The expressive vocabulary test was administered as part of a

neuropsychological battery to a representative sample of 308 children. The battery included modified measures of various constructs including executive function, problem-solving, planning ability, verbal and working memory, attention, cognitive flexibility and non-verbal reasoning. The tests are described in detail in Chapter 3.

**Other measures.** In the test of non-verbal reasoning (CPM), the child was presented with a matrix of abstract patterns with one missing piece - six pieces with various patterns appeared below the matrix. Only one piece completed the missing pattern in the matrix. The child was required to complete each matrix by placing the correct piece in the empty space. A demonstration trial was administered where the assessor showed the child which of the six pieces completed the picture on the first sheet. For the next four matrices, if the child picked the wrong piece, the assessor explained why it was incorrect and then administered a second trial. The remainder of the items were presented only once. If the child did not get any of the items correct on the first set (Set A), the assessor stopped the test. All the children completed the first set. Three sets (A, B and C) with 12 matrices each were presented. The child's score was the total number correct.

We also administered tests of reading (letters, words and sentences) and arithmetic (written and oral) (Bhargava, Bundy, Jukes, & Sachs, 2001) to 145 children in our study sample in order to quantify school achievement. In the reading tasks, children were required to indicate their choice of real letters, words and sentences from a list which included fake letters, words and sentences. The arithmetic tests required the child to complete addition, subtraction, multiplication and division items as well as answer some questions orally. To obtain the school achievement score, we summed the scores across each of the tests.

We obtained information on sociodemographic characteristics using a structured interview form. Based on a composite index of maternal and paternal education and occupation, ownership of livestock and type of household windows, children were assigned to one of three categories of household resources (Level 1, Level 2 or Level 3). The development of this index is described in detail in Chapter 3.

**Analysis**

A descriptive analysis of the background characteristics, distribution of scores and pattern of response was conducted. An independent samples t-test was conducted to compare naming performance on the initial and final versions of the KNT. Item difficulty, defined as the percentage of correct responses for each item, was assessed to determine whether the items included on the test had appropriate difficulty levels (easy, medium, hard). Internal consistency reliability of the KNT was measured by Cronbach's alpha. Pearson product-moment correlation coefficients were computed to examine the relationship between the KNT and specific background variables (age, gender, school experience, area of residence, nutritional status and household resources) and between the KNT and measures of non-verbal reasoning (CPM) and

school achievement (reading and arithmetic). Mean differences in performance according to the background variables were assessed using independent samples t-tests and univariate analysis. Effect sizes were computed when background variables showed a significant association with child outcome. Regression analyses were conducted to determine the proportion of variance in naming performance accounted for by each of the background variables.

## Results

### Descriptives

A description of the study sample is presented in Table 1. Children who completed the initial version of the KNT had significantly higher scores ($M$= 35.03, $SD$ = 5.382; range 21-49; $N$ = 100) than those who completed the final version ($M$= 20.74, $SD$ = 8.368; range 1-45; $N$ = 208); $t(267_{\text{unequal variances}}) = 15.376$, $p<.001$. To correct for the differences in difficulty levels, the scores were standardised thereby enabling direct comparison of the scores. The z-scores of all children were normally distributed.

The total number of correct responses was counted for each of the items (Table 2). Overall, 59 out of 61 (97%) test items were named correctly by at least one child. An analysis of the pattern of responses demonstrated that on 20 items, less than 10% of the sample provided a correct response; on 28 items, between 10% and 62% of the sample provided a correct response while on 13 items, 63% and more of the sample answered correctly. All children accurately named 8 of the 61 items. None of the children responded correctly on 2 items. The KNT had a mean difficulty level of 0.58 ($SD$ = 0.37).

### Reliability and Validity

The KNT had an internal consistency reliability of .905 and a test-retest reliability level of .918. There was a weak correlation between the KNT and the school achievement score, r = .249 (p = .003). A moderate correlation, r =.464 (p < .001) was recorded between the vocabulary scores (KNT) and non-verbal reasoning (CPM).

### Associations with Background Characteristics

Univariate analysis of variance revealed significant differences in performance on the KNT according to various background factors (Table 3). There was a significant effect of gender with boys performing better than girls. Younger children had lower performance levels than those who were older. Children with growth retardation performed more poorly than those who did not. There was a tendency towards higher scores for those who had more schooling experience than those with less. The results indicated that there were no significant differences in performance according to household resources and area of residence.

### Multivariate Analysis

Significant correlations among background variables were generally small and ranged from -.300 to .427 (Table 4). Results from the regression analysis indicated that the overall model was statistically significant ($F$ = 12.521, $p$ = .000). Age, gender and school experience

were statistically significant predictors of vocabulary scores and together explained a significant proportion of variance in KNT scores, $R^2$ = .252 (Table 5); nutritional status, household resources and area of residence were not statistically significant.

## Discussion

The aims of the current study were to develop a psychometrically-sound measure of expressive vocabulary for use in a resource-constrained setting, examine sources of variability to test outcome and determine if there was an association between children's vocabulary scores and other outcomes (non-verbal reasoning and school achievement). In designing the KNT, we supplemented existing measures of language development (Carter et al., 2006; Carter et al., 2005; Holding et al., 2004) with words obtained from a survey of children's language. The KNT did not require reading and writing; this feature made it suitable for both schooling and non-schooling children. The test was short, relatively inexpensive and easy to administer without the need for specialised training and equipment.

It is imperative to point out some salient features of the setting within which the study was conducted as these may have had a covert influence on children's performance on the KNT. Traditionally as in most African societies, a child was expected to be obedient, quiet and undemanding in the presence of adults and talkativeness was frowned upon (Nyasani, 1997). Children could not initiate conversations and were taught to avoid asking adults questions as it would seem as though they were challenging them and attempting displays of superior knowledge. Adults rarely engage in any play activities with children (Mbise & Kysela, 1990) as most adult-child communication is for the purpose of giving instructions (Wenger, 1989). Given such a situation, we expected that children in the study would be reticent to respond to adult strangers in the testing situation. However, KNT scores showed a normal distribution providing evidence of sensitivity to within-population variance. The pattern of response demonstrated that levels of difficulty on the items ranged from low to moderate to high. Overall, the KNT had an adequate difficulty level in conformity with the requirement of an item difficulty index of approximately 0.5 on most test items to ascertain whether or not a test can distinguish those who know the correct responses and those who do not (L. C. Jacobs & Chase, 1992).

Results also indicated that the KNT had excellent internal consistency and test-retest reliability levels (George & Mallery, 2003). The positive and moderate correlation between vocabulary scores (KNT) and non-verbal reasoning (CPM) demonstrated evidence of convergent validity in accordance with earlier reports (Court & Raven, 1995; Storms et al., 2004). We expected that vocabulary scores would correlate strongly with academic performance as established in previous studies among low-income children living in similar (Sigman, Neumann, Carter, et al., 1989) and different contexts (Hemphill & Tivnan, 2008) – however, our tool only demonstrated marginal concurrent validity with educational achievement

scores. Our findings may be related to differences in the manner in which children's competencies were conceptualised in the earlier and current studies. For instance, in the study conducted by Sigman and colleagues, children's cognitive scores were derived through the summation of scores obtained on tests of verbal comprehension and performance abilities while in the current study, we used vocabulary scores alone. And whereas school achievement of children in our study was based on scores obtained on both reading and arithmetic tests, Hemphill and Tivnan only measured early letter and word reading skills in their study.

Beyond simply reporting the development of a measure of expressive vocabulary for school-age children, the current study's major contribution is the examination of the sources of variability in naming performance. Older children performed better than those who were younger in line with what has been reported in other studies among both infant (Githinji, 2011) and school-age populations living within a similar context. Reports from studies among school-age children living in a different context also present a similar picture (Storms et al., 2004). These age-related differences in vocabulary scores suggest that naming ability improves as children mature and with increased exposure, they acquire more vocabulary.

Second, although the effects of gender were evident in the current study, the existing body of literature that has examined similar outcomes reports contradictory patterns of performance. Boys in the current study performed better than girls. This finding is congruent with other reports of school-age populations where males scored significantly higher than females on tests of verbal abilities (Ardila & Rosselli, 1994; Storms et al., 2004; Wachs et al., 1995) but contrasts findings of other studies which have reported superior performance among girls (Hamadani et al., 2010). Although we did not establish gender parity of the items included in the measure, it may be speculated that boys performed better than girls because of a gender bias in the items presented, or in the categories from which items were derived. The possibility of a bias in the categories used has been suggested in earlier studies (Alcock, Holding, Mung'ala-Odera, & Newton, 2008). Although our items may have been biased, as has been reiterated earlier, it is very difficult to obtain pictures that are familiar to children within this setting. Limitations in financial and personnel resources make it difficult to produce a reliable alternative.

Third, the findings of the current study demonstrated the role of school exposure in a predominantly non-literate setting, where universal provision of opportunities for formal education is not guaranteed. The positive effects of school exposure on vocabulary acquisition have also been reported in other studies within similar contexts (Alcock et al., 2008; Carter et al., 2005; Sigman, McDonald, Neumann, & Bwibo, 1991). The experience of schooling may foster certain cognitive styles (Sigman, Neumann, Carter, et al., 1989; Sinha & Misra, 1982) and promote knowledge of common and uncommon objects (Strauss, Sherman, & Spreen, 2006). The testing format may also closely mimic the requirement of following instructions that

children who go to school are exposed to, thus making them more confident in responding to test items than their counterparts who have never been to school.

Fourth, in the univariate analysis, poorer nutritional status was associated with lower language scores. Wachs (1995) and Grantham-McGregor and others (2007) have made similar conclusions in a review of studies on the relation of malnutrition to human development – that chronic malnutrition is associated with a variety of cognitive deficits in school-age children. Risk factors related to poverty frequently co-vary (Grantham-McGregor et al., 2007) and in the current study, the association recorded between nutritional status and the measure of household resources could be a marker for environmental conditions. Previous studies of poorly resourced contexts have also reported a strong association between children's nutritional status and socioeconomic conditions (Kanjilal, Mazumdar, Mukherjee, & Rahman, 2010; Sigman, Neumann, Carter, et al., 1989). A major problem of the current and previous studies is the difficulty of controlling for potential confounders in order to determine the unique contribution of co-existing adverse environmental factors that have a negative effect on child outcome.

There was no association between household resources, our representation of SES, and vocabulary scores. Earlier reports have also established the lack of significant associations between SES and other cognitive outcomes (Kitsao-Wekulo et al., 2012). However, our finding contrasts other studies in both non-Western and Western contexts which report superior performance among children from households with more resources at their disposal compared to their peers from poorly-resourced households (Ardila & Rosselli, 1994; Hart & Risley, 1995; Hoff, 2003; Sigman et al., 1991; Sigman, Neumann, Carter, et al., 1989; Whaley, Sigman, Beckwith, Cohen, & Espinosa, 2002). The relatively homogeneous distribution of resources among households within the current study setting may possibly explain our null findings.

Our neighbourhood variable was represented by the locality of the school. This variable did not seem to significantly impact children's vocabulary scores as there were no significant differences between those living in the peri-urban area and their peers in rural areas. This lack of differences in performance may be attributed to several possibilities. For one, perhaps differences in the various neighbourhood settings were too subtle to create any real differences in children's performance (Fotso, Holding, & Ezeh, 2009). Secondly, this variable may not have been well quantified in the current study. Our classification of children under different neighbourhood settings may therefore be more a reflection of other characteristics rather than neighbourhood advantage.

In the multivariate analysis, the effects of nutritional status disappeared as only age, gender and school experience remained significant, accounting for a considerable proportion of the variance observed in vocabulary scores. The school setting however explained the biggest proportion of this variation. Other studies within similar contexts (Sigman et al., 1991; Sigman, Neumann, Carter, et al., 1989) have reported that nutritional adequacy, duration of schooling

and family economic resources accounted for much of the variability seen in children's scores. The overlap between the current study and previous studies seen only in terms of schooling exposure may point to regional differences in the influence of contextual factors even within similar settings, or to differences in the characterisation of the measure of family socioeconomic and educational resources. These factors may contribute to the differences seen in performance among children, demonstrating that individual variation in vocabulary scores arises within the context of factors which are both proximal (such as age and gender) and distal (such as household wealth) to the child. The lack of significant effects of nutritional status on outcome, where these have been reported in earlier studies, suggested the need for further investigation on the role of nutritional status within the current study context. We therefore tested a model with nutritional status as a mediator to determine if nutritional status remained an important influence at this age; the results of this analysis are reported in a later chapter (see Chapter 7 on the mediating role of nutritional status).

The study context posed several challenges to the assessment of vocabulary acquisition in children. Limited skills and resources, limited African empirical literature and lack of validation studies from elsewhere all contribute to this situation. Standardised tests are designed to be administered by specially trained professionals and much expertise is required for scoring and interpretation. We put in place a rigorous training programme to ensure that standardised procedures were followed during administration and scoring of the test. Secondly, similarly to Barker-Collo's (2001) conclusions in her study of New Zealanders, we can surmise that while the modifications made to the KNT resulted in a test that was more culturally valid within a rural African context, it is unlikely that any single test version will be culturally appropriate to the diverse linguistic groupings within the larger society. These challenges notwithstanding, we were able to develop a test that allows large-scale screening of children to identify those in need of further specialised assessments.

In interpreting our test results, we took various contextual factors which appear to be important influences on performance, into account. However, while earlier studies (Kitsao-Wekulo et al., 2012) have demonstrated that the patterns of influence and strength of these relationships may differ even within similar contexts, some of the relationships were common across several outcomes whereas others were specific to expressive vocabulary. Furthermore, improving the measurement of variables such as neighbourhood advantage may elucidate the contribution of other salient factors. Knowledge about these contextual variables is vital to the accurate interpretation of test scores.

Our study took multilingualism into account – we made provisions for responses in more than one language. This should be replicated in other contexts in SSA where children grow up using more than one language (Alcock et al., 2008) as they are likely to pick up vocabulary terms in more than one language. We also recommend longitudinal studies to elucidate cause-

effect relationships between antecedent factors and outcome variables. Furthermore, applying the tool on a clinical population will extend its utility by providing sensitivity data to allow early identification and remediation of problems associated with vocabulary development in children. We suggest the additional analysis of types of errors which can help establish if one's ability to correctly name a target item is related to brain function or to environmental exposures. We believe that our study findings provide preliminary evidence for the range of scores that we should expect from typically developing children. These findings are important for development of normative tables which will be a significant contribution for researchers and professionals in the child development field. In the next paper, the change and stability in influences on the vocabulary development of infants is discussed.

Table 1

*Description of the School-age Study Sample, N = 308*

| Variables | | N (%) |
|---|---|---|
| Gender | Female | 160 (51.9) |
| | Male | 148 (48.1) |
| Age (years) | ≤ 8.0 | 72 (23.4) |
| | 8.5 - 9.0 | 108 (35.1) |
| | ≥ 9.5 | 128 (41.6) |
| | Range | 5.00-13.50 |
| | M (SD) | 9.08 (1.12) |
| Growth retardation | Present | 74 (24.0) |
| | Absent | 234 (76.0) |
| | Range | -4.81 – 2.12 |
| | M (SD) | -1.32 (1.03) |
| School experience | None | 35 (11.4) |
| | 1-2 years | 101 (32.8) |
| | >2 years | 172 (55.8) |
| | Range | 0-7 |
| | Mean (SD) | 2.72 (1.69) |
| Household status | Level 1 | 123 (39.9) |
| | Level 2 | 94 (30.5) |
| | Level 3 | 91 (29.5) |
| Residence | Rural | 245 (79.5) |
| | Peri-urban | 63 (20.5) |

Table 2

*Total Number and Proportion Correct of Selected KNT items, N = 308*

| Item number | Target word | Total correct (n) | Proportion correct (%) |
|---|---|---|---|
| 59 | Sail | 6 | 1.9 |
| 58 | Anchor | 9 | 2.9 |
| 47 | Horn | 9 | 2.9 |
| 31 | Adze | 12 | 3.9 |
| 56 | Mat coil | 16 | 5.2 |
| 55 | Torch | 18 | 5.8 |
| 28 | Pipe | 19 | 6.2 |
| 48 | Xylophone | 20 | 6.5 |
| 34 | Udder | 25 | 8.1 |
| 32 | Traditional pot holder (*kata*) | 29 | 9.4 |
| 5 | Adam's apple | 29 | 9.4 |
| 26 | Traditional sieve (*kifumbu*) | 35 | 11.4 |
| 52 | Gutter | 36 | 11.7 |
| 37 | Pilot | 47 | 15.3 |
| 50 | Turtle | 54 | 17.5 |
| 43 | Ring | 65 | 21.1 |
| 39 | Lobster | 67 | 21.8 |
| 53 | Jingles | 70 | 22.7 |
| 45 | Drummer | 90 | 29.2 |
| 40 | Owl | 92 | 29.9 |
| 44 | Guinea fowl | 97 | 31.5 |
| 41 | Earrings | 102 | 33.1 |
| 60 | Praying mantis | 108 | 35.1 |
| 38 | Turkey | 114 | 37.0 |
| 49 | Fish scales | 130 | 42.2 |
| 35 | Hooves | 146 | 47.4 |
| 51 | Snail shell | 147 | 47.7 |
| 4 | Eyebrows | 150 | 48.7 |
| 36 | Hump | 155 | 50.3 |
| 42 | Horse | 163 | 52.9 |
| 3 | Elbow | 171 | 55.5 |
| 46 | Mat | 181 | 58.8 |
| 10 | Traditional skirt (*hando*) | 172 | 55.8 |
| 54 | Charm | 197 | 64.0 |
| 27 | Desk | 228 | 74.0 |
| 30 | Trap | 230 | 74.7 |
| 29 | Leaf | 259 | 84.1 |
| 17 | Traditional ladle (k*ipawa*) | 271 | 88.0 |
| 24 | Maize | 276 | 89.6 |
| 33 | Tail | 292 | 94.8 |
| 13 | Door | 292 | 94.8 |
| 20 | Cat | 297 | 96.4 |
| 18 | Cup | 298 | 96.8 |
| 8 | Tap | 303 | 98.4 |
| 14 | Ball | 306 | 99.4 |

Table 3

*Differences in Performance According to Background Characteristics*

| Variable | *df* | *t* | Cohen's *d* | *p* |
|---|---|---|---|---|
| Gender | 306 | 2.937 | .34 | .004 |
| Nutritional status | 306 | -2.627 | -.34 | .009 |
| Area of residence | 306 | -.788 | -.11 | .431 |

| | *df* | *F* | $\eta^2$ | *p* |
|---|---|---|---|---|
| Age | 2 (305) | 12.674 | .08 | .000 |
| School exposure | 2 (305) | 27.777 | .15 | .000 |
| Household resources | 2 (305) | .890 | - | .412 |

Table 4

*Correlations among Background Variables and KNT z-scores*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Area of residence | - | -.012 | -.025 | .313** | .130* | .135* | .045 |
| 2. Gender | | - | .019 | -.084 | -.006 | -.067 | -.166** |
| 3. Age | | | - | .041 | -.300** | -.240** | .318** |
| 4. School exposure | | | | - | .272** | .391** | .427** |
| 5. Nutritional status | | | | | - | .146* | .127* |
| 6. Household resources | | | | | | - | .048 |
| 7. KNT z-score | | | | | | | - |

**Correlation is significant at the 0.01 level (2-tailed)

*Correlation is significant at the 0.05 level (2-tailed)

Table 5

*Significant Predictors of KNT Scores*

| Predictor | *B* | *SE* | *t* |
|---|---|---|---|
| *Constant* | -1.374 | .213 | -6.441** |
| Area of residence | -.117 | .128 | -.916 |
| Gender | -.209 | .101 | -2.072* |
| Age | .779 | .135 | 5.772** |
| School exposure | 1.215 | .181 | 6.722** |
| Wealth index | -.024 | .132 | -.182 |
| Nutritional status | .235 | .124 | 1.897 |

DF = 298, *$p$<.05, **$p$<.001

## Paper 2. Examining Sources of Variability in Language Outcomes in Infancy: Stability and Change across Time

### Introduction

Previous studies among infants report remarkable variations over the first few years of a child's life characterised by rapid changes in several areas of development, such as vocabulary competence (Hoff, 2009). Early vocabulary in itself, is a major predictor of subsequent child functioning across several spheres, including academic (R. C. Anderson & Freebody, 1981), cognitive and social development. Even during the infancy stage, children of the same age show substantial differences in vocabulary production due to various background influences. Sources of variability in vocabulary scores in early childhood, which include both child-related and environmental factors, therefore need to be examined in context.

In line with Bronfenbrenner's bioecological theory, more proximate factors will have a stronger impact than distal factors. Proximal factors, those closer to the child, include age and gender, while distal factors include parental education and occupation, as well as household wealth. The influence of child variables such as age and gender on vocabulary has been reported in the literature. For instance, the effects of child maturation are seen in sharp increases in vocabulary development towards the age of 2 years (Hamilton, Plunkett, & Schafer, 2000). However, the exact course of this process is not very clear as vocabulary scores may or may not always vary linearly with age (Hamilton et al., 2000; Huttenlocher et al., 1991; Pan, Rowe, Singer, & Snow, 2005; Rowe, Raudenbush, & Goldin-Meadow, 2012). Some words which are acquired at younger ages may continue to be part of children's vocabulary as they mature (Huttenlocher et al., 1991); others may enter the vocabulary with time; still, other words may never form part of a child's vocabulary at any age (Mallikarjun, 2002). With regard to gender, a slight advantage consistently reported for girls in early vocabulary development (Fenson et al., 1994) may reflect differences in brain maturation or socialisation according to gender.

Environmental variables have also been related to child language development. Family socioeconomic factors have consistently been shown to have a positive association with children's vocabulary size (Hart & Risley, 1995) as children from low-income households may produce fewer vocabulary items than their counterparts from better off households. Older mothers may differ from younger mothers in the communicative patterns of interaction, resulting in higher vocabulary scores among their children (Culp, Osofsky, & O'Brien, 1996). Furthermore, low maternal age is considered a marker for socioeconomic disadvantages in educational and employment opportunities (Moore & Snyder, 1991), which may mean that the children of such mothers have limited opportunities for stimulation of their vocabulary development. Similarly to maternal age, children of mothers with higher levels of education (Hart & Risley, 1995; Hoff-Ginsberg & Lerner, 1999) may show more advanced vocabulary

skills than their counterparts with less educated mothers. Higher levels of fathers' education have also been linked to more advanced child language skills (Pancsofar, Vernon-Feagans, & Investigators, 2010).

While the evidence documenting the influence of background variables on infants' vocabulary development in Western settings is abundant, there is a paucity of similar data on populations in rural non-Western contexts, particularly in sub-Saharan Africa. Earlier studies conducted in sub-Saharan African settings, are concerned with other aspects of language development. Much of what is known about language in resource-poor settings relates to the influence of specific social contexts (Childers, Vaughan, & Burquest, 2007) as well as individual behaviours (Mastin & Vogt, 2011); sequelae of severe encephalopathy (Carter, Murira, Ross, Mung'ala-Odera, & Newton, 2003); and, early production of various speech forms (Alcock, Rimba, & Newton, 2012; Alcock, Rimba, Tellaie, & Newton, 2005).

Understanding the sources of variability within our settings is of relevance to research and health professionals in early child vocabulary development, as this information is useful in identifying meaningful points of intervention. A longitudinal study was therefore conducted among infants to examine the role of child-related (gender and nutritional status) and demographic factors (maternal age, parental education and occupation and home ownership) in vocabulary development. Through the current study, we sought to establish the pattern of change in infants' vocabulary scores as well as the influence of various background variables on vocabulary scores across time.

## Method

Detailed descriptions of the study setting and sample are presented in Chapter 3.

### Study Setting

The study was conducted in Msambweni district, a rural locality within the Coast Province of Kenya.

### Study Sample

The sample consisted of 231 infants who were assessed over the three time points, at 12, 18 and 24 months.

### Data Collection Procedures

**Vocabulary measure**. We relied on parental report to obtain information on children's vocabulary. Communicative Development Inventories (CDIs) are parent-completed checklists which ask parents to report which of a list of words is closest to what their child produces and/or understands at that moment in time. They rely on parent knowledge of their child's current and emerging language and communication skills but do not rely on long-term memory of the child's behaviour (Fenson et al., 1993). Parent report measures are preferred because they are inexpensive to administer and administrators do not require much training (Pan, Rowe, Spier, & Tamis-LeMonda, 2004). Furthermore, because parents, especially mothers, observe

and interact with their infants and toddlers in a variety of contexts on a daily basis, they are more likely to understand the less than perfectly articulated words that their children produce (Pan et al., 2004). Triangulation of data from various sources has revealed that parent reports provide a rich and valuable source of information on infants' vocabulary development in both low- and medium-income families (Hamilton et al., 2000; Pan et al., 2004). The MacArthur Communicative Development Inventories originally named the *CDI Infants* and the *CDI Toddlers* to cater for children in the age ranges of 8 – 30 months were used in the current study. The Infant form has been formally renamed the *CDI: Words and Gestures* and the Toddler form, the *CDI: Words and Sentences* (Fenson et al., 1994). The Infant form is designed for use with 8-16-month-old children while the Toddler form is for children aged between 16 and 30 months. Details of the process followed in adapting the CDIs for the current study context are presented in Chapter 3. In the current study, infants were tested at 12, 18 and 24 months using locally validated CDI measures.

**Background variables.** Information on background variables was used to determine the person characteristics of the child and the distal context factors which influence child development.

***Child variables.*** Information on child age and gender was obtained from the mother. Weight-for-age, height-for-age and weight-for-height z-scores were computed using the WHO Anthro software (World Health Organization, 2010) and index values of less than -2.00 SDs below the mean were used to identify underweight, stunted and wasted children.

***SES variables.*** Information on maternal age, marital status, provision of support, parental education, parental occupation and living arrangements was obtained from mothers through a structured interview.

**Analysis**

Descriptive statistics were used to provide details about the sample characteristics. Internal consistency reliability was established with the Intraclass Correlation Coefficient (ICC). Means, medians and standard deviations were used to describe test score distributions. Inter-correlations of test scores at 12, 18 and 24 months were used to establish the association between earlier and later vocabulary production.

To identify correlates of language development at each time point, I first identified child characteristics pertaining to proximal influences (child gender and anthropometric status), key variables that reflected maternal demographics (maternal age and partner's contribution) and other more distal influences such as household socioeconomic status (parental education and occupation and home ownership). I fit separate, univariate models between each of these variables and CDI scores at 12, 18 and 24 months. Effect sizes were measured using partial eta squared.

In the multivariate analysis, I constructed regression models that included all variables

that had effect sizes of .01 or more in the univariate analysis. Using the stepwise method, the best predictors were entered into the model until no more variables met the entry criteria. Given the potential for collinearity between the anthropometric measures, I included stunting (HAZ) and wasting (WHZ), but not underweight (WAZ) in the multivariate model if all three variables had effect sizes ≥ .01 in the univariate analysis. (Stunting and wasting reflect chronic and acute undernutrition, respectively, but underweight does not distinguish between the two and is correlated with both). Creation of dummy variables for categorical variables with more than two categories (maternal age, maternal and paternal education, maternal and paternal occupation and home ownership) preceded this analysis. Significance was based on a *p*-value of < 0.05.

## Results

### Descriptive Statistics

A summarised description of the sample is presented in Table 6.

**Child variables.** A total of 231 children were assessed with nearly equal proportions of boys (n = 113, 48.9%) and girls (n = 115, 49.8%). Across the three time points, children's mean ages were 12.2 (*SD* = .31, range: 11.56 – 14.09), 18.1 (*SD* = .32, range: 16.72 – 19.08) and 24.1 (*SD* = .29, range: 23.46 – 25.82).

At 12 months, 14.3% (n = 33) were stunted, 7.4% (n = 17) of the children were wasted, while 9.5% (n = 22) of the children were underweight. Two children had both wasting and stunting. Mean levels of wasting, stunting and underweight were -.26 (*SD* = 1.3), -.68 (*SD* = 1.24) and -.53 (*SD* = 1.17), respectively.

**SES variables.** The majority of mothers were aged between 20 and 34 years. A large proportion of caregivers reported that they received support for upkeep from their partners. More than 60% of mothers and approximately 40% of fathers reported having no education. Unemployed mothers constituted slightly more than half the sample. Nearly 40% of fathers were employed at Level 1. More than half the sample lived in their own houses.

### Reliability and Inter-correlations of CDI Scores

Internal consistency reliability levels of the CDI measure were high, with an alpha value of .95. Moderate correlations were seen between CDI scores at 12 and 18 months, $r(170) = .48$, $p < .001$, and between 18 and 24 months, $r(160) = .47$, $p < .001$. The correlation between scores at 12 and 24 months was positive but weak, $r\ (170) = .29$, $p < .01$.

### Distribution of CDI Scores

Results of children's productive vocabulary scores, sentence production and total CDI scores are summarised in Table 7.

**Productive vocabulary.** The median number of words produced by the children in the current study was 38 at 12 months, 37 at 18 months and 102 at 24 months. This finding suggested that productive vocabulary decreased slightly with age between 12 and 18 months, and then increased sharply between 18 and 24 months. Mean productive vocabulary increased

slightly from 14.7 to 20.0 between 12 and 18 months. A sharp increase to a mean productive vocabulary of 82.9 words was recorded by the time children were 24 months.

**Sentence production.** At 18 months, more than two-thirds of the caregivers (67.7%) reported that their children had not yet started combining sentences into words. We did not therefore perform any further analysis on this section of the CDI Toddlers. At 24 months, 83.6% (n = 168) of the children had started combining words into sentences; 26.4% (n = 53) of the children rarely combined words, 17.4% (n = 35) combined words sometimes while 39.8% (n = 80) combined words all the time. The number of words in each sentence ranged from 2 – 4.

**Total scores.** Mean total scores decreased slightly from 41.8 (*SD* = 20.0, Range: 2 - 118) at 12 months to 41.4 (*SD* = 20.6, Range: 4 - 130) at 18 months. This figure increased sharply to 96.7 (*SD* = 28.9, Range: 28 – 183) at 24 months.

**Correlations with Background Characteristics**

At 12 months, home ownership was negatively associated with CDI scores, $r(211) = -.159$, $p = 021$. At 18 months, maternal education was positively but weakly associated with CDI scores, $r(184) = .218$, $p = 003$. At 24 months, wasting, $r(177) = .197$, $p = 009$ and paternal education, $r(186) = .159$, $p = 031$ were significantly associated with vocabulary scores.

**Effects of Background Characteristics**

Child and SES variables showed varying associations with CDI scores across the three time points. These results are summarised in Table 6. Effect sizes of these differences are depicted in Figure 3.

**Child variables**

***Gender.*** Gender effects revealed a consistent pattern across ages with girls scoring slightly higher than boys. However, these differences were not statistically significant. Furthermore, effect sizes across all ages were small ranging between .002 and .012.

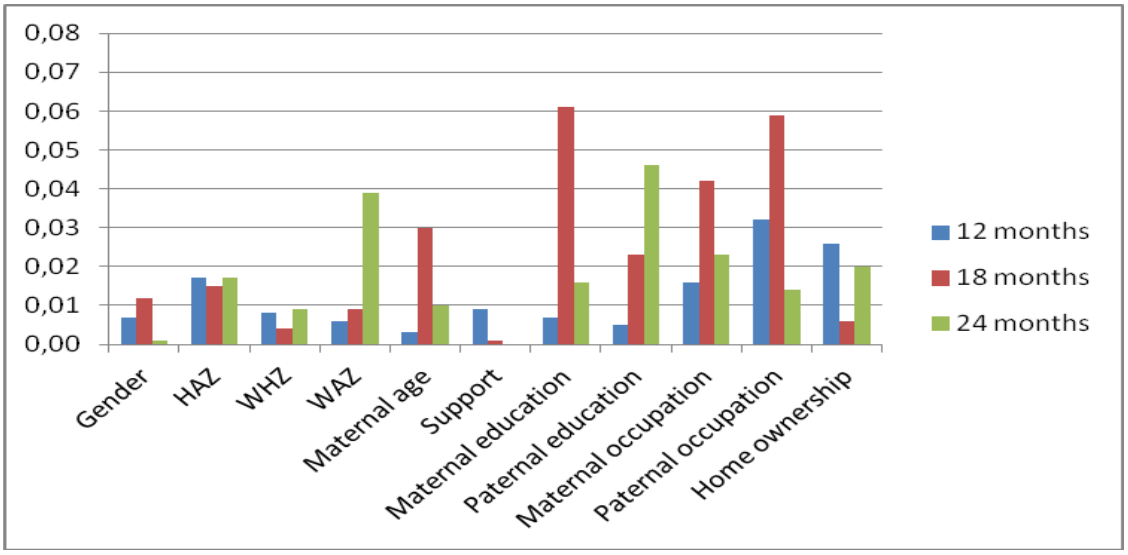
***Nutritional status.*** Children with stunting had lower scores at all ages than those who did not – and the differences were marginally significant. Effects sizes were small and ranged from .015 to .017. Across the three time points, children who were wasted also had lower scores than those who did not, but effect sizes were small and the differences were not significant.

Children with underweight had lower scores than their counterparts without across all ages. These differences were however not significant at 12 and 18 months and effect sizes were small (.006 - .009). At 24 months, differences in CDI scores were statistically significant, $F(1, 175) = 7.04$, $p = .009$, with a medium effect size ($\eta_p^2 = .039$).

**SES variables**

***Maternal age.*** Children of mothers aged between 20 and 34 years had the highest scores at 12 and 18 months. At 24 months, CDI scores increased with maternal age. At 12 and 24 months, these differences were non-significant, but approached significance levels at 18 months. Effect sizes were highest at 18 months (.028).

*Figure 3.* Effect sizes of associations between background variables and CDI scores




***Support for upkeep.*** Children whose mothers reported that they did have partners or did not receive any form of support from their partners had higher scores at 12 and 18 months, but not at 24 months. However, these differences were not significant and effect sizes across all ages were small (<.010).

***Maternal education.*** At 12 months of age, children of mothers with between 8 and 11 years of education had the highest scores. CDI scores increased with higher maternal education levels at 18 and 24 months. However, differences in CDI scores were significant only at 18 months where medium effect sizes were also recorded ($\eta_p^2$ = .061).

***Paternal education.*** The pattern of change in CDI scores according to paternal education was similar to that seen for maternal education. At 12 months, children whose fathers had between 8 and 11 years of education had the highest scores. At 18 and 24 months, CDI scores increased with higher paternal education. These differences were however significant only at 24 months with a medium effect size of .041.

***Maternal occupation.*** Children whose mothers had occupations at Level 1 had the highest scores at 12 and 18 months, while at 24 months, those at Level 3 had the highest scores. Small effect sizes were seen across all the ages (.013 - .032) and differences were not significant.

***Paternal occupation.*** A mixed pattern of performance on the CDI according to paternal occupation was seen. At 12 months, children of fathers who were in Level 3 occupations had the highest scores. At 18 months, children of fathers with no employment had the highest scores while at 24 months, children of fathers with Level 2 occupations had the highest scores. Differences according to paternal occupation were significant only at 18 months, $F(3, 185) = 3.72$, $p = .013$, and medium effect sizes were recorded ($\eta_p^2$ = .057).

***Home ownership.*** Children whose parents lived as tenants or squatters had consistently

higher scores across all ages. These differences were nearly significant at 12 months and effect sizes across all ages were small ranging from .006 - .027.

Overall, the trend observed in the magnitude of effects demonstrated that at 12 months, paternal occupation and home ownership were the most important background influences on child language scores. At 18 months, maternal age, maternal education, maternal and paternal occupation were important variables to consider, while at 24 months, WAZ, maternal occupation and paternal education had note-worthy effects on infant CDI scores.

**Multivariate Results**

The first model regressed CDI scores at 12 months on the variables for HAZ, maternal and paternal occupation, and home ownership. The final model (Model 4) was highly significant, $F(4, 161) = 7.152$, $p < .001$. HAZ, maternal occupation and paternal occupation together accounted for 15.1% of the variance observed on CDI scores.

The second model regressed CDI scores at 18 months on the variables for gender, HAZ, WAZ, maternal age, maternal and paternal education and maternal and paternal occupation. The final model (Model 4) was also highly significant, $F(4,169) = 6.558$, $p < .001$. WAZ, maternal age, maternal and paternal occupation together explained 13.4% of the variance observed in test scores.

The third model regressed CDI scores at 24 months on the variables for HAZ, WAZ, maternal and paternal education, maternal and paternal occupation and home ownership. The final model (Model 1) was significant, $F(1,149) = 11.575$, $p = .001$. Underweight alone accounted for 7.2% of the variance observed in test scores. The results of the regression analyses are presented in Tables 8, 9 and 10.

## Discussion

The current study reports the stability and change in CDI scores among a rural infant population at the Coast of Kenya, highlighting important variables to consider at each time point. In order to avoid validity issues that may have arisen over assessment of children growing up in bilingual households, we administered the vocabulary measure in both languages that were used by children in this study context. The variability observed at different time points to the varying effects of diverse influences as children become older.

**Background Characteristics**

The sample was fairly evenly distributed in terms of gender, a reflection of national demographics (Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010). While the proportion of children in the sample who were wasted was comparable to national levels, it was lower than district levels. On the other hand, the proportions of those who were stunted and those who were underweight were much lower than both district and national levels (Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010). A high proportion of mothers was aged between 20 and 34 years; given that anecdotal reports suggest that mothers within this

context give birth at a young age, it was expected that the majority of them would be young. The proportion of mothers and fathers with no education was twice that reported at district levels (Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010), a pointer to the low literacy levels reported within this study context. This situation necessitated administering the CDI as an oral interview rather than as a parent-completed checklist. Due to poor education levels, unemployment levels, especially among women were high.

**Reliability**

The CDI measure demonstrated high reliability levels in line with earlier studies reporting the application of the tool within contexts that are different from the one the tool was originally developed for (Alcock et al., 2014; Berglund & Eriksson, 2000). The associations among scores at the various ages pointed to the possibility that scores at earlier ages were predictors of scores at later ages.

**Distribution of CDI Scores**

The analysis of overall vocabulary production at each time point was a measure of the stability or change in expressive vocabulary of infants. Across the different time points, our data demonstrated continuity between early and later vocabulary between 18 and 24 months when expressive vocabulary scores increased dramatically. That production vocabulary showed a rapid increase toward the end of the second year is in line with what Fenson et al. (1994) and Hamilton et al. (2000) reported in their studies of American and British children, respectively. This finding supports the notion of the often-cited 'vocabulary spurt' at 2 years of age (Goldfield & Reznick, 1990; Reznick & Goldfield, 1992). On the other hand, our findings contrasted those of Roberts and colleagues (1999) who found that children's raw scores on the CDI increased linearly with age up to 2 years.

That children had started combining words into sentences after the age of 18 months supports evidence from earlier studies that between the ages of 18 and 20 months, toddlers combine two or more words into simple utterances (Tomasello & Bates, 2001). This finding illustrates that even in a resource-constricted setting with possible limitations in the support offered for children's development, children's vocabulary shows the expected pattern of growth, demonstrating the universality of vocabulary development.

**Effects of Background Characteristics**

**Child variables**

***Gender.*** In partial support of the findings of Feldman and colleagues (2000), we found that girls had higher CDI scores than boys at all three time-points even though the differences between boys and girls within individual age groups were insignificant and effect sizes were small. Some studies suggest that gender effects on vocabulary size become significant after the age of 24 months (Eriksson, 2006), and this may explain the lack of significant gender differences in the current study sample.

***Nutritional status.*** Our study demonstrated that children who did not receive proper nutrition suffered deficiencies in test scores across all ages. This may be directly attributed to poor structural and functional development of the brain, or indirectly to non-stimulating caregiver behaviour and less than optimal interaction with the environment by the child (Prado & Dewey, 2012). Our findings further show evidence that the negative effects of underweight on children's vocabulary persisted, becoming stronger at older ages. We speculate that the effects of underweight are amplified at older ages due to the increasingly common practice within the study context of leaving young children under the care of slightly older siblings. These older siblings may not provide the most optimal care, especially in terms of hygienic and satisfactory feeding practices.

**SES variables**

***Maternal age.*** The effects of maternal age varied across children's ages; it should be noted though, that these differences were not significant. The non-significance of these findings is similar to what some studies among low-income families have reported (Pan et al., 2004). Contrary to the current study findings however, other studies report that for children within this age range, those whose mothers are younger have lower vocabulary scores than their counterparts with older mothers (Moore & Snyder, 1991). Others have reported the reverse; that children of younger mothers spoke more words than those with older mothers (Westerlund & Lagerberg, 2008). The lack of significant associations as well as the inconsistent patterns observed in the current study in relation to the findings of other studies may reflect differences in the manner in which information on maternal age was obtained. The current study measured maternal age at the time of the current child's birth while other studies have measured maternal age at first birth. And as Westerlund and Lagerberg have noted, we cannot discount the possibility that children's vocabulary test scores were largely spurious since we relied on maternal report which is likely to introduce some bias in the findings. Our findings may also be related to the lack of a means to verify mothers' ages, as most did not have written birth records.

***Support for upkeep.*** Surprisingly, children of mothers who reported that they did not receive any support from their partners had higher scores than their counterparts whose mothers received support. Even though the net worth of female-headed households has been found to be significantly lower compared to other households (as there may be a relationship between female-headed households and poverty) (Appleton, 1996), our positive findings may be explained by the presence and support of other members of the extended family. Within a study context such as the current one where multiple caregivers are involved in raising the child, children are not disadvantaged by the absence of a father, whose role as provider and role model may be taken up by male members of the extended family. Furthermore, interactions between the child and members of the extended family may support the stimulation necessary for vocabulary development.

***Parental education.*** The pattern observed for the effects of maternal education on children's vocabulary scores was comparable to that of paternal education, suggesting that the effects of parental education are similar, regardless of which parent is educated. Children of more educated parents had higher productive vocabulary and the influence of parental education seemed to become stronger with an increase in child age. These findings corroborate those from earlier studies which report that maternal and paternal education are positively correlated with vocabulary scores in children (Bornstein & Haynes, 1998; Pancsofar et al., 2010). The effects of parental education on vocabulary scores may be related to the quality and quantity – more frequent use of diverse vocabulary terms – of the verbal interactions that more educated parents have with their children, as has been suggested by other studies (Hart & Risley, 1995).

***Parental occupation.*** An unexpected finding in the current study was that at 18 months, children of unemployed fathers had higher vocabulary scores than those who were employed. As such fathers are likely to spend long periods of time at home, this finding implied that the presence of the father in the house is an important influence on child vocabulary development; this may be even more so when the child has begun to be speech-fluent, and other people apart from the mother begin to be more involved with them. As other studies have suggested, (Pancsofar et al., 2010) fathers' involvement with their children during infancy is key as these interactions have important implications for vocabulary development.

***Home ownership.*** Even though the differences were not significant, the pattern of influence of home ownership on children's vocabulary scores was interesting. We expected that children of parents who lived in their own homes, an indication of high socioeconomic wealth, would have the highest scores, as has been reported by (de Paiva, de Souza Lima, de Carvalho Lima, & Eickmann, 2010). As this was not the case, we speculate that our contrasting findings may be related to the amount of disposable income available to parents living in rental houses, hence their ability to afford their children more opportunities for stimulation.

**Significant Predictors of Outcome**

The current study has highlighted the importance of considering the effect size of a difference, rather than the significance (p-value) when looking at the multivariate effects of various background influences on outcome, especially among at-risk groups. Results of the multivariate analysis suggest that predictors of outcomes vary with age, even within a restricted age-band like the one included in the current study. Child- and environment-related variables influenced outcomes at the various time points; however, they explained a very small proportion of the variance observed in test scores. At 12 months of age, nutritional status, together with maternal and paternal occupation were significant predictors of child vocabulary scores, suggesting that their effects were experienced proximally by the child. At this age, the scope of infants' environments is just beginning to expand and it would be expected that most of what shapes their experiences is within themselves or in their immediate surroundings.

At 18 months, the number of significant predictors was higher than at earlier ages but they explained a smaller proportion of the variance than that observed earlier. It may be speculated that, with the addition of maternal age to the predictors at earlier ages, these are the variables that are experienced proximally by the child. The enduring influence of underweight at older ages, points to the combined effects of wasting and stunting, and may be a result of poor weaning practices, and the less than optimal care when the care of infants is transferred to others within the household or community.

Inclusion of additional individual variables such as age of acquisition, and word attributes such as word frequency will enhance the investigation of influences on vocabulary scores at this age. In addition to those variables which demonstrated a note-worthy influence on test scores at each time point, we considered other additional influences, such as the proximal processes within the home environment, in the next stage of analysis. The results of this analysis are reported in Chapter 6.

