The Relationship Between Parent-Child Interaction and Early Childhood Development in Rural Limpopo Province, South Africa

by

Nelisiwe Mkize
2455074

Research Report Submitted to the Faculty of Health Sciences, University of the Witwatersrand in Partial Fulfilment of the degree in Master of Science in Epidemiology in the Field of Epidemiology and Biostatistics

Supervisor: Dr. Denise Evans

MARCH 2025

Declaration

I, Nelisiwe Mkize, declare that this research report is my own unaided work and I have acknowledged all sources. This research report is being submitted in partial fulfilment of the degree of Master of Science in Epidemiology at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

Signature: Date: 31 March 2025

Dedication

This research report is dedicated to myself, for having an enthusiasm to seek knowledge, despite life experiences continuously weighing me down.

Abstract

Introduction: The South African social dynamics, which include socioeconomic status, limited access to education, a struggling healthcare system, high unemployment, and exposure to crime and violence, significantly hinder early childhood neurodevelopment by restricting resources and creating challenging environments. Approximately 71% of South African children under five live below the upper-bound poverty line, with half not enrolled in early learning programs. Among those enrolled, 55% are not developmentally on track. Limpopo is one of the rural provinces that has the highest headcount of adult poverty and children who are not attending early learning programs. Furthermore, children from rural communities are more vulnerable to suppressed development potential due to inadequate stimulation and exposure to adverse experiences. Currently, there is a lack of understanding of how dysfunctional parent-child interactions (PCDI) and difficult child (DC) behaviors affect early childhood neurodevelopment domains in children from rural communities of South Africa.

Aim: This study aimed to investigate the impact of dysfunctional parent-child interactions and difficult child behaviors on early childhood neurodevelopment in rural Mopani District, Limpopo.

Methodology: This cross-sectional analysis was part of a larger “Birth-to-2” cohort study (PACTR 201710002683810) conducted in rural Limpopo Province, South Africa. Trained fieldworkers conducted surveys with caregivers (aged 18 and older) at the household. Neuro PCDI and DC were measured using the Parenting Stress Index Short Form (PSI™-4-SF) at 17 months of age. Bivariate and multivariate logistic regression were used to assess factors influencing elevated neuro PCDI scores (>27) and DC scores (>33). Furthermore, multivariate regression models were used to investigate the effect of clinically elevated neuro PCDI and DC scores on neurodevelopmental outcomes measured by the Child Rearing and Early Development Inventory.

Results: The study included 178 mother-child dyads, with 72 pairs from the control arm and 106 pairs from the intervention arm. The mean PCDI scores for the intervention and control arms were 0.14 (±0.35) and 0.19 (±0.40), respectively. In terms of DC scores, the means were 0.29 (±0.46) for the intervention arm and 0.28 (±0.45) for the control arm. The study found that elevated PCDI scores were significantly influenced by factors such as the overall child’s health and stunting, while elevated DC scores were influenced by marital status. Furthermore,

elevated PCDI scores were significantly associated with negative cognitive development, while elevated DC scores were linked to significant social-emotional challenges.

Conclusion: The findings highlight the significant impact of a clinically elevated score of PCDI and DC on early childhood neurodevelopment in rural settings. This study underscores the importance of early interventions targeting parent-child interactions and socioeconomic support to mitigate developmental delays in rural South African children. Further research is needed to address the barriers to access for child support grants and other factors affecting child development in these communities.

Acknowledgements

I am sincerely grateful to Dr Denise Evans for providing me with the opportunity to conduct my research at Health Economics and Epidemiology Research Office (HE²RO), and for all the resources and support they provided. Her guidance and mentorship, alongside the resources and support provided by HE²RO, were essential for me to complete this research study. She also introduced me to opportunities that greatly fostered my academic growth, for which I will be forever grateful.

Furthermore, I would like to acknowledge the Epidemiology and Biostatistics Division of the Wits School of Public Health (WSPH) for allowing me to enroll in the program. The academic and logistical support I received from the faculty and staff made a valuable contribution to my success and professional growth throughout my studies.

Lastly, I would also like to extend my heartfelt gratitude to everyone who has supported me during this journey, whether through guidance, encouragement, or companionship. Their unwavering support made a significant difference, and I am truly appreciative of their contributions to both my personal and academic development.