Table 6

*Univariate Analysis of CDI Scores of the Infant Study Sample, 12, 18 and 24 Months*

| | 12 months | | | | 18 months | | | | 24 months | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gender | N | Mean (SD) | F (p value) | $\eta_p^2$ | N | Mean (SD) | F (p value) | $\eta_p^2$ | N | Mean (SD) | F (p value) | $\eta_p^2$ |
| Boys | 104 | 40.6 (19.5) | .926 (.337) | .004 | 93 | 39.0 (16.3) | 2.191 (.141) | .012 | 96 | 99.3 (31.2) | .339 (.561) | .002 |
| Girls | 107 | 43.3 (20.5) | | | 93 | 43.4 (24.0) | | | 102 | 102.0 (33.2) | | |
| Stunting (HAZ) | | | | | | | | | | | | |
| Present | 33 | 35.8 (16.1) | 3.452 (.065) | .017 | 46 | 36.9 (17.4) | 2.782 (.097) | .015 | 70 | 91.2 (27.7) | 3.09 (.081) | .017 |
| Absent | 171 | 42.8 (20.4) | DF (1,202) | | 133 | 42.7 (21.7) | DF (1, 177) | | 108 | 99.0 (29.6) | | |
| Underweight (WAZ) | | | | | | | | | | | | |
| Present | 22 | 37.1 (13.1) | 1.269 (.261) | .006 | 21 | 35.8 (12.3) | 1.622 (.204) | .009 | 17 | 78.6 (26.5) | 7.037 (.009) | .039 |
| Absent | 182 | 42.2 (20.6) | DF (1, 202) | | 158 | 41.9 (21.7) | (1,177) | | 160 | 98.0 (28.8) | | |
| Wasting (WHZ) | | | | | | | | | | | | |
| Present | 17 | 35.8 (11.4) | 1.592 (.209) | .008 | 13 | 36.3 (11.4) | .782 (.384) | .004 | 10 | 84.9 (33.7) | 1.573 (.211) | .009 |
| Absent | 187 | 42.2 (20.5) | DF (1, 202) | | 166 | 41.5 (21.3) | DF (1,177) | | 167 | 96.8 (28.8) | DF (1, 175) | |
| Maternal age | | | | | | | | | | | | |
| <20 yrs | 47 | 40.1 (21.4) | .286 (.752) | .003 | 40 | 34.7 (15.9) | 2.591 (.078) | .028 | 45 | 97.1 (32.0) | .469 (.626) | .005 |
| 20-34 | 142 | 42.7 (20.2) | | | 128 | 43.1 (21.3) | | | 133 | 101.6 (33.6) | | |
| >=35 | 15 | 42.5 (18.6) | | | 16 | 40.6 (23.1) | | | 15 | 105.2 (23.0) | | |
| Support | | | | | | | | | | | | |
| No | 15 | 48.7 (24.1) | 1.897 (.170) | .009 | 12 | 43.2 (24.7) | .119 (.731) | .001 | 13 | 98.2 (41.5) | .093 (.761) | .000 |
| Yes | 199 | 41.3 (19.7) | | | 177 | 41.1 (20.2) | | | 188 | 101.0 (31.3) | | |
| Maternal education | | | | | | | | | | | | |
| <8yrs | 130 | 40.7 (18.7) | .611 (.544) | .006 | 123 | 39.1 (17.9) | 5.909 (.003) | .060 | 121 | 97.9 (29.0) | 1.263 (.285) | .013 |
| 8-11yrs | 63 | 44.0 (22.4) | | | 51 | 41.3 (23.1) | | | 61 | 104.4 (36.2) | | |
| 12+ yrs | 20 | 42.8 (22.0) | | | 15 | 57.9 (24.1) | | | 19 | 107.3 (35.6) | | |
| Paternal education | | | | | | | | | | | | |
| <8yrs | 88 | 40.2 (17.7) | .420 (.658) | .004 | 82 | 39.1 (21.2) | 1.692 (.187) | .018 | 85 | 95.2 (29.8) | 4.23 (.016) | .041 |
| 8-11yrs | 75 | 43.1 (21.8) | | | 68 | 40.7 (19.5) | | | 75 | 100.6 (34.1) | | |
| 12+ yrs | 51 | 42.8 (21.3) | | | 39 | 46.4 (20.0) | | | 41 | 112.6 (29.4) | | |
| Maternal occupation | | | | | | | | | | | | |
| None | 116 | 41.2 (21.2) | .956 (.414) | .013 | 99 | 40.2 (20.0) | 2.052 (.108) | .032 | 106 | 101.5 (32.3) | .913 (.436) | .023 |
| Level 1 | 18 | 47.9 (22.8) | | | 17 | 51.2 (27.4) | | | 19 | 102.1 (44.9) | | |
| Level 2 | 69 | 40.4 (16.9) | | | 65 | 39.2 (18.6) | | | 66 | 97.1 (29.1) | | |
| Level 3 | 11 | 47.2 (22.3) | | | 8 | 48.9 (19.2) | | | 10 | 114.3 (11.0) | | |
| Paternal occupation | | | | | | | | | | | | |
| None | 28 | 42.9 (20.3) | 2.455 (.064) | .034 | 26 | 48.1 (26.9) | 3.718 (.013) | .057 | 27 | 99.7 (37.1) | .649 (.584) | .010 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Level 1 | 87 | 41.7 (21.2) | | | 75 | 39.7 (16.1) | | | 81 | 97.3 (31.9) | | |
| Level 2 | 53 | 36.6 (17.5) | | | 50 | 35.3 (18.8) | | | 52 | 104.2 (33.1) | | |
| Level 3 | 46 | 47.4 (19.6) | | | 38 | 47.1 (22.9) | | | 41 | 104.0 (27.1) | | |
| Home ownership | | | | | | | | | | | | |
| Tenant | 11 | 50.3 (28.2) | 2.964 (.054) | .027 | 8 | 48.5 (27.5) | .560 (.572) | .006 | 7 | 105.3 (23.5) | 1.255 (.287) | .013 |
| Family home | 95 | 44.3 (22.5) | | | 80 | 41.3 (20.9) | | | 92 | 104.3 (34.5) | | |
| Own home | 108 | 38.8 (16.2) | | | 101 | 40.5 (19.5) | | | 102 | 97.3 (29.9) | | |

Table 7

*CDI Scores at 12, 18 and 24 Months*

| | Comprehension | | | Production | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | 12 m | 18m | 24m | 12m | 18 m | 24 m | 12m | 18m | 24 m |
| N | 216 | 189 | 201 | 216 | 189 | 201 | 216 | 189 | 201 |
| Mean | 27.0 | 21.3 | 17.9 | 14.7 | 20.0 | 82.9 | 41.7 | 41.2 | 100.8 |
| SD | 15.32 | 11.98 | 13.27 | 10.83 | 19.6 | 39.68 | 20.11 | 20.44 | 31.98 |
| Minimum | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 28 |
| Maximum | 81 | 68 | 76 | 58 | 128 | 180 | 118 | 130 | 185 |

Table 8

*Significant Predictors of CDI Scores at 12 Months*

| Model 4 | Unstandardised Coefficients | | Standardised Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 43.859 | 1.884 | | 23.279 | .000 |
| HAZ_12m | 3.643 | 1.156 | .230 | 3.150 | .002 |
| Dummy 1 for maternal occupation | 14.183 | 4.938 | .211 | 2.872 | .005 |
| Dummy 2 for paternal occupation | -7.684 | 3.056 | -.184 | -2.514 | .013 |
| Dummy 3 for maternal occupation | 16.080 | 7.305 | .160 | 2.201 | .029 |

Table 9

*Significant Predictors of CDI Scores at 18 Months*

| Model 2 | Unstandardised Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 38.179 | 1.802 | | 21.187 | .000 |
| Dummy 1 for maternal occupation | 13.237 | 5.354 | .184 | 2.472 | .014 |
| Dummy 3 for paternal occupation | 8.115 | 3.860 | .156 | 2.102 | .037 |

Table 10

*Significant Predictors of CDI Scores at 24 Months*

| Model 1 | Unstandardised Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 92.643 | 8.267 | | 11.206 | .000 |
| Wasting | 18.136 | 7.185 | .184 | 2.524 | .012 |
| Dummy 1 for partner's education | -15.319 | 5.714 | -.262 | -2.681 | .008 |
| Dummy 2 for partner's education | -17.149 | 5.912 | -.283 | -2.901 | .004 |

CHAPTER 5: MOTOR DEVELOPMENT IN CHILDREN

## Paper 3: Determinants of Variability in Motor Performance in Middle Childhood: A Cross-sectional Study of Balance and Motor Co-ordination Skills

### Introduction

The processes that take place in gross and fine motor development allow children to explore the spatial properties of their environment and the functional properties of the objects in it. This exploration in turn facilitates general development and supports the achievement of healthy and independent functioning in everyday life. Poor motor proficiency, therefore, interferes with participation in physical and social activities and is likely to be associated with limitations in multiple spheres of development (Skinner & Piek, 2001).

As with many areas of development, motor skills follow a sequential and predictable pattern (Berk, 2006) that is comparable among children. However, differences in environmental context and in parenting strategies lead to observable precocity in African infants in early motor development (Leiderman, Babu, Kagia, Kraemer, & Leiderman, 1973). Little is known about the later influences upon variability in motor performance amongst a normal population of school-age children in the African setting. Attempts to develop culturally valid measures of psychomotor development or to establish normative standards for African children (Abubakar, Holding, et al., 2008; Gladstone et al., 2010) have focussed primarily on infants and preschoolers. The consequent lack of locally validated measures of motor development for school-age children may limit the reliability of measurement and lead to mis-classification of children (Connolly & Grantham-McGregor, 1993; van de Vijver & Tanzer, 2004). Given the widely reported precocity of motor development among African children (Super, 1976; Warren, 1972), existing norms for measures published in western settings may therefore not be appropriate. In addition, in the rural East African context and in similar settings, assessment protocols need to address the lack of available staff with previous assessment experience, limited resources for purchasing expensive published tests and equipment, and the issue of engaging children who are unused to standardized testing procedures.

Bronfenbrenner's bioecological model (Bronfenbrenner & Ceci, 1994) posits that a child's development is determined by both proximal and more distal influences. The rate of motor progress of healthy children is therefore susceptible to the influence of several interrelated factors and contributes to variability in motor skill proficiency (Lotz, Loxton, & Naidoo, 2005). These include internal (biological) factors such as gender and age (Largo, Fischer, & Rousson, 2003). Other background characteristics may impact motor development through their influence on experience, and or by altering brain development and function (Walker et al., 2011). Previous studies in Africa and other low resource settings have indicated multiple influences upon variability in motor proficiency including nutritional status (Stoltzfus et al., 2001; Wachs, 1995), HIV, malaria and helminthic infections (e.g. Bagenda et al., 2006; Botha & Pienaar, 2008; Olney et al., 2009), poverty, poor health

and unhealthy environments (Evans, 2006; Grantham-McGregor et al., 2007), and the lack of opportunities for play (Gallahue & Ozmun, 2002).

In order to identify deviations from normal progress in a reliable manner, it is necessary to have tools that have been validated in context. The measurement of motor proficiency in the current study was part of a larger study that focused upon developing a methodology to examine the longer-term effects of central nervous system (CNS) infections (such as malaria, meningitis and neonatal sepsis) endemic to the region. Previous studies have suggested that while the effects of these infections in the brain may be diffuse (Holding & Boivin, 2013), in the longer-term larger effect sizes are commonly seen in more complex tasks associated with executive functions. The primary objective of this study was therefore to describe the motor performance of a sample of school-age children from coastal Kenya through the examination of associations of motor performance with sociodemographic factors. To achieve this objective, a battery of motor assessments was developed that would be reliable, valid and sensitive to the long-term developmental consequences of health-related risk factors in our target population.

## Method

The details of the study setting and sample are presented in Chapter 3.

### Study Setting

The study was conducted in Kilifi District, a predominantly rural location at the Coast Province of Kenya.

### Study Sample

A sample of 308 boys and girls aged between 8 and 10 years was included in the current study.

### Data Collection Instruments

A battery of motor tests adapted and modified from existing measures was used to assess motor skills in the sample. In the development of the battery, we followed the 4-step systematic test adaptation procedure outlined by Holding, Abubakar and Kitsao-Wekulo (2009). This process is described in detail in Chapter 3. Detailed descriptions of the tests of balance, motor co-ordination and dexterity are also presented in Chapter 3.

### Data Collection Procedures

**Background characteristics.** Information on children's heights was collected through the process described earlier in order to establish whether or not they had growth retardation. A household wealth index score was established from a review of SES indicators.

**Test administration.** The motor tests were administered to 148 boys and 160 girls (N = 308) aged between 8 and 10 years as part of a neuropsychological battery. The full battery consisted of tests of memory, planning and attention. These tests are described in detail in Chapter 3.

Lateral preference (hand and foot) was assessed to establish on which side testing should begin, as all tests required the assessor to begin with the preferred limb. We asked the child to demonstrate a variety of lateralized tasks with the hand (show me how you throw an object) and foot

(show me how you kick a ball) (Denckla, 1985). The tests were administered outside in an open flat area away from other children to avoid distractions. Each child was tested individually but within sight of other children, and in familiar surroundings to minimise test anxiety. To improve standardisation in administration, care was taken to ensure that the testing environment in all the schools was as similar as possible. Most children were able to complete the motor tests in 30 minutes, with overall testing times ranging from 23 to 46 minutes. Assessors who were native to the study area and who were fluent in both testing languages provided instructions in the language with which children were most familiar.

A second test administration was completed about 6 weeks after the initial administration. To reduce the burden on each child we only administered half of the full battery at re-test. Thus, only 149 children were included in the sample to calculate reliability estimates of the motor tests. Five children were not re-tested for various reasons such as relocation from the study area, travelling outside the study area and refusal for continued participation.

**Analysis**

The intraclass correlation coefficient (ICC) was used to evaluate test-retest reliability (Portney & Watkins, 2000). A paired-samples t-test was conducted to determine whether a practice or learning effect existed between test and retest scores. Age effects were significant for most measures, documenting significant increases in scores with increasing age. Constituent motor tests were therefore age standardized by regressing scores on age. Age-corrected scores were obtained by computing differences between observed and predicted scores in units of standard error of the estimate (i.e., in z-score units).

To discount the influence of outliers, extreme scores below -3 or above 3 were winsorized by replacing their values with the nearest scores within this range. Tests of skewedness and kurtosis confirmed normalcy of score distributions. Maximum likelihood factor analysis with oblique rotation was then applied to the z-scores to reduce the multiple motor scores to ability composites (Ackerman & Cianciolo, 2000). Factor analysis yielded support for a two-factor solution; there were few cross-loadings and more than three tests loaded on each factor, with all tests loading above .30 on each. Tests loading on the Motor Co-ordination factor were Pegboard, Bead Threading, Bolt Board and Jumping and Clapping, and those loading on Static and Dynamic Balance were Stork Balance, One Board Balance, Ball Balance and Hopping in Squares (Table 11). Factor scores were defined as the mean of the z-scores for the tests loading on each factor. An Overall Motor Index was also defined as the mean of the two factor scores. A similar procedure was applied on the z-scores of the tests of cognitive functioning to produce factor composites labelled Executive Function and Verbal Memory.

The standardized scores of these summary variables were used in subsequent analyses. We used Pearson's correlation coefficient to measure associations of composite motor scores with executive function and verbal memory scores in order to establish convergent and discriminant validity. Independent sample t-tests were applied to examine the effect of gender, nutritional status

and area of residence on test scores. Univariate analysis was used to make group comparisons among categories based on school exposure and household resources. Regression analysis was conducted to determine the relative contribution of each background characteristic to constituent tests, factor composites and the Overall Motor Index. For all analyses, $p < .05$ was used to determine statistical significance.

## Results

### Descriptive Statistics

The mean age was 9.06 years for boys (SD = 1.05) and 9.10 years (SD = 1.18) for girls. Overall, the mean age for the sample was 9.08 years (SD = 1.16). The distribution of overall scores obtained on the various motor tests is shown in Table 12. Noteworthy is the strong ceiling effect seen on the Hopping in Squares Test as nearly half of the sample (compared to between two and twenty percent on the other four tests) obtained the maximum possible score on this test. Nearly 20% of the sample scored '0' on the One Board Balance compared to between two and nine percent on the other tests.

Data were incomplete for 16 children due to limb deformities, inability to maintain balance for at least one second, illness on the day of testing and missed appointments. We assigned scores as follows for these missing data: a score of '0' was assigned if the child was unable to meet basic task demands; if a test was not administered to the child because of an error on the assessor's part, we assigned the modal score attained on the specific test for a given age-group. Because findings were highly similar when these data were excluded we present results only with assigned scores included.

The following results are presented in Table 12. Test-retest reliability levels ranged from .5 to .9 for seven tests; one test, Bead Threading, was administered only once. The paired samples *t* test showed a statistically significant improvement (practice effect) from the first to second assessment for all tests given on two occasions except the Jumping and Clapping and One Board Balance Tests. Scores on the Stork Balance Test decreased with repeated assessment.

Motor Co-ordination ($r = .512$, n = 300, $p < .01$), Balance ($r = .351$, n = 300, $p < .01$), and the Overall Motor Index ($r = .51$, n = 300, $p < .01$) had moderate to strong correlations with Executive Function. All three motor composite scores had weak associations with Verbal Memory: Motor Co-ordination, $r = .144$, n = 300, $p = .013$; Balance, $r = .176$, n = 300, $p = .002$; Overall Motor Index, $r = .189$, n = 300, $p = .001$.

### Effects of Background Characteristics

The distribution of scores obtained on the motor tests varied according to the background variables tested (Tables 13 and 14).

#### Constituent motor scores

***Gender.*** Although girls performed better than boys on most of the measures of motor performance, significant differences were only recorded for the Hopping in Squares and Ball Balance Tests. Absolute effect sizes (Cohen's *d*) on all the tests ranged from .07 to .31 (Table 15).

***Nutritional status.*** Analysis revealed significant differences for the Stork Balance, Hopping in Squares, Jumping and Clapping and Peg Board tests in relation to stunting (Table 15), with children with growth retardation performing worse than those without. Effect sizes for nutritional status were between -.30 and -.44.

***Household resources.*** Children with more household resources (Level 3) had significantly higher scores on the Stork Balance Test than those in Levels 1 (most poor) and 2 (moderately poor). An effect size (partial eta squared) of .04 was recorded (Table 16). The pairwise comparison of the most poor and moderately poor groups was non-significant.

***School exposure.*** Children with more than two years of schooling had significantly higher scores than those with fewer years on all of the motor measures. Effect sizes (partial eta squared) on all these differences ranged from .02 to .08 (Table 16).

***Area of residence.*** Children living in peri-urban areas had significantly higher scores than those living in rural areas on the Hopping in Squares Test (Table 15), with an effect size of -.38.

**Composite scores**

***Static and Dynamic Balance.*** Gender, nutritional status, household resources and school exposure created significant differences in the composite score for Static and Dynamic Balance (Tables 15 and 16).

***Motor Coordination.*** Nutritional status and school exposure had significant effects on the Motor Coordination composite score (Tables 15 and 16).

***Overall Motor Index.*** Significant differences due to nutritional status, household resources and school exposure were recorded on the Overall Motor Index. Details are presented in Table 15 and 16.

**Multivariate Findings**

We compared the unique contribution of individual variables to the models for the constituent and composite motor scores. Variance inflation factors were less than 2 for all motor outcomes indicating no substantial multicollinearity in all the models.

**Constituent motor measures.** While nutritional status, household resources and school exposure were associated with the Stork Balance Test scores in the univariate analysis, these effects ceased to be significant in the regression analysis. Gender alone was associated with the Ball Balance Test, $F(3,303) = 4.337$, $p = .005$. Together with nutritional status and school exposure, gender accounted for 11.6% of the variance in the Hopping in Squares Test, $F(4,302) = 11.005$, $p < .001$. Nutritional status and school exposure were the strongest predictors ($R^2 = .074$) for the Jumping and Clapping Test scores, $F(3,303) = 9.178$, $p < .001$ (Table 17).

Nutritional status and school exposure were associated with the Peg Board Test scores. School exposure alone contributed to the variance in the Bead Threading and Bolt Board Tests (Table 18).

**Composite motor scores.** The models for the composites of Motor Co-ordination, $F(2,304) = 25.043$, $p < .001$, Static and Dynamic Balance, $F(4,302) = 7.070$, $p < .001$, and the Overall Motor Index, $F(3,303) = 15.295$, $p < .001$, were significant. Nutritional status and school exposure were

associated with the Motor Co-ordination Composite. Gender and school exposure were associated with the composite score for Static and Dynamic Balance. Gender and school exposure also accounted for significant variance in the Static and Dynamic Balance Composite score. Nutritional status and school exposure accounted for 12.3% of the variance observed in the Overall Motor Index (Table 19).

## Discussion

The current study documents performance of school-age children on static and dynamic balance, as well as motor co-ordination tests. The stimulus materials used were simple to develop, not time-consuming and children participated willingly, demonstrating their suitability. Furthermore, the tests were inexpensive to develop and could be easily administered by trained testers. The developed motor measures were culturally appropriate and psychometrically sound with moderate to excellent reliability levels. Moderate to strong correlations of the motor scores with executive function scores provided evidence of convergent validity; on the other hand, weak associations with verbal memory demonstrated evidence of discriminant validity. Consistent with Bronfenbrenner's bioecological model (Bronfenbrenner & Ceci, 1994), we were able to identify proximal and distal influences on motor proficiency in school-age children.

### Influence of Background Characteristics

The superior performance of girls on the tests of dynamic balance is similar to what has been reported among South African (du Toit & Pienaar, 2002; Portela, 2007), Nigerian (Toriola & Igbokwe, 1986) and Australian (Livesey, Coleman, & Piek, 2007) children. And congruent with the conclusions of Largo and colleagues (2003), gender differences on the various tasks varied in size and direction. Despite the differences observed in the current study, our findings do not however support the suggestion by Livesey and colleagues (2007) that separate gender-specific norms be used in the assessment of motor abilities in school-aged children. Reported differences between boys and girls within the studied age-group may result from differences in cultural expectations – the socialising influences of parents and teachers – and environmental practices, as has been emphasized by others (Bénéfice, Fouére, & Malina, 1999; Munroe & Munroe, 1975; Thomas & French, 1985). In many rural communities such as the one in which the current study was conducted, girls are socialised to perform household activities from a young age. To perform some of these tasks such as fetching water from the river successfully requires balance.

Nutritional status was an important determinant of motor performance as it had moderate effects on balance and co-ordination. Children with growth retardation achieved lower scores on the composite motor test scores, similar to what has been reported in varied contexts from studies among younger (Abubakar, van de Vijver, et al., 2008; Bénéfice et al., 1999; Bénéfice, Fouéré, Malina, & Beunen, 1996), older (Chang, Walker, Grantham-McGregor, & Powell, 2010) and children of comparable ages (Chowdhury, Wrotniak, & Ghosh, 2010; Kar, Rao, & Chandramouli, 2008). The negative impact of poor nutritional status on motor performance may be attributed to deficiency in

muscular strength (Malina & Little, 1985), low energy levels (Dufour, 1997) and slower motor development (Malina, 1984). Given that the negative impact of chronic undernutrition is long-term (Hoorweg & Stanfield, 1976), and that stunting has a particularly strong effect on early gross motor development (Pollit et al., 1994), opportunities for interventions to specifically improve children's nutritional status, should be explored.

Contrary to our expectations, children from the least wealthy households had lower scores than their counterparts from wealthier households only on the balance composite score. Furthermore, children from households with moderate wealth levels performed the worst on the Stork Balance Test and had the lowest scores on the Overall Motor Index. The moderate effect sizes recorded suggested the existence of only modest differences among the various groups, demonstrating that socioeconomic conditions did not have such a major influence on children's motor performance. These findings are in contrast to those reported in studies among populations with similar socioeconomic characteristics (Chowdhury et al., 2010). We offer the following explanations for our findings. As both nutritional status and household resources showed similar effect sizes in their associations with motor outcomes, it may be that the two are inextricably linked. For one, poorer households have fewer resources at their disposal and are therefore more likely to make poor nutrition-related choices. Second, our findings that nutritional status had a more pervasive role than SES may be related to the measure of stunting used. Height-for-age as a measure of chronic undernutrition may in itself be indicative of the cumulative effects of poor nutrition which impacts outcomes from a young age. Infant data from an earlier study in this area (Abubakar, van de Vijver, et al., 2008) suggested that SES (conceptualised as a distal factor) had less of an impact on child outcome than proximal factors (such as anthropometric status). Among our school-age population, we anticipated that SES would play a more influential role as the impact of outside environments surpasses that of immediate environments. Studies investigating the specific pathways through which poor SES and nutritional status affect outcome are presented in later chapters.

Schooling effects were consistently larger than those of the other background influences suggesting that school exerted a much stronger influence on child outcomes. Our findings have precedence in this setting where previous studies have reported strong consistent effects of school attendance on children's performance (Alcock et al., 2008; Holding et al., 2004). Superior performance in children with greater exposure to school may, as has been postulated elsewhere (Bénéfice & Ba, 1994), be attributed to the positive effects of attending school; the ability to follow instructions, pay attention to tasks and increased opportunities for practice.

With regard to area of residence, the pattern of motor performance observed in the current study was unexpected as children living in the more rural areas had lower scores only on the Hopping in Squares test. These findings were in stark contrast to reports from elsewhere which demonstrate that rural children consistently outperform their urban counterparts on tests of motor abilities (Portela, 2007), since they have much more open play areas and they are more likely to engage in outdoor

activities for longer periods of time (Loucaides, Chedzoy, & Bennett, 2004). It should be noted that a much wider (and significant) variance in the mean scores of three tests for rural children in the current study possibly affected the significance levels recorded and may have jeopardized the validity of the obtained results (Glass, Peckham, & Sanders, 1972). Perhaps we did not observe the expected differences in performance due to the widely disparate numbers of children in the two groups, reflecting a misclassification according to area of residence. Furthermore, our data failed to suggest that area of residence was a confounder on school attendance. Secondly, because we did not have a truly urban population, variations in the living conditions of children residing in rural and peri-urban areas may have been too subtle to create any real differences.

**Multivariate Findings**

After accounting for the effects of age, various predictors created differences on the constituent motor scores, in isolation and collectively. Environmental (context) variables accounted for a greater proportion of the variance seen in test scores than biological (person) variables. These findings are in line with Bronfenbrenner's (1999) model which stipulates that various aspects of the child's environment have differential effects on development. Being male and having fewer years of schooling were risk factors for poorer scores on the balance composite scores, while growth retardation and less exposure to school were associated with poorer outcomes on the motor co-ordination composite and the Overall Motor Index. Compared with the other predictors, school exposure remained a consistent and strong influence on the composite scores.

**Conclusions**

The current study provides preliminary evidence of motor performance from a typically developing rural population within an age range that has not been previously studied. As well as being culturally appropriate, the developed tests were reliable, valid and sensitive to biological and environmental correlates. Further, the use of composite scores seems to strengthen the magnitude of differences seen among groups. These correlates should be taken into account when assessing motor performance of school-age children living in similar contexts.

With strong ceiling effects, the Hopping in Squares Test, which closely mimics a game that children within this context regularly engage in, seemed to be too easy. However, we recommend its inclusion in future batteries because it was sensitive to a number of the background influences tested. Imposing more stringent cut-offs for success will possibly increase the difficulty level of the test. On the other hand, we recommend the exclusion of the One Board Balance Test from test batteries because apart from strong floor effects, there were non-significant effects for all background influences apart from school exposure. In addition to small effect sizes, schooling effects disappeared when we included other predictors. The remaining tests performed well and their use in similar settings is recommended.

The children in the current study constituted a typically developing population at low risk for motor problems. The generally small to moderate effect sizes observed in the current study may be

due to the types of comparisons being made or predictors considered. Larger effects may well be observed, for example, when comparing cognitive/motor skills in children with a neurological disorder (e.g. HIV or cerebral malaria) to those without a disorder. The sensitivity of 79% and specificity of 78% of the TQQ for detecting severe cognitive impairment suggests the need for a further screening procedure to detect those with mild or moderate cognitive impairment. Indeed, because we did not do further specific visual and audiological testing, impairments in these areas of functioning may have contributed to variability in performance on the more complex motor tasks. Further research with a more high-risk sample will provide an opportunity to test the clinical validity of the measures of motor performance. I examined background influences on motor performance during infancy in the next paper.

Table 11

*Factor Loadings of Constituent Motor Tests*

| Test items | Factor 1 | Factor 2 |
|---|---|---|
| Peg Board | .812 | - |
| Bead Threading | .797 | - |
| Bolt Board | .538 | - |
| Jumping & Clapping | .304 | - |
| One Board Balance | - | .658 |
| Stork Balance | - | .641 |
| Hopping in Squares | - | .398 |
| Ball Balance | - | .327 |

Table 12

*Distribution of Overall Scores and Test-retest Reliability Indices on Motor Tests*

| Tests | Range | % with max score | Mean (SD) | | ICC |
|---|---|---|---|---|---|
| | | | Time 1[a] | Time 2[b] | |
| Stork Balance | 0-12 | 2.9 | 6.64 (3.30) | 4.79 (1.79) | .682 |
| Ball Balance | 0-12 | 20.1 | 9.17 (2.46) | 9.60 (1.93) | .507 |
| Hopping in Squares | 0-12 | 42.1 | 8.91 (3.51) | 10.19 (2.81) | .522 |
| One Board Balance | 0-6 | 15.3 | 2.44 (2.04) | 2.81 (2.06) | .511 |
| Jumping and Clapping | 0-4 | 1.6 | 1.81 (.626) | 1.86 (.626) | .730 |
| Bolt Board[c] | 2.50-20.50 | - | 9.07 (2.49) | 10.43 (2.74) | .813 |
| Bead Threading[c, d] | 3.33-15.33 | - | 9.73 (1.70) | - | - |
| Peg Board[c] | 3.56-13.56 | - | 8.68 (1.61) | 9.03 (1.77) | .896 |

[a]n = 308

[b]n = 149

[c]No maximum scores as these were timed tests

[d]No retest data available

Table 13

*Differences in Gross Motor Test Raw Scores According to Background Characteristics, Mean (SD)*

| Variable | N | Stork Balance | Ball Balance | Hopping in Squares | Jumping and Clapping | One Board Balance |
|---|---|---|---|---|---|---|
| Gender | | | | | | |
| Boys | 148 | 6.44 (3.27) | 8.94 (2.14) | 8.36 (3.57) | 1.87 (.78) | 2.33 (1.93) |
| Girls | 160 | 6.82 (3.32) | 9.38 (2.72) | 9.42 (3.39) | 1.74 (.74) | 2.54 (2.14) |
| Age | | | | | | |
| ≤ 8 yrs | 72 | 5.74 (3.39) | 8.11 (3.01) | 7.96 (3.58) | 1.63 (.78) | 2.07 (2.02) |
| 8.5 - 9.0 yrs | 108 | 6.32 (3.45) | 9.24 (2.26) | 8.56 (3.62) | 1.73 (.72) | 2.26 (2.00) |
| ≥ 9.5 yrs | 128 | 7.41 (2.95) | 9.70 (2.09) | 9.74 (3.21) | 1.97 (.75) | 2.80 (2.05) |
| Nutritional status | | | | | | |
| Stunted | 74 | 6.26 (3.42) | 8.92 (2.94) | 8.45 (3.91) | 1.68 (.846) | 2.65 (2.21) |
| Not stunted | 234 | 6.76 (3.25) | 9.25 (2.29) | 9.06 (3.37) | 1.85 (.725) | 2.38 (1.98) |
| Household resources | | | | | | |
| Level 1 | 123 | 6.59 (3.29) | 9.12 (2.72) | 8.73 (3.70) | 1.74 (.76) | 2.37 (2.10) |
| Level 2 | 94 | 5.97 (3.18) | 9.09 (2.49) | 8.98 (3.54) | 1.81 (.82) | 2.28 (1.93) |
| Level 3 | 91 | 7.38 (3.30) | 9.32 (2.06) | 9.09 (3.51) | 1.89 (.69) | 2.70 (2.07) |
| School exposure | | | | | | |
| None | 35 | 5.17 (3.47) | 8.14 (3.63) | 7.37 (4.35) | 1.34 (.76) | 1.43 (1.93) |
| 1-2 years | 101 | 6.65 (3.20) | 8.97 (2.77) | 8.30 (3.68) | 1.81 (.81) | 2.73 (2.09) |
| > 2 years | 172 | 6.92 (3.26) | 9.49 (1.85) | 9.59 (3.05) | 1.90 (.69) | 2.48 (1.98) |
| Area of residence | | | | | | |
| Rural | 245 | 6.64 (3.24) | 9.19 (2.60) | 8.68 (3.69) | 1.78 (.78) | 2.42 (2.05) |
| Urban | 63 | 6.60 (3.54) | 9.10 (1.84) | 9.81 (2.57) | 1.90 (.64) | 2.54 (2.02) |

Table 14

*Mean Differences in Raw Scores for Timed Motor Tests, Mean (SD)*

| Variable | N | Pegboard | Bead Threading | Bolt Board |
|---|---|---|---|---|
| Gender | | | | |
| Boys | 148 | 8.59 (1.65) | 9.65 (1.70) | 9.16 (2.35) |
| Girls | 160 | 8.77 (1.57) | 9.81 (1.71) | 8.99 (2.63) |
| Age | | | | |
| ≤ 8 yrs | 72 | 8.07 (1.06) | 9.13 (1.42) | 7.89 (2.10) |
| 8.5 - 9.0 yrs | 108 | 8.36 (1.52) | 9.50 (1.66) | 8.89 (2.18) |
| ≥ 9.5 yrs | 128 | 9.29 (1.74) | 10.27 (1.73) | 9.89 (2.67) |
| Nutritional status | | | | |
| Stunted | 74 | 8.41 (1.75) | 9.68 (2.02) | 8.93 (2.77) |
| Not stunted | 234 | 8.77 (1.56) | 9.75 (1.59) | 9.12 (2.40) |
| Household resources | | | | |
| Level 1 | 123 | 8.79 (1.71) | 9.89 (1.72) | 9.22 (2.87) |
| Level 2 | 94 | 8.41 (1.58) | 9.59 (1.70) | 8.72 (2.15) |
| Level 3 | 91 | 8.81 (1.48) | 9.66 (1.68) | 9.24 (2.26) |
| School exposure | | | | |
| None | 35 | 7.80 (1.85) | 8.90 (2.11) | 7.74 (2.67) |
| 1-2 years | 101 | 8.47 (1.47) | 9.79 (1.56) | 8.72 (2.59) |
| > 2 years | 172 | 8.99 (1.56) | 9.86 (1.66) | 9.55 (2.27) |
| Area of residence | | | | |
| Rural | 245 | 8.66 (1.62) | 9.72 (1.72) | 8.98 (2.45) |
| Urban | 63 | 8.78 (1.58) | 9.79 (1.65) | 9.43 (2.67) |

Table 15

*Associations of Background Characteristics with Age-standardised Motor Co-ordination, Balance and Composite Motor Scores*

| Variable | Gender | | | | | | Nutritional Status | | | | | | Area of Residence | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Boys (n = 148) | | Girls (n = 160) | | | | Stunted (n = 74) | | Not stunted (n = 234) | | | | Rural (n = 245) | | Peri-urban (n = 63) | | |
| Balance | M | SD | M | SD | $t^a$ | *d* | M | SD | M | SD | $t^b$ | *d* | M | SD | M | SD | $t^c$ |
| Stork Balance | -.06 | .99 | .05 | 1.00 | -.96 | -.11 | -.23 | 1.00 | .07 | .99 | **-2.25*** | -.30 | -.00 | .99 | .00 | 1.04 | -.01 |
| Ball Balance | -.04 | .72 | .18 | .80 | **-2.60*** | .29 | -.08 | .79 | .12 | .76 | -1.97 | -.26 | .09 | .80 | .01 | .62 | .83 |
| Hopping in Squares | -.15 | 1.00 | .15 | .94 | **-2.70**** | -.31 | -.22 | 1.07 | .08 | .94 | **-2.34*** | -.30 | -.06 | 1.02 | .27 | .74 | **-2.94**** |
| One Board Balance | -.05 | .95 | .05 | 1.04 | -.86 | -.10 | .01 | 1.05 | -.00 | .98 | .05 | - | -.02 | 1.01 | .06 | .97 | -.53 |
| Motor Co-ordination | | | | | | | | | | | | | | | | | |
| Peg Board | -.05 | .98 | .06 | .94 | -.99 | -.12 | -.31 | .95 | .11 | .94 | **-3.35**** | -.44 | -.01 | .96 | .08 | .98 | -.65 |
| Bead Threading | -.03 | .94 | .04 | .98 | -.64 | -.07 | -.16 | 1.11 | .06 | .91 | -1.58 | -.22 | -.01 | .95 | .05 | 1.01 | -.43 |
| Bolt Board | .04 | .90 | -.05 | 1.00 | .83 | .10 | -.20 | 1.12 | .05 | .89 | -1.77 | -.22 | -.04 | .95 | .13 | .94 | -1.29 |
| Jumping and Clapping | .06 | .94 | -.09 | .97 | 1.42 | .16 | -.27 | 1.06 | .06 | .90 | **-2.46*** | -.34 | -.06 | .98 | .14 | .86 | -1.61 |

| Composite scores | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Balance | -.08 | .61 | .11 | .66 | **-2.53*** | -.30 | -.13 | .70 | .07 | .61 | **-2.35*** | -.31 | .00 | .65 | .09 | .58 | -.92 |
| Coordination | .01 | .69 | -.01 | .71 | .21 | .03 | -.24 | .79 | .07 | .65 | **-3.37**** | -.43 | -.03 | .71 | .10 | .67 | -1.32 |
| Overall Index | -.03 | .55 | .05 | .60 | -1.27 | -.14 | -.18 | .66 | .07 | .53 | **-3.37**** | -.42 | -.01 | .58 | .09 | .54 | -1.31 |

*$p$<.05, **$p$<.01, ***$p$<.001, df = 306

[a]Jumping and Clapping (df = 109);

[b]Jumping and Clapping (df = 109), Bead Threading (df = 106) and Bolt Board (df = 103)

[c]Jumping and Clapping (df = 107), Ball Balance (df = 121) and Hopping in Squares (df = 130)

Table 16

*Associations of Background Characteristics with Age-standardised Balance, Motor Co-ordination and Composite Motor Scores*

| Variable | Household Resources | | | | | | | | School Exposure | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Level 1 (n = 123) | | Level 2 (n = 94) | | Level 3 (n = 91) | | | | None (n = 35) | | 1-2 years (n = 101) | | >2 years (n = 172) | | | |
| Balance | M | SD | M | SD | M | SD | *F* | $\eta^2$ | M | SD | M | SD | M | SD | *F* | $\eta^2$ |
| Stork Balance | -.06 | .99 | -.19 | .95 | .29 | 1.00 | **6.04**** | .04 | -.55 | 1.03 | .05 | .97 | .08 | .98 | **6.26**** | .04 |
| Ball Balance | .02 | .79 | .08 | .75 | .15 | .76 | .743 | .01 | -.24 | .83 | .07 | .82 | .14 | .72 | **3.52*** | .02 |
| Hopping in Squares | -.09 | 1.03 | .04 | 1.00 | .11 | .89 | 1.206 | .01 | -.52 | 1.18 | -.13 | 1.03 | .19 | .85 | **9.58***** | .06 |
| One Board Balance | -.08 | 1.00 | -.07 | .96 | .18 | 1.02 | 2.159 | .01 | -.60 | .93 | .19 | 1.01 | .01 | .96 | **8.42***** | .05 |
| Motor Co-ordination | | | | | | | | | | | | | | | | |
| Peg Board | .00 | 1.01 | -.15 | .92 | .17 | .92 | 2.54 | .02 | -.65 | .95 | -.06 | .90 | .18 | .94 | **12.06***** | .07 |
| Bead Threading | .03 | 1.00 | -.05 | .92 | .03 | .95 | .221 | .00 | -.59 | 1.07 | .10 | .84 | .07 | .97 | **7.99***** | .05 |
| Bolt Board | -.03 | 1.07 | -.13 | .85 | .15 | .88 | 1.94 | .01 | -.66 | 1.07 | -.10 | .91 | .18 | .89 | **12.81***** | .08 |
| Jumping and Clapping | -.14 | .93 | -.01 | 1.02 | .14 | .89 | 2.42 | .02 | -.72 | .87 | .01 | .98 | .11 | .90 | **11.89***** | .07 |
| Composite scores | | | | | | | | | | | | | | | | |
| Balance | -.06 | .66 | -.04 | .63 | .18 | .59 | **4.25*** | .03 | -.48 | .69 | .05 | .66 | .11 | .58 | **13.03***** | .08 |
| Coordination | -.04 | .74 | -.08 | .69 | .12 | .65 | 2.24 | .01 | -.65 | .73 | -.01 | .68 | .13 | .63 | **20.88***** | .12 |
| Overall Index | -.05 | .61 | -.06 | .57 | .15 | .51 | **4.16*** | .03 | -.57 | .63 | .02 | .56 | .12 | .50 | **23.67***** | .13 |

*$p$<.05, **$p$<.01, ***$p$<.001

df = 2,305

Table 17

*Significant Predictors of Scores for Tests of Static and Dynamic Balance*

| Variable | | Gender | Nutritional status | Household Resources | School Exposure |
|---|---|---|---|---|---|
| Stork Balance[a] | *B* | - | .209 | .016 | .066 |
| | *SE B* | - | .136 | .016 | .037 |
| | β | - | .090 | .061 | .111 |
| Adjusted $R^2$ = .027 | *t* | - | 1.537 | 1.003 | 1.772 |
| Ball Balance[b] | *B* | .240 | .050 | - | .049 |
| | *SE B* | .087 | .044 | - | .027 |
| | β | .156 | .067 | - | .106 |
| Adjusted $R^2$ = .032 | *t* | **2.762**** | 1.148 | - | 1.808 |
| Hopping in Squares[c] | *B* | .349 | .145 | - | .128 |
| | *SE B* | .105 | .053 | - | .034 |
| | β | .179 | .154 | - | .221 |
| Adjusted $R^2$ = .116 | *t* | **3.317**** | **2.747**** | - | **3.778***** |

*$p$<.05, **$p$<.01, ***$p$<.001

[a]$F(3,304) = 3.813$, $p = .010$

[b]$F(3,304) = 4.235$, $p = .006$

[c]$F(3,304) = 14.797$, $p < .001$

Table 18

*Significant Predictors of Scores for Tests of Motor Co-ordination*

| Variable | | Nutritional status | School Exposure |
|---|---|---|---|
| Peg Board[a] | *B* | .160 | .126 |
| | *SE B* | .053 | .032 |
| | β | .172 | .221 |
| Adjusted $R^2$ = .093 | *t* | **3.049**** | **3.909***** |
| Bead Threading[b] | *B* | .104 | .089 |
| | *SE B* | .054 | .033 |
| | β | .112 | .156 |
| Adjusted $R^2$ = .040 | *t* | 1.917 | **2.686**** |
| Bolt Board[c] | *B* | .075 | .148 |
| | *SE B* | .052 | .032 |
| | β | .081 | .262 |
| Adjusted $R^2$ = .081 | *t* | 1.423 | **4.607***** |
| Jumping and Clapping[d] | *B* | .162 | .094 |
| | *SE B* | .053 | .035 |
| | β | -176 | .165 |
| Adjusted $R^2$ = .074 | *t* | **3.070**** | **2.695**** |

*$p$<.05, **$p$<.01, ***$p$<.001

[a]$F(2,304) = 16.775$, $p < .001$

[b]$F(2,304) = 7.394$, $p = .001$

[c]$F(2,304) = 14.482$, $p < .001$

[d]$F(2,305) = 13.156$, $p < .001$

Table 19

*Significant Predictors of Composite Test Scores*

| Variable | | Gender | Nutritional status | Household Resources | School Exposure |
|---|---|---|---|---|---|
| Balance[a] | *B* | .211 | .059 | .007 | .073 |
| | *SE B* | .071 | .035 | .010 | .023 |
| | β | .165 | .096 | .042 | .191 |
| Adjusted $R^2$ = .074 | *t* | **2.978**** | 1.673 | .695 | **3.103**** |
| Coordination[b] | *B* | - | .126 | - | .117 |
| | *SE B* | - | .037 | - | .023 |
| | β | - | .186 | - | .280 |
| Adjusted $R^2$ = .136 | *t* | - | **3.361**** | - | **5.078***** |
| Overall Motor Index[c] | *B* | - | .094 | -.002 | .097 |
| | *SE B* | - | .031 | .009 | .020 |
| | β | - | .169 | -.013 | .283 |
| Adjusted $R^2$ = .123 | *t* | - | **3.043**** | -.224 | **4.734***** |

*$p$<.05, **$p$<.01, ***$p$<.001

[a]$F(4,303) = 7.078$, $p < .001$

[b]$F(3,304) = 17.227$, $p = .001$

[c]$F(3,304) = 15.755$, $p < .001$

## Paper 4. Background Influences on Motor Outcomes in Infancy

### Introduction

Infancy and early toddlerhood are critical periods for the development of motor abilities, and nearly all children acquire specific motor skills due to brain and neuromuscular maturation (Purves, 1994). Engagement in daily routines supports the development of fine and gross motor skills in young children (Kariger et al., 2005). On the other hand, restriction in motor performance may interfere with optimal functioning in several spheres of life.

Individual variations in motor development are evident from an early age and a child's progression across time may be unstable or steady (Pollitt & Triana, 1999). The age and sequence of motor development varies both within and across individuals perhaps due to caregiving practices and the opportunities for practice. Across genders, sex differences in motor abilities begin to be seen early in childhood (Rademeyer & Jacklin, 2013) and may be attributed to physical differences among boys and girls or to the influence of cultural socialisation. For example, boys may be pushed towards more vigorous outdoor activities, while girls may be encouraged to engage in more quiet indoor activities. Nutritional status influences on motor development are seen directly through their effects on the structural and functional development of the brain, or indirectly through their influence on children's experiences and behaviour (Grantham-McGregor et al., 2007). In modelling the potential mechanisms of the influence of nutrition on child outcomes, Prado and Dewey (2012) explicate that, 'undernutrition affects motor development, which in turn may influence brain development through both caregiver behaviour and child interaction with the environment.'

With maturation and as children's environments become increasingly differentiated, the importance of biological factors decreases as other factors within the environment begin to be more influential. In line with Bronfenbrenner's bioecological theory (Bronfenbrenner & Morris, 2006), factors which are closest to the child may exert the strongest influence while those that are more distal to the children may show less impact. Some of these associations may be stronger during infancy while others are strongest during toddlerhood, suggesting that changes occur in the pattern of influences as the child matures. In view of the variety of child-related and environmental factors that may influence the course of motor development at this age, an investigation of their impact will be useful in identifying the risk factors for poor outcomes in resource-constricted settings.

The assessment of infants using tools that have been validated in context will provide an accurate picture of child functioning at this age. The Kilifi Developmental Inventory (KDI: Abubakar, Holding, et al., 2008) provides a valid and reliable assessment of motor functioning in early childhood among rural African populations. The tool has been extensively applied in Kenyan

studies of typically developing children and HIV-infected populations (Abubakar, Holding, Newton, van Baar, & van de Vijver, 2009; Abubakar et al., 2013; Abubakar, van de Vijver, et al., 2008). Its use has also been reported in studies among infants in several sub-Saharan African contexts including Malawi (Prado et al., under prep.), Ghana (Prado et al., under prep.) and South Africa (Mathe, 2011). However, there are currently no studies reporting the use of the KDI in longitudinal studies. Our study therefore set out to test two hypotheses. The first hypothesis tested whether or not within-person changes occurred in mean KDI scores over time. The second hypothesis tested whether or not there were variations in intra-individual influences on KDI scores over time.

## Method

Detailed information on the study setting, sample, data collection tools and procedures is presented in Chapter 3.

### Study Setting

The study was conducted in Msambweni District.

### Study Sample

The sample consisted of 231 infants across the 3 ages, 12, 18 and 24 months.

### Data Collection Tools

The KDI was used to obtain information on psychomotor functioning in infants at the three time points.

### Analysis

Stability of scores across time was examined using correlation coefficients. We correlated test scores at 12, 18 and 24 months with one another.

To detect if there were any overall differences in changes in mean scores across all the ages, an ANOVA with repeated measures was performed with time points as independent variables and KDI scores at 12, 18 and 24 months as the dependent variables. Only the scores of the children who were seen at all three time points were included in this analysis (n = 150). We tested the homogeneity of variance assumption for the KDI scores using Mauchly's Test of Sphericity. Main effects were tested using the Bonferroni correction.

To identify correlates of psychomotor development at each time point, I first identified child characteristics pertaining to proximal influences (child gender and anthropometric status), key variables that reflected maternal demographics (maternal age and partner's contribution) and other more distal influences such as household socioeconomic status (parental education and occupation and home ownership). I fit separate, univariate models between each of these variables and KDI scores at 12, 18 and 24 months. Effect sizes were measured using partial eta squared.

In the multivariate analysis, I then constructed regression models that included all variables that had effect sizes of more than .01 in the univariate analysis. Using the stepwise method, the best predictors were entered into the model until no more variables met the entry criteria. Given the potential for collinearity between the anthropometric measures, I included stunting and wasting, but not underweight in the mulitivariate model if all three variables had effect sizes > .01 in the univariate analysis. Stunting and wasting reflect chronic and acute undernutrition, respectively, but underweight does not distinguish between the two and is correlated with both. Significance was based on a *p*-value of < 0.05.

## Results

### Descriptives

At infancy, the mean age at follow-up was 12.15 (*SD* = .31. range: 11.56, 14.09). During early and late toddlerhood, the mean age at follow-up was 18.13 (*SD* = .32, range: 16.72, 19.68) and 24.14 (*SD* = .29, range: 23.46, 25.82), respectively. The proportion of boys (n = 102, 48.3%) and girls (n = 106, 50.2%) was nearly equal. One-tenth (n = 22) of the sample was wasted while 16% (n = 33) was stunted. Nine children (4.3%) were both stunted and wasted. Mean WAZ and HAZ were -.5259 (*SD* = 1.17, range: -3.86, 4.29) and -.6802 (*SD* = 1.24, range: -3.73, 4.51), respectively.

The majority of mothers were aged between 20 and 34 years (n = 148, 70%). Nearly all the mothers (92.9%) received financial support from a partner. Almost two-thirds of the mothers (61.6%) compared to less than half of fathers (41.2%) had attained less than 8 years of education. More than half of the mothers (54.5%) compared to 13.3% of the fathers were not employed. Slightly more than half of the sample (50.2%) lived in their own homes.

### Retention Rates

A total of 231 children were seen at 12 months, 184 at 18 months and 186 at 24 months. The number seen at each time point represents an attrition rate of 8.7% at 12 months, 20.3% at 18 months and 19.5% by the end of the study. There were no differences by gender between those who completed the KDI and those who did not at 12 months ($\chi^2(1, n = 208) = .259$, $p = .611$), 18 months ($\chi^2(1, n = 181) = .179$, $p = .672$) and 24 months ($\chi^2(1, n = 183) = .010$, $p = .920$). Reasons for loss to follow-up included travel outside the study area and partners' refusal for continued participation. Although none of the mothers indicated that they no longer wished to be part of the study, repeated unsuccessful visits (at least 3) to some homes suggested loss of interest in continued participation in the study.

### Stability of Test Scores

KDI scores at 12 months correlated moderately with the scores at 18 months ($r = .306$, $p < .001$). The correlation between scores at 18 and 24 months was also moderate, $r = .284$, $p < .001$.

Scores between 12 and 18 months had significant but weak correlations, $r = .222$, $p = .004$.

**Repeated Measures Results**

Mean KDI scores differed significantly across time points, $F(1.678, 250) = 757.477$, $p < .001$, $\eta_p^2 = .836$. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(2) = 31.592$, $p < .001$, and therefore a Greenhouse-Geisser correction was used. Post hoc tests using the Bonferroni correction revealed that the increase of KDI z-scores between 12 and 18 months (27.18 ± 2.72 vs. 35.00 ± 2.3, respectively) and between 18 and 24 months (35.00 ± 2.3 vs 39.67 ± 4.23, respectively) were statistically significant ($p < .001$).

**Effects of Background Variables**

A summary of the differences in KDI scores according to the various background characteristics is presented in Table 20. Effect sizes of these differences are depicted in Figure 4.

**Child variables**

***Gender.*** Boys had consistently higher scores than girls at all ages, and these differences became significant at 24 months, $F(1,181) = 6.62$, $p = .011$. Medium effect sizes were also seen at 24 months ($\eta p^2 = .035$).

***Wasting.*** Children with wasting had significantly lower scores at 12, 18 and 24 months, and effect sizes for these differences were strongest at 24 months ($\eta p^2 = .049$).

***Stunting.*** Children with growth retardation had lower scores than their counterparts who were not stunted across all ages and this effect was significant, $F(1,177) = 4.211$, $p = .042$, and strongest ($\eta_p^2 = .023$) at 18 months.

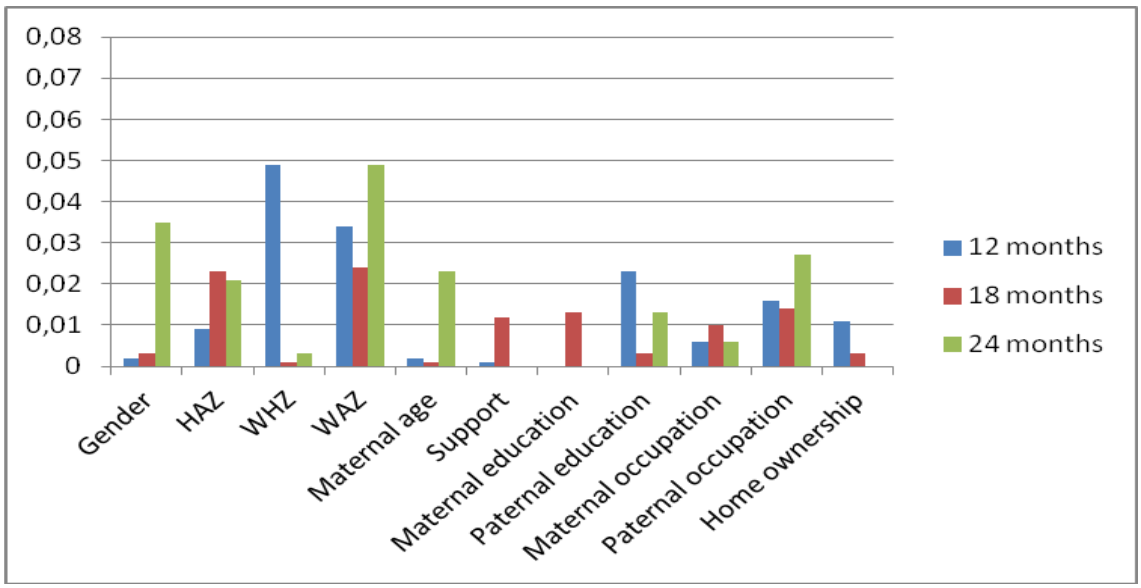
***Underweight.*** Children who were underweight had lower scores across all time points. These differences were significant at 12 months, $F(1,202) = 10.468$, $p = .001$, with medium effect sizes ($\eta_p^2 = .049$).

**SES variables**

***Maternal age.*** Effects of maternal age on test scores increased as children became older although differences seen were not significant. The pattern of differences in scores was not consistent. At 12 months, children of the youngest mothers had the lowest scores. At 18 months, children of mothers aged between 20 and 34 years had the lowest scores while at 24 months, children of the oldest mothers had the lowest scores.

***Support for upkeep.*** Children whose mothers reported that they did not have partners or did not receive any support from their partners had higher scores across all ages. Although not significant, the effects of this variable were strongest at 18 months.

*Figure 4.* Effect sizes of associations between background variables and KDI scores




***Maternal education.*** The influence of maternal education varied at the different time points. Differences in test scores according to maternal education were only seen at 18 months, with children of mothers with between 8 and 11 years of education attaining the highest scores. However, these differences were not significant.

***Paternal education.*** Children whose fathers had less than 8 years of education obtained lower scores across all ages, and the effects of this differences were strongest at 12 months ($\eta_p^2$ = .023).

***Maternal occupation.*** There was no pattern to the differences seen in children's scores according to maternal occupation at any of the ages although the strongest (but small) effects were seen at 18 months ($\eta_p^2$ = .010).

***Paternal occupation.*** At 12 months, children of fathers who were not employed had the highest scores while at 24 months, children of fathers employed at Level 3 performed better than children whose fathers were at employed at other levels. The effect sizes of these differences, although small across all the ages, were strongest at 24 months (($\eta_p^2$ = .027).

***Home ownership.*** Children who lived in homes shared with members of the extended family had the highest scores across all ages. The effect of these differences, although not significant at all ages, was strongest at 12 months (($\eta_p^2$ = .011).

**Multivariate Results**

A summary of the results of the regression analysis at the different time points is presented in

Tables 21, 22 and 23. None of the child-related variables was associated with KDI scores in the multivariate analysis at 12 months. For instance, although wasting was significantly associated with child outcome in the univariate analysis at 12 months, this significance was not retained in the multivariate models. Only home ownership and paternal education were significant predictors of KDI scores at 12 months, explaining 6.1% of the variance observed. The final regression model (Model 2) was significant, $F(2, 163) = 5.317$, $p = .006$. Being coded '1' for home ownership (those living in homes shared with members of the extended family) increased estimated KDI scores by .969 while being coded '0' for paternal education (having less than 8 years of education) reduced KDI scores by .851.

At 18 months, the final model (Model 2) was significant, $F(2, 176) = 5.009$, $p = .008$. HAZ and paternal occupation explained 5.4% of the variance observed. Children who were not stunted scored higher on the KDI by .379 points compared to their counterparts who were stunted. Being coded '1' on paternal occupation (Level 1 – low income and uncertain) predicted an increase of .690 on KDI scores.

The final model (Model 3) was significant at 24 months, $F(3, 142) = 6.680$, $p < .001$. Gender, maternal age and stunting explained 12.4% of the variance observed on KDI scores. Having a mother aged between 20 and 34 years increased estimated KDI scores by 1.791. For females, the predicted KDI scores at 24 months were nearly 2 points lower than those for males. HAZ had the smallest effect, and for every unit increase, there was an increase of .833 on KDI scores.

## Discussion

The undesirable consequences of poor motor development in early childhood may only be detected at later ages when skills become more differentiated. As many of these impairments may be persistent, early identification of risk factors for poor motor skills in children is important, providing an opportunity to minimise their impact on overall child development through implementation of targeted preventive intervention programmes. The current study set out to identify risk factors for poor motor outcomes between the ages of 12 and 24 months, and whether or not the effects of the identified risk factors changed or remained the same.

The attrition rates seen in the current study were within acceptable ranges. The reasons for loss to follow-up suggest that attrition rates may be related to social factors, such as the availability of support from a partner. Future studies should therefore consider factors such as long-term residency and partner involvement when recruiting participants into similar studies. This is especially so in patriarchal societies where male members of the family are the chief decision-makers on many issues affecting the family.

The strength of the correlation of scores between 12 and 18 months, and between 18 and 24 months was of a similar magnitude. As expected, scores for adjacent time points were more highly correlated than for those that were not. This finding suggested that the change in infants' scores between 12 and 18 months, and between 18 and 24 months was stable, and that scores increased in tandem. However, the low correlations between initial and final scores suggested that the trajectory of motor development from 12 to 24 months was unstable. These findings are in line with previous studies which have found that motor developmental trajectories vary considerably among healthy children (Darrah, Hodge, Magill-Evans, & Kembhavi, 2003; Roze et al., 2010).

Mean KDI raw scores increased substantially more between 12 and 18 months than between 18 and 24 months, suggesting that they were sensitive to maturational changes in children. This finding demonstrates that rapid changes take place in motor development between 12 and 18 months whose rate slows down from then until the age of 2 years. In line with what Darrah et al., (2003) have suggested, it could be that the longitudinal motor performance of typically developing infants is variable and non-linear, rather than constant.

**Effects of Background Variables**

Boys consistently scored higher than girls, with the magnitude of gender differences in KDI scores increasing with age, corroborating findings from other studies. For example, in a review of the sex differences in the activity levels of infants, Campbell and Eaton (1999) consistently found that boys were more active than girls, even from a young age. These differences in activity levels, an important component of motor skill development, were attributed to biological processes and socialisation experiences. The same may apply to the current study context. Mothers' expectations of their children's performance of various tasks may show a gender bias (Mondschein, Adolph, & Tamis-LeMonda, 2000) as they may encourage boys to engage in vigorous outdoor play activities while girls are pushed toward more quiet indoor activities (Lever, 1976).

The finding that mean KDI scores were lower in undernourished children than their well nourished counterparts reinforces findings from previous studies linking poor nutritional status to impaired development (Y. B. Cheung, Yip, & Karlberg, 2001; Kuklina, Ramakrishnan, Stein, Barnhart, & Martorell, 2006; McDonald et al., 2013; Walker et al., 2007). Past research however does not clarify the precise mechanism through which undernutrition is linked with poor motor development during infancy. We surmise, like has been done in past studies, that undernutrition may directly affect motor development through its impact on the central nervous system and brain maturation processes; or indirectly through decreased opportunities for interaction with the environment and with caretakers (Kuklina et al., 2006). Taking anthropometric measurements at each time point that children were tested on the KDI allowed us to capture the pattern of the

changing influence of nutritional status over time. The pattern of change in effect sizes observed in the current study suggests at the influences of underweight, stunting and wasting were strongest at 12, 18 and 24 months, respectively. The findings of the current study demonstrated that each of these indices of anthropometric status (HAZ, WAZ and WHZ) exert independent effects on outcome at different ages during infancy and toddlerhood. Such information is useful in timing nutritional interventions during infancy.

The current study did not find significant effects of maternal age on child outcome, even though the magnitude of its effects increased with child age. This finding suggests that interventions should be put in place earlier rather than later. The null effects of maternal age on child outcome have been reported previously in low-income settings (Kuklina et al., 2006). On the contrary, some studies in high-income settings have reported that higher maternal age predicts low developmental scores among infants (Alvik, 2013).

Surprisingly, children whose mothers reported the lack of a partner from they received any support obtained higher scores, and more so at older rather than at younger ages. This finding is contrary to research which indicates that growing up in a family structure headed by a single parent has negative implications for child development (Bain, Boersma, & Chapman, 1983; Downey, 1994). The availability of other forms of social support that such mothers may rely on from members of the extended family may explain our findings. It could be that other family members provide numerous opportunities for motor stimulation through their interaction with the child on various levels (de Paiva et al., 2010). The increase in the influence of family support at older ages supports the notion that environmental influences become stronger as children move away from exclusive caregiving by the mother. Access to a broader support network in such contexts may thus ameliorate the negative effects of the absence of a supportive partner on a mother, as the members of this network provide a mother with direct (caregiving) or indirect assistance (advice on child-rearing practices), which in turn impacts a child's developmental status.

The lack of significant associations between maternal education and KDI scores across all ages, as well as small effect sizes, confirmed previous findings among infants in both low- (Abubakar, Holding, van de Vijver, Newton, & van Baar, 2010; Kuklina et al., 2006) and high-income settings (Ravenscroft & Harris, 2007). However, other studies have reported a strong association between maternal education and fine (but not gross) motor skills at 18 months (Koutra et al., 2012). These inconsistencies may be related to the manner in which maternal education was conceptualised (none/some vs number of years of schooling) or to the age of the child at which these measures are taken. On the other hand, paternal education seemed to exert stronger effects on child motor outcomes, more so at younger ages, suggesting that having an educated father may

impact developmental outcomes during the first year of a child's life. One of the pathways through which paternal education may influence child outcome is in the increased opportunities for paid employment for educated fathers, hence more income available to the household. Within this context of high adult illiteracy rates, it may be worthwhile promoting access to parental literacy as a means of improving outcomes for children.

Differences in maternal occupation levels did not create variations in test scores at any of the child ages studied and effect sizes remained small. These null findings are contrary to what other studies have reported; that children of mothers who work achieve higher scores on motor tests than their counterparts whose mothers are not employed (Brooks-Gunn, Han, & Waldfogel, 2002; Huerta et al., 2011; Waldfogel, Han, & Brooks-Gunn, 2002). Our findings may be attributed to the fact that the majority of mothers were not employed, or to minimal variations in the occupational levels of mothers in this study. Although employment provides an opportunity to make more financial resources available to the family, differences in earnings for the various income levels may have been unremarkable.

Surprisingly, children of fathers who were not employed had the highest scores at younger ages. It may have been that such fathers spend a lot of time at home with their children. At older ages, a different pattern emerged with children of fathers employed at the top level (Level 3) achieving the highest scores. Furthermore, effect sizes were strongest at older ages. These findings suggest that higher occupation levels for fathers are related to higher incomes for families, contrary to what we found for maternal occupation. The positive effects of high family incomes on child development have been consistently reported in the literature, and may relate to provision of better nutrition.

The relationship between home ownership and child outcomes in the current study was not as expected. Effects of the differences seen among groups were also negligible. Owning a home, which may be used as a proxy for family resources, did not seem to exert a strong influence on children's motor scores, as has been reported in other studies (de Paiva et al., 2010). Living in a home shared with members of the extended family may provide greater opportunities for interaction with several family members, thus enhancing children's motor skill development.

**Multivariate Results**

Among the predictors entered into the regression model, home ownership, HAZ and gender stood out as the most influential on psychomotor scores at 12, 18 and 24 months, respectively. Unsurprisingly, none of the proximal, child-related variables was associated with psychomotor scores in the multivariate analysis at 12 months. Other studies have also reported that the effects of gender on motor performance are only detected at older ages (Thomas & French, 1985). For one,

gender may operate solely as a biological influence before the age of one year, and as a socio-cultural influence thereafter. These findings preclude the use of gender-specific norms in the application of the KDI at younger ages. Secondly, although undernutrition during this age has a negative impact on motor development, it may be that any delays can only be detected at older ages. The findings from the current study suggest that environmental influences have a stronger impact on motor performance than child-related variables during infancy (up to the age of 12 months), while the reverse is true at toddlerhood (up to the age of 24 months). This has important implications in the planning of interventions to improve outcomes in children.

Other possible correlates of motor development such as birth order could be included in further explorations, since older siblings model motor behaviour that their younger siblings may imitate. Reports from other studies also suggest that parents may be more responsive to first-born than later-born children. Other possible influences of motor development are the stimulation offered within the immediate home environment, and findings from the investigation of this aspect are reported in later chapters of this thesis.

Table 20

*Univariate Analysis of KDI Scores, 12, 18 and 24 Months*

| | 12 months | | | | 18 months | | | | 24 months | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | Mean (SD) | F (p value) | $\eta_p^2$ | N | Mean (SD) | F (p value) | $\eta_p^2$ | N | Mean (SD) | F (p value) | $\eta_p^2$ |
| Gender | | | DF (1,206) | | | | DF (1,179) | | | | DF (1,181) | |
| Boys | 102 | 27.3 (2.9) | .499 (.481) | .002 | 91 | 35.2 (2.0) | .562 (.454) | .003 | 91 | 40.3 (4.0) | 6.62 (.011) | .035 |
| Girls | 106 | 27.0 (2.7) | | | 90 | 34.9 (2.5) | | | 92 | 38.8 (4.1) | | |
| Underweight (WAZ) | | | | | | | | | | | | |
| Present | 22 | 25.6 (2.4) | 7.197 (.008) | .034 | 21 | 34.1 (2.5) | 4.360 (.038) | .024 | 17 | 36.7 (3.0) | 9.05 (.003) | .049 |
| Absent | 182 | 27.3 (2.8) | DF (1, 202) | | 156 | 35.2 (2.2) | DF (1, 175) | | 160 | 39.7 (4.0) | DF (1, 175) | |
| Stunting (HAZ) | | | | | | | | | | | | |
| Present | 33 | 26.6 (2.9) | 1.77 (.185) | .009 | 48 | 34.5 (1.9) | 4.211 (.042) | .023 | 70 | 38.7 (3.3) | 3.69 (.056) | .021 |
| Absent | 171 | 27.3 (2.8) | DF (1,202) | | 131 | 35.3 (2.4) | DF (1, 177) | | 108 | 39.9 (4.4) | DF (1, 176) | |
| Wasting (WHZ) | | | | | | | | | | | | |
| Present | 17 | 25.1 (2.4) | 10.468 (.001) | .049 | 13 | 34.8 (2.5) | .112 (.738) | .001 | 10 | 38.6 (3.0) | .447 (.505) | .003 |
| Absent | 187 | 27.4 (2.8) | DF (1,202) | | 166 | 35.1 (2.3) | DF (1, 177) | | 167 | 39.5 (4.1) | DF (1, 175) | |
| Maternal age | | | | | | | | | | | | |
| <20 yrs | 48 | 26.9 (2.4) | .154 (.857) | .001 | 41 | 35.1 (2.8) | .202 (.817) | .002 | 43 | 38.8 (4.3) | 1.80 (.169) | .019 |
| 20-34 | 148 | 27.2 (2.9) | DF (2,208) | | 127 | 35.0 (2.1) | DF (2, 181) | | 128 | 39.9 (3.7) | DF (2, 183) | |
| >=35 | 15 | 27.0 (3.0) | | | 16 | 35.3 (2.5) | | | 15 | 38.3 (6.0) | | |
| Support | | | | | | | | | | | | |
| No | 15 | 27.5 (2.2) | .299 (.585) | .001 | 11 | 36.0 (2.0) | 2.141 (.145) | .012 | 13 | 40.0 (4.0) | .028 (.868) | .000 |
| Yes | 196 | 27.1 (2.8) | DF (1, 209) | | 173 | 35.0 (2.3) | DF (1, 182) | | 173 | 39.5 (4.1) | DF (1, 184) | |
| Maternal education | | | | | | | | | | | | |
| <8yrs | 130 | 27.1 (2.7) | .051 (.95) | .000 | 121 | 34.9 (2.2) | 1.174 (.311) | .013 | 114 | 39.5 (3.2) | .011 (.989) | .000 |
| 8-11yrs | 61 | 27.1 (3.0) | DF (2, 208) | | 48 | 35.4 (2.4) | DF (2, 181) | | 53 | 39.5 (5.7) | DF (2, 183) | |
| 12+ yrs | 20 | 27.0 (3.1) | | | 15 | 34.6 (2.0) | | | 19 | 39.6 (3.5) | | |
| Paternal education | | | | | | | | | | | | |
| <8yrs | 87 | 26.6 (2.7) | 2.436 (.090) | .023 | 82 | 34.9 (2.1) | .237 (.789) | .003 | 84 | 39.0 (3.8) | 1.21 (.302) | .013 |
| 8-11yrs | 74 | 27.3 (3.0) | DF (2,208) | | 65 | 35.2 (2.4) | DF (2, 181) | | 66 | 40.0 (4.6) | DF (2, 183) | |
| 12+ yrs | 50 | 27.6 (2.6) | | | 37 | 35.0 (2.3) | | | 36 | 40.0 (3.7) | | |
| Maternal occupation | | | | | | | | | | | | |
| None | 115 | 26.9 (2.8) | .450 (.718) | .006 | 99 | 34.9 (2.4) | .601 (.615) | .010 | 98 | 39.4 (4.3) | .37 (.775) | .006 |
| Level 1 | 18 | 26.8 (2.8) | DF (3,207) | | 16 | 35.7 (.95) | DF (3, 180) | | 18 | 39.1 (2.8) | DF (3, 182) | |
| Level 2 | 69 | 27.3 (2.8) | | | 62 | 35.1 (2.4) | | | 62 | 39.7 (4.2) | | |
| Level 3 | 9 | 27.6 (3.3) | | | 7 | 34.7 (1.5) | | | 8 | 40.8 (3.4) | | |
| Paternal occupation | | | 1.156 (.327) | .016 | | | .834 (.477) | .014 | | | 1.67 (.175) | .027 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| None | 28 | 27.9 (2.8) | DF (3,207) | | 26 | 34.8 (2.7) | DF (3, 180) | | 26 | 38.6 (4.8) | DF (3, 182) | |
| Level 1 | 85 | 27.0 (2.8) | | | 72 | 35.4 (2.3) | | | 74 | 39.0 (3.8) | | |
| Level 2 | 53 | 26.7 (3.0) | | | 50 | 34.9 (2.4) | | | 46 | 40.1 (4.5) | | |
| Level 3 | 45 | 27.1 (2.4) | | | 36 | 34.8 (1.8) | | | 40 | 40.3 (3.5) | | |
| Home ownership | | | 1.204 (.302) | .011 | | | | | | | | |
| Tenant | 11 | 26.6 (2.2) | DF (2, 208) | | 8 | 34.5 (1.3) | .256 (.774) | .003 | 7 | 39.1 (1.9) | .045 (.956) | .000 |
| Family home | 94 | 27.4 (2.8) | | | 79 | 35.1 (2.3) | DF (2,181) | | 84 | 39.6 (4.5) | | |
| Own home | 106 | 26.8 (2.8) | | | 97 | 35.0 (2.3) | | | 95 | 39.5 (3.9) | | |

Table 21

*Significant Predictors of KDI Scores at 12 Months*

| Model 2 | Unstandardised Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 27.309 | .348 | | 78.526 | .000 |
| Dummy 2 for home ownership | .969 | .423 | .175 | 2.290 | .023 |
| Dummy 1 for partner's education | -.851 | .422 | -.154 | -2.018 | .045 |

Table 22

*Significant Predictors of KDI Scores at 18 Months*

| Model 2 | Unstandardised Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 35.262 | .268 | | 131.525 | .000 |
| HAZ_18m | .379 | .141 | .198 | 2.679 | .008 |
| Dummy 1 for paternal occupation | .690 | .343 | .148 | 2.008 | .046 |

Table 23

| Model 3 | Unstandardised Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| (Constant) | 42.466 | 1.292 | | 32.858 | .000 |
| Sex of the infant | -1.886 | .649 | -.230 | -2.908 | .004 |
| Dummy 2 for maternal age | 1.791 | .682 | .207 | 2.626 | .010 |
| HAZ_24m | .833 | .334 | .198 | 2.496 | .014 |

*Significant Predictors of KDI Scores at 24 Months*

CHAPTER 6: THE HOME ENVIRONMENTS OF SCHOOL-AGE CHILDREN AND INFANTS

## Paper 5: Exploring Differences in the Home Environment among Rural Households: The Role of Biological and Environmental Factors in Middle Childhood

### Introduction

The home environment is an important influence on children's health and development (Boivin et al., 1996; Bradley & Caldwell, 1995; Sigman, Neumann, Carter, et al., 1989). Having adequate levels of stimulation, support and enabling structures at home is especially important for children who live in general conditions of poverty or threat (Bradley & Corwyn, 2006). In order to develop programmes to protect children and to promote their healthy development, researchers, policy makers and practitioners have long felt the need to better understand how children's home environments affects their well being. Consequently, considerable attention has been devoted to finding ways to gauge the quality of children's environments accurately. One of the most frequently used measures of the quality and quantity of stimulation and support available to a child in the home environment is the Home Observation for Measurement of the Environment (HOME) Inventory (Caldwell & Bradley, 2003).

The Middle-Childhood (MC) HOME Inventory (Bradley, 1994), which is the subject of the current investigation, was designed for children aged between 6 and 10 years. It comprises observations of parental responsivity to the child, descriptions of family routines and experiences, measures of orderliness in the home, and the opportunities for stimulation within the child's physical home environment. Several studies suggest that these dimensions of family influence are strongly related to socio-economic status (Bradley, Corwyn, McAdoo, & Coll, 2001; Hart & Risley, 1995). However, in settings where many households are characterised by low parental education and low household income, it is unclear whether the indicators contained in the HOME Inventory are optimal for characterizing diversity within the home environments of families.

Bradley, Corwyn and Whiteside-Mansell (1996) have also reviewed evidence for the validity of the HOME Inventory across different cultural settings. Measurement of certain constructs which are assumed to be universal is expected to yield similar results across cultures (Whiteside-Mansell, Bradley, Little, Corwyn, & Spiker, 2001); however, this may not be the case due to the cultural specificity of the actions, activities and relationships within the home environment (Bradley & Corwyn, 2005). Across diverse settings, the items in the HOME Inventory may not adequately reflect the manner in which, for example, parental sensitivity to a child's needs and behaviour is expressed. For example, within some societies a child is not seen as an interactive partner for adults, and parents do not play with their children (Bornstein,

2007). In other societies, adults do not consider it appropriate for a child to be independent, assertive and inquisitive (Aina, Agiobu-Kemmer, Etta, Zeitlin, & Setiloane, 1993; Greenfield, 1994). On the other hand, some activities which are not included in the HOME Inventory may be just as important to children's well being among families living in different contexts (Lancy & Grove, 2011; Shweder, 1995). These differing expectations may lead to home environments being described as 'limited, deprived or deficient rather than different' (Bernstein, Harris, Long, Iida, & Hans, 2005) and contribute to the limitations seen in the cross-cultural application of the HOME. Such limitations, which are part of a larger problem of how to select indicators to characterize the resources and events present in diverse contexts or with diverse groups (Hagerty & Land, 2007), may compromise the validity of the measure.

Although the HOME Inventory has been used in several scientific studies world-wide (Baker-Henningham, Powell, Walker, & Grantham-McGregor, 2003; Bradley & Caldwell, 1981; Bradley et al., 2001; Burston, Puckering, & Kearney, 2005; Caughy, Randolph, & O'Campo, 2002; Hamadani et al., 2010; Pessanha & Bairráo, 2003) and as part of numerous efforts to evaluate programs for parents and children (Bradley & Putnick, 2012), one major limitation is the over-concentration on children younger than school-age (Bradley & Corwyn, 2005). Furthermore, few studies have applied this measure in sub-Saharan Africa (Aina et al., 1993; Bangirana, Ssegane-Musisi, et al., 2009; Goldberg, 1977a; Holding et al., 2011; Richter & Grieve, 1991; Sigman, Neumann, Carter, et al., 1989). The need for a measure that accurately assesses the proximal processes within the rural child's environment from an ecological perspective provided the impetus for the current study.

I sought to establish the influence on child well-being of specific actions, objects, events and conditions within households. In line with Bronfenbrenner's bioecological theory (Bronfenbrenner & Ceci, 1994), I expected an association between child characteristics and the processes within the home environment, and between distal contexts and the home environment. I aimed to establish the reliability of the modified indicators and to determine whether or not patterns of response varied by age and gender of the school-age child. I also examined the extent to which nutritional status and an index of household wealth (distal factors) were associated with the quality of the home environment (in terms of availability of stimulating materials, aspects of physical surroundings and parental nurturance). In so doing, I sought to obtain preliminary evidence for convergent validity of the home measure, through a positive association with the index of household wealth. The identification of discrete components of the home environment that influence outcome will facilitate the formulation of interventions in a more targeted and effective manner.

## Method

### Study Site and Sample Selection

The study was carried out in Kilifi District in the Coast Province of Kenya. More than

half of the district's population lives below the poverty line (Kahuthu et al., 2005a) with incomes of less than $2 USD a day. The majority (>80%) of the population is engaged in agricultural activities that include crop cultivation and rearing of livestock. Other sources of income include trade and services, tourism, fishing and mining.

A typical home in Kilifi comprises a large homestead with several small huts in which members of the extended family live together and share in the daily household chores. It is not uncommon for members from different generations to share in child-rearing duties. Children of school-going age spend a lot of their time outdoors with near-age siblings or peers. Boys have more unstructured time engaging in mostly play activities while girls attend to chores such as fetching firewood and water and helping their mothers in the fields (Wenger, 1989).

The participants in this cross-sectional study comprised a sub-group of 146 children aged 8-10 years who were part of a larger programme concerned with the development of psychological assessment materials for school-age children (Kitsao-Wekulo et al., 2012). Children were included in the main study if they lived within a 5-km radius of five schools randomly chosen to represent a cross-section of schools within the district. For the HOME Inventory sub-sample, attempts were made to ensure an equal representation of boys and girls, and a representative cross-section of residential areas. A detailed description of the study area is presented in Chapter 3.

**Materials and Procedures**

**Home environment measure.** The Kilifi-Home Inventory for Primary School Children (Kilifi-HIPSC: Kitsao-Wekulo et al., under review) was used to gather information on parental involvement and provision of stimulating experiences for school-age children. This measure incorporates similar concepts as the original version of the Home Observation for Measurement of the Environment (HOME: Caldwell & Bradley, 2003) Inventory. However, a significant number of items from the original measure were excluded because of limited variability, negative item-total correlations and ambiguity in scoring. Similar to the original HOME Inventory, a 'Visitor' endorses each item through a semi-structured interview with the primary caregiver, and from observing caregiver-child interaction in the home environment. In order to make it more sensitive to variations within this context, the original dichotomous rating scale was changed to a three-level rating system.

The Kilifi-HIPSC was administered to selected primary caregivers who were interviewed at home in the presence of the target child at pre-arranged times. The 'Visitors' completed a form on which they recorded the caregivers' responses verbatim. When specific objects that were not clearly visible were mentioned during the interview (for example, toys and books that the family possessed), the 'Visitor' asked the caregiver to show her the items. The interview took about one hour to administer. Appendix L presents a summary showing the proportion of respondents who selected each rating level, and highlights items that were retained from,

modified in or added to the original version. Inter-rater reliability data were collected for all the interviews conducted. The written responses of one observer were reviewed and re-coded by a second rater. Discrepancies in coding were discussed with a third coder until consensus on the correct score was reached (de Temple & Snow, 1998).

During the visit, additional information was collected on aspects of household SES (as detailed in Chapter 3) which was calculated as a composite index of six indicators; parental education, parental occupation, ownership of small livestock and type of household windows. These items were selected from a review of SES indicators made in the study population. Previous research had revealed a significant positive association of these indices with children's final school examination score (Holding, personal communication, 2003). We derived an index of household wealth that divided the sample into three approximately equal groups – least wealthy (Level 1), moderately wealthy (Level 2) and the most wealthy (Level 3).

**Analysis**

We described the characteristics of the study sample using frequencies and proportions. Items were clustered into six groups of connected items to derive conceptually meaningful subscales. The relationship of each item to the subscale as a whole was evaluated by examining point-biserial correlations. We used a minimum threshold value of .15 and items whose item-to-subscale correlations fell below this level were dropped from the subscale; except in the case where there were strong conceptual grounds for retention or they contributed to internal consistency (Han, Leventhal, & Linver, 2004). Internal consistency reliability levels of each of the six subscales were also examined.

The association of the final subscales with age and with gender was tested using analysis of variance and an independent samples t-test. In order to assess convergent validity, we measured correlations between the Kilifi-HIPSC subscale and total scores and child nutritional and socioeconomic status. Correlation and multiple regression analyses were conducted to examine the relationship between Kilifi-HIPSC scores and various potential predictors. We carried out all analyses using SPSS Version 19 and set an alpha level of .05 for statistical significance.

## Results

**Sample Description**

Children were on average 9.0 years old (range: 6.5 – 13 years) and 52.1% were boys. The majority of children were rural residents; 16% lived in a peri-urban area, on the outskirts of the main town. Only 21(14.4%) children were not attending school (Table 24). Children to whom the Kilifi-HIPSC was administered were not significantly different from the remainder in the main study in terms of gender distribution, age, area of residence, nutritional status and household wealth. However, the Kilifi-HIPSC sub-sample had significantly less number of years of exposure to school, $t(306) = 2.574$, $p = .011$.

**Conceptual Clusters**

The mean total score on all the 60 items was 64.46 (*SD* = 11.61; range, 37-97) out of a possible maximum score of 120. The final selected 45 items were grouped into clusters according to the manner in which they cohered conceptually. The groupings in the original MC-HOME Inventory guided this process which yielded six subscales representing Language Stimulation, Parental Concern, Emotional Support, Provision for/Involvement in Activities, Cognitive Stimulation and Physical Environment (Figure 5). All items had acceptable item-to-subscale correlations except for item 27, 'Child has free access to musical instrument,' in the Provision for/Involvement in Activities Subscale. However, this item was retained because it differentiated households from each other. Cronbach's alphas of the subscales ranged from .593 to .707. Subscales for Emotional Support and Physical Environment had the greatest internal consistency levels (Table 25). Significant correlations among the subscales ranged from .171 to .544.

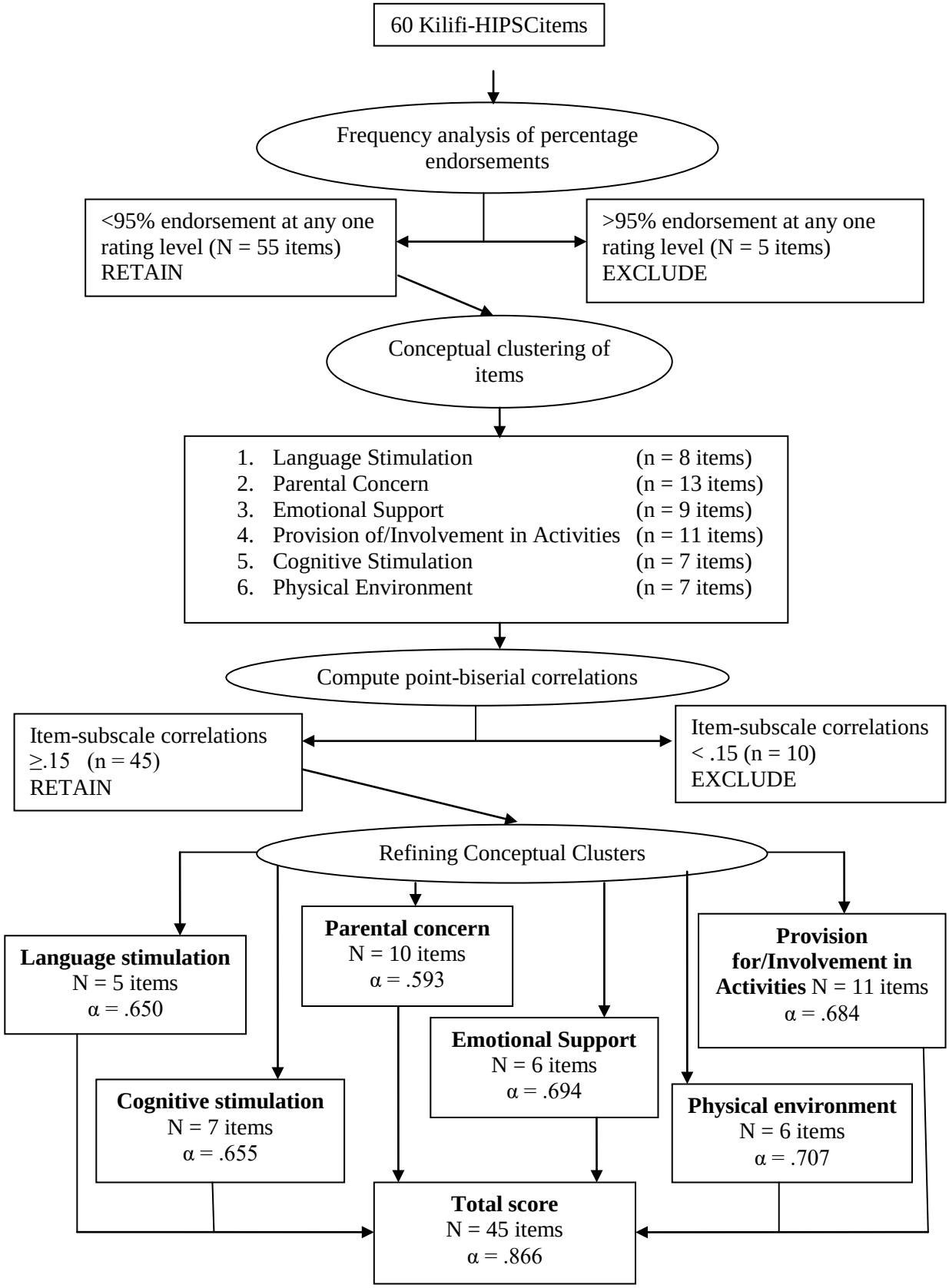
**Associations with Background Variables**

Correlations between age, gender and the Kilifi-HIPSC subscale and total scores were all non-significant. The Language Stimulation, Provision for/Involvement in Activities and Cognitive Stimulation subscales as well as the total scale score, were moderately correlated with height-for-age z-scores, such that lower scores were associated with poorer nutritional status. Household wealth positively correlated with all the Kilifi-HIPSC subscales (correlations ranged from .280 to .567) with the exception of the Emotional Support subscale (Table 26).

**Significant Predictors**

The multiple regression model with the two predictors, nutritional status and household wealth, produced $R^2 = .220$, $F(4, 142) = 21.301$, $p < .001$ for the Language Stimulation subscale; $R^2 = .066$, $F(4, 142) = 6.089$, $p = .003$ for the Parental Concern subscale; $R^2 = .133$, $F(4, 142) = 12.007$, $p < .001$ for the Activities subscale; $R^2 = .333$, $F(4, 142) = 37.025$, $p < .001$ for the Cognitive Stimulation subscale; and, $R^2 = .095$, $F(4, 142) = 8.549$, $p < .001$ for the Physical Environment subscale. Nutritional status and household wealth also predicted nearly 26% of the variance on the combined Kilifi-HIPSC score, $R^2 = .255$, $F(4, 142) = 25.655$, $p < .001$. Table 27 summarises the results of the regression analysis.

*Figure 5.* Flow diagram of formation of conceptual clusters for the Kilifi-HIPSC items



## Discussion

This study highlights the unique contribution of specific components of the home environment that could be targeted to improve children's outcomes in a more effective manner. The Kilifi-HIPSC is a 45-item scale (for use in middle childhood) that consists of items modified from the original MC-HOME Inventory with regards to content, format and the examples used. The tool which assesses the quality and quantity of stimulation within the home environment was designed to fit the cultural context of the current study setting. The increasing importance of outside environments during this developmental period (Bronfenbrenner & Ceci, 1994) necessitated the inclusion of an additional item on the immediate surroundings of the household. Trained interviewers who underwent an intensive training programme generated responses on the items through caregiver reports and observer ratings. We developed a more detailed format than the original semi-structured interview to facilitate data collection. We changed the coding system from a two- to a three-point scale to increase variability in responses. The Kilifi-HIPSC sub-sample was representative of rural school-age children. Our sample included a sizable proportion of out-of-school children despite the fact that they were more often resident further away from schools and hence less accessible. For school-going children who were in school for most of the day, the requirement of having both the child and the primary caregiver present during the interview posed a challenge. However, we scheduled numerous visits to selected homes and visited homes when families were engaged in non-demanding tasks.

The current study contributes to the existing literature in several important ways. First is the production of a measure that was reduced in length and yet its psychometric properties remained acceptable. Inter-rater reliability for all the items ranged from moderate to nearly perfect agreement illustrating the utility of the 3-point coding system. Conceptual coherence of items was the primary basis for organising indicators into meaningful groups. In a previous application of the HOME Inventory within a similar context (Holding et al., 2011), no common underlying structure was found for the components derived from a factor analysis. In line with this earlier study, we therefore did not expect the original factor clusters to be replicated within this population largely due to differences in cultural contexts and the range of behaviours sampled.

Internal consistency reliability levels of the conceptually-derived Kilifi-HIPSC subscales ranged from .6 to .7, consistent with those of the original MC-HOME Inventory (Bradley, Caldwell, Rock, Hamrick, & Harris, 1988). It was not surprising that moderate alpha levels were recorded for some of the subscales; as Bradley (2004) postulates, this is not a problem given that there may be no inherent connection between the indicators that we grouped together. What was more important was the inclusion of all (rather than a sample of) causal indicators

used to derive our latent constructs to be sure that they were sufficiently representative (Bollen & Lennox, 1991).

After identifying features of the home environment which support child development, we established face validity of the modified measure through parental assessments of the cultural appropriateness and clarity of the items. This step was necessary in a context of low literacy levels, to prevent the limitation of participants responding incorrectly because the items are confusing or incomprehensible. We speculated that parents presumably manifest the beliefs, goals and patterns of behaviour that pervade life in the larger society and therefore had a general idea of the actions, events, behaviours and conditions that promote their children's well-being (Bradley, 2004). The low to moderate correlations between the Kilifi-HIPCS and the index of household wealth and with nutritional status provided evidence for convergent validity of the tool. These positive associations are in line with results from the broader research literature and from other studies in similar contexts (Elardo, Bradley, & Caldwell, 1975; Holding et al., 2011; Kaur & Kalaramna, 2004; Masud, Luster, & Youatt, 1994; Sarsour et al., 2011). Comparisons between the current study and earlier ones should however be made cautiously because many of these earlier studies were conducted among younger populations.