Research Outputs

Conference proceedings

Nelisiwe Mkize, Lezanie Coetzee, Jukka Leppänen, Peter Rockers, and Denise Evans. 2024. The role of parent-child dysfunctional interaction and difficult child on early childhood development in a cohort of children from rural Limpopo, South Africa. Accepted to present at the 2024 Annual Young Scientists' Conference (AYSC) (where only 60 of the 140 applications received were invited to present), 9-11 Sept 2024, Gqeberha. Received the Best Oral Presentation award.

Nelisiwe Mkize, Lezanie Coetzee, Jukka Leppänen, Peter Rockers, and Denise Evans. 2025. Parent–Child Dysfunctional Interaction and Difficult Child in a cohort of children from rural Limpopo, South Africa. The Public Health Association of South Africa, 6-9 April 2025, Western Cape, South Africa.

Table of Contents

Contents

List of Figures

List of Tables

List of Abbreviations

ECD - Early Childhood Development

WHO - World Health Organization

SDG -Sustainable Development Goal

PCI -Parent Child Interaction

PCDI - Parent-child Dysfunctional Interaction

DC - Difficult Child

MDAT - Malawi Developmental Assessment Tool

PSI - Parent Stress Index

PSI-SF - Parent Stress Index-Short Form

SA - South Africa

CREDI - Child Rearing and Early Development Inventory

CSG - Child Support Grants

DNA - Deoxyribonucleic Acid

mC - Cytosine methylation

SD - Standard Deviations

IQR - Interquartile Range

OR - Odds Ration

CG - Control Group

IG - Intervention Group

LAZ - Length-for-Age z-score

WHZ - Weight-for-Height z-score

WAZ - Weight-for-Age z-score

BCG - Bacille Calmette-Guérin

OPO0 - Oral Poliomyelitis Vaccine at Baseline

OPV1 - Oral Poliomyelitis Vaccine at 6 months

Definitions

Parental Stress Index (PSI) is a tool used to measure the relative stress in the parent-child relationship. child characteristics in the full scale include distractibility/hyperactivity, adaptability, reinforcement from parents, demandingness, mood, and acceptability. parent measures include competence, isolation, attachment, health, role restriction, depression, and spouse. The PSI is used for early identification of dysfunctional parent-child interactions, parental stress, family functioning, risk for child abuse and neglect, and for evaluation of child custody decisions.

Parent-child Dysfunctional Interaction (PCDI) - measures the parent's perception of the parent-child relationship and the child not meeting parental expectations.

Difficult Child (DC) - measures the child's behavioral characteristics that may be difficult to manage by a parent or a caregiver.

Caregiver Reported Early Development Instruments (CREDI) is an instrument designed for an assessment of ECD for children between 0 and 35 months, flexible to be used across a wide variety of cultural, linguistic, and socioeconomic contexts.

Schedule of events for the primary "Birth-to-2 cohort"

	Baseline	7 months	17 months	36 months
Child demographics	**X**			
Caregiver demographics, food security,	**X**			
Child's physical growth and overall health	**X**	**X**	**X**	**X**
Parenting Stress Index Short Form (PSI™-4-SF		**X**	**X**	**X**
Child Rearing and Early Development Inventory (CREDI)		**X**	**X**	
Malawi Developmental Assessment Tool (MDAT)				**X**

Chapter Explanation

Chapter 1:

This chapter delivers the introductory aspects of the study and the literature review. The literature review unpacks the dynamics of early childhood development in South Africa, the role of parent-child relationships on early childhood development, and factors influencing dysfunctional parent-child interactions.

Chapter 2:

The chapter was written in a form of a research article format, the focus is on the role of Parent–Child Dysfunctional Interaction and Difficult Child on Early Childhood Neurodevelopment in the rural community of Limpopo, South Africa.

1 Chapter one: Introduction and literature review

1.1 General Introduction

Early childhood development (ECD) is a very important period of life, because it is when various capabilities and competencies develop [1]. ECD is regarded as a critical phase where various processes of domains such as gross and fine motor, speech and language, cognitive, intellectual, social, and emotional skills develop. This period includes a variety of activities like early learning, nutrition, healthcare, and socialization, all of which contribute to shaping a child's early development and have a lasting impact on their future success. ECD is of public health concern in both developed and developing countries, as it significantly affects life trajectories in areas such as health, education, employment, and social aspects throughout the course of a person's life.