Second, given the evidence of modest but significant correlations among the Kilifi-HIPSC subscales, we suggest that the modified measure is measuring distinct yet related aspects of the home environment, highlighting their importance. Because they are focused in content, subscales may allow very specific hypotheses about the home environment to be tested (Linver, Brooks-Gunn, & Cabrera, 2004). These newly developed subscales therefore offer an advantage over using all the items of the MC-HOME or factor analysis-derived subscales, as they determine discriminatory features of the home environment. Such information makes it possible to distinguish between families providing adequate levels of support and those that offer little or no support.

Third, non-significant differences in the patterns of response for boys and girls illustrate the applicability of the measure across both genders. This finding was as expected and suggests that we do not need to make different interpretations in the scores that boys and girls obtain. An earlier study (Hannan & Luster, 1991) similarly reported little effect of the child's gender on the quality of the home environment. Contrasting findings have however been reported by Baharudin and Luster (1998) who found that female children received more supportive care than their male counterparts. As the authors themselves highlighted, these differences may have arisen because they used a short form of the HOME Inventory. A noteworthy difference is the paths followed in the derivation of the short forms of the home measure in the current and earlier study; the items comprising each version were therefore necessarily different.

Fourth, we demonstrated that scores did not vary significantly across the different age groups studied. Age effects have been previously illustrated by Bradley and colleagues (2001)

who compared the frequency with which children were exposed to particular activities in their life experiences from infancy through adolescence. Age differences would have more likely been evident if the age spread covered in the current study was larger – our study only included children aged approximately between eight and ten years. The lack of an association between the home environment scores and age may therefore be attributed to the restricted age range of the children included in the current study. Our findings suggest that the measure is equally applicable across the age range for which it is intended.

Nutritional status and household wealth predicted higher scores on all the subscales (except for Emotional Support) as well as on the total Kilifi-HIPSC scores. Associations of sub-scale and total scores with household wealth were however stronger and more consistent than those with nutritional status. These findings are consistent with the bio-ecological theory which stipulates that distal contexts, represented by household wealth, have a substantial effect on the proximal processes within the child's home environment (Bronfenbrenner & Ceci, 1994). Gutman and colleagues (2003) point to a cognitively stimulating environment as being a protective factor against risk factors such as socio-economic disadvantage and poor nutritional status.

Our study findings demonstrate that the Kilifi-HIPSC is a viable and rich alternative to the original MC-HOME Inventory. The brevity of the scale facilitates a quick screening of the promotive aspects of a child's home environment. Furthermore, the derivation of subscales reveals a more precise picture of the proximal processes within the child's home environment. We omitted several items either due to restricted variability or because they did not make a substantial contribution to internal consistency. Weak, poorly performing items may provide clues on those aspects of the home environment that need more complete documentation. Rare items (because they were considered culturally inappropriate) may have an impact on children's functioning, based on the findings obtained in other contexts. These non-discriminative items may however have clinical significance for this population as it may be the rarity of an event that makes it meaningful.

Examination of the influence of maternal characteristics such as age of mother at first birth and maternal intelligence; contextual factors such as number of children and presence of spouse or a partner; and, child characteristics such as birth weight and temperament on the home environment will expand the findings of the current study. We recommend the inclusion of these factors in future studies within similar settings.

Table 24

*Characteristics of the Kilifi-HIPSC Sub-sample*

| | Kilifi-HIPSC sub-sample | | non-Kilifi-HIPSC sample | |
|---|---|---|---|---|
| Variable | N | % | N | % |
| Gender | | | | |
| Boys | 76 | 52.1 | 72 | 44.4 |
| Girls | 70 | 47.9 | 90 | 55.6 |
| Area of residence | | | | |
| Rural | 123 | 84.2 | 122 | 75.3 |
| Peri-urban | 23 | 15.8 | 40 | 24.7 |
| Nutritional status | | | | |
| Stunted | 38 | 26.0 | 36 | 22.2 |
| Not stunted | 108 | 74.0 | 126 | 77.8 |
| Variable | M | SD | M | SD |
| Age (years) | 8.99 | 1.12 | 9.16 | 1.11 |
| Range | 6.5-13.0 | | 5.00-13.50 | |
| School experience (years) | 2.47 | 1.72 | 2.96 | 1.63 |
| Range | 0-7 | | 0-6 | |
| Household wealth | 8.98 | 4.09 | 8.48 | 3.79 |
| Range | 1-21 | | 1-19 | |

Table 25

*Description of the Kilifi-HIPSC Subscales*

| Subscales | # items | ICC | *M* (*SD*) | Range item-subscale *r*s |
|---|---|---|---|---|
| Language Stimulation | 5 | .650 | 3.73 (2.676) | .241 - .581 |
| Parental Concern | 10 | .593 | 7.34 (2.878) | .168 - .419 |
| Emotional Support | 6 | .694 | 10.12 (1.906) | .310 - .740 |
| Provision for/Involvement in Activities | 11 | .684 | 6.40 (3.916) | .144 - .491 |
| Cognitive Stimulation | 7 | .655 | 5.29 (2.704) | .198 - .524 |
| Physical Environment | 6 | .707 | 8.34 (2.405) | .183 - .733 |

Table 26

*Correlations Among Variables in the Study*

| | Gender | Age (years) | Height-for-age Z-scores | Household wealth |
|---|---|---|---|---|
| Language stimulation | NS | NS | .288** | .442** |
| Parental concern | NS | NS | NS | .280** |
| Emotional Support | NS | NS | NS | NS |
| Provisions for/Involvement in Activities | NS | NS | .237** | .344** |
| Cognitive stimulation | NS | NS | .280** | .567** |
| Physical environment | NS | NS | NS | .317** |
| HOME combined score for 45 items | NS | NS | .242** | .499** |

** Correlation is significant at the .01 level

*Correlation is significant at the .05 level

NS = non-significant

Table 27

*Predictors of Kilifi-HIPSC Subscale and Total Scores*

| Subscales | Nutritional status | | | Household wealth | | |
|---|---|---|---|---|---|---|
| | *b* | β | *t* | *b* | β | *t* |
| Language stimulation | .495 | .203 | 2.699** | .258 | .394 | 5.224*** |
| Parental concern | -.030 | -.011 | -.138 | .201 | .283 | 3.435** |
| Emotional Support | -.153 | -.088 | -1.029 | .030 | .064 | .749 |
| Activities | .612 | .171 | 2.157* | .293 | .305 | 3.834*** |
| Cognitive stimulation | .410 | .167 | 2.398** | .348 | .526 | 7.555*** |
| Physical environment | .147 | .067 | .824 | .182 | .307 | 3.780*** |
| Total scores | 1.481 | .142 | 1.924 | 1.312 | .466 | 6.325*** |

*$p<.05$, **$p<.01$, ***$p<.001$

## Paper 6: Exploring Changes in Caregiver Transactions in the Second Year of Life: Naturalistic Observations in a Rural Community Setting

### Preamble

This paper is set against the background of two major studies. The first is the main study on prenatal exposures from which the infants who were observed in the current study were selected. Preliminary analysis of caregivers' reports of children's experiences within the home environments (obtained through the measure of the home environment described earlier) provided a synopsis of infants' daily routines. The second study was a nutrition intervention study (Improving Nutrition through Staple Foods in Africa – INSTAPA) through which naturalistic observations were conducted on 309 children (51.8% girls, N = 160) at 6, 12, 18 and 24 months. This larger study provided information on various aspects of mother-infant interactions over time although I was not directly involved in collecting these data. As I borrowed some of the items used in my checklist from the INSTAPA study, I used the data from these observations to make generalisations about the developmental sequence on overlapping items. It should be noted that the study setting, participants and data collection tools for the nutrition intervention study (Appendix O) were fairly similar to those employed in the study described henceforth, allowing for direct comparisons.

To obtain a detailed picture into the daily experiences of infants growing up in this setting, I conducted naturalistic observations of selected children. These observations were informed by my curiosity over actual events and activities during the interactions within the child's immediate environment. Some of the information that I sought was on the structure of the environment within which the child lived, the types of interactions that infants within this context engaged in – who the child was involved with, what the child was engaged in and what form of interaction took place – and whether these activities were initiated by the child, by the caregiver or by other people. I speculated about the availability of toys for the children to play with, and if they had toys, how they used them. I also sought to establish whether any of the interactions and activities supported the development of language skills, motor abilities or both.

Because of the uniqueness of each individual, I anticipated that my observations would reveal variations in caregiver-interactions from one child to another. The questions then were, were these interactions normative or unique, and were there any shared patterns? If the interactions revealed differences, what then was the nature of these differences? In addition, as these observations were conducted over a period, I sought to identify any changes in the interaction patterns, and whether these changes were related to child factors (such as age and gender) or to environmental factors (such as maternal age and education). In line with Bronfenbrenner's bioecological theory, I expected that factors closer to the child would have a greater impact on these interaction patterns, than those further away. Finally, an important aspect would be to establish if these observations add to data that have already been collected

within the current study.

## Introduction

Caregiver-infant interactions are important because they are associated with several aspects of immediate and later child development (Bornstein & Tamis-LeMonda, 1989; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996). Both social and didactic, these interactions are characterised by physical activity of both partners which includes frequent touching of the infant by the caregiver (Stack & Muir, 1990), as well as dyadic exchanges between the caregiver and child. Underlying these interactions are parenting constructs which, because of their assumed universality, are considered relevant across contexts. These include parental sensitivity to a child's needs and behaviour (Whiteside-Mansell et al., 2001), parent socialisation of the child to cultural norms of behaviour (Baumrind, 1996) and the child's attachment to the primary caregiver (Posada et al., 2002). During infancy, the most important quality of these interactions is sensitivity and responsiveness to the infant's signals (Goldberg, 1977b).

Cultures that encourage child interdependence, such as that of the current study context, place emphasis on social-affective socialisation (Greenfield, 1994; Nsamenang & Lamb, 1994). This type of socialisation occurs when a child is securely attached to an adult, and because of that attachment, is able to adapt some aspect of that adult's beliefs, values or perspective. The child is then socialised through the strength of the trust, love and security of the relationship, making the child more willing to adapt the ideals or beliefs of that adult than of someone else. Within these cultures, the responsibility for care-giving and transmitting societal values is shared by members of the immediate and extended family and community members, and children are socialised to share responsibility and resources with others in the family and community. The parent concerned with fostering interdependence then gears the interaction toward helping the infant develop sensitivity, perspective taking and co-operation

The manner in which caregiver-infant interactions are displayed will necessarily differ across children due to the influence of various background factors. Child variables such as gender (Clearfield & Nelson, 2006), birth order (B. S. Jacobs & Moss, 1976) and temperament (Belsky & Isabella, 1988; deVries, 1984) may affect the manner in which a mother relates with her child. For instance, boys, who some cultures may consider more important than girls, are afforded better care and more privileges. Girls, on the other hand, may face discrimination in the care they receive in terms of their access to nutritious foods and health care (UNICEF, 2007). Similarly, gender-based differences are seen in the way that mothers may encourage dependency in girls while at the same time encouraging boys to work out their problems for themselves (Fagot, 1994). In relation to temperament, a difficult child whose demanding style is a strong solicitor of greater care and more feeding, may be more likely to survive than an

easy-going child (deVries, 1984), particularly in low-resourced settings where children face many risks to their survival.

With regard to caregiver characteristics, risk factors such as low maternal age (L. Levine, Garcia-Coll, & Oh, 1985), poor education levels (Richman, Miller, & LeVine, 1992) and maternal employment (Nomaguchi, 2006) may reduce the likelihood of positive involvement of mothers in interactions with their infants. As demonstrated through these earlier studies, older mothers talk more and show more positive affect towards their infants than younger mothers. Compared to older mothers, teenage mothers may provide less than optimal care-giving environments due to factors inherent to their younger age: lower levels of education and limited access to social support. For employed mothers, the complexity of work and work-related stress may have a negative impact on the relationship she has with her child. On the other hand, for the infant, this is a period of tremendous growth and development and the temporary loss of a significant other (during the time when the mother is away at work) may prove detrimental to the development of the parent-child attachment relationship.

Environmental variables including number of persons within the household, socioeconomic situation and those embedded within the cultural context such as acceptable modes of child rearing, differences in the value assigned to gender and the role of members of the extended family (Harkness & Super, 1992; Keller, Voelker, & Yovsi, 2005; Richman et al., 1992), also impact caregiver-infant interactions. Munroe and Munroe (1971) while discussing the issue of multiple caregivers in relation to mother-infant interactions suggest that the number of persons available to the infant may, to some extent, determine the degree of exclusivity of the mother's caregiving, which in turn affects the infant-mother relationship. Socioeconomic factors are related to parental education, the quality of neighbourhoods and the conditions of the daily living environment, and many studies have reported a positive association between these factors and the quality of interactions between mothers and their infants (Duncan & Magnuson, 2002; Hoff-Ginsberg & Tardif, 1995). And in many non-Western settings, infants are carried by their mothers for a substantial part of the day (R. A. LeVine, 1990) and, when the mother is away, may be left for extended periods of time under the care of other members of the family.

There exist a number of studies in which African mothers have been observed with their infants (deVries, 1984; Monroe & Monroe, 1971). However, few of these have been conducted in the context of multiple caregiving, particularly during the second year of life. The present study was designed with the central goal of providing descriptive data on infants' behaviour and to explore specific variations in the pattern of common behaviours within the unique circumstances of their home environments. As children spend a lot of time with women in real-world settings, it is of crucial importance to study mother-infant interactions because mothers are accustomed to interacting with their children in dyadic settings (I use the term 'mother' and

'caregiver' interchangeably because even though other people may take up the role of caregiving, it is usually the mother who is primarily involved in this task). I therefore examined similarities and differences in mother-infant interactions when infants were aged between 12 and 24 months to provide information on stability and change in patterns of interaction over time. As it is during infancy that children are the most vulnerable, such information is important for the timing of interventions to improve the health and well-being of infants.

## Method

### Study Design

The study made use of systematic naturalistic observations to collect information about children's typical daily activities. My choice of this method of data collection was informed by the advantage that it 'creates the possibility of giving sustained attention to the activities that the infant is engaged in, and the relational dynamics of a family, without having to take an active role, or to take account of the consequences of deliberate interventions' (Rustin, 2006). Although naturalistic observations are time-consuming, these types of observations yield highly accurate, detailed, and verifiable information about children in their natural settings. Other advantages (and limitations) of this method are outlined below.

**Advantages of naturalistic observations.** The primary strength of naturalistic observations is that one can observe behaviour as it naturally occurs in everyday life ensuring that ecological validity of the data is maintained. Moreover, this method is easy to use as it has minimal equipment needs: a clock for keeping time, and a pen and paper or checklist for recording the occurrence of target behaviour. Also, this method provides a fairly complete picture of a child's interactions with others as target children can be observed together with those around them. Another advantage of this method is that it allows the collection of data in cases where the use of experimental techniques would be impractical.

**Limitations of naturalistic observations.** Selecting the optimal distance from which to conduct the observation is a concern because if the observer is too close, children may be reactive and restrict their interactions. On the other hand, if observers are too far from the child, they may fail to observe behaviours of interest, particularly those that may occur for brief periods (Pepler & Craig, 1995). The lack of experimental control is another limitation of this method due to the very nature of collecting observational data. For instance, observers cannot determine that the observed participants should behave in a specific manner.

### Study Setting and Context

The study was conducted within Msambweni, a rural district at the Coast province of Kenya. Msambweni District is predominantly populated by the Digo, a sub-tribe of the Mijikenda ethnic group. Approximately 86% of the labour force is engaged in farming, mainly small-scale farming of maize, cassava, cashew nuts, coconut and mangoes. The remainder are

involved in trading and informal employment (Kahuthu, Muchoki, & Nyaga, 2005b) The majority of houses within the district are characterised by mud structures with coconut palm-thatched roofs. Household structure mainly comprises primary members of the family living together with members of the extended family. Female members of the household share in daily household tasks, which include farming of small portions of land located near the house, fetching water and child caretaking. Girls within this community get married off at a young age, resulting in a large population of mothers aged between 15 and 24 years.

**Participants**

Participants were drawn as a subset from a larger study on the impact of pre-natal exposures to children. Families with an infant of the appropriate age (7-10 months) were eligible to participate. Mothers were approached by a child development assessor linked to the larger project who invited them to be part of this sub-study. A sub-sample comprising six dyads of equal gender distribution (3 mother-son and 3 mother-daughter) was selected purposively, from three residential areas representing different sub-locations in the district. None of the children had overt physical health concerns. Two children were firstborn and four were later born. All families were two-parent at the initial recruitment. For the majority of the observation sessions, biological mothers were the primary caregivers. All participants belonged to the Digo sub-tribe of the Mijikenda, which is the predominant ethnic group of the resident community members.

**Ethical Considerations**

None of the mothers who were approached refused participation. They were given specific additional details about the purpose of the observations. Written parental consent was obtained for all participating children, in accordance with the regulations of the Kenya Medical Research Institute/National Ethics Review Committee (KEMRI/NERC) and the Ethics Committee of the Faculty of Humanities, Development and Social Sciences (HDSS) at the University of KwaZulu-Natal (UKZN).

**Data Collection Instruments**

Data were collected by means of a researcher-developed observation checklist designed for the purpose of the study. The checklist was used to code discrete aspects of behaviour during the caregiver-infant interactions. Items included on the measure of the infants' home environment used in the parent study were grouped under five categories on the checklist, while items in three categories (Responsivity [vocalisation items], Behaviour and Maintenance) were borrowed from a naturalistic observation checklist applied in a concurrent nutrition intervention study (INSTAPA) within the same district. The actual coding involved noting the presence of specific behaviours within the categories of responsivity, acceptance, organisation, learning materials, involvement, child behaviour and maintenance. Behaviour codes were chosen over rating scales because of the detail they provided. Whereas rating scales provide information on

the frequency of a specific behaviour, behaviour codes provide a continuous coding format in which each occurrence of the behaviour is recorded and allows the observer to obtain information on the intensity, duration and type of behaviour.

**Data Collection Procedures**

All families were visited at monthly intervals during the child's second year of life until the age of 24 months. The data were collected by one of two people at each instance following a standard protocol. I collected the data for the earlier (when the children were aged 12 to 14 months) and the later observations (18-24 months) while a child development assessor trained in naturalistic observation techniques collected the data when I had to be away from the field for personal reasons. We produced operational definitions of the behaviours in question so that there was no conflict in coding. These definitions are provided at the end of this section. Both observers were members of the ethnic group to which the community under study belonged and were therefore aware of subtle cultural nuances of speech and gestures.

**Observation Strategy**

Initially, unstructured one-hour observations of the child and mother were conducted to gather information on typical behaviours during the mother-infant interaction process. The behaviours and activities observed were categorised under various themes. In the second observation session, a structured observation checklist was used so that specific information on targeted behaviour could be recorded at regular intervals. The purpose of this session was to establish the adequacy of 5-minute intervals in capturing the activities and behaviours that the child and parent engaged in. These observations lasted one-and-a-half hours. These 5-minute intervals were found to be too long as there were too many child-related activities observed within this period. After reducing the interval period, comparison of one- and one-and-a-half-minute intervals established that the differences in the information collected within these periods were negligible. I therefore settled on using one-minute intervals. A narrative of the findings from these initial sessions is presented in Appendices M and N.

The home visit began with greetings and small talk with the mother to establish some rapport. This was necessary because in this context, parents are likely to organise their own behaviour to conform with what they perceive to be the motivation of the observer, rather than behaving as they would naturally (Zaslow & Rogoff, 1981). We informed mothers that we were interested in infants' environments and behaviours at home. This situation required the child to be awake. Observations were therefore scheduled for times that were optimal for the child and at the primary caregiver's convenience. We especially emphasized that we were interested in recording a segment of the infant's typical daily experiences and activities. During each visit, mothers were asked to maintain their usual routines throughout the observations.

Children were acclimatised to the observer's presence and were observed individually using a focal child approach. All the observations were made outdoors so the observer was able

to maintain distance and to mask the actual observation so that the child did not get overly conscious. The observer did not initiate interactions with the infants but responded in a friendly manner to overtures from them (Vaughn & Waters, 1990).

Observation sessions were timed to commence as soon as the child was comfortable in the presence of the observer and began to engage in their normal activities. Because we waited until the child was comfortable in the observer's presence, we can be reasonably certain that we observed behaviour as it occurred naturally. Sometimes the mother moved away from the vicinity of the infant; in such cases, observation of the infant behaviour continued. If the child fell asleep during the observation period, another session was scheduled for the next day. A timeline and summary of the completed observations are presented in Tables 28 and 29.

Table 28

*Timeline of Completed Observations*

| Months | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Child 1 | - | - | √ | √ | √ | √ | √ | √ | √ | √ | - | √ | √ | - | √ | √ | √ |
| Child 2 | - | √ | √ | √ | √ | - | √ | √ | √ | √ | √ | √ | - | √ | √ | - | √ |
| Child 3 | √ | - | √ | √ | √ | √ | √ | - | √ | √ | √ | √ | - | √ | √ | √ | √ |
| Child 4 | √ | √ | √ | √ | √ | - | √ | - | √ | √ | √ | - | √ | √ | √ | √ | √ |
| Child 5 | √ | √ | √ | √ | √ | √ | - | √ | √ | √ | - | √ | √ | √ | - | √ | √ |
| Child 6 | √ | √ | √ | √ | √ | √ | - | √ | - | √ | √ | - | √ | √ | √ | √ | √ |

√ = observation was completed

To obtain a holistic picture of the child's behaviour in different settings, we observed the child during individual activities as well as in small- and large-group activities. The variety of settings and activities demonstrated how broadly the behaviour occurred. The entire observation session consisting of one-minute intervals lasted one hour. Behaviours of the infants, primary caregivers and others interacting with the baby were time sampled every 30 seconds using a checklist (S. E. Cohen & Beckwith, 1977); the next 30 seconds within each interval were designated for recording. All the session codes were summarised at the end of the day after all the observations were completed.

Table 29

*Summary of Completed Observations*

| | Age at initial observation (months) | Number of observations completed | Number of rescheduled observations | Reasons for rescheduling |
|---|---|---|---|---|
| Child 1 | 10 | 13 | 2 | Child slept and child unwell |
| Child 2 | 9 | 13 | 1 | Child slept |
| Child 3 | 8 | 14 | 0 | N/A |
| Child 4 | 8 | 14 | 0 | N/A |
| Child 5 | 7 | 14 | 0 | N/A |
| Child 6 | 8 | 14 | 2 | Child slept on both occasions |

**Analysis**

Two analytic strategies were employed: quantitative analysis and thematic groupings. All infant behaviours were included in the analysis. Behaviour codes were expressed as a proportion of the total number of scorable intervals (number of 30-second intervals out of 60 intervals) in which certain behaviours occurred within each category. Information on behaviour under the various predetermined categories was coded under themes reflecting support for language, motor and cognitive development, parental warmth, involvement and negative regard and child behaviour.

**Operational Definitions of Items**

**Responsivity**

1. Messy play: Instances in which the child was allowed to manipulate soil, water and other substances that made them dirty.
2. Parent to child vocalisation: The parent spontaneously vocalised toward the child by either making a sound or verbalising some words.
3. Parent responds to child's vocalisations: The parent responded in a similar or different fashion, to any sounds made or words produced by the child.
4. Parent tells the child the name of an object or person: The parent mentions the name of an object or person within the child's line of vision, thus providing a label for an object or person.
5. Parent uses distinct speech (free and easy conversation): The words that the parent uses in conversation with the child or with others are distinct, clear and comprehensible.
6. Parent praises child: The parent affirms the child or verbalises their pride over the behaviour or actions of the child.

7. Parent's voice conveys positive feelings: The observer can deduce, from the tone of voice which is not harsh or used in a disapproving manner, that the parent feels good about the child.
8. Parent caresses/kisses child: The parent shows feelings of affection toward the child by stroking, embracing or kissing the child.
9. Parent responds to child's crying: The parent takes action to quieten the child's crying.
10. Other to child vocalisation: Other people (children and adults) spontaneously verbalise sounds or words toward the child.

**Acceptance**

1. Physical punishment/spanking/slapping: The child is reprimanded by the parent using a hand, stick or other object.
2. Overt annoyance/hostility expressed: The parent's voice sounds harsh and angry when speaking about the child.
3. Parent scolds/criticises/shouts at child: The parent raises her voice toward the child and uses harsh words to criticize certain behaviours or actions.
4. Restrictions or interference: The parent stops the child from exploring his/her environment even in the absence of obvious danger.

**Organisation**

1. Caregiving provided by substitute: Another adult (apart from the mother) provides caregiving to the child when the mother is away.
2. Visit to grocery store: The child goes to the grocery store with the mother, siblings or other family members.
3. Child goes out of the house: The child spends some time outside the house.
4. Safe play environment: The parent provides a safe and secure play area which is free of hazards where the child enjoys opportunities for exploration.

**Learning materials**

1. Muscle activity toys: Toys which allow the child to make use of large muscles.
2. Push or pull toys: Toys which the child can pull along, or push on the ground.
3. Anything to ride in or on: Toys which render the child mobile when inside or on top of.
4. Role-playing toys: Toys that the child can use for pretend or make-believe play.
5. Learning facilitators: Toys that facilitate the acquisition of new knowledge or behaviour in the child.
6. Simple eye-hand co-ordination toys: Toys which the child manipulates using small muscles such as fingers.
7. Toys for literature and music: Toys which produce sound or which provide literary

stimulation to the child, for instance, a musical toy or a book which the parent can read to the child.

8. Toys provided during visit: Whether or not the parent actively made toys available to the child during the visit.

**Involvement**

1. Parent talks to child when doing housework: The parent allows the child to watch the parent doing housework and engages them in conversation during the process.
2. Parent encourages developmental advance: The parent provides opportunities for the child to engage in activities which promote development, rather than doing the task for the child.
3. Parent provides maturing/challenging toys: The parent avails toys that require complex manoeuvres and challenges the child to develop new skills.
4. Structured play periods: The parent or sibling structures the play periods for the child in such a manner that the child can be meaningfully engaged. The parent or sibling makes appropriate changes to the infant's play activities when the infant gets tired or bored.
5. Child is kept in visual range at all times: Parent/caregiver or siblings constantly keep an eye on the child.

**Behaviour**

1. Playing alone: The child is involved in solitary play, even in the presence of others.
2. Playing with others: The child is involved in play with others in a group or individually.
3. Laughing: The child expresses mirth or delight by making a series of spontaneous unarticulated sounds.
4. Crying: The child sheds tears because of pain, hunger or other uncomfortable state.

**Maintenance**

1. Breastfeeding/eating: Any instance in which the mother suckled or nursed the child, or offered him/her something to eat.
2. Grooming: Maintaining a state of cleanliness and hygiene in the child's dressing and bodily appearance. Grooming consisted of instances when the mother changed the child's soiled clothes, or bathed the child.
3. Soothing: Any behaviour by the parent intended to calm, relax or quieten the child. Forms of soothing include singing, carrying or breastfeeding.
4. Sleeping: Child observed in a state of inactivity or rest, with the eyes closed.
5. Elimination: Child removes unwanted waste from the body.

## Results

### Sample Description

I observed six children, three boys and three girls. Child 1 was a boy with one older female sibling of preschool age. Child 2 was a girl with two older female siblings aged approximately 13 and 15 years. Child 3 was a boy with three older siblings, aged between 6 and 10 years. Child 4 was a boy with an older brother of preschool age. Child 5, a girl, was a lone child. Child 6 was a girl who also did not have any siblings.

As with the INSTAPA study, most of the observations in the current study were conducted outside the target child's house. The observations of the interactions between these children and their parents started when the children were aged between 7 and 10 months and ended when they were 24 months old. All children were considered healthy as they had no overt health issues. All children lived with both parents. Three lived in their own homes while three others lived in homes also shared with members of the extended family. Mothers were the primary caregivers for all children except one for whom it was the grandmother. The majority of primary caregivers in the INSTAPA study were also the children's mothers. Maternal age ranged from 17 to 29 with a mean of 20.8 (SD = 4.49) years. All the mothers, except one who had incomplete primary schooling (less than 8 years of education), were not educated. Three fathers had no education while three had attained less than 8 years of education. None of the mothers, except one, reported that they were employed. Fathers were engaged in occupations from Level 1 to Level 3. Four fathers at Level 1, had occupations that provided low irregular incomes (< Kshs. 5,000). One father was engaged at Level 2 (medium and fixed income – between Kshs. 5,000 and 15,000) while another was at Level 3 (high income > Kshs. 15,000).

### Thematic Categories

The findings from the observations are presented below with items grouped under various thematic categories. The mean observation time for each of the items is summarised in Table 30. The data obtained through the INSTAPA study provide a basis for comparison against the results from my naturalistic observations.

#### Activities promoting language development

***Parent-to-child vocalisation.*** Vocalisation to Child 1 began high (above 50%) at 12 months, dipped (to 25%) at around 16 months and then showed a further decrease (up to 10%) at between 17 and 22 months. Levels increased to 40% by the time the child was aged 24 months. Parent-to-child vocalisation for Child 2 was observed about 40% of the observation time at 12 months. At around 16 months, the parent was not observed vocalising to the child in any manner. From the age of 18 up to 24 months, vocalisation levels ranged between 8 and 30%. For Child 3, parent-to-child vocalisation began at around 12% and increased to 42% by 17 months. From this age to 20 months, levels were fairly stable until 21 months when a sharp

rise to 72% was observed. Parent-to-child vocalisation levels then dropped off to 12% by 24 months. Vocalisation for Child 4 remained around levels ranging from 20% to 32% between the ages of 12 and 17 months, and from 5% to 40% between 18 and 24 months. For Child 5, vocalisation from the parent was high (50-95%) throughout all observation sessions except at 21 months when it was at 20%. Parent-to-child vocalisation for Child 6 was between 50 and 95% during all observation sessions except at 13, 18 and 23 months when it was below 13%.

This item was recorded at all observation sessions for all the children (except on one visit each for Child 2 at 17 months and for Child 6 at 15 months). The pattern of parent-to-child vocalisation was erratic and remained below 60% of the time throughout for all children except for Child 5 and Child 6 for whom levels of up to 95% were recorded. For children in the INSTAPA study, mother to child vocalisation was high at 12 months and then dropped steadily up to the time the child was 24 months old.

***Parent responds to child vocalisation.*** The parent of Child 1 responded to his vocalisations 2% of the time at 12 months, increasing steadily to 15% of the time by the time the child was aged 24 months. For Child 2, the occurrence of this behaviour was first observed at 18 months (2% of the time), increased sharply to 22% at 21 months and then reduced to initial levels (2% of the time) at 24 months. The parent of Child 3 responded to her child's vocalisation 2% of the time at 12 months. This level rose sharply to 18% at 16 months and to 65% at 21 months before falling to 10% at 24 months. Parental response to child vocalisations for Child 4 remained low (between 2% and 8% of the time) between the ages of 12 and 24 months. Levels of parental response to child's vocalisations for Child 5 began low (3% at 13 months), rose sharply to 50% of the time at 15 months and then increased to 70% at 23 months. For Child 6, the parent responded to the child's vocalisations 2% of the time at 17 months of age, 13% at 21 months then 2% at 22 months.

Parental levels of response to their children's vocalisations generally began low at younger ages and increased as children grew older. Especially high levels at older ages were recorded for Child 3 and Child 5. A comparison with children in the INSTAPA study showed that they vocalised less to their mothers as they grew older.

***Parent tells the child the name of an object or person.*** All the parents told their children names of objects or persons at several observation sessions. However, the frequency with which this item was observed varied across children. The lowest levels (10% or less) were recorded for Child 2 while the highest were recorded for Child 5 at 15 (50%) and 23 months (53%).

***Parent uses distinct speech (free and easy conversation).*** For Child 1, the proportion of time during which the parent used distinct speech varied from 40% to 80% between child ages 12 and 16 months to between 70% and 100% from 17 to 24 months. For Child 2, use of distinct speech by the parent ranged from 30% to 63% between 12 and 15 months and from 40% to

nearly 100% between 17 and 24 months. The parent's use of distinct speech remained high (50 to 100%) through all the observation sessions for Child 3. Between 12 and 24 months, the proportion of time in which the parent of Child 4 used distinct speech was 50% to 100% except at 22 months when levels fell to 22%. The parent of Child 5 used distinct speech at levels ranging from 65% to 95% through all the observation sessions. For Child 6, use of distinct speech was lowest at 40% when the child was 15 months of age. For the remainder of the observation period, levels ranged from 60% to 100%. For all children, the use of distinct speech by the parent remained at fairly high levels of between 50% and 100% of the time.

***Other to child vocalisation.*** The maximum levels of vocalisation by other people recorded for each child were 52% of the time for Child 1 at 23 months, 45% for Child 2 at 19 months, 83% for Child 3 at 20 months, 67% for Child 4 at 22 months, 57% for Child 5 at 21 months and 33% for Child 6 at 24 months. The people who vocalised to the children included older siblings, cousins and friends, as well as adult relatives (aunts, uncles and grandparents) and neighbours. The levels of vocalisation increased somewhat steadily as children grew older. Vocalisation by other people to the child in the INSTAPA study increased sharply across time between the ages of 12 and 24 months.

***Parent talks to child when doing housework.*** This item was recorded at all observation sessions, except at 14 and 16 months, for Child 1. Levels ranged from 3% of the time at 12 months to 35% of the time at 23 months. The parent of Child 2 only talked to the child when doing housework 8% of the time at 24 months. For Child 3, these instances increased from 8% of the time at 14 months to 30% at 20 and 21 months then decreased again to 8% of the time at 24 months. Instances of the parent of Child 4 talking to the child when doing housework were only recorded at 14 (5% of the time), 21 (2%) and 24 months (12%). For Child 5 we recorded this item 5% of the time at 13 months, 8% of the time at 20 months, 20% of the time at 21 months and 8% of the time at 24 months. This item was recorded at levels of between 2% (14 months) and 60% (21 months) for Child 6 at all observation sessions except at 13, 15, 17 and 18 months.

This item was observed at most observation sessions for two of the children, and at only one session for one child (Child 2). And as children grew older, this item was recorded with greater frequency.

**Activities promoting motor development**

***Messy play.*** Messy play was recorded at fairly low levels (less than 25%) for Child 1, Child 3, Child 5 and Child 6. Child 2 engaged in messy play two-thirds of the time at 16 months, half the time at 19 months and more than 70% of the time at 24 months. The types of messy play included making mud balls and filling up a plastic jug with water and emptying it onto the ground. I observed Child 4 playing with soil at 16, 17 and 21 months, and scooping from a mound of dried-up cow dung using a plastic bottle cut in half at 23 months. The amount

of time that Child 4 engaged in messy play ranged from 35% to 60%. Messy play was recorded at especially high levels for Child 2 and Child 4, and was observed more frequently at older than at younger ages.

***Safe play environment.*** Caregivers maintained relatively safe play environments for their children. However, for Child 3 and Child 4, dangerous items such as knives, rubbish, rakes and hoes were found cluttered around the compound of the house which the child used as a play area. Caregivers did not seem to be aware of the danger posed by having these items lying around.

***Muscle activity toys.*** The most common muscle activity toys that children played with were balls, either shop-bought or fashioned out of paper. The highest proportion of time during which the child played with a ball was recorded for Child 4 (28% of the time at 17 months) while no instance of such play was recorded for Child 6. The children played with balls from the age of 12 months.

***Push or pull toys.*** An array of items, including home-made wooden 3-wheeler cars, toys or plastic bottles with strings attached to them, bucket lids with long sticks fixed on them, pushcarts, tyres and empty jerricans, were used as push or pull toys. The children were more often observed engaging with these toys at older ages, from around 17 months of age. The highest number of instances in which play with push or pull toys was observed was recorded for Child 5 while Child 2 was not observed playing with such toys.

***Anything to ride in or on.*** Only one child (Child 4) had an item which he rode on for 30% of the time at 23 months. This was an upturned piece of a traditional wooden coconut grater that his older brother pulled while another playmate pushed.

***Simple eye-hand co-ordination toys.*** Some of the simple eye-hand co-ordination activities observed included aiming a catapult at a goat and putting small round non-edible fruits into and out of a container. Other toys which the children used were plastic pegs and teddy bear which were used to play a game of 'catch.' These items were used at older ages.

**Activities promoting cognitive development**

***Visit to grocery store.*** None of the children made a visit to the grocery store during any of the observations except for one. Child 4 was observed at the area where his mother operated a shop during the sessions from 16 months to 20 months.

***Child goes out of the house.*** From 15 months of age, all children except Child 3 and Child 5 went out of the house during the observation session. Child 1 was out of the house throughout the visit at 16 months. Child 2 was out of the house throughout at 19 months. Child 4 was out of the house throughout the visits at 16, 17, 18 and 20 months. Child 6 went out of the house 20% of the time at 15 months.

***Toys provided during visit.*** All the caregivers provided toys for their children during some of the visits. Toys were provided during 7 visits for Child 1 (12, 13, 14, 15, 17, 19, 22

months), 6 visits for Child 2 (12, 14, 15, 16, 17 and 22 months), 5 visits for Child 3 (12, 13, 14, 17, 21 months) and Child 5 (13, 17, 20, 21 and 24 months) and 4 visits each for Child 4 (14, 17, 21 and 24 months) and Child 6 (13, 14, 23 and 24 months). Two children had toys provided on six or more visits while the rest had toys provided on less than six visits.

***Role-playing toys.*** The materials used in role-playing games included those from the natural world as well as fabricated items. Natural materials included stones, pieces of wood, coconut shells, leaves, water, sticks, soil, shelled maize cobs, ash, tree branches, non-edible wild fruits and logs. Fabricated items included homemade dolls, pieces of cloth, plastic bottles, jerricans, teddy bears, toy mobile phones, toy aeroplanes and plastic bottles. These materials were used in various ways. Some of the activities that children pretended to do included cooking, driving, speaking on the telephone, washing clothes and sweeping.

Child 1 engaged in role-playing for 12% of the time at 12 months, 27% of the time at 13 months, 20% of the time at 14 months, and 10% of the time at 15 months. At 19 months, Child 1 played with a door lock, stones and a stick 63% of the observation time.

Child 2 played with some empty plastic bottles, coconut shells and some pieces of wood at 12, 14 and 16 months. At 17 months of age, for nearly 50% of the observation time, the girl played with some empty plastic containers, coconut shells and water, pretending that she was cooking. Between 19 and 24 months, the child used a phone as a make-believe car, sat on a log and pretended to drive it like a car while producing car noises, pretended to cook using a lid and to sweep on the ground with a stick. She also had a water jug, which she kept refilling and emptying onto the ground. Throughout the visit at 24 months, she played with water, a plastic bottle and soil. She kept refilling and emptying a bottle with wet sand.

Between 12 and 16 months, some of the items that Child 3 played with included a doll, plastic bottles and containers, some stones, a toy mobile, maize cobs, a basin and a traditional woven tray, '*uteo*.' For 40% of the time at 17 and 18 months, he played with a doll fashioned out of grass, cloth and sticks, wet ash which was used like 'henna,' and, a medicine bottle which he kicked like a ball. Between 22 and 24 months, forms of play included pretending to build a house with a piece of corrugated iron sheet, pushing a stick along the ground and pulling a tree branch like a car and kicking an orange peel like a ball.

In four instances at 16 months, Child 4 played with papers, a stone, an empty carton and the lid of a container with which he pretended to drive like a car. In 29 instances at 17 months, his role-playing activities included climbing onto a log and pretending it was a car, pushing a slipper like a car and pretending to light a fire under a container of non-edible fruits by blowing onto some sticks. At 18 months of age, he sat on a traditional wooden coconut grater with some playmates and pretended it was a car. For three-quarter of the observation period at 21 months, he sat on a log with two other children and pretended it was a car, and also played with a trowel-like instrument which he used to scoop some soil. At 22 months (in 20 instances or 33% of the

time), he sat on foldable chair with his brother and pretended it was a car.

Child 5 played with a toy mobile (in one instance) at 13 months, and at 17 months (in 31 instances), she played with a teddy bear which was used as a ball to play 'catch.' She also played with a stick, pretending it was a car. In 24 instances at 20 months, the girl played with a toy mobile phone, a toy aeroplane, a teddy bear and a door handle which was used like a gun. The girl sat on a log with some friends in one instance at 21 months and pretended it was a car. She also played with coconut shells and a doll in 11 instances at 24 months.

Child 6 played with an array of play materials including home-made dolls, pieces of cloth, plastic bottles, a pen, toy mobile, a torch, coconut shells, soil, leaves, papers and empty jerricans nearly 30% of the time at 13, 14, 15 and 23 months and for a shorter time (5 instances) at 24 months.

The amount of time that children engaged in role-play increased dramatically as they grew older, especially for Child 2 and Child 4. Similar play materials were used by children in the INSTAPA study who also engaged in similar forms of play.

***Learning facilitators.*** We observed the use of learning facilitators with only two children. Child 3 was allowed to use a large needle for sewing traditional mats to put together some pieces of woven palm fronds. The mother of Child 5 counted up to ten and then sang with a group of children, including the target child.

***Toys for literature and music.*** Only two children were observed playing with mobile phones which produced music. For 17% and 5% of the observation time at 18 months and 14 months respectively, Child 2 and Child 6 played with a mobile phone

***Parent encourages developmental advance.*** Children were sent on simple errands like fetching items for the caregiver from the house or elsewhere, sorting out beans and picking rice, and summoning someone from the neighbour's compound. Other activities that children were allowed to participate in included pumping water at the well, delivering a knife to the neighbour, arranging mat coils which the caregiver was using to make a traditional mat. For Child 3 and Child 5, this item was recorded when the children were as young as 13 months while for the rest, it was observed at older ages, from around 19 months.

Child 1 was sent to fetch water in a cup and to get a tray of groundnuts from inside the house at 23 months. At 24 months, he was allowed to use a hoe to dig up the ground in the house. At 19 months of age, Child 2 was encouraged to reach out and pull a lever which was high above her head in order to pump some water at the well. At 24 months, she was sent to deliver a knife to the neighbour. Three instances were recorded for Child 3 at 13 months, 9 instances at 16 months, 2 at 18 and 21 months, 1 at 22 months, five at 23 months and 10 at 24 months. In these instances, the child participated in simple errands like carrying a cup of water back into the house, helping the mother to sort some beans, bringing some sand from the neighbour's compound for the mother to wash dishes with and helping the mother to arrange

some mat coils that she was using to make a traditional mat. This item was recorded at all the observation sessions for Child 5 with levels as low as one instance at 21 months to as high as 30 (50% of the time) at 23 months. The mother allowed her to handle a breakable cup that she drank water from, sent her to take some dishes to the house and sent her to call someone from the neighbour's compound. She (the mum) also encouraged the target child to put on her sandals by herself and to respond appropriately to a greeting from her (the mum). Child 6 was shown by her grandmother how to pick rice in 10 instances at 20 months, 2 instances at 23 months and 19 instances at 24 months.

***Parent provides maturing/challenging toys.*** Only Child 5 and Child 6 were provided with such toys in one instance at 15 and 13 months, respectively.

**Parental warmth**

***Parent praises child.*** Throughout the observation period, none of the children, except for Child 5 (once at 24 months), were praised by their mothers.

***Parent's voice conveys positive feelings toward the child.*** This item was recorded at low levels (less than 15%) at all observation sessions for all children except for Child 5 where instances of nearly 42% of the observation period were recorded at15 months.

***Parent caresses/kisses child.*** This item was observed for only three children. Child 1 was caressed in three instances at the age of 16 months. Child 5 and Child 6 were caressed in one instance each at 12 and 16 months, respectively.

***Parent responds to child's crying.*** This item was observed 7% of the time at 14, 16 and 24 months for Child 1. Instances when this item was observed ranged from one (2% of the time) at 13 and 15 months to eight (13% of the time) at 19 months for Child 2. For Child 3, low levels were observed (less than 10%) at all times except at 16 months when levels peaked to 16%. This item was observed from 2% of the time at 14 and 22 months to 28% of the time at 20 months for Child 4. Response to crying ranged between 2% at 15 months and 10% at 23 months for Child 5 and between 2% at 13 months to 33% at 21 and 22 months for Child 6. Caregivers responded to children's crying by soothing them through various means; breastfeeding, rocking, carrying on the back, singing and talking in a gentle voice. This was also the case in the INSTAPA study. The lowest mean levels were recorded for Child 1 and the highest for Child 6.

**Parental acceptance**

***Physical punishment/spanking/slapping.*** Instances of physical punishment remained low (below 10% of the time) but peaked at between 14 and 15 months for all children except for Child 5 who was physically punished 15% of the time at 13 months of age.

***Overt annoyance/hostility expressed.*** Only three parents (of Child 1 at 17 and 23 months, Child 3 at 21 months and Child 6 at 16 months) were observed expressing overt annoyance toward their children at something they had done. These instances were recorded at

levels of below 5%.

***Parent scolds/criticises/shouts at child.*** The parent of Child 1 threatened to beat him at age 12 months when he pulled a cloth wrapper away from her waist, and scolded him once or twice between the age of 17 and 24 months. At 19 months of age, Child 2 was warned against making some water the mother was using to wash clothes dirty. At 21 months, the same child was admonished against the behaviour of scooping sand from the ground and pouring it onto her head. Child 3 was scolded twice at 14 months. At 17 months, Child 4 was warned against throwing stones toward a fireplace, and was scolded 3 times at 21 months. Child 5 was scolded once during the observation sessions at 16, 17, 20 and 23 months, and 5 times at 21 months. Child 6 was scolded twice at 20 months and once at 22 months. The highest number of scolding instances was recorded for Child 5.

***Restrictions or interference (child stopped from free exploration).*** I observed this item three times when Child 1 was aged 16 months; twice for Child 2 at 15 months; once for Child 3 at 12 and 18 months; once for Child 4 at 21 months; 3 times for Child 5 at 13 months and twice at 15 and 16 months; and, twice for Child 6 at 14 months. Child 4 was stopped from free exploration the least number of times while Child 5 was stopped the most number of times.