Research studies have shown that the early years of a child's life are critical, with findings emphasizing that the experiences they have during this time play a foundational role in the development of their biological, neurological, physiological, and social systems [2–4]. Positive experiences, such as secure caregiver attachments, nurturing and safe environments, proper nutrition, and early learning stimulation, promote healthy development across all domains [5–10]. On the other hand, negative experiences like neglect, inconsistent caregiving, food insecurity, and trauma can have long-lasting effects, disrupting the development of various domains and contributing to higher rates of poverty and social inequality [11–16].

A wide range of adverse exposures can impact the early life period, both directly and indirectly, from prenatal stages through to school age. During the prenatal stage, when organs are developing, this process is largely influenced by the mother's overall health, genetics, substance use, and environmental factors [17–19]. Post-natal adverse exposures include psychosocial factors such as child maltreatment, the mental health of parents or caregivers, parenting styles, substance use, domestic and community violence, crime, and discrimination. Additionally, socioeconomic factors, politics, culture, and religion also play significant roles. [20,21]. The negative effects of these exposures contribute to a range of adverse outcomes, including poor academic performance, a higher likelihood of not completing high school, unemployment, strained social relationships, involvement in crime and violence, and premature death [22,23]. Additionally, these exposures can influence the development of diseases later in life, such as cancer, diabetes, Alzheimer's, obesity, psychiatric disorders, and chronic illnesses [24–31].

Among the factors that influence ECD, the interaction between a child and their parent or caregiver is crucial. This interaction plays a key role in shaping the emotional, behavioral, and cognitive development of children [32]. A positive relationship between a child and their parent or caregiver makes a constructive contribution to the child's early childhood development. On the other hand, a dysfunctional parent-child interaction, marked by a poor or inactive relationship, can have a negative impact on the child's development [33,34]. Despite the available information from previous studies, there is still a paucity of information regarding the role of parent-child dysfunctional interactions in young children from rural areas in South Africa (SA). Therefore, this underscores the need for research studies to be conducted to explore this gap and better understand its impact on early childhood development in these communities.

This study seeks to examine the impact of parent-child dysfunctional interactions during the early childhood development (ECD) period in young children from rural areas. It aligns with South Africa's National Development Plan (NDP), particularly goals 4, 5, and 14, which focus on providing quality education, reducing inequality, and promoting inclusive development. On a global scale, the study also contributes to the achievement of the Sustainable Development Goals (SDGs), specifically goals 1, 3, and 10, which aim to eradicate poverty, ensure good health and well-being, and reduce inequality.

1.2 Literature Review

1.2.1 Early child development in South Africa

In the South African context, the early childhood development (ECD) period is defined as the stage from birth up to 9 years of age [35]. According to Statistics South Africa's 2021 mid-year report, the overall population of the country is approximately 60 million, with around 11 million children aged 0 to 9 years [36]. The population is growing, yet citizens continue to face persistent inequalities, shaped by factors such as race, gender, politics, and geography. South Africa's young children are growing up in challenging conditions, and their development must be regarded as a priority public health concern that requires urgent attention.

ECD is a complex period of life made up of different components, which include caregiving, stimulation, responsiveness, and safety [37]. During pregnancy and the ECD period, the mother's overall health, safety, food security, and access to adequate healthcare infrastructure are crucial for ensuring the delivery of a healthy baby, as well as providing essential nurturing

after delivery The majority of women in South Africa face adverse situations, as the country grapples with high levels of poverty, inadequate healthcare systems, gender-based violence against women, alcohol consumption, substance abuse, and unemployment. This highlights the reality that some pregnant women in SA are exposed to significant challenges during their pregnancies. Another concern is that the current generation of mothers is largely very young, with many being under 18 years of age [38,39]. In SA, an average 18-year-old is not well established financially to take care of a child, as many young people at this age are still completing their education, lack stable employment, and face significant socio-economic challenges that hinder their ability to provide for the needs of a child. When a young mother adds new members to the family, it becomes very stressful, especially for families already burdened by poverty.

The South African Bill of Rights caters to children; it states that children have a right to protection from neglect, abuse, and exploitation, access to basic education, and adequate health care [40,41]. Various programs have been established to support ECD in SA, including child support grants, efforts to ensure communities have access to schools and healthcare facilities, and the availability of feeding schemes in schools. However, despite these programs, the country's current economic, political, and environmental circumstances continue to undermine the rights of children. Most South African children come from disadvantaged backgrounds; these are the children who have been marginalized and forgotten by the country's systems. It has been reported that one-quarter of South African children are stunted, a rate similar to that found in other nearby low-income countries, according to UNICEF [42]**.** Early-life exposures common in rural areas, townships, and informal settlements of South Africa, such as undernutrition and chronic infections, contribute to neurodevelopmental deficits that have persistent effects throughout the school years and into adulthood. [43,44].

Attending preschool helps stimulate various ECD domains, provides basic nutrition and safety to children. It also grants the parent/caregiver an opportunity to participate in the labor sector. The fact is that not all children attend preschool in South Africa. Currently, the preschools are expensive, and most parents cannot afford them because of high levels of unemployment. In rural areas, the pre-schools are not abundant, the infrastructure is poor, and there is little or no support from the local government. In some instances, the children must walk a long distance, which puts them in danger and demotivates the parents to send them for enrolment. The children who are deprived of the right to attend pre-school are at a disadvantage in terms

of gaining a proper foundation in literacy, interpersonal, and social skills as compared to their counterparts.

The knowledge of the importance of positive childhood development is not well understood in South African communities. Studies need to be conducted to assess the country's current situation, and information needs to be disseminated to create awareness and ensure practice. This will also assist policymakers in seeing the need to create new policies, which will speak to the challenges facing childhood development currently. This review chapter is focused on the role of parent-child interaction during early childhood development. It will further unpack the factors influencing negative parent-child interaction and early childhood development outcomes.

1.2.2 Parent-child relationship during early childhood development

Parents play a crucial role in influencing their children's physical, emotional, mental, and social development, as parenting is also considered a major determinant of child health and development, significantly affecting various child outcomes throughout the life course [45]. Parenting is not a straightforward activity; however, it is considered a complex, multifaceted set of human activities that involves various dimensions. The dimensions can be positive or negative based on their outcome on the child's development. Parental role is very important during early childhood development because whatever teachings or acts a parent has instilled in a child propagate to adulthood. Effective parenting is primarily determined by the dynamics of the relationship between the parent and the child. The dynamics of effective parenting involve sensitive caregiving behavior, calmness, warmth, and prompt responsiveness. Mothers are mostly involved caregivers as compared to fathers, because mothers are primary custodians of their children and they get more time to develop the bond with their children through breastfeeding and nurturing [46–48]. The establishment of an effective parent-child interaction relies mainly on the parent's parenting skills, mentality, health, culture, and environment. Positive communication skills are a significant factor in the development of the relationship between parents and children [49]. The more parents communicate positively with their children, the more the children will improve their communication abilities and will relate better to the people around them. A positive parent-child relationship at an early stage of life is significant; it makes an important contribution in laying a proper health and developmental foundation for a child.

The relationship between a parent and child is bidirectional [50,51]. Child characteristics also influence their development. Their physical health, nutritional status, physical activity, and

physical growth influence their brain development and function [52–54] (Figure 1.1). In childhood, chronic stressors may include extreme experiences or more prevalent stressors such as exposure to poverty, food insecurity, interpersonal violence, parental mental illness, racism, and discrimination. Studies of young children report higher biological stress related to food insecurity and financial insecurity, in which the household members do not know whether and when food and other basic resources will be available [55,56], and unsafe contexts are associated with dysregulation of the biological stress hormone cortisol [31]. This increased biological stress places children at risk for long-term mental and medical health problems. In most regions, including South Africa, little is known about the actual impact of these circumstances on early childhood development.