**Parental involvement in child-care activities**

***Caregiving provided by substitute.*** Only Child 2 and Child 6 had caregiving provided by substitutes during the observation sessions. Throughout the observation session at 16 months, caregiving for Child 2 was provided by the child's adult sister. At 18, 19 and 24 months, caregiving was provided by the child's aunt, older sister and by both relatives 75%, 23% and 18% of the time, respectively. For Child 6, caregiving was provided by the child's grandmother throughout the observation sessions at 15, 17, 18, 20 and 21 months, and by the child's aunt at 22 months. At other times, the mother and older sister (18% of the time at 12 months), mother and grandmother (17% at 13 months) and the child's grandmother and aunt (20% of the time at 24 months) provided joint caregiving.

Older relatives (siblings, aunts and grandmother) provided this caregiving. For Child 2, these instances occurred when the mother had to perform household errands such as fetching water from the water point, going to the farm or going to the shop. For Child 6, caregiving was provided mainly by a substitute because the mother was employed and had to be away at work.

***Structured play periods.*** During the visits at 13, 16 and 24 months, caregivers structured the play periods for Child 6, Child 1 and Child 5, respectively.

***Child is kept in visual range at all times.*** All children were kept in visual range at all times. However, Child 1 (at 14 months), Child 2 (at 12 months) and Child 4 (at 14 months), were still within the hearing range of their caregivers even when they were not in their caregivers' visual range.

***Breastfeeding/eating.*** I observed Child 1, Child 2 and Child 3 breastfeeding for varying

periods up to around the age of 24 months. Some of the food items that children were observed eating included a local sweet pastry called '*mandazi*' and tea. Similar observations of children breastfeeding up to the age of 24 months were made through the INSTAPA study.

***Grooming.*** This item was observed during five visits each for Child 1 (at 13, 15, 16, 23 and 24 months), Child 2 (at 12, 14, 17, 22 and 24 months) and Child 5 (at 13, 15, 16, 17 and 23 months). During one of the visits, Child 1 was taken to a corner of the compound to relieve himself. He remained naked for a while before his mother's friend cleaned and washed him up. Child 3 was cleaned up by the mother during the visits at 12, 14, 17, 18, 22, 23 and 24 months. When Child 4 soiled his clothes during the visit at 17 months, he had them changed by his mother. Grooming was observed for Child 6 during eight visits, at 13, 14, 17, 18, 20, 22, 23 and 24 months.

***Soothing.*** Two children were soothed at levels ranging between 2% and 7% of the time during 3 visits (at 12, 14 and 16 months for Child 1 and at 12, 14 and 15 months for Child 2). I observed Child 3 being soothed during four visits at 14, 16, 17 and 24 months. Child 4 was soothed at levels of 2% of the time at 13 months up to 48% of the time at 23 months. Child 5 was soothed between 2% and 12% during visits at 20, 23 and 24 months. Child 6 was soothed for 2% to 30% of the time at seven visits (at 12, 15, 17, 18, 20, 21 and 22 months).

**Child behaviour**

***Playing alone.*** On average, Child 1, Child 2 and Child 4 played alone approximately 40% of the time; Child 1 played alone at levels ranging from 20% to 60% of the time while Child 2 played alone between 7% and 70% of the time. Child 4 played alone from 18% to 73% of the time. On average, Child 3, Child 5 and Child 6 played alone 32%, 26% and 21% of the time, respectively; Child 3 played alone from 2% to 53% of the time. Child 5 played alone from 12% to 44% of the time while Child 6 did so from 2% to 45% of the time.

Generally, children played alone for nearly one-third of the time at 12 months, a level which peaked to slightly more than 50% at 19 months then decreased to less than 30% at 24 months.

***Playing with others.*** Child 1 played with various people during the observation sessions including his older sister, his mother, a group of friends, a neighbour of the same age, a younger boy and a cousin. On average, he spent 24% of the time playing with others and levels ranged from 5% (at 14 months) to 47% (at 22 months) of the time.

Child 2 played with her cousin (male preschooler), her adult sister, her mother, her aunt, neighbours (male and female preschoolers), a group of neighbours, an older child (male neighbour) for varied periods of time ranging from 7% (at 13 months) to 52% of the time (at 24 months). The average time that she spent playing with others was 20%.

Playmates for Child 3 included his mother, his brother (preschooler), his sister

(preschooler), his cousin (younger male), neighbours (male and female preschoolers) and a group of children. They played together on average 39% of the time with levels ranging from 10% (at 14 months) to 88% (at 20 months) of the observation time.

Child 4 played with his mother, older brother (preschooler), cousins (one male of the same age and one younger female), neighbours (one male of the same age, one male and one female preschooler) and a group of children. Across all observation sessions, levels ranged from 8% (at 14 months) to 80% of the time (at 22 months), averaging at 28%.

Child 5 played with her mother, father, cousins (a male and female preschooler and an older female), an uncle, an aunt and a group of children in the neighbourhood. Amount of time spent on play with others ranged from 15% (at 13 months) to 73% (at 23 months) of the observation period and was on average 41% of the time.

Child 6 played with others 27% of the time across all observation session. Her playmates included her mother, her grandmother, her cousins (one male of the same age, one older female and one male and one female preschooler), uncle (preschooler), neighbours (one female preschooler and one female adult) and a group of children in the neighbourhood. They played with the child for periods ranging from 2% to 72% (at 17 months) of the time.

On average, children played with others for periods ranging from 20% to 41% across all the observation sessions. The levels seemed to increase drastically from around 17 months of age.

***Laughing.*** This item was observed most frequently for Child 6 (40% of the time) at 14 months and least frequently for Child 3 (12% of the time) at 21 months. The number of instances in which laughing was recorded ranged between one and eight for Child 1; two and 11 for Child 2, one and seven for Child 3; one and 15 for Child 4; one and 10 for Child 5; and, one and 24 for Child 6.

***Crying.*** The child for whom this item was observed with the highest frequency was Child 6 (57% of the time) at 22 months and the lowest was 13% of the time for Child 1 at 16 months. The number of instances in which crying was recorded ranged between two and seven for Child 1; two and 16 for Child 2; one and nine for Child 3; one and 17 for Child 4; two and 13 for Child 5; and, two and 34 for Child 6.

***Vocalisation to self.*** Child 1 vocalised to self 60% of the time at 14 months and at lower levels when he was aged 16 months (only 2% of the time). Child 2 vocalised to self 30% of the time at 12 months, 72% of the time at 21 months reducing to 35% of the time at 24 months. Child 3 vocalised to self 32% of the time at 12 months and 2% of the time at 18 months. Child 4 vocalised to self from low levels of 15% at 12 months which peaked to 30% of the time at 18 months then reduced to 10% of the time by the time the child was 24 months old. Child 5 vocalised to self at high levels (53% of the time) at 12 months but at other ages, levels ranged between 5% and 22% of the time. Levels of vocalisation to self for Child 6 started at 30% of

the time at 12 months, increased slightly to 35% at 14 months then went down to 3% at 24 months.

Vocalisation to self was higher at younger ages than at older ages for Child 1, Child 3, Child 5 and Child 6. For Child 2, vocalisation to self peaked at around 21 months, while for Child 4, peak levels were observed at around 18 months. Generally, vocalisation to self for all children showed a downward trend from levels of nearly 30% recorded at 12 months which steadily decreased to around 15% at 24 months of age. However, individual data revealed a downward trend for all children except one who surprisingly had higher levels at 24 months than at 12 months. For children in the INSTAPA study, vocalisation to self also decreased drastically with age.

***Sleeping.*** When any of the children went to sleep during an observation session, another visit was rescheduled. This item was observed for Child 1 (once), Child 2 (once) and Child 6 (twice).

***Elimination.*** In both the INSTAPA and current studies, when the need for elimination arose, children were taken to a secluded corner in a compound of the house or to the bush. Most times, they were accompanied by an adult caregiver.

## Discussion

The present study longitudinally observed infants' interactions with their principal caregivers at home up to the age of 24 months. Analyses of the activities and behaviours during the caregiver-infant interactions suggested that the approach used in conducting the observations captured children's activities in an appropriate manner. Furthermore, the duration and frequency of the observations provided a reasonable picture of the daily experiences of a typically developing child within the current study context. With regard to infant behaviours, the naturalistic observations among these infants provided a richer picture of what happens within the home environment. Through these observations, I was also able to obtain a record of the patterns of stability and change across time in the various activities, as well as within- and between-child differences. And for those items that were similar to the ones in the INSTAPA study, I was able to determine if the change in behaviour of children observed in the current study was comparable.

### Activities Promoting Child Language Development

Although there were variations in the amount of speech directed at children, parent vocalisation was generally recorded at moderate levels (nearly 40% of the time) for all except two children for whom levels were especially high (up to 95%). For the two exceptions, the caregiver of one child (who was demanding and cried frequently) mainly engaged in 'business talk' aimed at getting a message across (where parents are mostly giving commands and instructions to their children), whereas the other (of the child considered easygoing as she had a

happy disposition) engaged in 'non-business or play talk' (e.g. chit-chat, singing, conversation, story-telling) (Hart & Risley, 1995). Over time, the pattern of these vocalisations did not demonstrate a clearly discernible trend in within-child differences, a finding which contrasted the findings of the INSTAPA study. The observation that high levels of response by caregivers, though of different forms, are elicited by fussy as well as happy children demonstrated that child temperament has a role to play in caregiver-infant interactions (Sameroff & Chandler, 1975; Vernon-Feagans et al., 2008).

Caregivers' responses to their children's vocalisations remained low at younger ages, tended to peak at older ages (around 21 months) and then decreased by the time the child was 24 months old. A similar pattern was observed in the amount of time that caregivers conversed with their children as they (caregivers) performed tasks during their normal household routines. The above findings, together with the trend observed in the INSTAPA study of decreasing child-to-mother vocalisation as the child grew older, were unexpected. Although we did not distinguish the stages of language development, we anticipated that with the concomitant progression from pre-speech to speech, children's vocalisations towards their mothers would increase with age and caregivers' responses would show an exponential increase with infants' age. In many African communities, verbal exchanges are restricted to social equals (R. A. LeVine, 1990). The belief that a child was not an equal conversation partner for a parent and should learn culturally appropriate forms of behaviour through 'hands on' socialisation under the mentorship of older siblings and peers rather than adults (Nsamenang & Lamb, 1993) therefore seemed to inform the lack of conversation between caregivers and their infants at younger and older ages.

Caregivers generally maintained high levels of distinct speech in their everyday conversations within their children's hearing range. During these conversations, caregivers occasionally mentioned names of objects or people to their children. In addition, vocalisation to children by other people (apart from the primary caregiver) increased with age, a trend which was observed in both the current and the INSTAPA studies. This finding was expected because as children become more verbose, they tend to become more interesting conversation partners. Caregivers' verbal interactions with their children and taking turns speaking with their pre-verbal babies from a young age should be encouraged as they foster early language development (O'Carroll & Hickman, 2012).

**Activities Promoting Motor Development**

During most observation sessions, I observed that some caregivers made efforts to ensure that play areas were safe for their children; however, the seeming lack of awareness by other caregivers of the risk posed by dangerous items left lying around in the compound was not surprising. Whereas we may have considered them dangerous, studies among other African communities report that training for autonomy begins in infancy and children are taught to use

sharp objects from the time they learn how to walk (Rogoff, 2003). Such objects may therefore be considered as training tools for later life, rather than as hazards, as children get integrated into the everyday activities of their communities.

Messy play was generally recorded at low levels for all children except two. The following may be plausible explanations. Even though these two children were not provided with play clothes, their parents may have tolerated their getting messy so that they (the children) could keep themselves occupied. Also, 'natural materials' such as sand and water are easy to find and provide ready play items which are accessible to children. For the reason that the other parents may have considered messy play to be dirty and risky, they offered severely restricted opportunities for their children to engage in it. Given that children who are given the opportunity to engage in messy play are able to use all their senses to explore materials (Gainsley, 2011), it is important for parents to understand that messy play is an integral part of their young children's development.

Muscle activity toys were used on limited occasions. However, children engaged in other forms of play (not necessarily with toys) such as climbing trees, chasing pets around the compound and throwing stones. Push or pull toys and toys for eye-hand coordination consisted of homemade items which because of their complexity, looked like they were probably constructed by older siblings or adults. Other children used discarded items (tyres and jerricans) which were no longer in use, or items from the natural world (inedible fruits), as toys. With the help of older siblings and other children pushing and pulling, some of the target children used discarded items to ride in or on (in the case of an old wooden traditional coconut grater). It should be noted that even though the use of these items was recorded at low levels, their use was more common among boys than among girls.

**Opportunities for Cognitive Stimulation**

The observation that some of the children went out of the house around the ages of 16 and 20 months may have been an illustration of the caution that caregivers exercise in letting their young children out of their sight. Parents allowed their children out of the house at older rather than younger ages and only in the company of older siblings.

Some of the activities that caregivers allowed their children to engage in promoted developmental advance as they encouraged children to stretch themselves beyond their capabilities. This item was observed across nearly all observation sessions for one child while for another, the item was never observed. These variations may be related to caregivers' sensitivity to the developmental needs of a child, which may be related to their education levels.

Caregivers provided toys for their children during the observation sessions but this happened more frequently at older than at younger ages. In other cases, children found play materials on their own. Perhaps caregivers felt that the children would appreciate and use the

toys more appropriately when they were older. It was on the very rare occasion that caregivers provided maturing or challenging toys, and this was observed only for two children and only on one visit each. The number of occasions on which caregivers were observed structuring play periods for their children were also very few. Perhaps caregivers in this setting under-rated their children's capabilities; or, they did not understand that children's attention spans are too short for them to concentrate on one activity for a long time. Another plausible explanation is that parents, because of their generally low education levels, did not understand the need for such toys.

In both the current and INSTAPA studies, many of the play activities that children engaged in involved role-play with homemade toys, discarded household containers, materials found in the natural world and occasionally, toys bought from the shop. This form of play occurred more frequently at older than at younger ages and involved imitation of adult activities such as cooking, driving and washing clothes. These activities were not gendered since boys played 'cooking' games while girls were observed 'driving' cars. Through play, children engage in activities that promote their cognitive development (Elkind, 2007). This exposure allowed children an opportunity to experience the stimulation offered by activities happening outside the house.

The use of learning facilitators was observed at low levels and only among two children, as was the use of toys for literature and music. This may have been probably because caregivers lacked knowledge on the importance of such toys, given their low education levels.

**Parental Warmth**

The amount of time that mothers were in the visual presence of their infants remained high throughout all observation sessions in both studies. This was in line with African traditional child-rearing practices (Keller, Abels, et al., 2005) where infants normally spent at least 90% of their time awake in the presence of their mothers.

As with the INSTAPA study, offering the breast was the most common response to a child's crying, consistent with the commonly held view in African settings that infant care includes breastfeeding on demand up to 2 or 3 years (Jakobsen, Sodermann, Molbak, & Aaby, 1996; Konner, 2005; Schwartz, Hollenbeck, Fields-Gardner, Sucher, & Diop, 2006). Because the mother, caregiver or other relative has the baby near her at all time, this allows her to respond to her baby's cries immediately (Hewlett, 1996). The variations recorded between the highest and lowest levels of response were probably due to differences in child temperament; fussy and demanding vs easy going. Although parents varied widely in responsiveness, similar forms of caregiver response have also been observed in other cultures (Small, 1998), and may represent universal forms of adult responsiveness to infant cries. Infant crying mobilises a response in adults, and when the caregiver responds appropriately, the crying encourages attachment behaviours (Fannin & Hamblett, 2006). Parents who hold child-centred attitudes

toward child care are more likely to respond quickly to the child's crying (Zeifman, 2003), in the belief that immediate attention to infant cries and other signals of distress supports healthy development of children (R. A. LeVine, 1988). On the contrary, slow responses or failure to respond to an infant's cries may result in more demanding infants later in life (Hubbard & van IJzendoorn, 1991). Cultural beliefs therefore seemed to dictate how quickly or how slowly the caregiver responded to the infant's cries (Faris & McCarroll, 2010).

Caregivers largely avoided praising or voicing approval toward their infants across all the observation sessions. Related to this finding was the observation that caregivers hardly talked about their children to other people or if they did, their voices rarely conveyed positive feelings toward the child. A similar observation was made by LeVine (1977) who noted that Gusii parents in western Kenya did not praise or notice developmental progress in their children. Moreover, caregivers were seldom observed kissing or caressing their children. Such behaviour was likely nested within the belief among African communities that giving praise or conveying warm feelings when talking about the child would lead to children becoming conceited and disobedient (R. A. LeVine et al., 1996; Nsamenang & Lamb, 1994).

**Parental Acceptance**

The frequency with which physical punishment was meted out against children remained low (less than 10%) but was more commonly recorded at younger ages (between 12 and 15 months). On the other hand, instances of caregivers scolding, criticising or shouting at their children were more common at older than at younger ages. These patterns suggest that as children became older, the form of punishment changed from physical to verbal. Although not part of this investigation, observers noted that caregivers were more likely to slap or spank as well as shout at older siblings of the target children.

Caregivers were hardly ever observed expressing overt annoyance or hostility toward their children. As earlier noted, this negative form of expression was more frequently directed at older siblings than at the target children.

Restrictions or interference were imposed at varying levels with some children experiencing a greater number of restrictions than others, consistent with their activity levels. For instance, one of the children for whom high levels were recorded was a very active child. However, the overall pattern showed a downward trend with increasing age. These restrictions may be a form of obedience training where children are expected to listen and respond (through words or actions) to what their parents tell them from a young age. Also, perhaps caregivers believed that they were protecting their children from presumed danger by restricting their movements.

**Parental Involvement in Child Care Activities**

Mothers were the primary caregivers for their children on all observation sessions for four children, supporting the oft-reported finding of maternal caregiving being the most

common form of physical care activity that infants receive. For the other two children, caregiving was provided by substitutes because their mothers were involved in work outside the house. This work involved normal household routines such as fetching water, firewood and farming for one of the mothers; the other mother was in paid employment. These findings were also true for the INSTAPA study. The involvement of relatives in the caregiving role demonstrated forms of social support available to the mother, as well as the importance of other members of the family in providing care for the child when the mother was away.

All the children, (except one), were observed breastfeeding on demand up to the age of 2 years, similarly to those in the INSTAPA study. However, from around the age of 16 months, children seemed to breastfeed for comfort because they were observed having meals with other members of the family or eating other foods on their own. Breastfeeding for the child for whom this item was not observed seemed to have ceased early because the mother was in full-time employment outside the house. In comparison with previous work in this context (deVries & deVries, 1977), some of behaviours reported in the earlier studies were observed in the current study while others were not. One of these, breastfeeding, was still used to pacify a crying baby, and was observed until the age of 2 years.

Grooming of children was observed at very low levels as there were few (observed) instances of children soiling themselves. However, when children made themselves extremely dirty during play, they were not immediately changed. This delay in cleaning them may have been occasioned by the lack of nearby available water, as most homes relied on water fetched from distant sources, such as the river or a well.

**Child Behaviour**

Middle-born children were more likely to play alone than their first-born counterparts. These differences were unexpected considering that children with older siblings had more readily available playmates within the household than those without. Perhaps the children who were observed playing alone at higher levels were less outgoing than their counterparts for whom lower levels were observed. Solitary play may therefore have been related to child temperament rather than the availability or lack of play partners.

On the other hand, playing with others began at low levels at 12 months, and had doubled by 24 months, a finding which was observed as expected. Moreover, very high levels were observed for children who lived in neighbourhoods where there were many children. As children become older and as their network expands, they spend more time with other children away from their mothers.

Unexpectedly, laughing was recorded at low levels across all observation sessions compared to the incidence of crying which was seen at higher levels. Remarkably high levels of crying were recorded for one of the children who seemed to be very wary of strangers. The variations seen among children may be related to their temperament.

It was expected that as children grew older and became more verbose, their conversations would include others to a greater extent and vocalisation to self would decrease. For the one child for whom an unexpected trend was observed, this finding may be attributed to the fact that her mother did not have engage her in as much conversation as the mothers of other children as she (the mother) was much older.

Elimination (of body wastes) was rarely observed across all observation sessions and because this is presumably a private event (even for the young child), the observer only noted evidence of its occurrence (through soiled clothes). Few toilet 'accidents' by children may be attributed to the achievement of toilet training milestones at an earlier age than expected (according to Western norms) due to traditional practices (deVries & deVries, 1977).

Two infant behaviours were not captured through this study – visit to the grocery store and sleeping. The requirements to have both the caregiver and the child present at home and for the child to be awake precluded the observation of these two items. Observing for a longer period, although time-consuming, or interviewing the parent would have enabled me to obtain this information.

In sum, the observations revealed that the majority of caregiving practices were informed by cultural beliefs. Other factors that contributed to the variations observed included children's temperament, maternal age and education, and employment status. Some forms of mother-infant interactions remained stable while others changed with time. Current patterns of mother-infant interactions were also comparable to those observed through earlier studies within this population. Though they enabled me to observe change in interactions over time, these findings are only representative of a small sample of children. Although I was able to compare the results of the current study with those from the INSTAPA study, these comparisons are only limited to a few items. The findings therefore underscore the need to study a bigger sample, in order to establish if the patterns observed are representative of the larger population. These observations supplemented the information obtained through the measure of the home environment, and support the utility of a 3-point scoring system through which scores with greater variability can be obtained. It also remains to be seen how these interactions influence infant motor and language development.

Table 30

*Results of Naturalistic Observations from the INSTAPA Study, Mean (SD)*

| | 6 months N = 309 | 12 months N = 232 | 18 months N = 201 | 24 months N = 153 |
|---|---|---|---|---|
| Mother to child | 3.27 (4.01) | 4.7 (5.37) | 3.66 (3.56) | 3.12 (3.62) |
| Child to self | 5.19 (639) | 2.19 (3.3) | .93 (1.44) | .19 (.74) |
| Child to mother | 3.15 (4.3) | 3.86 (5.55) | 2.19 (2.99) | .43 (1.13) |
| Other to child | 3.8 (5.36) | 6.58 (7.26) | 7.36 (5.69) | 9.53 (5.69) |
| Child to other | 1.95 (3.42) | 4.71 (5.59) | 5.24 (3.76) | 7.74 (4.86) |
| Total from child | 10.3 (8.75) | 10.76 (9.46) | 8.36 (5.13) | 8.36 (4.9) |
| Total to child | 7.08 (7.48) | 11.28 (10.0) | 11.02 (7.11) | 12.65 (6.48) |
| Total vocalisation | 17.37 (13.73) | 22.03 (18.24) | 19.38 (11.27) | 21.02 (9.94) |

Table 31

*Mean Levels of Parent and Child Behaviours (in percent)*

| Behaviours | Mean (SD) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Child 1 | Child 2 | Child 3 | Child 4 | Child 5 | Child 6 | Total |
| *Responsivity* | | | | | | | |
| Messy play | 1.81 (2.83) | 15.97 (28.88) | 3.5 (7.13) | 19.6 (22.51) | 1.8 (2.88) | 1.41 (4.13) | 7.45 (16.73) |
| Parent to child vocalisation | 31.87 (15.08) | 20.56 (11.27) | 28.89 (15.8) | 21.84 (10.63) | 71.06 (24.6) | 41.96 (28.6) | 35.88 (25.1) |
| Parent responds to child's vocalisations | 7.88 (14.78) | 4.12 (6.63) | 14.88 (17.2) | 2.3 (3.16) | 19.35 (22.53) | 3.41 (4.67) | 8.6 (14.42) |
| Parent tells the child the name of an object or person | 14.34 (11.08) | 3.8 (3.29) | 7.69 (4.64) | 6.67 (4.81) | 21.43 (17) | 9.36 (5.12) | 10.39 (10.35) |
| Parent uses distinct speech | 65.66 (31.04) | 51.16 (21.91) | 74.1 (24.26) | 67.26 (23.69) | 81.57 (21.46) | 76.37 (20.19) | 69.53 (24.99) |
| Free and easy conversation | 65.5 (31.17) | 51.16 (21.91) | 73.25 (26.54) | 67.26 (23.69) | 81.57 (21.46) | 77.39 (20.44) | 69.54 (25.45) |
| Parent praises child | 0 | 0 | 0 | 0 | .14 (.48) | 0 | .02 (.19) |
| Parent's voice conveys positive feelings toward the child | 5.8 (16.55) | 4.72 (9.71) | 4.91 (10.84) | 3.67 (7.7) | 14.67 (27.65) | 5.04 (15.23) | 6.4 (15.75) |
| Parent caresses/kisses child | .45 (1.5) | 0 | .43 (1.54) | 0 | 1.57 (2.77) | .38 (.73) | .46 (1.49) |
| Parent responds to child's crying | 3.03 (2.56) | 5.05 (5.27) | 3.76 (3.88) | 8.08 (7.93) | 4.3 (3.44) | 9.19 (12.16) | 5.66 (7.02) |
| Other to child vocalisation | 19.65 (16.34) | 19.21 (18.55) | 23.93 (21.73) | 25.55 (18.79) | 19.81 (14.25) | 19.61 (18.33) | 21.39 (17.79) |
| ***Acceptance*** | | | | | | | |
| Physical punishment/spanking/slapping | 1.82 (3.11) | 1.11 (2.05) | .64 (1.87) | .51 (1.85) | 4.3 (5.75) | .9 (2.77) | 1.5 (3.32) |
| Overt annoyance/hostility expressed | .3 (.67) | 0 | .13 (.46) | 0 | .42 (1.03) | 0 | .13 (.53) |
| Parent scolds/criticises/shouts at child | .9 (1.37) | 0 | .26 (.92) | .51 (1.42) | 1.53 (2.4) | .38 (1.0) | .59 (1.42) |
| Restrictions or interference | .45 (1.5) | .28 (.96) | .26 (.62) | 1.84 (6.14) | 3.33 (7.07) | .26 (.92) | 1.07 (3.97) |
| ***Organisation*** | | | | | | | |
| Caregiving provided by substitute | 3.13 (8.31) | 19.12 (33.36) | 0 | 0 | .69 (1.5) | 50.17 (47.19) | 12.49 (29.92) |
| Visit to grocery store | 0 | 0 | 0 | 7.69 (27.73) | 0 | 0 | 1.35 (11.62) |
| Child goes out of the house | 9.55 (30.02) | 8.33 (28.87) | 8.2 (27.6) | 38.59 (50.53) | 0 | 1.54 (5.55) | 11.26 (31.2) |
| Safe play environment | 54.24 (48.72) | 29.58 (43.04) | 10.0 (24.16) | 7.82 (27.7) | 66.94 (43.19) | 45.51 (45.23) | 34.84 (43.98) |
| ***Learning Materials*** | | | | | | | |
| Muscle activity toys | 2.32 (4.2) | 1.25 (4.33) | 1.15 (2.83) | 4.36 (8.75) | 2.92 (6.89) | 1.32 (3.47) | 2.22 (5.45) |
| Push or pull toy | 4.14 (5.6) | 0 | .64 (2.31) | .26 (.62) | 3.75 (9.1) | .64 (2.31) | 1.49 (4.63) |
| Anything to ride in or on | 0 | 0 | .13 (.46) | 2.31 (8.32) | 0 | .13 (.46) | .45 (3.49) |
| Role playing toys | 15.45 (18.74) | 19.17 (27.89) | 9.74 (14.3) | 12.95 (24.1) | 9.44 (17.94) | 12.09 (14.14) | 13.05 (19.67) |
| Learning facilitators | 0 | 0 | .64 (2.31) | 0 | 4.44 (15.4) | 0 | .83 (6.26) |
| Simple eye-hand co-ordination toys | .45 (1.08) | 1.67 (5.77) | 2.95 (7.27) | .38 (1.39) | .28 (.96) | 0 | .97 (3.93) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Toys for literature and music | 0 | 1.39 (4.81) | 0 | 0 | 0 | .38 (1.39) | .29 (2.01) |
| Toys provided during visit | 24.6 (32.91) | 19.58 (29.9) | 5.26 (8.1) | 14.1 (30.7) | 19.58 (32.42) | 7.48 (11.63) | 14.72 (26.02) |
| ***Involvement*** | | | | | | | |
| Parent talks to child when doing housework | 8.28 (9.7) | .69 (2.4) | 11.41 911.11) | 1.41 (3.39) | 3.47 (6.17) | 13.33 (21.67) | 6.5 (11.98) |
| Parent encourages developmental advance | 3.18 (5.35) | .42 (1.04) | 4.1 (5.8) | .12 (.46) | 12.45 (13.59) | 7.18 (10.72) | 4.56 (8.63) |
| Parent provides maturing/challenging toys | 1.01 (3.35) | .00 | .00 | .00 | .14 (.48) | .13 (.46) | .19 (1.31) |
| Structured play periods (by whom) | .3 (1.0) | .00 | .00 | .00 | .42 (1.44) | .38 (1.39) | .18 (.9) |
| Child is kept in visual range at all times | 85 (26.4) | 93.3 (17.11) | 98.1 (4.8) | 94.1 (12.43) | 93.6 (20.12) | 92.4 (23.37) | 92.95 (18.28) |
| ***Behaviour*** | | | | | | | |
| Playing alone | 41.31 (13.11) | 40.83 (17.52) | 32.44 (15.25) | 40.26 (16.91) | 26.34 (13.63) | 21.24 (15.47) | 33.54 (16.85) |
| Playing with others | 23.84 (14.51) | 19.77 (15.9) | 38.85 (25.5) | 27.91(20.87) | 38.38 (25.77) | 25.17 (23.92) | 29.12 (22.19) |
| Laughing | 3.53 (4.88) | 5.74 (5.57) | 5.09 (4.15) | 5.6 (6.98) | 5.56 (10.00 | 8.8 (11.26) | 5.78 (7.56) |
| Crying | 8.38 (5.9) | 10.51 (9.84) | 5.51 (5.42) | 10 (8.19) | 13.15 (11.19) | 21.92 (22.03) | 11.66 (12.73) |
| Vocalisation to self | 19.83 (20.2) | 22.88 (22.62) | 11.67 (9.9) | 17.22 (14.66) | 22.58 (22.75) | 11.25 (13.8) | 17.35 (17.72) |
| ***Maintenance*** | | | | | | | |
| Breastfeeding/eating | 13.53 (8.12) | 21.11 (15.75) | 11.92 (6.23) | 12.95 (12.75) | 13.61 (9.71) | 12.69 (10.68) | 14.24 (11.05) |
| Grooming | 1.36 (2.45) | 2.08 (2.47) | 2.35 (2.17) | .26 (.63) | 3.15 (3.47) | 5.3 (4.4) | 2.44 (3.19) |
| Soothing | 1.06 (2.14) | 1.9 (3.55) | 4.78 (11.19) | 7.9 (15.6) | 2.59 (4.53) | 10.17 (13.66) | 4.9 (10.4) |
| Sleeping | .66 (1.7) | 3.15 (4.0) | 0 | .77 (2.77) | 0 | 1.67 (5.09) | 1.04 (3.09) |
| Elimination | 2.17 (2.07) | .56 (1.09) | .77 (.86) | 0 | .28 (.65) | .51 (1.42) | .68 (1.32) |

CHAPTER 7: RESULTS OF THE EXPLORATION OF THE SPECIFIED MODEL

## Paper 7: Nutrition as an important mediator of the impact of background variables on outcome in middle childhood

### Introduction

While the literature provides evidence that the negative effects of early malnutrition persist to school-age (Pollitt et al., 1996), there are several significant knowledge gaps. First, despite evidence that the impact of nutrition varies across different neurocognitive domains, there have been few studies investigating this area, especially in middle childhood. And yet at school age, children are exposed to more differential experiences and acquire more sophisticated abilities across various cognitive domains (Fischer & Bullock, 1984). Second, there is a complex inter-related relationship between poverty, nutritional status and neurocognitive outcomes. Not only do the constraints of low income in deprived settings create practical barriers to good nutrition; additional socio-environmental factors reinforce the effects of this deprivation (Engle & Black, 2008). Poor nutritional status at this age may have long-term negative consequences and restrict development of a child's full potential. This is therefore a critical period for investigating the link between malnutrition and developmental outcomes, especially within a multiple risk context.

In many developing countries, particularly in sub-Saharan Africa, linear growth retardation, or stunting, a manifestation of chronic protein-energy malnutrition (PEM), is highly prevalent, with rates as high as 38% (de Onis, Blössner, & Borghi, 2011). Various individual and environmental variables have been associated with an elevated risk of experiencing poor nutritional status. Important differences have been highlighted in the prevalence of stunting among boys and girls (Acham, Kikafunda, Oluka, Malde, & Tylleskar, 2008; Badenhorst et al., 1993; Goon et al., 2011; Lwambo, Brooker, Siza, Bundy, & Guyatt, 2000; Omigbodun et al., 2010; Semproli & Gualdi-Russo, 2007; Senbanjo, Oshikoya, Odusanya, & Njokanma, 2011) although there are substantial variations in regional trends. Moreover, patterns observed among school-age populations are similar to those reported at younger ages (Wamani, Åstrøm, Peterson, Tumwine, & Tylleskär, 2007). With regard to age, several studies have reported a dramatic increase in stunting among older children (Goon et al., 2011; Lwambo et al., 2000; Senbanjo et al., 2011; Stoltzfus, Albonico, Tielsch, Chwaya, & Savioli, 1997) demonstrating that linear growth continues to falter throughout the school-age years (The Partnership for Child Development, 1998). Mendez and Adair (1999) found that children who started school at earlier ages (5 or 6 years) were substantially taller than children who started school later (7 or 8 years) so it may be that better-off children enrol in school at earlier ages. And although children in low-income settings may all suffer the effects of

deprivation, those from the least wealthy households in low-income settings are more likely to be malnourished (Abubakar, van de Vijver, et al., 2008; Bradley & Corwyn, 2002; Brooks-Gunn & Duncan, 1997; Ndukwu, Egbuonu, Ulasi, & Ebenebe, 2013; Sigman, Neumann, Jansen, & Bwibo, 1989). Rural residence (Hautvast et al., 2000; Nabag, 2011) and a reduced likelihood of attending school (Ivanovic, Olivares, Castro, & Ivanovic, 2012) have also been related to poor nutritional status. Apart from adversely affecting cognitive functioning independently of nutritional status, these risk factors have been known to alter the profile of undernutrition (protecting against or accentuating the risk of undernutrition) in a population (Pollitt et al., 1996), as well as being recognised as adversely affecting cognitive functioning independently of nutritional status.

Undernutrition has been shown to negatively impact various developmental and cognitive domains including motor development (Chang-Lopez, 2007; Olney et al., 2007; Pollitt et al., 1994), language functioning (Duc, 2009; Wachs, 1995), IQ (Mendez & Adair, 1999) as well as memory and executive functions (Kar et al., 2008). This latter study observed that malnourished children showed poor performance on tests of higher cognitive functions but not on motor performance. Moreover, the impact of malnutrition on specific skills seems to vary according to diverse child-related and environmental variables. For instance, among the various gender-patterned deficits documented through an Indian study (Bhandari & Ghosh, 1980), malnutrition affected a wider range of aspects of immediate memory for boys than for girls.

The effects and outcomes of nutritional status are correlated with environmental factors, the most salient of which is socioeconomic status (Bradley & Corwyn, 2002). Low SES leads to poor dietary intake which in turn impacts on brain and mental development eventually causing developmental deficits. School attendance has also been associated with better cognitive scores among both stunted and non-stunted children (Mendez & Adair, 1999). And as we have reiterated earlier on, apart from poor cognitive outcomes, rural children have a substantially higher risk of poor nutrition (Fox & Heaton, 2012).

There have been efforts to investigate the complex relationship between background variables, nutritional status and developmental outcomes (Wachs, 1995). And in Kenya, a recent study investigated the direct and indirect effects of economic poverty on child outcomes (Abubakar, van de Vijver, et al., 2008). The Kenyan study suggested that in infancy, impaired psychomotor development is associated directly with undernutrition, while the effect of poverty is mediated entirely through nutritional status (Abubakar, van de Vijver, et al., 2008). These results are similar to what had been earlier reported from Indonesia where nutritional influences mediated the relationship between poverty-related variables (e.g. SES) and child outcomes (Pollitt et al., 1994). As far as our literature search has revealed, the majority of studies exploring the relationship

between undernutrition, co-occurring risk factors and other aspects of impaired child outcome has largely concentrated on children under the age of five years (Abubakar, van de Vijver, et al., 2008; Kariger et al., 2005; McDonald et al., 2013; Olney et al., 2009; Olney et al., 2007). We would like to build up on earlier work and extend the lines of research by focussing on school-age children.

Given the co-occurrence of malnutrition and multiple risk factors within this setting, are the adverse effects of these variables on neurocognitive outcomes related to their impact on nutritional status? Based on a model modified from Wachs (1995), we hypothesized that, a) sociodemographic and biological factors make a unique contribution to nutritional status, and, b) nutritional status is a strong predictor of various outcomes in school-age children. Because cognitive skills are more differentiated at this stage, we were able to explore the relationship between chronic malnutrition and developmental outcome across several outcomes. To delineate these effects and to investigate these relationships simultaneously required advanced statistical modelling. The main aim of this study was therefore to establish if diverse background characteristics created variations in nutritional status. We also sought to compare the relative strength of the effects of poor nutritional status on language skills and motor abilities at school age. This information will enable the identification of points of intervention for those most at risk.

## Material and Methods

The study was cross-sectional in nature and was conducted in Kilifi District, Kenya, among a predominantly rural community. The details of the study setting, study sample and ethical considerations are presented in Chapter 3.

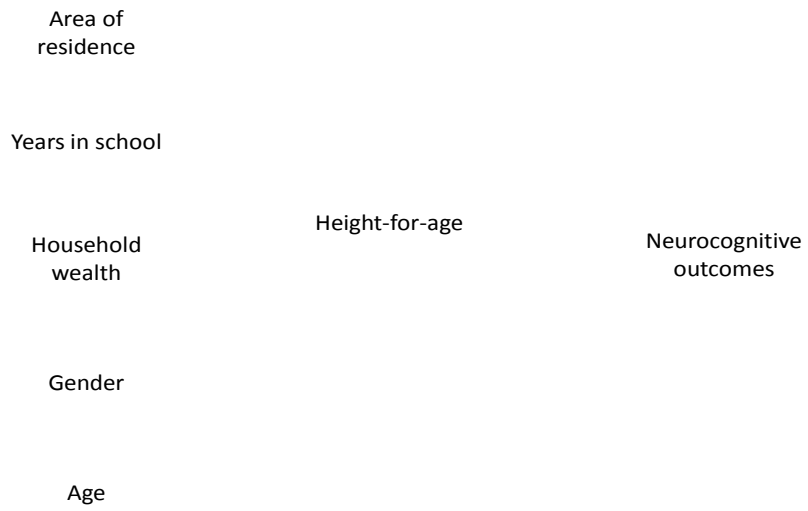
### Measurement of Variables

Building on the extant research literature, our analysis included age, gender, area of residence, school attendance and household wealth as underlying biological and environmental influences, nutritional status as a mediating variable, and language skills and motor abilities as child outcomes. In order to test the various hypothesized relationships, we developed the model presented in Figure 6.

In the full model which included all the explanatory variables, the use of structural equation modelling (SEM) allowed the disaggregation of the total effect of the explanatory variables into direct effects (effects that go directly from one variable to another) and indirect effects (effects between two variables that are mediated by at least one intervening variable) (Bollen, 1989). We hypothesized that the effects of area of residence, school attendance, household wealth, age and gender on child outcomes are experienced directly. Additionally, we hypothesized that the influence of these variables has an indirect effect on child outcomes through their influence on nutritional status. The model also took into account possible correlations among the five

background variables. We fitted separate models for language skills and motor abilities to see if there were differences in associations with child outcomes.

*Figure 6.* Hypothesised model for testing the mediating influence of nutritional status on child neurocognitive outcomes




**Background characteristics.** Information on child gender, age, school attendance (number of years that a child has attended school) and household wealth was collected using a standard questionnaire. Detailed information of this process is presented in Chapter 3. Area of residence was characterised as rural or peri-urban according to the most common settlement within the school catchment area.

**Mediating factor.** Children's heights were measured to the nearest centimetre using a stadiometer and height-for-age indices were calculated using WHO AnthroPlus (2009). Growth retardation was defined as height that was more than 2 standard deviations below levels predicted for age according to the World Health Organization reference curves for school-aged children (World Health Organization, 2007).

**Child outcomes.** A battery of neuropsychological tests was used to assess various domains of children's neurocognitive functioning. The current study was concerned with language skills and motor abilities.

***Language skills.*** The Kilifi Naming Test (KNT), a test of confrontation naming, was used to assess expressive vocabulary (refer to Chapter 4). In the KNT, the child is asked to spontaneously give one-word responses when presented with a black and while line drawing of a familiar object. Correct responses were coded '1.' A stimulus cue was provided when no response was given, the child stated that they did not know the name of the item or the item was perceived incorrectly. If the child did not provide a correct response after the stimulus cue, the word that the child said was recorded verbatim. The test was discontinued after six incorrectly-named consecutive items. The final score was calculated by summing the number of spontaneously correct items and the number of correct items following a stimulus cue. These scores were standardised enabling the direct comparison of children's performance across tests.

***Motor abilities.*** Children's motor abilities were assessed using five tests of gross motor abilities covering two areas of motor performance – static and dynamic balance – and three timed tests of fine motor coordination and manual dexterity (Kitsao-Wekulo, Holding, Taylor, Kvalsvig, & Connolly, 2013). Age-corrected scores were obtained by computing differences between observed and predicted scores in units of standard error of the estimate (i.e., in z-score units). Maximum likelihood factor analysis with oblique rotation was then applied to the z-scores to reduce the multiple motor scores to ability composites (Ackerman & Cianciolo, 2000). Factor analysis yielded support for a two-factor solution; four tests loaded on the Motor Co-ordination factor while the remaining four tests loaded on the Static and Dynamic Balance factor. Factor scores were defined as the mean of the z-scores for the tests loading on each factor. An Overall Motor Index was defined as the mean of the two factor scores. The development and validation of these tests is described in Chapters 3 and 5.

**Data Collection Procedures**

All the tests were administered at a school near the child's home. Each child was tested individually in a quiet area within sight of other children, and in familiar surroundings to minimise test anxiety. Observations by the assessors suggested that none of the children was unduly anxious during the test sessions.

**Data Analysis**

Independent samples t-tests, Chi-square tests and univariate analysis were undertaken to determine group differences in nutritional status and outcomes. Pearson product-moment correlation coefficients were used to examine the relationship between the background variables and cognitive outcomes, language skills, motor abilities and nutritional status. AMOS version 20 (SPSS) was used to test the fit of the overall model and to examine the relationships among the variables. Structural equation modelling (SEM) was used to examine the relationships between

background characteristics, child nutritional status and child outcomes. We developed and tested a path analysis model (Figure 6) based on logic and theory about how background variables co-vary with nutritional status, and how they influence child outcomes directly and indirectly. In the full model which included all the explanatory variables, this format allowed us to test the mechanisms through which each of the background variables influenced various child outcomes directly and indirectly though a mediated path. An independent disturbance term that represented unexplained variance was estimated for each endogenous variable.

In fitting the Structural Equation Models, missing information was taken into account using the Maximum Likelihood (ML) Estimates. The ML technique assumes data are missing at random for continuous, binary and categorical variables. All direct and indirect paths were tested and each of the four child outcomes was analysed in isolation. Specific procedures for model development were to remove non-significant paths ($p \geq .05$) and use modification indices as suggested by the AMOS SEM program (Arbuckle, 1988) to add paths or correlations that would improve model fit. Chi-square analysis was conducted in initial examination of the goodness of fit to assure non-significance. However, because this method is sensitive to sample size, other indices of goodness-of-fit included the Tucker Lewis Index (TLI), Comparative Fit Index (CFI) and the Root Mean Square Error of Approximation (RMSEA) (Bentler & Chou, 1987; Browne & Cudeck, 1993). Acceptable fit was defined as TLI and CFI >.90 and RMSEA <.08 and an excellent fit as TLI and CFI >.95 and RMSEA <.05.

## Results

### Descriptive Statistics

The study involved 308 boys and girls. The prevalence of linear growth retardation in this study population was high. Approximately 24% ($N = 74$) of all the children were stunted. Table 30 portrays a summary of the sample characteristics, comparing stunted and non-stunted children on various background characteristics. The proportion of stunted children residing in rural areas was significantly higher than that of their counterparts in peri-urban areas, $\chi^2$ (1, $N = 308$) = 4.12, $p$ = .04. A higher proportion of girls than boys was stunted but these differences were not significant, $\chi^2$ (1, $N = 308$) = 1.48, $p$ = .22.

More than one-third of the oldest children (aged 9.5 years or more) compared to 15.3% in the youngest group (aged 8 years or less) and 17.6% in the middle group (those aged between 8.5 and 9 years) were stunted. These differences were significant, $\chi^2$ (2, $N = 308$) = 12.98, $p$ = .002. Among children who did not attend school, a very high proportion was stunted compared to their counterparts who had attended school for at least one year and those with more than 2 years of school exposure. These differences were highly significant, $\chi^2$ (2, $N = 308$) = 32.89, $p < .001$. In

terms of household wealth, the highest proportion of stunted children was found among those in the sample who were least wealthy (Level 1). The differences in prevalence of stunting among the three groups were significant, $\chi^2$ (2, $N$ = 308) = 7.85, $p$ = .02.

**Correlations**

Variable intercorrelations are presented in Table 31. As can be seen from the table, more schooling and higher age were the most strongly correlated with household wealth, stunting and child outcomes. These correlations provide some initial evidence that school attendance and age have moderate to strong associations with nutritional status, which in turn is associated with children's language functioning and motor skills.

**Differences in Outcomes**

Children who were stunted performed more poorly than their counterparts who were not stunted on both outcomes tested (Table 32). These differences were significant for the tests of language, $t(306_{\text{equal variances}}) = -2.627$, $p$ = .009. Medium effect sizes were also seen for language tests.