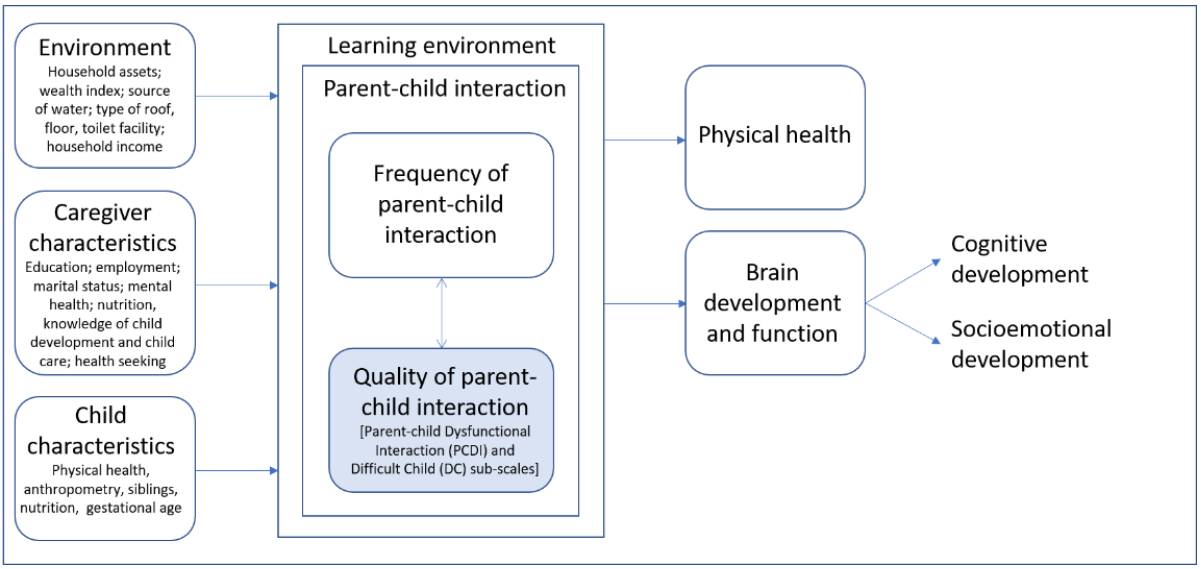

Figure 1.1: Parent-child interaction and the role in brain development and function (modified from *[54]*)

The circumstances of the parent or caregiver play a major role in a child's development. These include the parent/ caregiver's mental and emotional state, interpersonal skills, nutrition, socioeconomic and, time resources, abuse of drugs and alcohol, environmental conditions, lack of support from the family, culture, and the history of physical and emotional abuse. Under conditions of stress or crisis, it may be difficult for parents/caregivers to connect with children or notice their behaviors. Furthermore, it may be difficult to take care of their physical, mental, and emotional well-being or their educational needs.

Maternal mental health is important, as it influences how the mother engages with her child. A mental health mother or caregiver is at an advantage in making sound and informed

decisions during parenting and nurturing, putting aside the other external factors that might be playing. The chances for a child to be exposed to adverse experiences during development when the mother is mentally fit are decreased, as compared to when the mother is experiencing mental disturbances. It has been reported that maternal mental illnesses such as depression, anxiety, schizophrenia, and borderline personality disorders can have detrimental effects on the child's emotions, physical growth, behavior and social engagements, and cognitive development [57]. Children born to mothers with schizophrenia history have been observed to show increased developmental challenges, which include language skills disorder, delayed walking, and behavioral problems [57]. Maternal depression has also been linked to negative outcomes, which include insensitive caregiving behavior, minimal engagement in feeding and nurturing; these outcomes contribute to child maltreatment.

Factors affecting the parenting dynamics in South African communities include the occurrence of communicable and non-communicable diseases, family structures, household violence or conflicts, culture and religion, and geography. Single mothers, who are mostly assisted by their families to raise their children, head most South African homes [58,59]. Studies have shown that children being raised by single mothers are at a high risk of being subjected to adverse childhood effects as compared to their counterparts who are being raised by both parents [60,61]. Non-parental caregivers also play an important role in child development, especially within black South African communities, where maternal grandparents often facilitate the majority of child-rearing when parents are required to participate in the labor sector. Another major challenge that has led to grandparents raising children in South Africa is the high maternal death rate due to HIV/AIDS in recent years. However, the availability of ARV treatments has significantly reduced the mortality rate related to HIV/AIDS, allowing mothers to raise their children and protect them from transmission of the virus through preventive treatments such as nevirapine and associated practices.

Despite the issue of maternal death, grandparents in South African townships and rural areas are still carrying the responsibility of ensuring child development, as the current generation of mothers is often young and frequently disengaged from the process of raising their children. Many young mothers are still focused on enjoying their lives by engaging in alcohol and substance abuse, as well as attending parties and ceremonies. The involvement of grandparents in the development of their grandchildren has protected the children from being exposed to harsh parenting experiences from their biological parents [62]. Although

grandparents have their own challenges, their involvement is beneficial for the children's safety, well-being, and development. There is increasing patterning of young mothers in South African communities; these young mothers are not mentally and financially ready to take of children. This calls for grandparents to take the responsibilities of raising grandchildren together with their parents. In low-income families, this puts a huge financial strain on the finances of family and may result in increased family distress. The issue of the current generation of young mothers is a burden that needs prompt intervention because the circle of disengaged mothers does not stop; instead, it is increasing. This puts more pressure on grandparents and children born into such situations, forcing them to navigate through difficult circumstances with little hope that their situation will improve.

Caregiving behavior can be passed from one generation to another and is influenced by the history of good or bad circumstances. In instances where one has faced adversity during childhood, this can have implications on how they will behave as a parent in the future. It is known that what we become as adults is the product of the world we experienced as children. Therefore, interventions aimed at equipping caregivers with positive nurturing behaviors are necessary, especially in vulnerable communities.

There is limited knowledge on the dynamics of parent-child interactions and their role in early childhood neurodevelopment in South African communities. This elicits the need for research studies to be conducted to understand the dynamics of parent-child interaction in the South African population and its role in early life neurodevelopment. The priority should be focused on marginalized parent-child dyads who could potentially be at risk of being victimized by adverse life experiences. Knowledge generation will facilitate more specific intervention programs established to promote child well-being and positive development. Additionally, knowledge will create awareness about the implications of positive child-rearing, and it will further inform the development of new policies, which will ensure advocacy and practice.

1.2.3 Available tools to assess the status of parent-child interaction

Parent-child interaction (PCI) is normally assessed through self-reports, observational scales, and interviews [63]. Self-reports and interviews are normally amenable to bias reporting by parents or caregivers, and this distorts the accuracy of the outcomes. Bias is prompted by various factors, which include a lack of awareness, defiance, and others. Observational scales are considered more effective compared to self-report and interviews. Observational scales

are advantageous over the others because they offer the ability to generate data that goes beyond that provided by the reports, clinical information, which could be used for decision-making, and they are sensitive to changes produced by the treatment [64]. There are various instruments available to measure PCI (Table 1.1). The instruments are not only chosen based on validity and reliability, but they are also chosen based on the compatibility they offer for psychometric properties with the population being studied. All the available instruments serve a common objective of assessing the dynamics of the relation between child and parent or a caregiver. The most renowned instrument that is used currently is the Parenting Stress Index Short Form (PSI-SF) established by Abidin [65]. The PSI-SF is a condensed version of the main Parenting Stress Index (PSI) instrument that has 101 items to assess parent-child interaction stressors [65–67]. The PSI-SF instrument was condensed to 36 items, which makes it conducive to use in research and clinical trials [68]. The PSI-SF instrument is made up of three subscales, which are Parental Distress (PD), Parent-Child Dysfunctional Interaction (PCDI), and Difficult Child (DC) [68]. This instrument has been validated in other countries, but not in a South African context. However, it has been used in South African research studies by Potterton et al [69] and recently by Mbatha [70]. Despite the knowledge being presented by these studies, information on the context of parent-child interaction in South African communities is still scarce. This underscores the need for more studies to be conducted.

Table 1.1: Some available instruments to measure parent-child interaction

Instrument	**Age of a child**	**Caregiver scales**	**Child scales**	**Total number of items**	**Location**	**Ref**
PCIS	0-60 months	Sensitivity, Goal setting, physical interaction, relationship among activities	Positive involvement	11	Home	[71]
PCERA	0-60 months	Play, negative effect and behavior, responsiveness, verbal interaction, intrusiveness	Quality of play, interest and attentional skills	57	Home	[72]

CARE-Index	0-30 months	Verbalization, unresponsiveness, sensitivity, and control	Verbalization, cooperativeness, difficulty, passivity	15	Home, laboratory, and in the Hospital	[73]
PSI-SF	0-36 Months	Responsiveness, sensitivity	cooperativeness difficultness	36	Home, schools, mental health clinics	[65] [66] [68]

Parent/Caregiver Involvement Scale-**PCIS;** Parent-Child Early Relational Assessment-**PCERA**; Child-Adult Relation Experiment Index**-CARE-Index**

Factors affecting the parent-child relationship during early childhood development

1.2.3.1 Poverty and unemployment

South Africa is classified as an upper-middle-income country, and economic inequality remains high; more than half of South African children live in poverty. The country is still battling with issues of poverty, inequality, unemployment, and hunger, driven by historical events and a political economy that is unique to South Africa. Poverty is not uniform across the demographics of South Africa; people who reside in rural areas are more marginalized as compared to people living in urban areas.