**Model Modification**

For each outcome, the initial model did not have a good fit (Figures 7, 9). The steps in developing the individual path models involved making several revisions by deleting non-significant paths (non-significant paths in initial models are indicated with dashed lines). When the covariance between two variables indicated a non-significant correlation, the double-sided arrows were removed (Table 33). Modification indices did not suggest the need for additional paths or correlations. The final models for the child outcomes provided a good fit to the data. In order to simplify the output, only significant standardized path coefficients are shown in the final models (Figures 8, 10).

**Language skills.** The model for language skills (Figure 8) fitted well, TLI > .99, CFI > .99, RMSEA < .05. School attendance and age were related directly and indirectly (through nutritional status) to language skills. While more years of schooling were associated with both better nutritional status and higher language scores, associations of nutritional status and outcomes with gender and age were less consistently observed. Younger children had better nutritional status while older children had better language outcomes. Boys had higher language scores than girls. The indirect path from gender through nutritional status was not significant. Direct paths from height-for-age Z-scores to outcome indicated associations of better nutritional status with higher scores on the language test. These results suggest that the influences of school and age (but not gender) on language scores were partially mediated through nutritional status.

**Motor abilities.** The model for motor abilities had an excellent fit, $\chi^2$ (1, $N$ = 308) = .519, $p$

= .47; TLI > .99, CFI > .99, RMSEA < .05 (Figure 8b). Paths linking longer attendance at school and higher age with outcome suggest that these two variables were directly and indirectly associated with motor abilities. Direct paths from height-for-age Z-scores to outcome indicated associations of better nutritional status with higher scores on the motor test.

## Discussion

Although the effects of poor nutritional status on child outcome have been well documented in the literature, very little is known about the potential complex relationship with neurocognitive functioning in a multiple risk environment. Through the use of structural equation modelling, this study has attempted to elucidate some of the pathways through which nutritional status and other contextual characteristics may influence outcome in school-age children.

The risk factors for poor nutritional status in this population included older age, rural place of residence, low household wealth levels and not attending school. That younger children had a better nutritional status than their older counterparts was not unexpected; similar findings have been reported in earlier studies among infant (Powell & Grantham-McGregor, 1985) and school-age populations (Senbanjo et al., 2011). We also found that the prevalence of stunting was higher in rural than in peri-urban areas. As rural areas tend to have high concentrations of people with low education and low income levels, children are more likely to suffer the effects of these deprivations, though poorer nutritional status. Fotso (2006), in an effort to compare the magnitude of inequities in child malnutrition in urban and rural areas of selected countries in sub-Saharan Africa, reported similar findings. Moreover, in the current study, children from the least wealthy households faced the greatest risk of being stunted, compared to their counterparts in the most wealthy households, corroborating earlier findings in similar resource-restricted settings (Fotso, 2006). Our finding that levels of stunting were higher among children not attending school could be explained as follows; children from poor families are more likely to end up with poor nutritional status (Abubakar, van de Vijver, et al., 2008), and consequently, less likely to attend school (Ivanovic et al., 2012).

In turn, poor nutritional status predicted poorer outcomes on all the tests. These findings are consistent with reports from studies among infants and school-age children living in similar and different contexts (Abubakar, van de Vijver, et al., 2008; Bangirana, John, et al., 2009; Kar et al., 2008; Sigman, Neumann, Jansen, et al., 1989). Poor nutritional status results in a wide range of cognitive deficits linked to structural abnormalities of different parts of the brain (Kar et al., 2008). Because stunting occurs in early childhood, these results provide evidence that the effects of poor nutritional status may be long lasting, especially if appropriate interventions are not put in place.

*Figure 7.* Initial model for language score

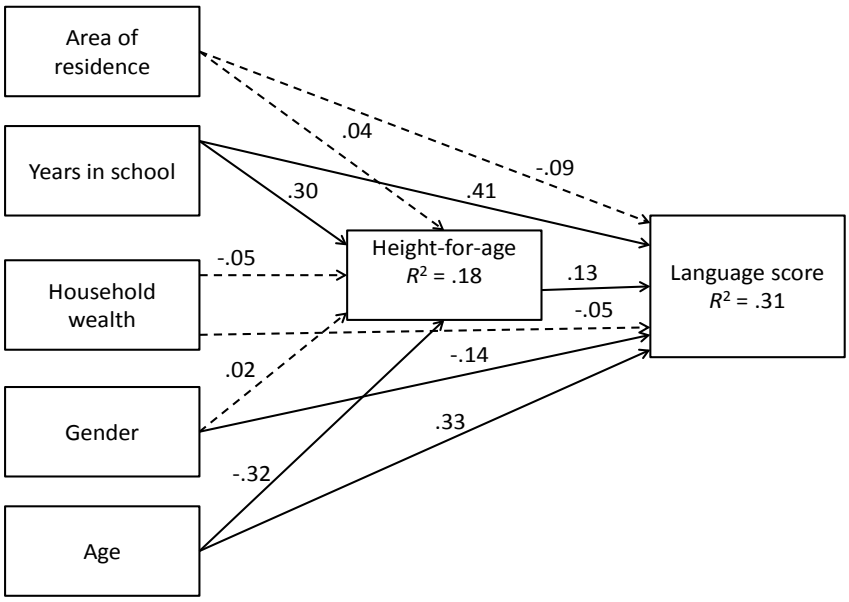



*Figure 8.* Final model for language score

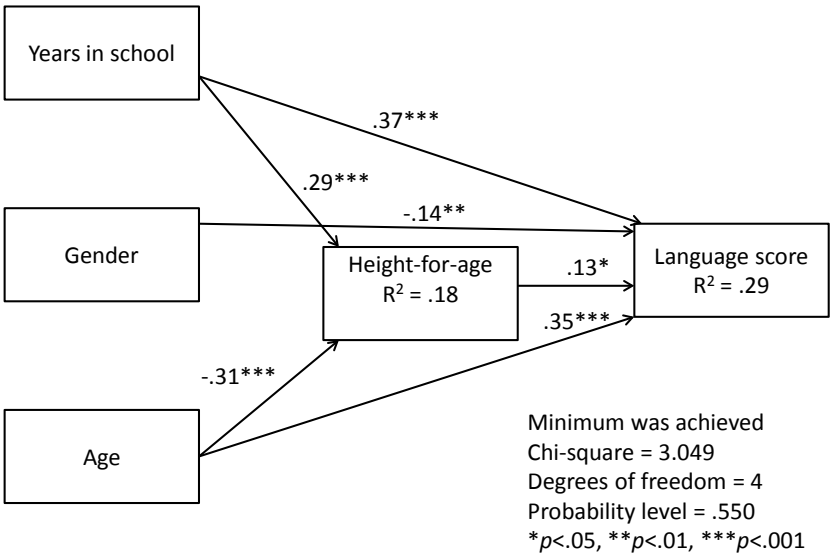


*Figure 9.* Initial model for motor skills

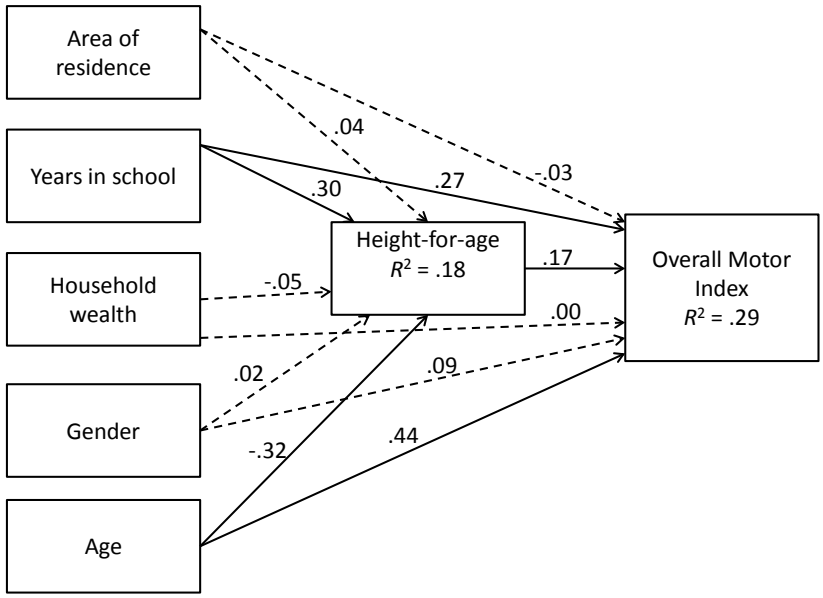
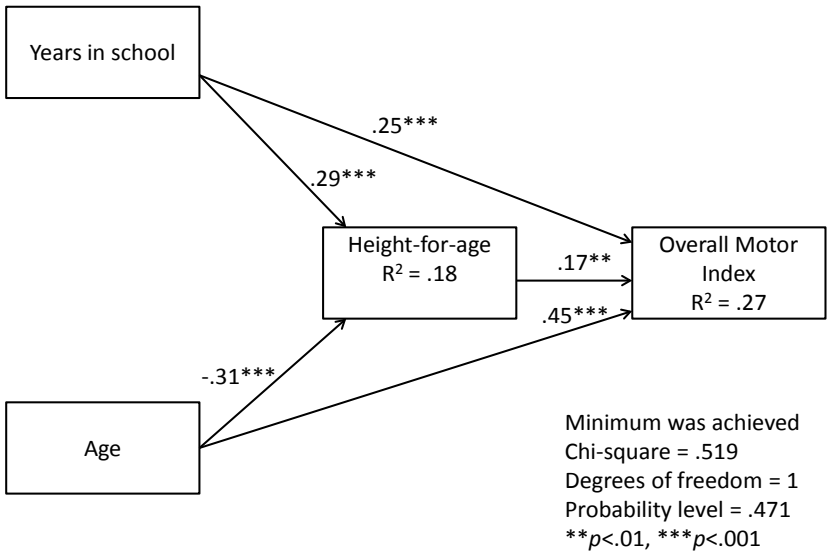



*Figure 10.* Final model for motor skills



The data show evidence for associations between background variables and nutritional status, and between nutritional status and multiple cognitive skills. As expected, the paths linking the variables to nutritional status and children's performance differed in magnitude for each outcome. The novelty, level of familiarity with and requirements of the various tasks could perhaps explain the differences observed. Mediated influences of nutritional status, as well as the direct effects of background variables were stronger for tests with a higher degree of novelty, which were less familiar and which had more complicated task requirements.

Noteworthy in the current study is the negative relationship between age and nutritional status. Similar patterns have been reported in earlier studies which have recorded a dramatic rise in the prevalence of stunting with age among African children (Hautvast et al., 2000; Senbanjo et al., 2011; Stoltzfus et al., 1997). Stoltzfus and colleagues (1997) as well as Glewwe and Jacoby (1995) have postulated that, parents probably enrol the more healthy children in school at earlier ages. As a result, a pattern of higher prevalence of poor nutritional status among older children emerges. The same situation may pertain to the current study context. Strong age effects were seen on motor skills and language abilities, a finding which may be attributed to the following. Children's vocabularies expand as their semantic development takes effect (Zembar & Blume, 2009) hence older children perform better than younger ones on vocabulary tests. A rapid increase of muscle strength and maturation of physical abilities related to balance and coordination also takes place in middle childhood (Zembar & Blume, 2009) resulting in better performance on motor tests among older children.

Associations of gender with nutritional status and with motor skills did not reach significance. The literature on gender differences in nutritional status and gender influences on child outcomes illustrates a non-uniform pattern. Studies in sub-Saharan Africa, for example, report higher levels of stunting among boys (Goon et al., 2011; Semproli & Gualdi-Russo, 2007; Wamani et al., 2007), while studies from elsewhere have recorded higher levels for girls (Chowdbury, Chakraborty, & Ghosh, 2008). Although the literature on malnutrition seems to suggest that the differences in the manner in which boys and girls are treated may help one gender overcome early adversity, this did not seem to be the case in the current study. Our study also revealed that boys achieved higher scores on the language test. Contrasting findings have however been reported in other studies where girls are found to consistently outperform boys on language measures (Kramer, Delis, Kaplan, O'Donnel, & Prifitera, 1997; Lowe, Mayfield, & Reynolds, 2003). Perhaps in their day to day interactions, boys had more extensive prior experience with the objects that were represented pictorially on the language test hence they had an advantage over girls in naming the items.

Our index for household wealth did not have significant direct or indirect effects on any of the child outcomes. On the contrary, several studies have reported that socioeconomic status is a strong predictor of both nutritional status (Brooks-Gunn & Duncan, 1997; Ndukwu et al., 2013) and outcomes in children (Bradley & Corwyn, 2002; Santos et al., 2008). The lack of an association between household wealth and child outcomes is not without precedence; an earlier study among infants living within the same context (Abubakar, van de Vijver, et al., 2008) has reported similar findings. We offer a couple of explanations for the non-significant direct effects of household wealth on nutritional status and child outcomes. First, we speculate that this finding may relate to the overwhelming influence of other factors, such as school attendance, among children at this age. This is evidenced by the moderate correlation seen between household wealth and school attendance. Secondly, our study was conducted within a context in which the majority of families live in economically depressed conditions. This may explain why, even though the indicators included in our SES measure distinguished one household from another, these differences were not significant in relation to the outcomes under study.

Although other studies have reported that children residing in rural areas have a substantially higher risk of poor nutritional status compared to their urban counterparts (Fox & Heaton, 2012; Hautvast et al., 2000), our study did not show evidence of such associations. The primary reason for this finding was that the current study was conducted within a predominantly rural context. Variations in children's area of residence may therefore have been too subtle to create any real differences in outcomes for children.

In the final trimmed models, school attendance had both direct and indirect (via nutrition) effects and was the most influential environmental predictor of nutritional status and child outcomes. The possibility that the nutrition-related benefits afforded by a school feeding program may explain this finding was negated by the fact that it was only in one school that children were offered food in school. When school attendance was taken into account, associations of nutritional status and cognitive functions with demographic factors like household wealth lost their significance; any bivariate associations washed out with the effects of going to school. This finding provides evidence that school attendance captures family resources more globally and meaningfully (such that there were no independent effects of area of residence and household wealth). Our model is also consistent with earlier studies which have demonstrated that where school attendance is not universal, even a little school exposure is associated with improved test-taking performance. In part, this may be due to increased test-taking awareness, as well as to methods of instruction, curriculum content or the types of questions that teachers ask, accelerating the development of cognitive skills over and above other factors (Alcock et al., 2008; Holding et al., 2004). Going to

school thus offers opportunities for learning and practice, and also trains children to follow instructions.

Building up on previous similar work in this area, similarities were seen in the magnitude of the associations between background variables and nutritional status. However, the relationship between SES, stunting and outcome seen among infants (Abubakar, van de Vijver, et al., 2008) within the same context was not fully replicated in the current study population. This may have been because older children are exposed to more varied environments. Furthermore, as with the infant study, the direct path between household wealth and outcome in our study was not significant. As reiterated earlier on in this discussion, school attendance seemed to exert a greater influence than household wealth on nutritional status, and had strong direct associations with both outcomes. A plausible explanation for this finding is that by the time children attain the age of going to school (around 6 years in the study context), the individual effects of socioeconomic status diminish as household wealth becomes an important determinant of whether or not a child goes to school (Mishra, Arnold, Otieno, Cross, & Hong, 2005). Parents who are doing relatively well economically are able to both provide more nutritious meals for their children as well as retain their children in school. On the other hand, poor nutritional status may reflect limited economic resources. School attendance patterns of children from less wealthy households may be characterised by prolonged absenteeism or dropouts as their parents are unable to initiate and maintain their children's schooling (Mendez & Adair, 1999). Such children may therefore benefit less from the effects of school exposure. The complex inter-relationship among the three factors is supported by the suggestion by Mukudi (2003) that the association between school attendance and nutritional status is a function of socioeconomic status. School attendance can therefore be considered a proxy for household wealth, which in turn is strongly related to nutritional status. These associations need to be explored more extensively through a longitudinal study.

Some of the major difficulties that emerge when comparing the effects of background variables on child development in different populations are the differences in environments to which they are exposed and in the outcomes tested. As noted by Goon et al. (2011), historical data such as birth weight, birth order, duration of breastfeeding and birth interval would likely provide a picture of previous states of malnutrition and provide further understanding of its aetiology within the current study population.

The estimated models demonstrated the continued importance of nutritional status as a powerful predictor of outcomes even as children grow older. Significant direct effects of the background variables on child outcomes suggest that the estimated models do not fully explain pathways through which they might influence child outcomes. The unexplained variance may be

found in the home environment, an area which remains poorly investigated among rural African populations. Interventions to ameliorate the negative effects of poor nutritional status earlier on may mitigate the need for costly interventions later on, especially for those growing up in the contexts of poverty and poor nutrition.

Table 32

*Description of Sample Characteristics, N = 308*

| Variable | Stunted | | Not stunted | |
|---|---|---|---|---|
| | N | % | N | % |
| Gender | | | | |
| Boys | 31 | 20.9 | 117 | 79.1 |
| Girls | 43 | 26.9 | 117 | 73.1 |
| Area of residence | | | | |
| Rural | 65 | 26.5 | 180 | 73.5 |
| Peri-urban | 9 | 14.3 | 54 | 85.7 |
| Age (years) | | | | |
| < =8.0 | 11 | 15.3 | 61 | 84.7 |
| 8.5 to 9.0 | 19 | 17.6 | 89 | 82.4 |
| > = 9.5 | 44 | 34.4 | 84 | 65.6 |
| School exposure | | | | |
| 0 years | 22 | 62.9 | 13 | 37.1 |
| 1 to 2 years | 21 | 20.8 | 80 | 79.2 |
| > 2years | 31 | 18 | 141 | 82 |
| Household wealth | | | | |
| Level 1 | 39 | 31.7 | 84 | 68.3 |
| Level 2 | 21 | 22.3 | 73 | 77.7 |
| Level 3 | 14 | 15.4 | 77 | 84.6 |

Table 33

*Correlations among Variables in the Model*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Area of residence | 1 | | | | | | |
| 2. Gender | -.012 | 1 | | | | | |
| 3. Age | -.025 | .019 | 1 | | | | |
| 4. Years in school | .313** | -.084 | .041 | 1 | | | |
| 5. HAZ | .130* | -.006 | -.300** | .272** | 1 | | |
| 6. Household wealth | .135* | -.067 | -.240** | .391** | .146* | 1 | |
| 7. Language scores | .045 | -.166** | .318** | .427** | .127* | .048 | 1 |
| 8. Motor scores | .060 | .074 | .402** | .318** | .106 | .017 | .499** |

Table 34

*Differences in Outcomes*

| | Stunted (N = 74) | | Not stunted (N = 234) | | Cohen's *d* |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | |
| Language skills | -0.26 | 1.09 | 0.08 | 0.95 | 0.333 |
| Motor abilities | -0.06 | 0.72 | 0.03 | 0.57 | 0.140 |

Table 35

*Maximum Likelihood Estimates of Covariances for Initial Model*

| Covariance | Covariance Estimate | Standard Error | Correlation Estimate | *p*-value |
|---|---|---|---|---|
| Years in School ↔ Area of Residence | .212 | .041 | .313 | <.001 |
| Age ↔ Household Wealth | -1.049 | .257 | -.240 | <.001 |
| Area of Residence ↔ Household Wealth | .214 | .091 | .135 | .019 |
| Age ↔ Gender | .011 | .032 | .019 | .738 |
| Years in School ↔ Age | .077 | .107 | .041 | .472 |
| Household Wealth ↔ Gender | -.132 | .112 | -.067 | .238 |
| Years in School ↔ Gender | -.071 | .048 | -.084 | .141 |
| Area of Residence ↔ Gender | -.002 | .012 | -.012 | .837 |
| Age ↔ Area of Residence | -.011 | .026 | -.025 | .657 |
| Years in School ↔ Household Wealth | 2.584 | .405 | .391 | <.001 |

Chapter 8: INFLUENCE OF SES AND HOME ENVIRONMENT ON CHILD OUTCOMES

# Paper 8: Linking SES and Home Environment to Language and Motor Outcomes in Children: A Comparison of School-age and Infant Populations

## Introduction

Healthy development of children depends on various environmental influences (Shonkoff & Phillips, 2000). One of these influences, socioeconomic status (SES) has been consistently associated with child outcomes (Duncan, Brooks-Gunn, & Klebanov, 1994; Hart & Risley, 1995; Magill-Evans & Harrison, 2001; Melhuish, Sylva, Sammons, Siraj-Blatchford, & Taggart, 1999). SES is conceptualised as a distal variable, and its effects may have an indirect impact on child outcomes through its influence on more proximal variables (Bradley & Corwyn, 2003). That is, SES is related to the quality of the child's immediate home environment, and the home environment predicts children's outcomes. Proximal environmental variables are those processes within the child's immediate home environment that the child experiences directly. As Bronfenbrenner postulates, the effect of these factors increases with their proximity to the developing child (Bronfenbrenner & Morris, 2006). This suggests that variables associated with proximal processes are likely to have greater effects on children's development than distal contexts. To illustrate this point, although maternal education, one of the commonly used SES variables, influences child outcomes, the child does not experience his/her mother's level of education directly. Instead, what the child may experience proximally with a well-educated parent is responsive interactions, regular daily routines, as well as the provision of opportunities for stimulation. Distal contexts therefore directly and indirectly influence child development.

The quality of the home environment describes the degree to which the child's environment provides opportunities for optimal development. Details on important aspects of the home environment are provided in an earlier chapter (Chapter 6). More supportive and stimulating home environments have been linked to better outcomes across several spheres for both infants and school-age children (Hart & Risley, 1995; Sarsour et al., 2011). However, in resource-poor settings, associated risk factors such as poverty are likely to preclude the provision of stimulating home environments for children mainly due to the level of daily stressors experienced (Baker-Henningham et al., 2003). For instance, poor parental psychosocial well-being related to stress (Conger, Rueter, & Conger, 2000) may impede parents' abilities to engage in positive interactions with their children and to provide supportive home environments. Lack of economic resources may also limit the availability of developmentally appropriate physical and psychosocial resources (Brooks-Gunn & Duncan, 1997). Furthermore, the physical structures of the homes of these children which may be characterized by inadequate lighting conditions and overcrowding are

associated with negative outcomes (Evans, 2006). Many of these children may therefore lack exposure to stimulating experiences and thus not acquire various skills as rapidly as children living in affluent homes (Elardo et al., 1975; Hart & Risley, 1995; Hoff-Ginsberg, 1991; Kiernan & Huerta, 2008) which results in poorer developmental outcomes (Dollaghan et al., 1999).

Associations among the home environment, SES and child outcomes have been previously reported in resource-poor settings (Abubakar, van de Vijver, et al., 2008; Sarsour et al., 2011). However, there have been no reports comparing the magnitude of these associations among populations of different ages within the same study. We therefore investigated whether the effects of the home environment and SES on language and motor outcomes among school-age children were similar to or different from those observed among infants.

## Method

The study drew data from two sources. First was a study among a school-age population which sought to determine the neurocognitive functioning of children assessed using a battery of neuropsychological tests. Second was an infant study of the influence of prenatal exposures on child outcomes. Detailed descriptions of both studies are presented in Chapter 3. We set up a model with all the variables in Figure 1, including the two child outcomes, language skills and motor abilities.

### School-age Study

We used a battery of neuropsychological tests to assess children's neurocognitive functioning (Kitsao-Wekulo et al., 2012). In addition, we administered the home environment measure to 146 children (for details, refer to Chapter 6).

**School-age outcomes.** Two outcomes, language skills and motor abilities were selected for the current study. The Kilifi Naming Test (KNT), a test of confrontation naming, was used to assess expressive vocabulary (refer to Chapter 4). Children's motor abilities were represented by an Overall Motor Index derived from scores obtained on tests of motor co-ordination and balance (refer to Chapter 3).

**Socio-demographic information.** Information on child gender, age and socioeconomic status was made available through the main study, as detailed in Chapter 3.

### Infant Study

A cross-sectional sample was obtained from the infant population. Every third child within the three age bands, 12, 18 and 24 months, was systematically sampled from a sampling frame. Only the children with complete data on all measures were included in the final sample (N = 231).

**Infant outcomes.** Language skills and motor abilities were assessed using the CDI and KDI respectively, as detailed in Chapter 3. These scores were transformed to z-scores to allow direct

comparison across variables.

**Socio-demographic information.** Information on the child's gender and date of birth was obtained at delivery. Interviews with mothers provided information on various aspects of socio-economic status of the family.

**Data Analysis**

Descriptive statistics of raw scores were used to provide summary information about the sample and the study measures.

Structural equation modelling (SEM) was conducted by developing and testing a path model based on logic and theory about how gender, age and environmental factors (home environment and SES) would be expected to influence children's language and motor skills. Initially, the Pearson Product-Moment Correlation Coefficient was used to determine the degree of association among the various variables included in the model, in order to establish if a linear relationship existed among them.

In this model, gender, age and SES were exogenous variables, home environment was a mediator variable, and the two child outcomes were endogenous variables. The paths between the exogenous, mediator and endogenous variables represented direct causal (structural) effects. Residual (error) terms were identified for the mediator and endogenous variables. I fixed the paths leading from the residual terms to the observed variables to be 1. The hypothesised model depicting anticipated paths between predictors and these skills is presented in Figure 11. I then used the maximum likelihood method to estimate the model.

I used the Chi-square analysis in initial examination of the goodness of fit to ensure non-significance. However, because this method is sensitive to sample size, I used other indices of comparative fit including the Tucker Lewis Index (TLI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) (Bentler & Chou, 1987; Browne & Cudeck, 1993). The initial model did not result in a good fit (Figure 12). Specific procedures to re-specify and modify the model were to remove non-significant ($p \geq .05$) paths and use modification indices as suggested by the AMOS SEM program (Arbuckle, 1988) to add paths or correlations that would improve model fit. Modification indices did not however suggest the need for additional paths or correlations. For the final model, acceptable fit was defined as TLI and CFI >.90 and RMSEA <.08 and an excellent fit as TLI and CFI >.95 and RMSEA <.05.

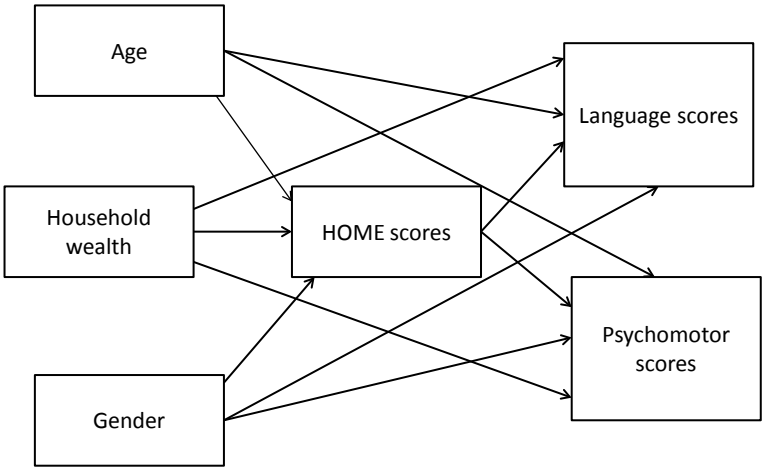
## Results

**School-age Study**

**Descriptive data and variable inter-correlations.** Descriptive data for each of the variables and variable inter-correlations are presented in Tables 35 and 36, respectively. Age had weak and

negative correlations with household wealth, $r(146) = -.177$, $p < .05$. Moderate correlations were seen between age and the two child outcomes (language, $r(146) = .311$, motor, $r(146) = .334$, both $p < .01$). The two environmental variables (household wealth and HOME scores) were moderately correlated with each other, $r(146) = .499$, $p < .01$, as were the two child outcomes, $r(146) = .561$, $p < .01$.

*Figure 11.* Hypothesised model of the association between SES, home environment and child outcomes




**Results of the final model.** The final model, shown in Figure 13, provided a good fit to the data, $\chi^2$ (7, $N = 146$) = 4.712, $p = .695$; TLI > .95, CFI > .95, RMSEA < .05. Higher age at assessment was related to both higher language and motor scores. Age was however not related to Kilifi-HIPSC scores. While higher family resources as assessed by the index for household wealth predicted more enriched home environments, direct paths from the wealth index to the language and motor measures were not significant. Household wealth explained 23% of the variance observed in home environment scores. Gender was significantly related only to language scores. This model also included direct paths from the Kilifi-HIPSC scores to both language and motor scores, indicating associations of more enriched home environments with higher scores on both language abilities and motor skills. Finally, the negative correlation of age with household wealth provides evidence that younger children had higher family resources than older ones. Moreover, the structural errors for the two test scores documented the correlation between these two measures

(Table 37). The full model predicted 18% and 19% of the variance in language and motor scores, respectively. The model parameters and covariances depicted in the final model were all significant.

*Figure 12.* Initial model for the School-age Study

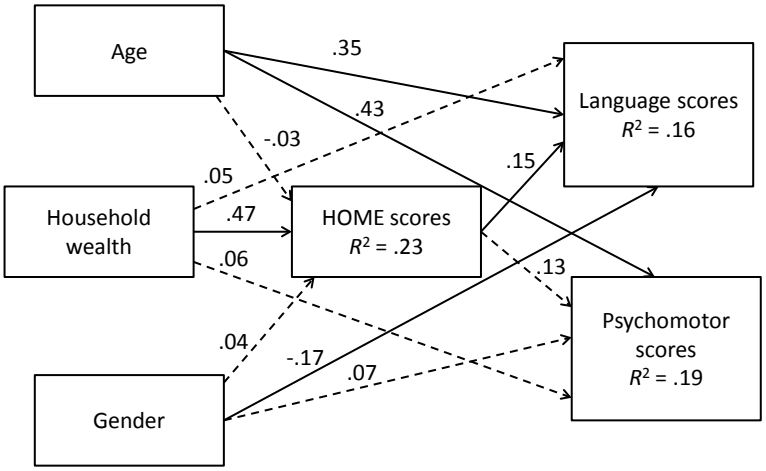
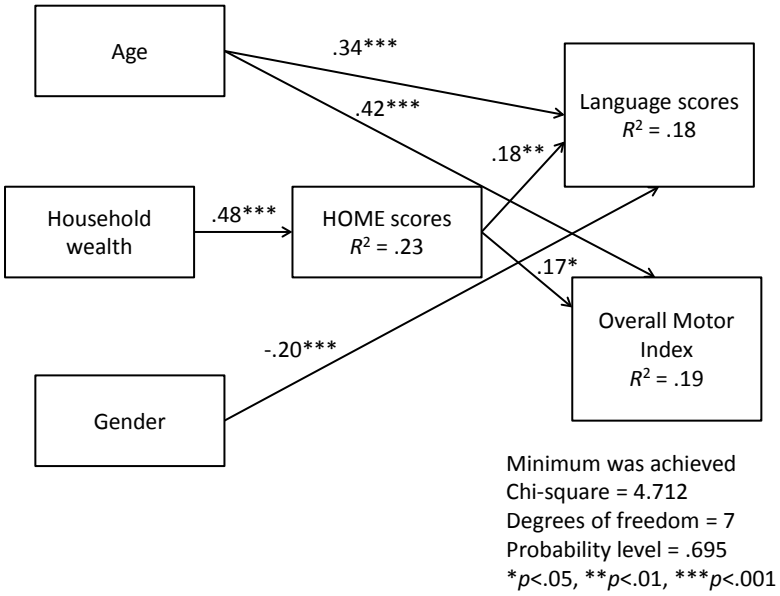


*Figure 13.* Final estimated model for the School-age Study




**Infant Study**

**Summarised and individual descriptive data.** Mean HOME scores were 18.28 (*SD* = 2.78) and ranged from 12 to 26. CDI scores ranged from four to 183, with a mean of 57.11 (*SD* = 33.08) while KDI scores ranged from 18 to 51 with a mean of 32.99 (*SD* = 6.00) (Table 35).

Girls had higher z-scores on the CDI, $t(228) = -1.517$, $p = .131$, and HOME, $t(228) = -1.801$, $p = .073$. Boys performed better than girls on the KDI, $t(228) = 1.381$, $p = .169$. These differences were however not significant.

Age differences were significant on CDI, $F(2, 228) = 103.329$, $p < .001$, $\eta_p^2 = .475$, and KDI scores, $F(2, 228) = 332.622$, $p < .001$, $\eta_p^2 = .745$, but not on the HOME scores, $F(2,228) = .083$, $p = .920$, $\eta_p^2 = .001$. Household wealth was not significantly associated with KDI scores, $F(2,228) = .752$, $p = .473$, $\eta_p^2 = .007$, CDI scores, $F(2, 228) = 1.479$, $p = .230$, $\eta_p^2 = .013$, or HOME scores, $F(2,228) = 1.603$, $p = .204$, $\eta_p^2 = .014$.

**Variable inter-correlations.** Correlations between age and household wealth, and between age and HOME scores were not significant. Age showed moderate ($r(231) = .602$, $p < .001$) to strong ($r(231) = .836$, $p < .001$) correlations with CDI and KDI scores, respectively. Household wealth and HOME scores had a weak correlation with each other, $r(231) = .161$, $p = .014$. Correlations between household wealth and the two child outcomes were not significant. The two child outcome scores were moderately correlated with each other, $r(231) = .529$, $p < .001$ (Table

36).

**Results of the final model.** The initial model resulted in a good fit, $\chi^2$ (1, $N$ = 231 = 2.004, $p$ = .157). However, some of the paths were not significant. Several revisions to the model were then made by deleting non-significant paths. The final model, shown in Figure 15, provided an excellent fit to the data, $\chi^2$ (9, $N$ = 231) = 12.567, $p$ = .183; TLI > .95, CFI > .95, RMSEA < .05. As with the School-age Study, higher age at assessment was related to both higher language and motor scores. Higher family resources, as assessed by the index for household wealth, were correlated with more enriched home environments. Household wealth contributed to 5% of the variance observed on the home environment scores. Direct paths from the wealth index to the language and motor measures were not significant. The effects of household wealth on language scores were thus fully mediated by the home environment. Gender predicted HOME scores and was significantly related to only the language scores. This model included direct paths from the HOME scores to language scores but not to psychomotor scores. Correlation of the structural errors for the two test scores was not significant (Table 38). The full model predicts 43% and 70% of the variance in language and motor scores, respectively. The model parameters depicted in the final model were all significant.

*Figure 14.* Initial model for the Infant Study

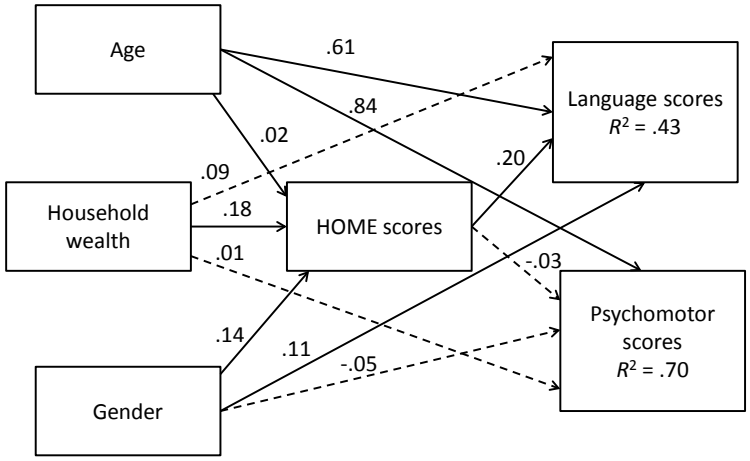
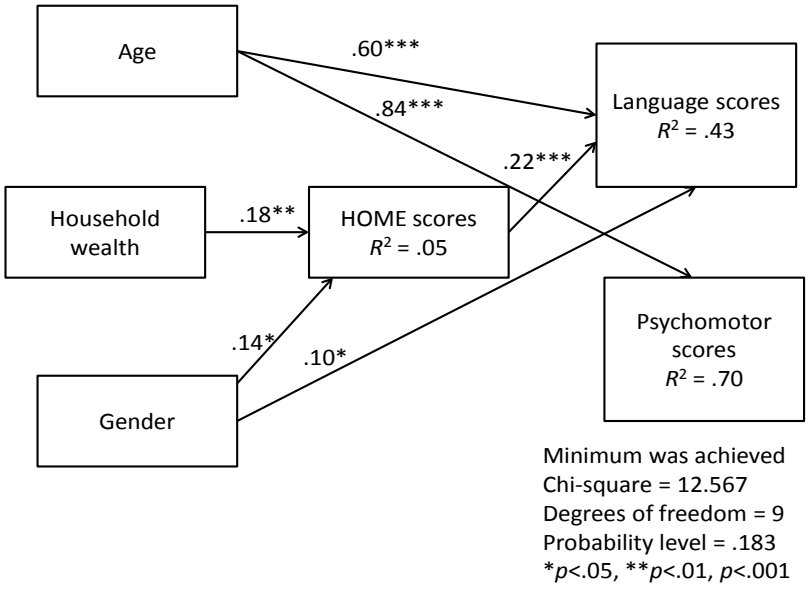


*Figure 15.* Final estimated model for the Infant Study




## The Results of Hypotheses Testing

**Hypothesis 1**

There is a direct association between distal contexts and proximal processes.

The SEM model for the School-age Study revealed that distal contexts, represented by household wealth were strongly and directly associated with the proximal process within the home environment. For the Infant Study, a similar association was seen, but the strength of the association was of a lower magnitude.

**Hypothesis 2**

In resource-constricted settings, proximal processes have a stronger influence on child language development than distal contexts.

This hypothesis was fully supported in both studies. There was no direct association between household wealth and child outcomes, while an association was seen between the home environment and language outcomes among both the school-age and infant populations.

**Hypothesis 3**

In resource-constricted settings, proximal processes have a stronger influence on child motor development than distal contexts.

In the school-age model, the lack of a significant association between household wealth and motor outcomes, and a significant association between the home environment and motor outcomes

provided evidence to support this hypothesis. This hypothesis was however not supported in the infant study, as both household wealth and the home environment were not directly associated with motor abilities.

**Hypothesis 4**

The relative contribution of proximal processes and distal contexts to child outcome were more discernible among older children who display a wider range of skills than among younger children.

This hypothesis was not supported by the data as a greater proportion of the variance observed was explained in the Infant Study than in the School-age Study. Moreover, this variance was attributed to age, rather than to proximal processes or distal contexts.

## Discussion

The findings of the current study supported the mediating role of the home environment in associations between household wealth and child outcomes. Household wealth was associated with home environment scores, but not with any of the child outcomes in both studies, suggesting an indirect effect on outcome. Greater household wealth predicted a more stimulating and supporting home environment, which in turn was associated with better developmental outcomes for both infants and school-age children. The non-significance of age effects on the measures of the home environment in both sub-studies supports the use of the measures for the age ranges studied. The results from the structural equation model confirm that the home environment is an important influence on child outcomes within the current study setting. The study also sheds light on the variability in child language and motor scores produced by differences in the quality of the home environment in resource-poor settings.

Even though not mediated through the home environment, the study findings show evidence of the strong effects of maturation on the two child outcomes, especially among infants, where scores increased sharply with age. The strength of the association between age and outcome in the infant study was nearly twice that observed in the school-age model. These findings suggest that age is a more powerful influence on outcome among younger children when tremendous growth takes place across all developmental domains (E. K. Allen & Marotz, 1989), compared to middle childhood when growth in language and motor development is less dramatic. Supporting the image of middle childhood as a latency stage, growth of language abilities and motor development is slow and steady as children build upon skills gained in early childhood (Collins, 1984).

Whilst the effects of gender on outcome were partially mediated through the home environment in the Infant Study, the same was not observed among the school-age population. These associations were however only observed for language skills. The magnitude of the direct

effects was twice as strong among infants as among school-age children, with the effects favouring girls at younger ages and boys at older ages. The findings for the infant model may be related to the advantage reported for language development among girls at younger ages (Bornstein & Haynes, 1998; Fenson et al., 1994; Huttenlocher et al., 1991). Furthermore, in the naturalistic observations conducted with some of the children in the current study, the researcher observed that caregivers of female children seemed to have more conversations with them than those of male children, supporting the notion that parents talk more to girls than to boys (Lutchmaya, Baron-Cohen, & Raggatt, 2002). However, as mentioned earlier, other studies have not found significant differences at this age (Pan et al., 2004). We speculate, as in an earlier chapter (see Chapter 4) that the superior performance of boys in the school-age population may be attributed to their greater familiarity with the pictures used on the language test. The direct association between gender and the home environment observed in the infant study may also be related to the items included on the home measure. In relation to this, perhaps caregivers were more responsive to girls than to boys. For example, caregivers of girls may have responded in the affirmative more frequently on the items related to caressing and kissing the child, and talking to the child while doing housework. This finding suggests the use of separate norms for boys and girls within this age range.

In relation to hypothesis 1, the association between the home environment and household wealth illustrated, as have other studies in similar and non-similar contexts (Baharudin & Luster, 1998; Totsika & Sylva, 2004), that the greater the socioeconomic disadvantage in a family, the less stimulating home environments are for children. The magnitude of the association between household wealth and the home environment in the school-age model was nearly 3 times that observed in the infant population. Moreover, the proportion of variance in HOME scores explained by household wealth among the school-age population was nearly 5 times that observed among infants. This finding demonstrated that the effects of household wealth were stronger at older child ages, and could be attributed to the increasing interaction with people and objects outside the immediate home environment. As has been stipulated earlier, household wealth as a distal context exerts its effects on child outcomes through other more proximal variables such as the home environment, and the final models for both studies supported this notion.

In support of hypothesis 2, direct effects of household wealth on child outcomes were not significant in both models, a finding which is not without precedence within this setting. An earlier study among an infant population living in a similar context has reported a similar pattern (Abubakar, van de Vijver, et al., 2008). This finding may be attributed to the homogeneity in family socioeconomic levels, creating subtle differences among households that did not result in significant variations in test scores. As a consequence, the effects of household wealth on outcome,

particularly language abilities, were fully mediated through the home environment for both the School-age and Infant Studies. This finding provided evidence that the home environment is a good starting point for interventions to support the enhancement of language abilities in children.

Not only did the findings of the current study provide only partial support for hypothesis 3 through the results obtained on the School-age model for motor outcomes; they also refuted earlier reports that the home environment fully mediates the relationship between household wealth and child motor outcomes (Abubakar et al., 2008) during infancy. The differences observed in the current and earlier studies could be explained by the variations in the age ranges of the infants studied; compared to the current study (12-24 months), the earlier study had a wide age range (6-35 months) which meant that the latter study demonstrated greater variability in the scores for motor functioning. Moreover, this finding may be related to the low levels of endorsement on items which may have promoted motor development (such as those asking about the availability of toys for riding in or on) on the infant measure of the home environment.

The current study demonstrated that the paths linking the home environment and outcomes in school-age children and infants were of similar magnitude. Compared to the school-age population however, the final model for infants accounted for a larger proportion of the variance observed in outcomes. These findings may be attributed to the strong effects of age in the Infant Study. There was however no evidence to support hypothesis 4 through the current study as the results were contrary to what I expected.

The results suggest that within the current study context as has been reported for other contexts, a stimulating home environment has a more pronounced effect on child functioning than the family's socioeconomic status. The proximal processes within the immediate home environment of a child allowed us to differentiate high and low scores on both outcomes, and were more sensitive to differences among households than the household wealth index. And although poverty threatens children's development, we were able to demonstrate that it is the processes and related supportive structures within the immediate home environment, rather than the economic resources available to families, that would have a greater impact in improving children's outcomes. Provision of opportunities for language and cognitive stimulation, more parental concern and emotional support, greater involvement in activities outside the home and a supportive physical environment - which are themselves more amenable to change - would have a greater impact in improving children's outcomes than distal variables such as parental education, parental occupation and type of living arrangements. It will be worthwhile to facilitate the identification of specific aspects which can be changed in order to improve the home environments of children living under adverse conditions, and hence better outcomes.

As Bradley and Corwyn (2005) have highlighted, an examination of the association between the home environment and child outcomes enabled us to establish the cultural implications of the changes made to the tools. In future studies, we will seek to unpack the individual components of the home environment that have the strongest impact on child outcomes, especially those that are not highly related to each other, and may therefore have differential effects on child outcomes. This will require further investigation on three levels. First would be to identify items on which children scored as expected. Children with low test scores would be expected to have low endorsement on certain items on the home measure, and vice versa. These items would form the core of a modified home measure, as they behave as expected. Second, it would be useful to disentangle those items on the home environment measure which were similar for both low and high scorers on test outcomes, i.e., items which were endorsed at the same level by children in either group. Such items could then be categorised as risk factors for high scorers and protective factors for low scorers. Third, it may be that the items that were excluded from the home environment measure may contribute to the unexplained variability. In the current study setting where children may have multiple caregivers, their experience with other caregivers within their immediate home environments may shed light on other facets of the home that may contribute to variability in test scores.

Table 36

*Descriptive Data for HOME Scores and Child Outcomes*

| School-age Study | | Kilifi-HIPSC scores | | Language scores | | Motor scores | |
|---|---|---|---|---|---|---|---|
| | N | M | SD | M | SD | M | SD |
| Gender | | | | | | | |
| Boys | 76 | 40.72 | 10.1 | -.001 | 1.03 | -.09 | .65 |
| Girls | 70 | 41.77 | 12.84 | -.212 | 1.01 | -.09 | .65 |
| Age (years) | | | | | | | |
| < =8.0 | 41 | 44.58 | 11.67 | -.46 | .87 | -.30 | .53 |
| 8.5 – 9.0 | 52 | 39.58 | 10.79 | -.19 | .96 | -.20 | .64 |
| > = 9.5 | 53 | 40.34 | 11.62 | .26 | 1.09 | .18 | .66 |
| Household wealth | | | | | | | |
| Level 1 | 58 | 35.69 | 10.51 | -.17 | .99 | -.10 | .68 |
| Level 2 | 45 | 40.84 | 9.19 | -.19 | .98 | -.22 | .68 |
| Level 3 | 43 | 49.09 | 10.47 | .07 | 1.11 | .06 | .56 |

Infant Study

| | HOME scores | | | CDI scores | | KDI scores | |
|---|---|---|---|---|---|---|---|
| | N | M | SD | M | SD | M | SD |
| Gender | | | | | | | |
| Boys | 113 | 17.95 | 2.83 | -.096 | .94 | .017 | .89 |
| Girls | 117 | 18.61 | 2.73 | .149 | 1.12 | -.093 | 1.06 |
| Age (months) | | | | | | | |
| 12 | 89 | 18.29 | 2.92 | -.46 | .58 | -1. 05 | .47 |
| 18 | 79 | 18.19 | 2.77 | -.37 | .68 | .39 | .34 |
| 24 | 63 | 18.38 | 2.65 | 1.12 | .94 | .99 | .70 |
| Household wealth | | | | | | | |
| Level 1 | 93 | 18.03 | 2.64 | -.005 | .99 | .08 | .92 |
| Level 2 | 64 | 18.09 | 2.87 | -.15 | .89 | -.11 | 1.00 |
| Level 3 | 74 | 18.76 | 2.87 | .14 | 1.08 | -.008 | 1.09 |

Table 37

*Variable Inter-correlations*

| School-age Study | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Gender | 1 | | | | |
| 2. Age | .037 | 1 | | | |
| 3. Household wealth | .022 | -.177* | 1 | | |
| 4. Language scores | -.103 | .311** | .084 | 1 | |
| 5. Kilifi-HIPSC Scores | .046 | -.119 | .499** | .151 | 1 |
| 6. Motor scores | .001 | .334** | .123 | .561** | .160 |

| Infant Study | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1. Gender | 1 | | | | |
| 2. Age | -.042 | 1 | | | |
| 3. Household wealth | -.118 | -.043 | 1 | | |
| 4. HOME score | .118 | .009 | .161* | 1 | |
| 5. CDI scores | .100 | .602** | .087 | .237** | 1 |
| 6. KDI scores | -.091 | .836** | -.028 | -.025 | .529** |

**Correlation is significant at the 0.01 level

*Correlation is significant at the 0.05 level

Table 38

*Covariance Structure for the School-age Study*

| Covariance | Covariance Estimate | Standard Error | Correlation Estimate | *p*-value |
|---|---|---|---|---|
| Gender ↔ Household Wealth | -.132 | .112 | .019 | .238 |
| Age ↔ Household Wealth | -1.049 | .257 | -.240 | .000 |
| Age ↔ Gender | .011 | .032 | -.043 | .738 |
| e1 ↔ e2 | .216 | .032 | .430 | .000 |

Table 39

*Covariance Structure for the Infant Study*

| Covariance | Covariance Estimate | Standard Error | Correlation Estimate | *p*-value |
|---|---|---|---|---|
| Gender ↔ Household Wealth | -.181 | .103 | -.117 | .079 |
| Age ↔ Household Wealth | -.641 | .989 | -.043 | .517 |
| Age ↔ Gender | -.103 | .160 | -.043 | .518 |
| e1 ↔ e2 | .038 | .027 | .093 | .160 |

# CHAPTER 9: GENERAL DISCUSSION AND CONCLUSIONS

## Continuities and Discontinuities across Time and Skill Areas

The sub-studies that form the current study were completed among infants and school-age children residing in two fairly similar rural contexts. The two sub-studies were conducted in two districts located at the Coast Province of Kenya – the School-age Study was conducted in Kilifi District, to the north, while the Infant Study was conducted in Msambweni District to the south. As has been described earlier in this thesis, both districts are predominantly rural and both study settings are similar in terms of economic opportunities. The majority of the resident population relies on agriculture as the main economic activity. The Mijikenda, composed of nine sub-tribes, are the indigenous ethnic group in both districts. However, members of the Giriama sub-tribe are the majority in the northern parts while those from the Digo sub-tribe are the majority in the southern parts of the province. Poverty is highly prevalent in both districts and is manifested through low education and low income levels, especially among females. The usual form of settlement in the northern areas of the province is a homestead comprising several households inhabited by related family members. In the south, the homestead consists of a single house in which several relatives occupy different rooms. In both areas, homesteads are headed by the most senior married male. Female members of the household share daily routine chores, including child caregiving, fetching water and firewood and farming.

The main purpose of the current study was to identify distinct aspects of the home environment which impacted children's outcomes, and to compare these effects among a school-age with those among an infant population. Prior to this, it was necessary to have reliable and valid tools to measure language abilities and motor skills in the two populations. Tools to measure the two outcomes, as well as the quality of the home environment were readily available for infants, and had been validated in a population similar to that included in the current study. However, similar tools were not available for school-age children; the modification and adaptation of existing tools developed for other contexts was therefore a necessary initial step. The process of developing the measures of child functioning and a measure of the home environment is described in the first part of this thesis. Both the school-age and infant measures of the home environment have been extensively adapted to local environmental and childrearing practices through focus group discussions and home observations. They have also been validated against SES indicators such as maternal education and household wealth. The developed tools demonstrated good psychometric properties and were sensitive to various background factors.

The differing rates of change in development of motor abilities and language skills among infants and school-age children suggested that skills in these areas develop independently (Darrah et

al., 2003). Furthermore, developmental progression of test scores in the expected direction showed that children in both studies were resilient to the adverse conditions that they experienced (Luthar, Cicchetti, & Becker, 2000; M. Rutter, 2007).

In the Infant Study, the results provided evidence that the negative effects of nutritional status on language abilities persisted throughout this period and became stronger as children grow older. Surprisingly, these direct effects seemed to disappear among the school-age population as nutritional status seemingly mediated the effects of various background factors on outcome. Other influences on language outcomes during infancy were parent-related (maternal age and parental occupation) factors while in middle childhood, child- (age and gender) and environment-related (school exposure) factors remained significant. These findings support the notion that during infancy, it is the motivation and encouragement that parents provide within the home that promote and enhance language development while during middle childhood, these supports are found in the outside environment (Scarr & McCartney, 1983). What immediate members of the family are doing seems to be of more importance during early child development. With motor outcomes, a similar pattern was maintained. Slight differences were however observed in that it was factors related to the father rather than to the mother that were more significant, highlighting the importance of the involvement of fathers in supporting child development. The influence of paternal education and occupation may be related to absence or presence of a father in the home.

An important contribution of the current study is in illustrating the application of Bronfenbrenner's theoretical framework to the study of child functioning within a context that has not been previously investigated using this model. The current study showed how data obtained in a collectivist society fit within the framework of the PPCT model. The research design for both sub-studies included all four elements of the model. Establishing the quality of the home environment fit in with identifying proximal processes which occurred 'on a fairly regular basis over extended periods.' The characteristics of the person appeared as 'age' and 'gender' and again as both child outcomes. The context variable was related to the index of household wealth. The time factor was implied in the cross-sectional design through the changes that occurred with maturation, as older children obtained higher scores than their younger counterparts. The limitation of using the time factor in this manner was that we considered between-person rather than within-person changes. The degree to which environmental factors produce stability and consistency over time could therefore not be ascertained.

Unfortunately, some of the elements explored in our study did not seem to fit in very well with Bronfenbrenner's elements of the bioecological theory. For instance, both across cultures and within societies, family is an ambiguous concept and there is no agreement on how it should be

defined (K. R. Allen, Fine, & Demo, 2000). Therefore, distinctions in the form and content of the different micro-systems of the developing child were not very clear-cut, and may have resulted in misclassification of some of the background factors.

The current study adds to the existing knowledge base on the interaction of SES and the home environment in several important ways. First, I extended previous evidence that the effects of SES on child outcome are fully mediated through the home environment. The results also revealed that the processes within the home environment are a more powerful predictor of outcome than the environmental contexts within which they occur. Although not fully replicated in the Infant Study, the results indicated that the quality of the home environments of children in low-income settings creates variations in language abilities and motor skills.

Second, in a homogeneous SES setting, the study findings revealed differences in home environment effect sizes, suggesting that some parents are able to demonstrate resilient parenting strategies through the provision of stimulating experiences for their children despite living in deprived socioeconomic settings (Murry, Bynumm, Brody, Willert, & Stephens, 2001). Such parenting behaviour is likely to buffer the negative effects of low SES (Garmezy, 1993; Michael Rutter, 1987). The variability observed in the quality of the home environments of infant and school-age populations in the current studies, was predictive of outcomes at both ages and allowed us to differentiate good and poor outcomes.

Third, the findings demonstrated that the association between household wealth and the home environment begins during infancy and persists into middle childhood. The current evidence also highlighted that the effects of household wealth on the home environment are more powerful during middle childhood than during infancy.

**Conclusions**

The key findings of the current study are summarised to emphasise the contribution made to the current body of research. For one, the current study has demonstrated the reliability and validity of tools that have been modified for this study context. Their applicability to the study of children's outcomes suggests that they can be meaningfully used to show how children are functioning in various domains.

The magnitude of the influence of background factors on outcome seemed to vary across ages. Some of the variables were more influential at younger ages, while others became important at older ages. These findings support the fundamentals of the theoretical model applied through this study that there are factors which are experienced directly by the child and are therefore more influential, while others found within the child's context may be less important. When looking at specific influences on child outcomes, this information is useful in making decisions on which

variables to consider at the various ages.

Even though the data did not fully support the theoretical model applied in the current study, I was able to demonstrate how the theory could be meaningfully applied within the study context. While it may be that cultural factors had a strong influence on some aspects of child functioning, the findings demonstrate their universality.

Even within relatively homogeneous SES settings, I was able to observe differences in the immediate home environments of children. Through the comparison of findings from infant and school-age populations, the study provided evidence of the interactions between SES and the home environment at younger and older ages. At both ages, there was strong evidence to support the association between proximal processes and distal contexts of the child, as well as their variable influence on child outcomes. Such information will enable the identification of families that are most at risk, based on children's developmental outcomes.

The results from the current study are generalisable to other low-income contexts in which households are socioeconomically homogeneous. In such settings, the environmental influences that affect child outcomes may be similar and the strength of these effects may be comparable. For researchers in similar settings, it will be useful to consider including the background factors that have been discussed in the current study, as they may work in a related manner in such contexts. Such information will allow comparisons of findings across contexts.

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# APPENDICES

*Appendix A UKZN Ethical Approval Form*

*Appendix B Consent form for the School-age Study*

**INFORMATION SHEET**

**The development of appropriate methodology to assess executive functions, motor development and the home environment in Kenyan children into late childhood.**

**What is this study about?**

We have come from KEMRI to ask permission for your child to be part of a study looking at growth and development of children. We would like to have your child carry out a number of activities to see how easy or difficult each task is for children of different ages. The kinds of questions we will be able to answer for each task are,

- Do children get quicker at it as they get older?
- Do children make fewer mistakes as they get older?
- Do they change the way they do the task as they get older?

When we have the answers to these questions we will then be able to pick out those tasks which best show differences in children's abilities as they grow and develop.

**What will happen after this study?**

The tasks that will be developed will be used later, on other studies looking at children who have been sick. Then we can measure whether the sickness has slowed down their growth and development in any way, or whether they are doing as well as other children.

**Why is my child needed for this study?**

For now we are interested in all children, not just the ones who have been sick. We need to see as many children as we can who are older than 6 years and younger than 12 (7 - 11 years old).

**What will my child or family gain from being part of this study?**

If there are any problems with your child we will try and guide you as to how to help him/her. We might be able to help you ourselves, otherwise we will advise you what to do best for your child, and guide you to who can help.

**What will I need to do?**

Tell us about your child. We will need to talk to you about your child, to find out how well you think she has been growing and developing. This will help us understand if our tasks are picking up important differences between children.

**Will my child need to take any medicine?**

NO. These tasks are designed to be enjoyed, and keep your child interested. We want your child to do her best, and she will not do her best if she is frightened. The person who delivered this letter should have shown you some examples of the type of tasks that we would like your child to do. None of them will harm your child; none of them will involve needles or anything painful or frightening.

**How much time will it take?**

If you agree to include your child in our study then we will need to see both you and her two times.

1. The first time will be for about half a day. The tasks themselves should take about 1 - 2 hours. So half a day includes travelling time, and waiting time between tasks.
2. The second time will be much shorter. We will ask your child to repeat some of the tasks, so that we can measure differences over time.

**Where will my child be seen?**

We will try to see your child as near to your home as we can. If you need travel money we will supply it.

**What should I do before I bring my child?**

- Please tell your child about the study.

Tell her that we will be doing games and other activities. Tell her that we want to see what children of different ages are able to do. Although she should try to do her best, she should not be worried, but try and enjoy the tasks. We will also want to know which ones she liked, which ones she found difficult. We are very interested in what the children themselves think about the tasks.

- Please try and send your child to us after having eaten breakfast.

Children work best if they have been fed. If this is a problem because of travelling times etc, please let us know, and we will help.

**What if I change my mind about taking part?**

You can choose to leave the study at any time, without needing to give a reason. This will not affect, in any way, you or your child's contact with KEMRI in the future.

**If I have any questions who should I contact?**

The team from KEMRI that you will be seeing will include specialist teachers, whose job it is to assess the children and a Field worker, whose job it is to keep in contact with you, and organise your visits.

If you have a question that you need to have answered, about the study, or your child's health, please ask to speak to the person who is named here .....… who can be found at ……..

**Thank you for agreeing to help us with this study.**

Principal Investigator
KEMRI Centre for Geographic Medicine Research (Coast)
Kilifi
Kenya

**1. Consent at enrolment/familiarisation visit** (Date.....)

I ..... (name) am the ..... (relationship to child)

of .....(child's name)

I agree to let my child be enrolled in the study on "Growth and Development". I understand that I can choose to leave the study at any time, without needing to give a reason. This will not affect, in any way, my families' contact with KEMRI in the future, or medical treatment at Kilifi District Hospital."

Signature or sign .....

Name/signature of person taking consent .....

I request that additional consent be taken from ..... (name)

the .....(relationship to child)

(if additional consent is requested fill out a second consenting form attach)

**2. Consent of child**

a) Consent of child at home visit (Date.....)

Name/sig. of person taking consent. .....

..

b) Consent of child taken at assessment 1 (Date.....)

Name/sig. of person taking consent. .....

..

c) Consent of child taken at assessment 2 (Date.....)

Name/sig. of person taking consent. .....

..

*Appendix C Consent form for the Infant Study*

**Project Title: HIV, Malaria, and Neurobehavioral Development in Early Childhood**

This is a research study and includes only people who choose to take part. Please take your time to decide if you want to join this study. Some people find it helpful to talk about the study with their family and friends before they make a decision. It may also be useful to talk with your doctor, clinic nurses about the study. If you have questions or want to know more about the study, you can ask them for more information.

You are being asked to take part in this study because you are pregnant and live in an area of the country that has a high rate of malaria.

WHY IS THIS STUDY BEING DONE?

The purpose of this study is to find out if having malaria and/or HIV infection during your pregnancy will affect your unborn child. This may subsequently affect their growth and development as young children. This study is being conducted in collaboration with the Kenyan Ministry of Medical Services (MOMS).

HOW MANY PEOPLE WILL TAKE PART IN THE STUDY?

About 600 mothers and their children will take part in this study.

WHAT IS INVOLVED IN THE STUDY?

During pregnancy we will ask you to come to the Mother-Child clinic **every month** for your regular checkups. The hospital and Mother-Child clinic staff will see you and measure your height, weight, blood, and general health, as should be done for a safe pregnancy. In addition they will look at the growth of your baby during pregnancy, and this will be followed using an ultrasound machine. This takes moving pictures of the baby and allows them to check the growth of the baby inside your stomach. It is completely safe, and will help the doctors responsible for your care to identify those mothers who need extra treatment for problems in the pregnancy. We will ask you questions about your general mental state, the stresses you may be facing, and if you are feeling sad (depressed). By asking these questions the doctors can also know if you need special treatment to help your baby grow in a healthy environment. We will also look closely at your blood for malaria and anaemia at each visit, which will allow them to treat you appropriately for these possible problems during your pregnancy.

You should be aware that it is the standard practice at the Mother-Child clinic to request mothers to have an HIV test, both for your own health and that of the child. As a mother involved in this study we will need you to carry out this test in the normal manner. You will be given detailed information about the benefits of this testing at the ANC clinic from trained staff at the Voluntary Counselling and Testing centre (VCT).

We will then request you **deliver your baby at the participating hospital/ clinic.** The reason for this is that we need to see how well both you and the baby are at birth. We will also wish to check the placenta to make sure that it was healthy through the pregnancy, and take the baby's birth weight. It is difficult to do these things if you give birth at home. The advantage for you will be that should there be any complications you will close to medical help. We will also encourage you to come to the delivery with a family member or a traditional birth attendant to support you at this time.

At the time of delivery we ask you to provide about 2 teaspoons of blood from your arm and to allow us to obtain blood from the umbilical cord and placenta of your newborn child. Removing a

small amount of blood from your vein is part of the standard hospital care that you receive when you are about to deliver a baby. We will also take a small sample from your placenta. This will allow us to check on infections, such as malaria, that you had during pregnancy. The main placenta will then be discarded as you wish.

*We would like to store your and your child's blood and/or placenta in a freezer for additional tests. If your child should become ill we can go back and test the newborn's blood or placental to help determine why they became sick.*

We will also obtain urine and stool samples from you before or after you give birth. These samples will be used to determine whether you have other parasitic infections such as schistosomiasis, or intestinal worms. You will be offered treatment by the hospital if you have any of these infections.

After birth we will want to see you and your child in the usual Mother-Child clinic at 6, 10, 14 weeks and 9 months of age when your baby is immunized. At these visits you and your child will get a health check. Your baby will be weighed and measured and we will ask you about the child's health since the last time we saw you.

We also request to see you and your child for longer assessments when your child is 6, 12, 18 and 24 months of age. Each of these visits will take about 2 hours. The purpose of these assessments is to measure how your child has been learning to move, talk, do things for him/herself and be with other people. During these longer assessments our trained staff will play with your child in your presence at our playroom near the clinic. We will use a number of activities to see how your child's thinking and moving is developing. We will also ask you how your child is behaving at home. Before each of these assessments we will check the health and growth of your child.

HOW LONG WILL I BE IN THE STUDY?
You and your child will be in the study from the time you first visit the Mother-Child clinic until your child is two years old.

You are very free to change your mind at any time, and stop being part of the study.

WHAT ARE THE RISKS OF THE STUDY?
While in the study, you/your child are at risk for minor side effects. These include bleeding or bruising at the site where blood is removed from the vein, and sometimes people may feel dizzy or faint if they have blood removed, but this will last only a short time. It is also possible that if you are HIV positive this information about you may become known. Every effort will be made to keep this information about you confidential.

ARE THERE BENEFITS TO TAKING PART IN THE STUDY?
Through careful monitoring that you receive it will be possible to increase the ability of your caregivers to identify early any potential problems in the pregnancy. When any problems are identified we will advise you on your treatment options.

For the later infant study we will give you a record book to keep on your child. Each time we see you we will fill in the book as a record of what your child has done, and how s/he has grown. Again this careful monitoring will increase the chances of identifying any problems in the infant's growth and development, allowing us to help you identify the appropriate treatment options available.

WHAT OTHER OPTIONS ARE THERE?
You do not have to participate in this study. Your care at delivery and your child's care after its birth will be administered by the maternity nurses and will not be adversely affected by not enrolling in this study. The normal Mother-Child program run at the hospital will continue to be available to you.

WHAT ABOUT CONFIDENTIALITY?
Efforts will be made to keep your personal information strictly confidential. It is possible that the Kenya Ministry of Medical Services or National Institutes of Health in the United States may review some of your records to assure that they are accurate and properly collected and stored.

WHAT ARE THE COSTS?
There are no costs to you to participate. Any tests that are part of the project described above will be paid for by the study. We will monitor you and your child's health during the study including free testing for malaria, intestinal helminthes, and other infections such as schistosomiasis. Additional tests as part of the study that includes haemoglobin levels and urinalysis will be provided free of charge. The project will also cover costs for a routine vaginal delivery. In the case of injury or illness during this study, emergency medical treatment is available but will be provided at the usual charge. We have no funds to pay for emergency treatment or to compensate you in the event of injury. You will receive no payment for taking part in this study. We appreciate that transportation will be an extra expense for you and a companion and we will pay you for your transportation costs from your home to the Msambweni District Hospital and/or the Port Reitz Hospital.

SUMMARY OF YOUR RIGHTS AS A PARTICIPANT IN A RESEARCH STUDY
Your participation in this research study is voluntary. Refusing to participate will not alter your usual health care or involve any penalty or loss of benefits to which you are otherwise entitled. If you decide to join the study, you may withdraw at any time and for any reason without penalty or loss of benefits. If information generated from this study is published or presented, your identity will not be revealed. In the event new information becomes available that may affect the risks or benefits associated with this study or your willingness to participate in it, you will be notified so that you can decide whether or not to continue participating.

CONTACT INFORMATION
Msambweni: If you have any questions or concerns during the study (name) can be contacted to describe further to you what is going to be done, the risks, hazards, and benefits involved, and can be contacted at (tel. no.).

Further information with respect to illness or injury resulting from a research procedure as well as a research subjects' rights is available from the (KEMRI) Kenya Medical Research Institute Institutional Review Board (which is a group of people who review the research to protect your rights) at (tel. no.) in Nairobi.

You can get additional information about the study from your local chief or the Ministry of Medical Services (MOMS) chief administrative officer at the Msambweni District Hospital (tel. no.).

| | | | | |
|---|---|---|---|---|
| Consent for HIV testing given | yes | ☐ | no | ☐ |
| Consent for delivery in hospital | yes | ☐ | no | ☐ |
| Consent for storing samples | yes | ☐ | no | ☐ |
| Consent for storing blood for investigation later | yes | ☐ | no | ☐ |
| Consent for follow-up if child is recruited into study | yes | ☐ | no | ☐ |

**Please check one box only**

Parent or guardian's printed name _____

Parent or guardian signature _____Date _____
(day/month/year)

Witnessed by_____Date_____
(day/month/year)

Printed Name of Person Obtaining Consent (Must be study investigator or individual who has been designated in the Checklist to obtain consent.)

_____ Date_____
Signature of Principal Investigator (Affirming subject eligibility for the Study and that informed consent have been obtained.)

*Appendix D Consent forms for naturalistic observations*

***Center for Global Health and Diseases***
***Mombasa Field Site Office***
***P.O. Box xxxxx Mombasa xxxxxx, Kenya***
***Tel: xxxxxxxxxxxxx***

Dear parent/caregiver,

I, Patricia Wekulo, would like to request your permission to visit your home. The reason for this visit is to make some observations on how you interact with your child and ask you a few questions about the child's environment. I will be in your home for about one hour and during the visit, I will not interrupt your daily schedule.

Thank you.

Mzazi/Mlinzi mpendwa,

Ningependa kukuomba ruhusa ya kukutembelea nyumbani mwako. Lengo la matembezi haya nikuangalia jinsi unavyohusiana na mtoto wako na pia kukuuliza maswali machache kuhusu mazingira ya mtoto. Nitakuwa nyumbani mwako kwa muda wa lisaa limoja na wakati wa matembezi, sitakatiza shughuli zako za kawaida.

Asante.

| Name of parent/caregiver | Date permission given | Date of visit | Signature of parent/caregiver | Initials (person obtaining permission) |
|---|---|---|---|---|

*Appendix E KNT Record Form*

KILIFI NAMING TEST
Record Sheet

**Child ID:** _____ **Assessor ID:** _____

**Date:** _____ **Start time:** _____

| **PICTURE** | | **STIMULUS CUE** | **SCORE** | | |
|---|---|---|---|---|---|
| | | | **Without Cue** | **With Stimulus Cue** | |
| | | | **Correct** | **Correct** | **Incorrect** |
| 1 | Ball/mpira/mupira | *Wa kuchezea* | [ ] | [ ] | [ ] |
| 2 | Tap/mfereji | *Ni kumboza madzi* | [ ] | [ ] | [ ] |
| 3 | Door/mlango/muryango | *Wa kufungira nyumba* | [ ] | [ ] | [ ] |
| 4 | Cat/paka | *Aina ya mnyama* | [ ] | [ ] | [ ] |
| 5 | Ladle/kipawa | *Ya kuhekera madzi* | [ ] | [ ] | [ ] |
| 6 | Maize/mahindi/matsere | *Aina ya chakurya* | [ ] | [ ] | [ ] |
| 7 | Tail/mkia/mukira | *Sehemu ya mnyama* | [ ] | [ ] | [ ] |
| 8 | Cup/kikombe | *Cha kunwira madzi* | [ ] | [ ] | [ ] |
| 9 | Leaf/jani/kodza | *Sehemu ya muhi* | [ ] | [ ] | [ ] |
| 10 | Fish scale/makoko | *Huparwa samaki* | [ ] | [ ] | [ ] |
| 11 | Desk/dawati | *Hupatikana skuli* | [ ] | [ ] | [ ] |
| 12 | Forehead/kidhangu | *(show part of body)* | [ ] | [ ] | [ ] |
| 13 | Water trapper/ mchirizi/mkinja | *Ya kutegea maji/ kuhegera madzi* | [ ] | [ ] | [ ] |
| 14 | Tyre/gurudumu | *Sehemu ya gari* | [ ] | [ ] | [ ] |
| 15 | Hump/nundu | *Mgongoni wa mnyama* | [ ] | [ ] | [ ] |
| 16 | Trap/mtego/muhego/muhoto | *Hushika panya* | [ ] | [ ] | [ ] |
| 17 | Mat/mkeka | *Atu manakelesira* | [ ] | [ ] | [ ] |
| 18 | Traditional skirt/hando | *Ivalwayo ni ache* | [ ] | [ ] | [ ] |
| 19 | Hooves/kwato/kwalo | *Mwisho wa mguu wa mnyama* | [ ] | [ ] | [ ] |
| 20 | Charm/hirizi/pengu | *Ni kupewa ni mganga* | [ ] | [ ] | [ ] |
| 21 | Elbow/kisukusuku/kikokora | *(show part of body)* | [ ] | [ ] | [ ] |
| 22 | Eyebrows/nyusi | *(show part of body)* | [ ] | [ ] | [ ] |
| 23 | Turkey/bata (batha) mzinga | *Ndege wa nyumbani* | [ ] | [ ] | [ ] |
| 24 | Wick/utambi | *Sehemu ya taa* | [ ] | [ ] | [ ] |
| 25 | Snail shell/kola | *Kitu kinaishi mo ndani* | [ ] | [ ] | [ ] |
| 26 | Horse/farasi | *Mnyama apandwaye* | [ ] | [ ] | [ ] |
| 27 | Praying mantis/bandauha/dungudungu | *Ni kurya mainzi* | [ ] | [ ] | [ ] |
| 28 | Custard apple/matomoko | *Ni tunda* | [ ] | [ ] | [ ] |
| 29 | Fire stones/mafiga | *Ni kuhumirwa kugita* | [ ] | [ ] | [ ] |

| | | | | | |
|---|---|---|---|---|---|
| 30 | egg shell/vikakaya | *Sehemu ya yai* | [ ] | [ ] | [ ] |
| 31 | Owl/bundi/kimburu | *Hulia usiku* | [ ] | [ ] | [ ] |
| 32 | Drummer/mpigaji ngoma | *Hutumbuiza watu* | [ ] | [ ] | [ ] |
| 33 | Guinea fowl/kanga | *Ndege wa msituni* | [ ] | [ ] | [ ] |
| 34 | Jingles/njuga/nduga | *Ni kuhumirwa ngomani* | [ ] | [ ] | [ ] |
| 35 | Earrings/vipuli | *Huvaliwa na wake* | [ ] | [ ] | [ ] |
| 36 | Coconut husk/marifu | *Hutoka kwa nazi* | [ ] | [ ] | [ ] |
| 37 | Gourd/kipuru/kibuyu/kirenje | *Ni kumbola kwa mmera* | [ ] | [ ] | [ ] |
| 38 | Corral/chaa/zizi | *Ni ya ng'ombe* | [ ] | [ ] | [ ] |
| 39 | Zebra/punda milia | *Mnyama wa msituni* | [ ] | [ ] | [ ] |
| 40 | Chick/kifaranga/kinda | *Ndege wa nyumbani* | [ ] | [ ] | [ ] |
| 41 | Udder/kiwele/ere | *(show body part on cow sketch)* | [ ] | [ ] | [ ] |
| 42 | Lobster/kamba | *Wanaishi majini* | [ ] | [ ] | [ ] |
| 43 | Ring/pete/pehe | *Watu huvaa* | [ ] | [ ] | [ ] |
| 44 | Turtle/kasa | *Kobe ra madzini* | [ ] | [ ] | [ ] |
| 45 | adam's apple/kikoromeo/tindimiro | *(show part of body)* | [ ] | [ ] | [ ] |
| 46 | Sieve/kifumbu | *Ni kutsudzira nazi* | [ ] | [ ] | [ ] |
| 47 | Pilot/rubani/dereva wa ndege | *Huendesha ndege* | [ ] | [ ] | [ ] |
| 48 | Arrow head/kivaa | *Sehemu ya mshale* | [ ] | [ ] | [ ] |
| 49 | Ankle bone/nguyu | *(show part of body)* | [ ] | [ ] | [ ] |
| 50 | mat coil/usitu/lusihu | *Inahumirwa kutengeza kikahana* | [ ] | [ ] | [ ] |
| 51 | Torch/change/mwenge | *Ni kumboza mwangaza* | [ ] | [ ] | [ ] |
| 52 | Adze/tezo/thezo | *Inahumirwa kwa kutsongera* | [ ] | [ ] | [ ] |
| 53 | Dipper/kata/kaha | *Kuhekera madzi* | [ ] | [ ] | [ ] |
| 54 | horn for blowing/gunda | *Kifaa cha muziki* | [ ] | [ ] | [ ] |
| 55 | Pipe/kiko | *Ni kuvuhiwa here sigara* | [ ] | [ ] | [ ] |
| 56 | Xylophone/marimba/kiringongo | *Kifaa cha muziki* | [ ] | [ ] | [ ] |
| 57 | Anchor/nanga | *Ni kuzulia chombo cha madzini* | [ ] | [ ] | [ ] |
| 58 | Sail/hanga/tanga | *Ni kuhirika chombo* | [ ] | [ ] | [ ] |
| 59 | Quiver /ryaka | *Ni kungizira maonza* | [ ] | [ ] | [ ] |
| 60 | Billy goat/beberu/ndenge | *Mnyama wa kufuga* | [ ] | [ ] | [ ] |
| 61 | Seedling/muche/mutse | *Ni mmera* | [ ] | [ ] | [ ] |

**End time:** _____

*Selected pictures from the KNT*

*Appendix F Gross and Fine Motor Tests Record Forms*

Child's ID: _____ **AI._____ Date: _____ Start:_____**

## GROSS MOTOR SKILLS SCORE SHEETS

**1. Stork balance**

| **Eyes open** | | **Trial 1** Time to first error | **Trial 2** (all children < 30) Time to first error | **Highest time** (secs) |
|---|---|---|---|---|
| Leg 1 | | | | |
| Leg 2 | | | | |

| **Eyes Closed** | | **Trial 1** Time to first error | **Trial 2** (all children < 30) Time to first error | **Highest time** (secs) |
|---|---|---|---|---|
| Leg 1 | | | | |
| Leg 2 | | | | |

Errors: moving standing foot from its original place; moving non-standing foot from knee; taking hands off hips, touching the ground (trial 1 only)

**1. <u>One board balance</u> (30 sec)**

| | | **Trial 1** Time to first error | **Trial 2** (all children < 30) Time to first error | **Highest time** (secs) |
|---|---|---|---|---|
| Leg 1 | | | | |
| Leg 2 | | | | |

Errors: tilting board so that side touches floor; touching ground with free foot; touches balance board/supporting leg with free foot

**2. <u>Jumping and clapping</u>**

| | No. Errors | No. of claps | | No of correct claps | |
|---|---|---|---|---|---|
| 1st trial | | | | | |
| 2nd trial | | | | | |
| 3rd trial | | | | | |

Errors: feet apart on take off and landing, loses balance on landing

**4. Ball Balance**

| | Hand Used | Number of Drops (S/T/E) Up to 10 times | No. Errors | | |
|---|---|---|---|---|---|
| | | | S | T | E |
| 1st trial | | | | | |
| 2nd trial | | | | | |
| 3rd Trial | | | | | |

Errors on Straight/ at Turn/ at End

- thumb on the upper surface
- not resuming walking from point of drop
- uses free hand to steady ball

- Only present 2nd trial if child did not achieve pass criterion
- 3RD TRIAL ARM BENT, IF ERRORS PERSIST

**5. Hopping in squares**

| | **Trial 1** | | | **Trial 2** | | |
|---|---|---|---|---|---|---|
| R/L | **errors** | **hops** | **L** | **errors** | **hops** | **L** |
| Leg 1 | | | | | | |
| Leg 2 | | | | | | |

**L**= Landing (1: if correct, 0: if wrong)

**Finish Time: _____**

CHECKED:
ENTERED:

**Child's ID Number: _____ Assessor's Initials _____ Date: _____**

**Start time: _____**

**FINE MOTOR SKILLS**

| Pegboard (25sec.) | Hand (s) | Trial no. | No. of pegs |
|---|---|---|---|
| | **RH** | **1** | |
| | | **2** | |
| | | **3** | |
| | **LH** | **1** | |
| | | **2** | |
| | | **3** | |
| | **BH (pairs)** | **1** | |
| | | **2** | |
| | | **3** | |

**BOLTS AND NUTS** (60 seconds)

| Bolt no. | Trial 1 | | | | | Trial 2 | | | | | Trial 3 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | | |
| Totals | D | T | H | #B | #C | D | T | H | #B | #C | D | T | H | #B | #C |
| | | | | | | | | | | | | | | | |

Key: errors = D ropping
T urning
H and order

#B = number of bolts completed
#C = number of correct bolts

**Bead Threading (30sec.)**

| TRIAL | No. of beads |
|---|---|
| BT1 | |
| BT2 | |
| BT3 | |

**End time: _____**

CHECKED:
ENTERED:

*Appendix G Kilifi-HIPSC Record Form*

CID: _____ AID: _____ DATE: _____

# HOME INVENTORY FOR PRIMARY SCHOOL CHILDREN
## RECORD FORM

| **SECTION 1 EMOTIONAL AND VERBAL RESPONSIVITY** | 1 | 2 | **HP12** (12) Familia hutia mtoto moyo aweke mahali pa kuishi na kucheza pawe safi na sawa. | | |
|---|---|---|---|---|---|
| **HP1** (1) Jamii ina mpango wa kawaida kila siku kwa mtoto (wakati wa kula, kulala, kazi za nyumbani) | | | **HP13** (13) Mtoto anajua kuweka sare, nguo za kuchezea, za kusafiri mahali maalum. | | |
| **HP 2** (2) Mzazi wakati mwingine hustahamili uoga wa mtoto (kumpeleka nje usiku, kuwacha taa ikiwaka usiku) | | | **HP14** (14) Mzazi huwekea mtoto mipaka na kusisitiza( kazi za shule au masharti mengine kulingana na mtindo wa familia e.g. wakati wa kula) | | |
| **HP 3** (3) Mtoto amesifiwa angalau mara mbili katika wiki iliyopita kwa kufanya kitu fulani. | | | **HP15** (15) Mzazi humjulisha mwenye kuhoji kwa mtoto | | |
| **HP 4** (4) a) Mtoto hutiwa moyo asome?<br>b) Mtoto husoma na nani? | | | **HP16** (16) Mzazi hutumia kanuni za familia kwa uthabiti. | | |
| **HP 5** (5) Mzazi hutia moyo mtoto kuchangia katika mazungumzo wakati huo huo wametembelewa | | | **HP17** (17) Mzazi havunji kanuni za ukarimu nyumbani | | |
| **HP 6** (6) Mzazi huonyesha itiko ya furaha mtoto anaposifiwa na wewe. | | | **SECTION 3 EMOTIONAL CLIMATE** | | |
| **HP 7** (7) Mzazi hujibu maswali ya mtoto wakati wote ukiwepo. | | | **HP18** (18) Mzazi hajakuwa na hasira kwa mtoto zaidi ya mara moja kwa wiki. | | |
| **HP 8** (8) Mzazi hutumia sentensi zilizokamilika zenye lugha nzuri kwenye mazungumzo. | | | **HP19** (19) Mzazi hajachapa mtoto zaidi ya mara moja kwa mwezi | | |
| **HP 9** (9) Wakati mzazi anazungumza na au juu ya mtoto, huonyesha mawazo mazuri (hisia) zake za ndani dhahiri | | | **HP20** (20) Mtoto aweza kukasirikia mzazi bila kuadhibiwa | | |
| **HP 10** (10) Mzazi huanzisha mazungumzo na mwenye kuhoji, huuliza maswali, hutoa maoni kwa hiari yake | | | **HP21** (21) Mzazi hajalia ama kununa wazi wazi mbele ya mtoto zaidi ya mara moja katika wiki iliyopita | | |
| **SECTION 2 ENCOURAGEMENT OF MATURITY** | | | **HP22** (22) Mtoto ana mahali maalum pa kuweka vitu vyake | | |
| **HP11** Familia hutia moyo mtoto ajifanyie mwenyewe kazi za kawaida kama kutandika kitanda, kusafisha chumba, kusafisha vitu vikimwagika au kuoga. | | | **HP23** (23) Mzazi anaongea na mtoto wakati wote waliotembelewa ( mbali na kusahihisha na kumtambulisha) | | |

| | | | | | |
|---|---|---|---|---|---|
| **HP24** (24) Mzazi hutumia maneno ya kuonyesha upendo na majina ya utani. | | | **HP35** (35) Familia hutia mtoto moyo kuendelea kufanya shughuli zenye mpango.(hobbies) | | |
| **HP25** (25) Mzazi haongei kuhusu mtoto kwa kuudhika au chuki, kulalamika ama kueleza kuwa mtoto ni ‘’mbaya’’, kusema hajali etc. | | | **HP36** (36) (a) Watu wa familia hufanya nini wakati hawana shughuli za kufanya?<br>(b)Mtoto huhusishwa na kile watu wa familia hufanya wakati hawana shughuli | | |
| **SECTION 4 GROWTH FOSTERING MATERIALS AND EXPERIENCES** | | | **HP37** (37) Familia hutoa mafunzo au uanachama ili kusaidia talanta za mtoto hasa katika vituo vya mafunzo ya mazoezi ya viungo, kituo cha sanaa etc. | | |
| **HP26** (29) (a) Muna radio?<br>(b) Mtoto ana ruhusa ya kukaribia radio (ana ruhusa kuisikiliza?) | | | **HP38** (38) Tayari kuna vitu uwanjani vya mtoto kuchezea. | | |
| **HP27** (30) (a) Muna vyombo vya muziki kama kayamba, ngoma, guitar e.t.c.<br>(b) Mtoto ana ruhusa ya kuvitumia? | | | **HP39** (39) Mtoto anaenda maktaba? Familia humpangia mtoto kwenda maktaba. | | |
| **HP28** (31)Mtoto yuko huru kutumia vitabu vya watoto | | | **HP40** (40) Mmoja wa jamii amepeleka mtoto au kumpangia mtoto kwenda kwa mambo ya kisayansi, historia ama mambo ya kale katika mwaka uliopita | | |
| **HP29** (26) Mmoja wa jamii anasoma gazeti | | | **HP41** (41) a) Mmoja wa jamii amemchukua mtoto, au amempangia safari kwa basi (au gari nyingine) katika mwaka uliopita.<br>b) Gari gani ? | | |
| **HP30** (32) Mtoto ana mahali pakufanyia kazi za shule. | | | **SECTION 6 FAMILY PARTICIPATION IN DEVELOPMENTALLY STIMULATING EXPERIENCES** | | |
| **HP31** (27) Familia ina kamusi na hutia mtoto moyo wa kuitumia. | | | **HP42** (42) Familia hutembelea au hutembelewa na jamaa au marafiki. | | |
| **HP32** (28) Mtoto amemtembelea rafiki akiwa peke yake wiki iliyopita. | | | **HP43** (43) Mtoto ameandamana na mzazi katika safari kwa shughuli ya kinyumbani katika mwaka uliopita (kununua nguo). | | |
| **HP33** (33) Nyumba ina picha au michoro mingine ya sanamu kwenye ukuta | | | **HP44** (44) Mmoja wa jamii amemchukua mtoto au amempangia kutembelea sherehe za kitaifa, arusi au vikundi vikiimba au vikiigiza mchezo | | |
| **SECTION 5 PROVISION FOR ACTIVE STIMULATION** | | | **HP45** (45) Mmoja wa jamii amemchukua au amempangia mtoto kuenda mbali na nyumbani (kwa mji mkubwa, au pahali zaidi ya maili 50). | | |
| **HP34** (34) Muna runinga? Mtoto ana ruhusa hutumika kwa busara, (siyo kuachwa ionyeshe wakati wote). | | | **HP 46** (46) Wazazi huzungumza hadithi gani za mambo yaliotokea ujiranini, nchini au ulimwenguni na mtoto. | | |

| | | | | | |
|---|---|---|---|---|---|
| **HP47** (47) Familia husaidia mtoto kupata ujuzi wa kutumia viungo kama kutwanga mahindi, kubeba mzigo kwa kichwa, kuendesha baiskeli au kuogelea | | | **HP53** (53) Sehemu ya ndani ya nyumba sio giza au isio ya kuvutia | | |
| **SECTION 7 GROWN-UP INVOLVEMENT** | | | **HP54** (54) Kwa nafasi iliyopo katika vyumba, hii nafasi imerundikwa na vyombo vya nyumba | | |
| **HP48** (48) Baba (au baba mdogo, mjomba au babu) huhusisha mtoto kwa michezo ya kupitisha wakati, kama mpira wa miguu. | | | **HP55** (55) Vyumba vinavyo onekana ni safi vya kutosha na vitu havikuwekwa ovyo | | |
| **HP49** (49) Mtoto humuona na kutumia wakati wake saa zingine na babake (au baba mdogo, mjomba au babu) siku nne kwa wiki. | | | **HP56** (56) Idadi ya vyumba na watu wanao lala ndani yake | | |
| **HP50** (50) Mtoto angalau hula chakula mara moja kwa siku, karibu siku zote pamoja na watu wakubwa kama mama, baba, nyanya, baba mdogo au babu. | | | **HP57** (57) Nyumba isio na kelele sana-runinga, kelele za watoto, radio etc | | |
| **HP51** (51) Mtoto ameishi na jamii ile ile kwa maisha yake mbali na wiki 2-3 za likizo, au ikiwa mama ni mugonjwa au familia imetembelewa. | | | **HP58** (58) Nyumba isiyo na hatari yoyote kwa hali za afya (chokaa iliobomoka, ukuta unaoanguka, paa linavuja etc.) | | |
| **SECTION 8 ASPECTS OF THE PHYSICAL ENVIRONMENT** | | | **HP59** (59) Mazingira ya mtoto ya kuchezea yanaonekana salama na huru na hatari zozote. | | |
| **HP52** (52) Juhudi za kuwa au kutengeneza vitu vya kufurahisha au kuchangamsha mtoto. | | | **HP 60** Kiwanja cha nyumba kina vitu tofauti tofauti vya kuwezesha mtoto kupata ufahamu wa mambo | | |

*Appendix H CDI Record Forms*

## Communicative Development Inventory - Kiswahili Short 12 months

Participant ID: [M][_][_][_][_] Today's date: ……/……./…….

| Neno | E | E/S | Neno | E | E/S | Neno | E | E/S |
|---|---|---|---|---|---|---|---|---|
| Miau miau | ☐ | ☐ | Kipkapa/Kepa/ Cap/Kofia | ☐ | ☐ | Ahsante/ Shukrani | ☐ | ☐ |
| Mmee mmee | ☐ | ☐ | Nguo | ☐ | ☐ | Kwa kheri/Bye bye | ☐ | ☐ |
| Mooh mooh | ☐ | ☐ | Shati | ☐ | ☐ | La/Hapana/ Sitaki | ☐ | ☐ |
| Tamu tamu | ☐ | ☐ | Soksi | ☐ | ☐ | Naam/Ndio/Ehe | ☐ | ☐ |
| Umia | ☐ | ☐ | Mkono | ☐ | ☐ | Pole | ☐ | ☐ |
| Vruum vruum | ☐ | ☐ | Bakuli | ☐ | ☐ | Ssssshh | ☐ | ☐ |
| Baiskeli | ☐ | ☐ | Beseni/Karai | ☐ | ☐ | Cheka/ Tabasamu | ☐ | ☐ |
| Kuku | ☐ | ☐ | Dawa | ☐ | ☐ | Cheza | ☐ | ☐ |
| Mbuzi/Mee | ☐ | ☐ | Kichana | ☐ | ☐ | Chukua/Pokea | ☐ | ☐ |
| Mbwa/Jibwa | ☐ | ☐ | Kijiko | ☐ | ☐ | Endesha | ☐ | ☐ |
| Mdudu | ☐ | ☐ | Kikombe | ☐ | ☐ | Fagia | ☐ | ☐ |
| Mnyama | ☐ | ☐ | Kisu | ☐ | ☐ | Imba | ☐ | ☐ |
| Ng'ombe/Boo | ☐ | ☐ | Pesa/Ngenje | ☐ | ☐ | Kaa | ☐ | ☐ |
| Paka/Nyau | ☐ | ☐ | Sabuni | ☐ | ☐ | Keti | ☐ | ☐ |
| Gari/Motokaa | ☐ | ☐ | Taa/Stima/ Kandili | ☐ | ☐ | Kula | ☐ | ☐ |
| Kalamu | ☐ | ☐ | Ufagio | ☐ | ☐ | Kunywa | ☐ | ☐ |
| Kitabu | ☐ | ☐ | Kitanda | ☐ | ☐ | Lala | ☐ | ☐ |
| Mpira/Boli | ☐ | ☐ | Kiti | ☐ | ☐ | Leta | ☐ | ☐ |
| Biskuti | ☐ | ☐ | Fimbo | ☐ | ☐ | Maliza | ☐ | ☐ |
| Chai | ☐ | ☐ | Jembe | ☐ | ☐ | Mwaga | ☐ | ☐ |
| Chakula | ☐ | ☐ | Jiwe | ☐ | ☐ | Ota | ☐ | ☐ |
| Embe | ☐ | ☐ | Mchanga | ☐ | ☐ | Piga makofi | ☐ | ☐ |
| Maji | ☐ | ☐ | Nyumbani | ☐ | ☐ | Simama | ☐ | ☐ |
| Maziwa | ☐ | ☐ | Shuleni/Skuli | ☐ | ☐ | Tazama/ Angalia | ☐ | ☐ |
| Ndizi | ☐ | ☐ | Baba/Daddy | ☐ | ☐ | Vuta | ☐ | ☐ |
| Nyama | ☐ | ☐ | Babu | ☐ | ☐ | Chafu | ☐ | ☐ |
| Sima | ☐ | ☐ | Jina la mlezi | ☐ | ☐ | Kelele | ☐ | ☐ |
| Supu/Mchuzi | ☐ | ☐ | Jina la mtoto mwenyewe | ☐ | ☐ | Kimya/ Nyamavu | ☐ | ☐ |
| Tamu | ☐ | ☐ | Mama/Nina/ Mummy | ☐ | ☐ | Moto/Choma | ☐ | ☐ |
| Titi/Nono/Nyonyo | ☐ | ☐ | Mjomba/Uncle | ☐ | ☐ | Njaa | ☐ | ☐ |
| Uji | ☐ | ☐ | Mtoto | ☐ | ☐ | Polepole | ☐ | ☐ |
| Viazi | ☐ | ☐ | Mtu | ☐ | ☐ | Hii | ☐ | ☐ |
| Kiatu | ☐ | ☐ | Nyanya/Bibi | ☐ | ☐ | Kile | ☐ | ☐ |
| | | | | | | Mimi | ☐ | ☐ |

**Communicative Development Inventory - Kiswahili Short 18 months Version A**

Participant ID: [M][_][_][_][_] Today's date: ……/……./…….

| Neno | E | E/S | Neno | E | E/S | Neno | E | E/S |
|---|---|---|---|---|---|---|---|---|
| Chri chri chri | ☐ | ☐ | Shuka/Shiti | ☐ | ☐ | Andika | ☐ | ☐ |
| Huo huo | ☐ | ☐ | Jicho | ☐ | ☐ | Chagua | ☐ | ☐ |
| Kukuriukuu/ kokoiiko | ☐ | ☐ | Makalio/Matako* | ☐ | ☐ | Cheka/ Tabasamu | ☐ | ☐ |
| Bata | ☐ | ☐ | Mguu | ☐ | ☐ | Funga | ☐ | ☐ |
| Mbwa/Jibwa | ☐ | ☐ | Nywele | ☐ | ☐ | Gonga | ☐ | ☐ |
| Nyoka | ☐ | ☐ | Beseni/Karai | ☐ | ☐ | Kunywa | ☐ | ☐ |
| Nzi | ☐ | ☐ | Chupa | ☐ | ☐ | Lala | ☐ | ☐ |
| Paka/nyau | ☐ | ☐ | Fimbo | ☐ | ☐ | Mwaga | ☐ | ☐ |
| Punda | ☐ | ☐ | Kichana | ☐ | ☐ | Piga makofi | ☐ | ☐ |
| Baiskeli | ☐ | ☐ | Kikombe | ☐ | ☐ | Ruka | ☐ | ☐ |
| Gari la moshi | ☐ | ☐ | Kopo | ☐ | ☐ | Shika/Ganda / Kamata | ☐ | ☐ |
| Chaki/Makaa | ☐ | ☐ | Mbuzi | ☐ | ☐ | Sukuma/Peleka | ☐ | ☐ |
| Kalamu | ☐ | ☐ | Pesa/ngenje | ☐ | ☐ | Weza | ☐ | ☐ |
| Kibofu | ☐ | ☐ | Taa/Stima/Kandili | ☐ | ☐ | Baya | ☐ | ☐ |
| Udongo | ☐ | ☐ | Ukuta/Kiambaza | ☐ | ☐ | Kimya/Nyamavu | ☐ | ☐ |
| Asali/uki | ☐ | ☐ | Gogo/Kumbi | ☐ | ☐ | Moto/Choma | ☐ | ☐ |
| Biskuti | ☐ | ☐ | Kitanda | ☐ | ☐ | Mpya | ☐ | ☐ |
| Chocolate | ☐ | ☐ | Sofa/Kochi | ☐ | ☐ | Jioni | ☐ | ☐ |
| Chumvi | ☐ | ☐ | Barabara | ☐ | ☐ | Siku | ☐ | ☐ |
| Kiazi | ☐ | ☐ | Kijiti/Kigongo | ☐ | ☐ | Changu | ☐ | ☐ |
| Maharagwe | ☐ | ☐ | Maua | ☐ | ☐ | Chetu | ☐ | ☐ |
| Mkate | ☐ | ☐ | Mbingu | ☐ | ☐ | Chote | ☐ | ☐ |
| Nazi | ☐ | ☐ | Panga | ☐ | ☐ | Hizi | ☐ | ☐ |
| Sambusa | ☐ | ☐ | Shimo | ☐ | ☐ | Huku | ☐ | ☐ |
| Sima | ☐ | ☐ | Kanisani/Msikitini* | ☐ | ☐ | Kwenu | ☐ | ☐ |
| Sukuma | ☐ | ☐ | Nyumbani | ☐ | ☐ | Lingine | ☐ | ☐ |
| Supu | ☐ | ☐ | Shuleni/Skuli | ☐ | ☐ | Yenu | ☐ | ☐ |
| Kamisi | ☐ | ☐ | Bibi/Mke | ☐ | ☐ | Zote | ☐ | ☐ |
| Kiatu | ☐ | ☐ | Mtoto | ☐ | ☐ | Nani | ☐ | ☐ |
| Kipkapa/Kepa/Cap | ☐ | ☐ | Kujisaidia/Pembeni/ Haja/Pupu/Kanye | ☐ | ☐ | Hapa | ☐ | ☐ |
| Koti | ☐ | ☐ | Shikamoo | ☐ | ☐ | Kwa | ☐ | ☐ |
| Leso | ☐ | ☐ | Sitaki | ☐ | ☐ | Mbali | ☐ | ☐ |
| Chri chri chri | ☐ | ☐ | Ukuti | ☐ | ☐ | Yote | ☐ | ☐ |

Vipi mtoto wako ameanza kuchanganya maneno kama vile "Taka chakula" au" mbwa uma"?