The family's economic spectrum is very important for the child's development; it influences the extent of the family dynamics. It has been observed that the family dynamics improve if the economy is positive and deteriorate when the economic situation is poor [74]. A poor economic spectrum breeds poverty and exposes children to vulnerability, discrimination, and isolation. Children born into poverty have high chances to be exposed to a broad spectrum of health problems, maltreatment, and malnutrition [75,76]. Brook-Gunn and Duncan [76] illustrated the three models of how poverty affects childhood development (Table 1.2).

Table 1.2: Three model effects of poverty on child development (sources from *[77]*)

Model the effect of poverty	**Model description**	**Example**

Moderated	A moderated effect is one in which the effects of poverty vary across characteristics of families or children	Families who are poorly educated with poor decision-making skills may have more difficulty protecting their children from the effects of poverty than families who are better educated with rational decision-making skills
Mediated	Refers to the effects of poverty, which are felt through disruptions in family functioning, which in turn have negative repercussions on the children	Poverty associated with economic hardship may lead to family stress and harm parental emotional well-being and mental health, undermining parenting behavior and increasing the likelihood of parents using harsh and controlling parenting
Transactional	In transactional models, the effects of poverty reverberate through the relations between families and children, incorporating both moderated and mediated processes	Caregivers of temperamentally difficult children are less likely to exhibit sensitive, responsive caregiving and more likely to report depressive symptoms than caregivers of temperamentally easy children.

South Africa has been experiencing slow economic growth, largely due to the global recession. During this period, many people lost their jobs as employers took actions to reduce the labor force. In addition to this challenge, the emergence of the COVID-19 pandemic further contributed to job losses across the country. This has worsened the unemployment burden faced by South African citizens. Currently, the unemployment estimates record the overall national rate of 34, 5%, with 63,9 % being youth aged 15-24 years and 42,1% percent for 24-34 years; these estimates were recorded during the first quarter of 2022 by the Quarterly Labor Force Survey (QLFS) [78].

Among the nine South African provinces, Limpopo is considered the second highest, with 11.2% of households living in poverty [79]. The Living Conditions Survey (LCS) and the Income and Expenditure Survey (IES) conducted by Stats SA report that Limpopo Province has the highest level of poverty in South Africa at 78,9% [55]. Limpopo is made up of five different districts, which are mostly made up of rural villages. Statistics SA Quarterly Labor Force Survey (QLFS) for the period 1 April 2021 to 30 June 2021 reported that Limpopo's unemployment rate is 49.9%, placing the province in third place on the unemployment provincial list. Food insecurities are reported to be 37% in rural areas within Limpopo provinces, having a hunger prevalence >30% [80]. In Mopani subdistrict, the majority of child deaths (82% of children <1 year and 65% of children age 1-4 years) are caused by communicable diseases together with maternal, perinatal, and nutritional conditions [81]. These high mortality figures suggest that the effects of social and economic inequality are especially visible in this rural region, which suffered from increased poverty and poor access to healthcare.

1.2.3.2 Nutrition

Nutrition is very important during early childhood development. It not only supports growth and development, but it also ensures the health and well-being of an individual. Every child has a right to access nutrition; however, the high levels of poverty in South Africa infringe this right. Disadvantaged communities still have children who are facing high levels of food insecurity. Adequate nutrition is necessary for normal brain development. Poor nutrition promotes the loss of developmental potential, life-long health, and economic disparities among millions of children younger than five years of age [82]. The negative outcomes of poor nutrition include damage to brain development, as well as impaired cognitive and learning abilities [83]. One-quarter of children are stunted, similar to rates found in nearby low-income countries, according to UNICEF. Early-life exposures that are common in rural South Africa, including

undernutrition and chronic infection, contribute to neurodevelopmental deficits that have persistent effects throughout the school years and into adulthood [43,44].

The government has established programs aimed at reducing hunger, malnutrition, and food insecurities in South African communities by providing child support grants and feeding schemes in schools. The child support grant of R560.00 is given to eligible caregivers for children under the age of 18 years [84]. The child support grant is aimed at assisting the caregivers in providing basic needs for their children. This grant has been increasing over the years; however, the challenge is that the grant is not enough, since the costs of living are high, and food and fuel prices are continuously increasing. This makes it difficult for the grant to cater to children's basic needs, especially in households where no one is working. Additionally, the government has implemented feeding schemes in schools, which have been very helpful in providing nutrition to children. However, children from high-poverty-stricken families still face the challenge of not getting food when they go back home after school and during the weekends. Despite the establishment of these programs, food insecurity, malnutrition, and hunger remain an epidemiological challenge in South Africa.