Bado maranyingine/mara kwa mara Kila wakati: Naomba unipe mfano:

Completed by: …… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]
Reviewed by: …… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

**Communicative Development Inventory - Kiswahili Short 24 months Version B**

Participant ID: [M][_][_][_][_] Today's date: ……/……./…….

| Neno | E | E/S | Neno | | E/S | Neno | E | E/S |
|---|---|---|---|---|---|---|---|---|
| Heoo heoo | ☐ | ☐ | Kidole | ☐ | ☐ | Acha | ☐ | ☐ |
| Umia | ☐ | ☐ | Kitovu | ☐ | ☐ | Angusha | ☐ | ☐ |
| Buibui | ☐ | ☐ | Mkono | ☐ | ☐ | Cheza | ☐ | ☐ |
| Jimbi/Jogoo | ☐ | ☐ | Bakuli | ☐ | ☐ | Chukua | ☐ | ☐ |
| Jongoo | ☐ | ☐ | Bilauri/Glasi | ☐ | ☐ | Gawana/ Gawanya | ☐ | ☐ |
| Kondoo | ☐ | ☐ | Dawa | ☐ | ☐ | Jenga | ☐ | ☐ |
| Mnyama | ☐ | ☐ | Karatasi | ☐ | ☐ | kula | ☐ | ☐ |
| Samaki | ☐ | ☐ | Kijiko | ☐ | ☐ | Maliza | ☐ | ☐ |
| Ndege/Eropleni | ☐ | ☐ | Kisu | ☐ | ☐ | Nunua | ☐ | ☐ |
| Pikipiki | ☐ | ☐ | Mkeka | ☐ | ☐ | Osha/Nawa | ☐ | ☐ |
| Tingatinga | ☐ | ☐ | Mto | ☐ | ☐ | Piga teke | ☐ | ☐ |
| Gun | ☐ | ☐ | Redio | ☐ | ☐ | Umia | ☐ | ☐ |
| Kamba | ☐ | ☐ | Sabuni | ☐ | ☐ | Weka | ☐ | ☐ |
| Kitabu | ☐ | ☐ | Taka/Chafu | ☐ | ☐ | Choka | ☐ | ☐ |
| Barafu | ☐ | ☐ | Uma/Fork | ☐ | ☐ | Haraka | ☐ | ☐ |
| Embe | ☐ | ☐ | Kiti | ☐ | ☐ | Kelele | ☐ | ☐ |
| Kungu | ☐ | ☐ | Mlango | ☐ | ☐ | Usinzini | ☐ | ☐ |
| Madafu | ☐ | ☐ | Msalani/Chooni | ☐ | ☐ | Asubuhi | ☐ | ☐ |
| Mahamri/ Maandazi | ☐ | ☐ | Maji | ☐ | ☐ | Baadaye | ☐ | ☐ |
| Nyama | ☐ | ☐ | Mchanga | ☐ | ☐ | Kingine | ☐ | ☐ |
| Nyanya/ Tomato | ☐ | ☐ | Mvua | ☐ | ☐ | Kwetu | ☐ | ☐ |
| Pilau | ☐ | ☐ | Njia | ☐ | ☐ | Wale | ☐ | ☐ |
| Siki | ☐ | ☐ | Dukani | ☐ | ☐ | Wangu | ☐ | ☐ |
| Supu | ☐ | ☐ | Shambani | ☐ | ☐ | Wetu | ☐ | ☐ |
| Tambi | ☐ | ☐ | Sherehe/Hafla/ Birthday/Harusi | ☐ | ☐ | Zangu | ☐ | ☐ |
| Viazi | ☐ | ☐ | Baba mkubwa | ☐ | ☐ | Ipi | ☐ | ☐ |
| Wali/Mchele | ☐ | ☐ | Mwalimu | ☐ | ☐ | Ngapi | ☐ | ☐ |
| Buibui | ☐ | ☐ | Rafiki | ☐ | ☐ | Juu | ☐ | ☐ |
| Kamisi | ☐ | ☐ | Karibu | ☐ | ☐ | Kando | ☐ | ☐ |
| Kifungo | ☐ | ☐ | Kibe | ☐ | ☐ | Katika | ☐ | ☐ |
| Nepi | ☐ | ☐ | Kuoga | ☐ | ☐ | Nje | ☐ | ☐ |
| Nguo | ☐ | ☐ | La/Hapana | ☐ | ☐ | Sana | ☐ | ☐ |
| Rinda | ☐ | ☐ | Pole | ☐ | ☐ | Halafu | ☐ | ☐ |
| | | | Usiku mwema/ Lala salama/ Ulaze salama | ☐ | ☐ | | | |

Vipi mtoto wako ameanza kuchanganya maneno kama vile "Taka chakula" au" mbwa uma"?

Bado maranyingine/mara kwa mara Kila wakati: Naomba unipe mfano:

Completed by: …… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

Reviewed by: …… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

*Appendix I KDI Record Form*

**Prenatal Exposure Study**

Participant ID: [M][__][__][__][__]

**Kilifi Developmental Inventory**
***Psychomotor Scale /Working Memory and Inhibition –*** *Version 1108*

Assessment date: [__][__]/[__][__]/[__][__] Age at assessment: [____] Months [____] Days

Test session observations

| | |
|---|---|
| **Mood**<br>a) Crying/ inconsolable b) Occasional crying<br>c) Changeable (mood swings) d) No visible emotions<br>e) Occasional smiles f) Smiling/laughing **[____]** |
| **Child's interaction with the assessor**<br>a) Avoidant and withdrawn b) Clings to family member<br>c) Hesitant (when approached will accept reluctantly) d) Difficult to engage in tasks<br>e) Inappropriate approaches to assessor f) Friendly **[____]** |
| Any unusual events during testing |

**Codings**:

Code each item yes/no (Y/N) (coding box shaded)
If action not observed code: 99 – failure to administer
98 – refusal by child
97 – no score as item designated as inappropriate (too difficult) by assessor

Where specifically indicated some items require a time or quantity (coding box not shaded).
If no score available code: 999 – failure to administer
998 – refusal by child
997 – no score as item designated as inappropriate (too difficult) by assessor

**<u>Instruction:</u> Brief the person accompanying the child on the tasks and the role they are expected to play during the assessment.**

**Prenatal Exposure Study**

Participant ID: [M][__][__][__][__] **START TIME [____:____]**

Page numbers refer to KDI manual instructions

| MOVING (page 10) | | Yes/No |
|---|---|---|
| LM 01 | Stands with support | |
| LM 02 | Stands without support | |

| PLAYING WITH THE BALL (page 11) | | |
|---|---|---|
| Code/score | | Yes/No |
| EH 01 | THROWS and CATCHES ball – at least 3 throws and catches anyhow. | |
| EH 02 | Releases a ball purposefully | |
| EH 03 | Throws a ball towards someone | |
| EH 04 | Catches a ball using arms and hands | |
| EH 05 | Catches a ball using hands only | |
| LM 03 | Can kick a ball from stationary position | |
| LM 04 | Can kick a moving ball | |

| MOVING (page 10 and pages 12- 19) | | |
|---|---|---|
| Code/score | | Yes/No |
| LM 05 | Walks when held with one hand | |
| LM 06 | Walks without help | |
| LM 07 | Jumps with two feet together, holding on to person's hand (p.12) | |
| LM 08 | Jumps with two feet together unsupported both feet leave the ground | |
| LM 09 | Stands on one leg, without support for 10 – 20 seconds (p.13) | |
| LM 10 | Stands on one leg, without support for 21 seconds+ | |
| LM 11 | Walk on tip toes for 3 or more steps (p.14) | |
| LM 12 | Walk on tip toes for length of mat | |
| LM 13 | Walks backwards with support or for less than length of mat (p.15) | |
| LM 14 | Walks backwards alone for length of mat | |
| LM 15 | Walks along line heel to toe, arms out for 3 steps (p.16) | |
| LM 16 | Walks along line heel to toe, arms out for length of mat | |
| LM 17 | Walks on side of feet (p.17) | |
| LM 18 | Can pull self onto platform (p.18) | |
| LM 19 | Can climb straight onto platform | |
| LM 20 | Jumps off platform with support | |
| LM 21 | Jumps off platform and lands on both feet | |
| LM 22 | Hops on one leg on spot (p.19) | |
| LM 23 | Hops on one leg for length of mat | |

| LYING AND STANDING (pages 20-24) | | |
|---|---|---|
| Code/score | | Yes/No |
| LM 24 | Lifts upper body while lying on stomach (p.20) | |
| LM 25 | Sits with support (p.21) | |
| LM 26 | Can sit steadily/ without support | |
| LM 27 | No head lag in sitting position | |
| LM 28 | Can reach out and return to sitting position | |
| LM 29 | Rolls from side to back (p.22) | |
| LM 30 | Rolls from side to side | |
| LM 31 | Moves from lying to sitting pushing up with hands (p.23) | |
| LM 32 | Moves from lying to sitting not using hands | |
| LM 33 | Moves from sitting to standing rolling over and up | |
| LM 34 | Moves from sitting to standing not using hands | |
| LM 35 | Can sit down steadily (from a standing position- without hands) (p.24) | |

| VISION: RING AND RED TASSEL (page 26) | | |
|---|---|---|
| Code/score | | Yes/No |
| EH 06 | Reaches for dangling ring | |
| EH 07 | Takes dangling ring | |
| EH 08 | Follows red tassel with eyes/attempts to grasp | |
| EH 09 | Grasps red tassel successfully | |
| EH 10 | Can hold and examine object (ring, bear etc) | |
| EH 11 | Passes object from hand to hand | |

| BUTTON (page 27) | | |
|---|---|---|
| Code/score | | Yes/No |
| EH 12 | Can do up button with adult holding one piece of cloth | |
| EH 13 | Can do up button alone | |

| BLOCK TOWER (page 28) | | | |
|---|---|---|---|
| A. Can retain cube in either hand when given | B. Retains one cube when second offered | C. Picks cube up from mat | D. Mature (radial) grasp |
| E. Can hold 2 cubes in one hand | F. Retains 2 cubes when third offered | G. Releases one cube on top of another | H. Builds tower 3-4 cubes |
| I. Builds tower 5-6 cubes | J. Builds tower 7-8 cubes | K. Builds tower 9-10 cubes | L. Builds tower 11-12 cubes |
| EH 14 | Number of boxes ticked | | |

| CONTAINERS AND CUBES (page 29) | | | | |
|---|---|---|---|---|
| A. Rattles box | B. Lifts lid of box (not knocking off/over) | C. Tries to take cube out of box | D. Manages to take 1 cube out of box | E. Removes both cubes from box |
| F. Opens 2 boxes | G. Puts 1 cube in box (encourage) | H. Puts 2 cubes in box (encourage) | I. Puts cubes in and out of box | J. Puts lid back, trial and error |
| K. Puts 2 cubes and lid back | L. Puts lid back, adjusts lid to box | M. Puts 3 boxes together | N. Assembles boxes by colour | |
| EH 15 | Score (count number of boxes ticked) | | | |

| COIN BOX (page 30-31) | | | | | |
|---|---|---|---|---|---|
| A. Picks up coin any method<br>R L | B. Picks up coin between thumb and finger<br>R L | C. Can put coin in the box (slot horizontal)<br>R L | D. Can put coin in rotated box (slot vertical) shakily<br>R L | E. Can put coin in rotated box: easily<br>R L | F. Puts in 6 coins in rotated box<br>R L |
| Code/score | | | | | Yes/No |
| EH 16 | Score (count number of ticks) | | | | |
| EH 17<br>R 6<br>Rotated box | a) Trial 1(secs) (record time) | | | | |
| | b) Trial 2(secs) | | | | |
| | c) Trial 3(secs) | | | | |
| EH 18<br>L 6<br>Rotated box | a) Trial 1(secs) | | | | |
| | b) Trial 2(secs) | | | | |
| | c) Trial 3(secs) | | | | |

**

| BEAD THREADING (page 32) | | |
|---|---|---|
| Code/score | | Yes/No |
| EH 19 | Picks up beads with pincer grasp | |
| EH 20 | Drops beads into container | |
| EH 21 | Threads 2 beads on to shoe lace | |
| EH 22<br>How many in 30 secs. | a) Trial 1 (record number) | |
| | b) Trial 2 (record number) | |
| | c) Trial 3 (record number) | |

| PAPER AND PEN (page 33) | | |
|---|---|---|
| Score | | Yes/No |
| EH 23 | Holds a pen in any way | |
| EH 24 | Holds a pen between finger and thumb | |
| EH 25 | Can scribble using a pen | |
| EH 26 | Can imitate a straight line | |
| EH 27 | Can imitate a circle | |

TIME [___:___]

Completed by: …… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

Reviewed by: ……..… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

*Appendix J IT-HOME Record Form*

**Prenatal** Exposure Study

**HOME Record Form**

**Participant ID: [M][ ][ ][ ][ ]** **Date: [____/___ / _____]**

Age at assessment: [____] Months [____] Days

Parent Interviewed: M- Mother, F- Father, O- Other (Specify_____) [____]

**Key- (O- observation, I – interview, E- either)**

**Start Time: [ ]**

| |
|---|
| **1. Mzazi anamwambia mtoto jina la kitu fulani ama jina la mtu wanapotembelewa. O**<br>(Parent tells child name of object for example food, names of members of the family or name of a person.) |
| **2. Mzazi anampapasa au kumbusu mtoto angalau mara moja**. **O**<br>(If parent caresses, kisses at least once.) |
| **3. Mtoto hajagongwa au kuchapwa zaidi ya mara moja wiki iliyopita I**<br>(Child has not been hit or beaten more than once the previous week) |

| |
|---|
| **4. Mtoto hupelekwa kwa duka angalau mara moja kwa wiki. I**<br>(Child is taken to a kiosk/shop at least once a week.) |
| **5. Mtoto hupelekwa kliniki mara kwa mara kuangaliwa afya na anavyokua. I**<br>(Often child is taken to clinic for health check up and development) |
| **6. Mtoto anaweza kupata vitu vyake vya kuchezea na anavyookota kwa urahisi E** |

(Child can easily access his/her play materials)

**7. Kuna vitu vya kuchezea ambavyo vinasaidia mtoto kujenga misuli. E**
(Observe for play materials which help the child to build muscles)

**8. Kuna vitu vya kuchezea kwa kuvuta au kusukuma. E**
(Observe for play materials for pulling or pushing)

**9. Kuna vitu vya kuchezea vyenye magurudumo ambavyo mtoto anaweza kuchezea/peleka akiwa ndani au juu yake.** E
(Observe for anything with wheels that a child can ride in or in).

**10. Kuna vitu vidogo vidogo vya kuchezea vinavyosaidia mtoto kujifunza kutumia mikono yake kujenga au kuunganisha vitu pamoja. E**
(Observe if there are small play materials that help child develop finger dexterity or joining things together)

**11. Kuna vitu vidogo vya kuunganisha pamoja au kuvitoa, vyenye na sehemu zaidi ya moja vinavyoweza kuunganishwa kwa urahisi.K.m shanga kubwa za kutunga. E**
(Observe for small objects that can be placed in and out of receptacle, toys with more than one part that can easily be fit together).

12. **Kuna vitu vya kucheza vya fasihi au kutoa hadithi na muziki kwa mfano vitabu, radio, au vitu vya kuchezea ambavyo vinatoa kelele au sauti. E**
(There are play materials for comprehension or stories and music like books, radio or play materials that produce noise or sound)

13. **Mzazi humpatia mtoto vitu vya kuchezea wakati wa ukaguzi**. **O**
(Parent gives play materials to child during assessment)

14. **Mzazi huzungumza na mtoto wakati anafanya kazi za nyumbani. I**
(Parent talks to child when carrying out household activities)

15. **Mzazi au watoto wenzake hupanga vipindi vya michezo ya mtoto kwa siku I**
(Parent or other children structure play sessions for child for the day)

16. **Mzazi au watoto wenzake humuweka mtoto mahali wanaweza kumuona na humwangalia mara kwa mara. I**
(Parent or other children keep child in visual range and looks at her often when they are at home together)

17.**Mtoto hula chakula angalau mara moja kwa siku pamoja na mama na baba. I**
**(**Child eats food with both parents at least once a day.)

Completed by: ……. Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

Reviewed by: ……..…… Date: [ ][ ]/[ ][ ]/[ ][ ][ ][ ]

*Appendix K Kappa coefficients for Kilifi-HIPSC items*

| Items | % of overall agreement | Free-marginal kappa | Items | % of overall agreement | Free-marginal kappa |
|---|---|---|---|---|---|
| HP01 | 0.986 | 0.979 | HP31 | 0.959 | 0.918 |
| HP02 | 0.884 | 0.767 | HP32 | 0.993 | 0.986 |
| HP03 | 0.979 | 0.959 | HP33 | 0.979 | 0.959 |
| HP04 | 0.904 | 0.808 | HP34 | 0.952 | 0.904 |
| HP05 | 0.966 | 0.932 | HP35 | 0.904 | 0.808 |
| HP06 | 0.932 | 0.863 | HP36 | 0.952 | 0.904 |
| HP07 | 0.966 | 0.932 | HP37 | 0.952 | 0.904 |
| HP08 | 0.979 | 0.959 | HP38 | 0.938 | 0.877 |
| HP09 | 0.952 | 0.904 | HP39 | 0.973 | 0.945 |
| HP10 | 0.979 | 0.959 | HP40 | 0.973 | 0.945 |
| HP11 | 0.863 | 0.726 | HP41 | 0.986 | 0.973 |
| HP12 | 0.849 | 0.699 | HP42 | 0.973 | 0.945 |
| HP13 | 0.904 | 0.808 | HP43 | 0.966 | 0.932 |
| HP14 | 0.959 | 0.918 | HP44 | 0.918 | 0.836 |
| HP15 | 0.973 | 0.945 | HP45 | 0.959 | 0.918 |
| HP16 | 0.979 | 0.959 | HP46 | 0.918 | 0.836 |
| HP17 | 0.973 | 0.945 | HP47 | 0.897 | 0.794 |
| HP18 | 0.890 | 0.781 | HP48 | 0.945 | 0.890 |
| HP19 | 0.925 | 0.849 | HP49 | 0.829 | 0.658 |
| HP20 | 0.692 | 0.383 | HP50 | 0.945 | 0.890 |
| HP21 | 0.959 | 0.918 | HP51 | 0.767 | 0.534 |
| HP22 | 0.945 | 0.890 | HP52 | 0.959 | 0.918 |
| HP23 | 0.966 | 0.932 | HP53 | 0.883 | 0.767 |
| HP24 | 0.890 | 0.781 | HP54 | 0.973 | 0.945 |
| HP25 | 0.932 | 0.863 | HP55 | 0.986 | 0.973 |
| HP26 | 0.925 | 0.849 | HP56 | 0.973 | 0.945 |
| HP27 | 0.843 | 0.685 | HP57 | 0.938 | 0.877 |
| HP28 | 0.884 | 0.767 | HP58 | 0.973 | 0.945 |
| HP29 | 0.932 | 0.863 | HP59 | 0.973 | 0.945 |
| HP30 | 0.925 | 0.849 | HP60 | 0.959 | 0.918 |

*Appendix L Modifications made on the Kilifi-HIPSC*

| Original version | Adapted version | Percentage endorsement | | |
|---|---|---|---|---|
| **Changes in item format** | | **0** | **1** | **2** |
| (26) Parent buys and reads a Newspaper daily | (29) A member of the family reads a Newspaper | 59.6 | 24.7 | 15.8 |
| (34) Family has a TV and it is used judiciously, not left on continuously | (34) Do you own a TV? Child is allowed free access and it is used judiciously, not left on continuously | 26.7 | 58.2 | 15.1 |
| (36) Child is regularly included in family's recreational hobby | (36) What do family members do when they have no chores? Is the child involved in that activity? | 75.3 | 15.8 | 8.9 |
| (37) Family provides lessons or organizational membership to support child's talents (Y membership, gymnastic lessons, Art Centre, etc.) | (37) Family gives training through membership of registered organizations and/or at home to support the child's talents | 88.4 | 6.2 | 5.5 |
| (38) Child has ready access to at least two pieces of playground equipment in the immediate vicinity | (38) There are already things in the compound for the child to play with | 44.5 | 37.7 | 17.8 |
| (39) Child has access to library card, and family arranges for child to go to library once a month | (39) Child regularly attends an activity out of the home | 96.6 | 1.4 | 2.1 |
| (42) Family visits or receives visits from relatives or friends at least twice a month | (42) Family visits or receives visits from relatives or friends | 39.0 | 24.0 | 37.0 |
| (48) Father (or father substitute) regularly engages in outdoor recreation with child | (48) Father (or father substitute) engages child in games to pass time, e.g. football | 91.1 | 7.5 | 1.4 |
| (56) There is at least 100 square feet of living space per person in the house | (56) Number of rooms in the house and number of people in each room | 0 | 39.7 | 60.3 |
| **Changes in item content** | | | | |
| (4) Child is encouraged to read on his own | (4) Child is encouraged to read. With whom does the child read? | 45.9 | 15.8 | 38.4 |
| (27) Family has a dictionary and encourages child to use it | (31) Family has a Kiswahili dictionary and encourages child to use it | 89.7 | 10.3 | 0 |
| (31) Child has free access to at least ten appropriate books | (28) Child has free access to children's books | 71.2 | 8.2 | 20.5 |
| (32) Child has free access to desk or other suitable place for reading or studying | (30) Child has an appropriate place to read and write | 34.2 | 19.2 | 46.6 |
| (43) Child has accompanied parent on a | (43) Child has accompanied parent on | 74.7 | 15.1 | 10.3 |

| | | | | |
|---|---|---|---|---|
| family business venture 3-4 times within the past year (to garage, clothing shop, appliance repair shop, etc.) | a family business trip within the past year (to buy clothes etc.) | | | |
| (46) Parents discuss TV programs with child | (46) Parents discuss news about happenings in the neighbourhood, country or world with child | 45.9 | 11.0 | 43.2 |
| (52) Child's room has a picture or wall decoration appealing to children | (52) Efforts have been made to have or make equipment which is pleasing and stimulating to the child | 91.8 | 7.5 | 0.7 |
| **Changes in examples used in the item** | | | | |
| (2) Parent sometimes yields to child's fears or rituals (allows night light, accompanies child to new experiences, etc.) | (2) Parent sometimes yields to child's fears or rituals (escorting child out at night, leaving light on at night) | 11.0 | 6.2 | 82.9 |
| (13) Child puts his outdoor clothing, dirty clothes, night clothes in special place | (13) Child knows how to keep school uniform or play clothes and 'Sunday best' in a special place | 15.8 | 18.5 | 65.8 |
| (30) Child has free access to musical instrument (piano, drum, ukulele, or guitar, etc.) | (27) Child has free access to musical instrument (*kayamba*, drum, guitar, etc.) | 78.1 | 3.4 | 18.5 |
| (44) Family member has taken child to (or arranged for child to attend) some type of live musical or theatre performance | (44) Family member has taken child to (or arranged for child to attend) some national celebrations, wedding, choir presentation or theatre performance | 73.3 | 17.8 | 8.9 |
| (47) Parent helps child to achieve motor skills – ride a two-wheel bicycle, roller skate, ice skate, play ball, etc. | (47) Parent helps child to achieve motor skills – pounding maize, carrying a load on the head, riding a bicycle or swimming | 1.4 | 13.0 | 85.6 |
| (58) Building has no potentially dangerous structural or health defects (e.g. Plaster coming down from ceiling, stairway with boards missing, rodents, etc.) | (58) Building has no potentially dangerous structural or health defects (e.g. Broken wall plastering, falling walls, leaking roof, etc.) | 4.1 | 11.6 | 84.2 |
| (14) Parents set limits for child and generally enforce them (curfew, homework, before TV, or other regulations that fit family pattern) | (14) Parents set limits for child and generally enforce them (school work, other regulations depending on family routines e.g. Playing near the road) | 1.4 | 2.7 | 95.9 |
| (1) Family has fairly regular & predictable daily schedule for child (meals, day care, bedtime, TV, homework, etc.) | (1) Family has fairly regular & predictable daily schedule for child (meal times, bedtime, domestic work, | 0.7 | 7.5 | 91.8 |

| | | | | |
|---|---|---|---|---|
| | etc) | | | |
| (53) The interior of the apartment is not dark or perceptually monotonous | (53) The interior of the house is not dark or perceptually monotonous | 21.2 | 69.9 | 8.9 |
| **Deletion of item content** | | | | |
| (29) Child has free access to record player or radio | (26) Do you own a radio? Does your child listen to the radio? How often? | 1.4 | 17.1 | 81.5 |
| (41) Family member has taken child on (or arranged for child to take) a plane, train, or bus trip within the past year | (41) Family member has taken child on (or arranged for child to take) a bus trip within the past year | 28.8 | 24.7 | 46.6 |
| **Additional item** | | | | |
| | (60) Compound provides a variety of perceptual experiences | 59.6 | 20.5 | 19.9 |
| **Other items** | | | | |
| (3) Child has been praised at least twice during past week for doing something | | 31.5 | 8.9 | 59.6 |
| (5) Parent encourages child to contribute to the conversation during visit | | 45.9 | 12.3 | 41.8 |
| (6) Parent shows some positive emotional responses to praise of child by Visitor | | 8.9 | 5.5 | 85.6 |
| (7) Parent responds to child's questions during visit | | 85.6 | 4.8 | 9.6 |
| (8) Parent uses complete sentence structure and some long words in conversing | | 0 | 0 | 100 |
| (9) When speaking of or to child, parent's voice conveys positive feelings | | 2.7 | 3.4 | 93.8 |
| (10) Parent initiates verbal interchanges with Visitor, asks questions, makes spontaneous comments | | 0 | 0 | 100 |
| (11) Family requires child to carry out certain self-care routines, e.g., make bed, clean room | | 1.4 | 73.3 | 25.3 |
| (12) Family requires child to keep living and play area reasonably clean and straight | | 9.6 | 56.8 | 33.6 |
| (15) Parent introduces Visitor to child | | 92.5 | 4.1 | 3.4 |
| (16) Parent is consistent in establishing or applying family rules | | 3.4 | 2.1 | 94.5 |
| (17) Parent does not violate rules of common courtesy during visit | | 0.7 | 0 | 99.3 |
| (18) Parent has not lost temper with child more than once during previous week | | 4.1 | 13.7 | 82.2 |
| (19) Parent reports no more than one instance of physical punishment occurred during past month | | 5.5 | 19.9 | 74.7 |
| (20) Child can express negative feeling toward parents without harsh reprisals | | 16.4 | 4.1 | 79.5 |
| (21)Parent has not cried or been visibly upset in child's presence more than once during past week | | 76.7 | 17.8 | 5.5 |
| (22) child has a special place in which to keep his/her possessions | | 69.9 | 8.9 | 21.2 |
| (23) Parent talks to child during visit (beyond correction and introduction) | | 34.2 | 30.8 | 34.9 |
| (24) Parent uses some term of endearment or some diminutive for child's name when talking about child at least twice during visit | | 8.2 | 72.6 | 19.2 |

| | | | |
|---|---|---|---|
| (25) Parent does not express overt annoyance with or hostility toward child (complains, describes child as "bad," says child won't mind, etc.) | 3.4 | 7.5 | 89.0 |
| (32) (28) Child has visited a friend by him/herself in the past week | 22.6 | 12.3 | 65.1 |
| (33) House has at least two pictures or other type of art work on the walls | 79.5 | 7.5 | 13.0 |
| (35) Family encourages child to develop and sustain hobbies | 83.6 | 8.9 | 7.5 |
| (40) Family member has taken child to (or arranged for child to visit) a scientific, historical or art museum within the past year | 91.1 | 6.8 | 2.1 |
| (45) Family member has taken child to (or arranged for child to take) a trip of more than 50 miles from home (50 miles radial distance, not total distance) | 43.2 | 26.0 | 30.8 |
| (49) Child sees and spends some time with father or father figure 4 days a week | 19.9 | 65.8 | 14.4 |
| (50) Child eats at least 1 meal per day, on most days, with mother and father (or mother and father figures) | 30.8 | 15.8 | 53.4 |
| (51) Child has remained with this primary family group for all his life aside from 2-3 week vacations, illnesses of mother, visits of grandmother, etc | 13.0 | 10.3 | 76.7 |
| (54) In terms of available space, the rooms are not overcrowded with furniture | 18.5 | 8.2 | 73.3 |
| (55) All visible rooms of the house are reasonably clean and minimally cluttered | 24.7 | 17.8 | 57.5 |
| (57) House is not overly noisy – shouts of children, radio, etc | 5.5 | 70.5 | 24.0 |
| (59) Child's outside play environment appears safe and free of hazards | 5.5 | 23.3 | 71.2 |

*The figures in parentheses are the item numbers on the original and adapted versions of the HOME Inventory

*Appendix M Results from the first naturalistic observation session*

Below is a narrative of the findings observed.

Child 1: The toys available included cars with wheels, empty containers and a toy caterpillar. These toys had been kept in a shelf which was accessible to the child. The child played with an older girl (nearly 3 yrs) who talked to him. Some of the words the child was told were 'gari,' 'vroom.' The two kids were driving cars together. The house was in relatively good condition. At some point, the child just sat in one position looking around. When the child started crying, the mother responded to child's crying by asking what the sister had done to him. Each time the baby cried, the sister would quieten him down. The compound and child's play area is generally well kept and tidy. The older sister kept feeding the boy with mango peels. The boy crawled toward his mother and then crawled back toward his sister. Playful games and singing by his sister made him laugh. At some point, the mother went into the house and he started to cry for something the sister was holding. The sister tried to soothe his crying with singing but the boy crawled toward the house looking for his mother. The mother picked him up and began to breastfeed him till he calmed down. The mother asked him for something and he gave her. Some of the words he was told were "chape dudu." He could follow simple instructions like 'simama,' and "chapa" and when the mother asked him for something, he gave it to her. The mother talked to the child in complete sentences. The child was kept within visual and hearing range of the mother at all times. At the end of the observation, the mother told the child to say goodbye while gesturing to him by waving her hand.

Child 2: The mother kept the child within her visual range at all times. She said to her 'chukua kalamu.' The mother responded to the child's vocalisations with some sounds. When the child started to eat some soil, the mother told her to stop but did not make any effort to physically stop the child. The house was in a state of good repair and the compound was tidy. The child played with some coconut shells which were left lying around in the play area. There was no special place to keep them. Child played alone and vocalised to herself. When she started to cry, the mother took her and breastfed her till she slept.

Child 3: The child did not have materials for playing with. The siblings also do not have any playing materials. The mother did not seem to know where they keep whatever they play with. When the baby cried, the mother told him to crawl to her and then she breastfed him. The play area did not look safe as there was a rake lying on the ground.

Child 4: The child played with jingles for quite a long time. When he started to cry, the mother took him and breastfed him for a short time. She then got busy doing her work away from the baby. The child was seated within sight of the mother at all times. When the child began to cry again, she put him on her back and continued with whatever she was doing.

Child 5: The child had a rattle and an empty container to play with. Other people in the home include the child's aunt and grandparents who shared in the care of the child when the mother was away. There were older children that played with the child. The child generally had a happy disposition and when the mother talked to her, she showed some pleasure. The house and play area were well kept.

Child 6: The child played with a doll, a home-made ball and contained lids. Her uncle – a 4-yr-old boy – stayed near her on the mat playing with her. When the child started crying, the mother came to try and console her and then breastfed her for a short while. The child was left with her grandmother when the mother had to go somewhere. As the mother went about her daily activities, the child sat near her. The child's grandparents and mother's siblings live with them. The house was not in a state of good repair. The mother occasionally encouraged the child to put things in a container and shake them. There were signs of a poultry rearing business being carried on in the family. The child was kissed at least once during the visit. The mother

told the child, ‘ona kuku,’ ‘mpe toto nyonyo.’ She was also told to take something from her uncle. The girl wanted to stand on her own so the mother held her up.

*Appendix N Results from the second observation session*

The purpose of the second session was to establish if 5-minute intervals were adequate to capture the activities and behaviours of the child during the observation. The observations lasted one-and-a-half hours.

The findings from this session are summarised below:
Child 1
The session was conducted outside the house. The compound is well kept and the play area is clean.
Responsivity: The child was told the name of an object 'gari.'
Organisation: His aunt kept him busy while his mother chopped some firewood nearby. She put him on a home-made swing and pushed him a little before removing him.
Learning materials: The mother removed some toys for the child to play with including a push toy with 3 wheels, a caterpillar and a toy that produced sound.
Involvement: The child stayed near his mother as she chopped firewood. The child pushed the 3-wheeler and walked for quite a long distance with it. He said 'vroom' as he pushed it.
Behaviour: When the child's sister came running toward him at one point, he was very happy and started laughing. He's trying to walk on his own. He played on his own for some time. Then a group of children came to sit in a circle around him. He was given a key to play with and when it was taken away, he started to cry.
Maintenance: The child soiled in his pants but no efforts were made to change him.

Child 2
The session was conducted outside the house. There were many people seated outside as the mother weaved some 'makuti.'
Responsivity: One of the adults in the group told the child to take 'tamu.'
Behaviour: For most of the session, the girl sat alone as adults went about their business. She seems to be very comfortable in the presence of other people.

Child 3
When we arrived, the child was very excited to see the car and he started crawling toward it.
Acceptance: At one point, the mother smacked the child's older sister because she was disturbing the baby.
Organisation: The child's play environment was not safe as there was a rake lying nearby which the child crawled toward and tried to lift. At some point, he picked some razor blades and the mother told the child's older sister to dispose of them. The house compound was not very clean as there were items scattered all over the place and some waste paper lying around. Some motorcycles and the occasional car passed by.
Learning materials: No toys were provided for the child during the visit and so he played with the soil and anything he picked from the ground.
Maintenance: The mother made an effort to change his pants at some point during the session. At some point during the session, the mother fell asleep on the mat as the child sat quietly near her. After 3.00pm, the mother seemed restless because she needed to go and fetch water. At 3.10 pm, the mother walked away with the child and returned a few minutes later with him on her back. She soothed him so he could go to sleep.

Child 4:
Responsivity: In four instances, the mother did not respond to the child's vocalisations.
In one instance toward the end of the session, the parent did not respond to the child's crying.
Organisation: The observation session was conducted away from the house where the mother operates a small grocery kiosk. Nearby was a mosque, a school and a madrasa. Many motorcycles, cars and bicycles passed by. The play environment was not safe for the child.
Learning materials: The toys provided for the child included some empty containers and lids.
Behaviour: At some point, the child's older brother came and made some playful noises at him.

He then tickled him and the child started laughing.
Maintenance: No efforts were made to change the baby's clothes even after he had made himself very dirty in the soil.
In two instances, the boy ate some non-food items but the mother made no efforts to stop him.

Child 5:
It was raining outside so we sat in the corridor of the house for the session. The house was generally clean and with adequate lighting. On the verandah of the house, there were many children and adults seated conversing and playing.
Responsivity: The child's grandmother came in at some point to say hello to the baby.
Acceptance: Child was spanked playfully on the thigh and shouted at some point when she started crying.
Child kept crawling all over the place.
Organisation: A mat was laid on the ground for the child to play on.
Learning materials: No toys were provided for the child to play with during the session.
Involvement: The mother threw a coin out of the reach of the child to encourage her to crawl after it. The mother also held a key ring high up above the child's head to encourage her to stretch and reach out for it.
Behaviour: The child lay on the mat for some time vocalising to herself.
Maintenance: The baby soiled herself on the mat and the mother went off to bathe her. Then she cleaned the mat and changed the baby.
When the mother noticed that the child was sleepy, she sang a lullaby to her so she could sleep.
Toward the end of the session, the child stood near her mother holding her and looking outside.

Child 6:
The session was carried out in one of the rooms in the house. The interior of the house is not dark – there is adequate light.
Responsivity: The child was told names of people/objects like 'bibi' 'pesa' 'mpira''babu.' In one instance, the mother did not respond to the child's crying. At one point, the grandmother came out of her room and talked to the child.
Acceptance: The child was stopped from putting a coin in her mouth by the grandmother.
Learning materials: The playthings provided for the child included a teddy bear, a ball, empty bottles used like rattles.
Involvement: The mother made the child stand on her own and then reached out with her hands for the baby to go to her. The baby stood on her own for a short while. A comb was thrown out of her reach to encourage her to crawl. The child was able to walk a few steps while being held.
Behaviour: The child played on her own and made some sounds as she did so. The mother sat silently watching the child with an occasional word now and then. As soon as the baby started to cry, she was given the breast. Breastfeeding was used as a way of soothing the child.
Toward the end of the session, the child started crying continuously so the mother put her on the back and rocked her. The child was calm as the mother sang to her. As soon as she was put down again, she started crying.

*Appendix O Study setting, participants and data collection tools in the INSTAPA study*

The objectives of the INSTAPA study were to (1) determine the effect of micronutrient fortification of maize-based complementary foods on child social, emotional and cognitive development and (2) to assess the effects of early-in-life prevention of micronutrient deficiencies with fortified foods on the longer term development of children. Apart from direct assessments of the children on and maternal reports of child functioning, naturalistic observations were completed to obtain information on patterns of mother-child interactions among a rural population.

**Study setting**

The naturalistic observations were conducted in Kikoneni Location in Msambweni District of the Coast Province of Kenya. The indigenous ethnic groups in Kikoneni Location are the Digo and Duruma who form two of the sub-tribes of the Mijikenda. The Digo community is a patriarchal society and male members are usually the heads of households and the main decision-makers.

The mainstream economic activities of this community are fishing and subsistence farming mainly growing cassava, millet, maize and beans. Cash crop production of coconuts, cashew nuts, bixa, cassava and citrus fruits could contribute significantly to poverty alleviation in this region. A youthful population below 20 years accounts for 57% of the labour force (Musoga, Salim, Ndubai, Ondieki, & Hayombe, 2011).

Approximately 30% of mothers and 19% of fathers are not educated. Negative attitudes towards schooling and poor role modelling contribute to low education levels among the populace. The vulnerabilities that children face in the district are child labour for boys and early pregnancy and marriage for girls (Ruto, Mugo, & Kipserem, 2010).

Islam is the dominant religion and as a consequence, many families are polygamous. However, divorce rates are quite high. A typical Digo homestead comprises several temporary structures made of grass, mud, earth and wood. The average household size is 9 members. Members of the extended family live together in homesteads consisting of houses with 3 bedrooms and a verandah that doubles up as a kitchen.

**Participants**

Participants were identified through a 2-week census in selected villages. The purpose of the study was explained to community members at local meetings. Infants aged less than six months were eligible for enrolment into the main study. Those attending the post-natal clinic at the Kikoneni Health Centre in Msambweni District were recruited into the main study. They were seen at 6-month intervals over a period of 24 months beginning at 6 months. A total of 322 infants were assessed at baseline.

The following criteria were used to select participants into the main study:

- Maternal age of at least 15 years;

- Willingness to provide informed consent and to participate in a prosepctive follow-up program to monitor infant health and development;
- Apparent good health for both mother and baby;
- Long-term residence in the study location; and,
- Speak Kiswahili or a Mijikenda dialect in the home.

**Data collection tools**

The naturalistic observations were completed at 6, 12, 18 and 24 months using a checklist through which the occurrence of behaviour under five categories was recorded using the time sampling method. These categories included vocalisation (of the child to others and others to the child), posture, activity, sundry behaviours (object manipulation, social gesture and aggression), emotion and maintenance.