The establishment of social grants and feeding scheme programs has positively addressed the issues of nutrition with relation to poverty, because needy people are benefiting. However, these programs do not deal with the root cause of poverty in South Africa, and their sustainability is not certain since the number of unemployed and low-income people who are depending on social welfare is rapidly increasing, with no hope of positive changes in the economy.

1.2.3.3 Health

Early childhood development can be improved by providing quality healthcare to mothers, children, caregivers, and overall family members. A healthy mother, living with healthy people, has the potential to nurture her child positively. On the other hand, an unhealthy mother or caregiver, living in inadequate health and environmental conditions, struggles during parenting, which subjects the child to detrimental adverse outcomes. To ensure healthy development and well-being during early childhood, it is essential for the parent or caregiver to be well-informed about child nurturing, maintain a positive attitude, and demonstrate well-regulated behavior. A parent or caregiver who is knowledgeable about child nurturing, health, and nutrition creates an environment that promotes positive child outcomes. It has been noted

that the health gradient of children follows the socioeconomic spectrum; the circumstances in which children are born significantly impact their health and development [85]. This contributes to inequality in child development; children from poor backgrounds grow up under difficult experiences as compared to their counterparts. Growing up in a poor family affects children's health and development.

About 80% of the South African population depends on the public health care system, which is subsidized by the government and is normally underfunded and poorly managed [86]. The majority of South African communities face barriers like poor infrastructure and understaffed health facilities when seeking health care in their communities [87]. The situation is worse for marginalized communities in rural areas, because it is not easy to access government facilities, and they tend to receive limited healthcare services. Since some have to walk a long distance to get health services, and when they arrive, they are not guaranteed to find help. This has contributed to some people losing hope of finding health care from government facilities.

Every child has the right to access basic health services, which is supported by section 28(1)(c) of the South African Constitution. These children's right is infringed by the various socioeconomic effects, including inequality and political dynamics. The health of a child depends on access to adequate basic health services, proper housing, clean water, hygiene, and sanitation. The majority of South African children still reside in areas that are characterized by poor access to clean water, housing, basic health services, hygiene, and sanitation. In South Africa, rural communities make use of pit toilets or a bucket system for sanitation, in conjunction with restricted or no access to clean water. This results in young children being prone to a spectrum of diseases, which affects their health and development. The government currently knows the association between poverty and health; however, the development of new strategies to fight poverty and provide better health to citizens is paralyzed by high levels of corruption and incompetence. The investigation on the relationship between child health and early development trajectories is particularly important in high-poverty settings like rural South Africa, where some children do not attend preschool and where preschool quality is poor [88].

1.2.3.4 Parents' Educational Attainment

Parents' educational attainment is one of the important predictors of child development. It influences the economic, social, and behavioral dynamics of the child's household. Since it drives the parents' occupation, income, housing, awareness, belief, behavior, goals, and expectations [89,90].

There are distinct differences in parenting skills between educated parents and non-educated parents. The parents' level of education contributes to parenting skills. Parents who have a high level of education are keen to source information to enhance their parenting skills. This improves their parenting skills and practices, making parenting less difficult and beneficial for their children's development and well-being [91].

Educated parents are flexible in using the current technological tools to source information, which could benefit the development of their children. This makes high-level educated parents not only rely on experiences attained through their parents. Moreover, this group of parents is mostly motivated to expose their children to activities that will stimulate their cognitive system. Low-level educated and uneducated parents mainly rely on the parenting skills attained through their upbringing, and most of the time, they are less motivated to seek information that could help to enhance their parenting skills for the better development of their children.

Parents' level of education and socio-economic status influence child development outcomes directly and indirectly. The children's outcomes are directly influenced through the transfer of knowledge via biological pathways [92]. The indirect influence is attributed to environmental pathways, one of which is illustrated graphically by [90,93], depicted in Figure 1.2.

In South Africa, the rate of academic attainment has been progressively increasing since 1994. Currently, the majority of people have some form of education. Statistics SA reported that in 2022, 73.4% of individuals aged 5 to 24 years were attending school [94]. The government has various mechanisms operating to ensure that the citizens attain education. The mechanism is not perfect, and the country is still battling with high levels of high school dropouts [95,96]. The role of the parents' level of education on child development has not

been well studied in the South African context. This elicits the need to investigate the impact of parents' level of education on child development in South Africa.

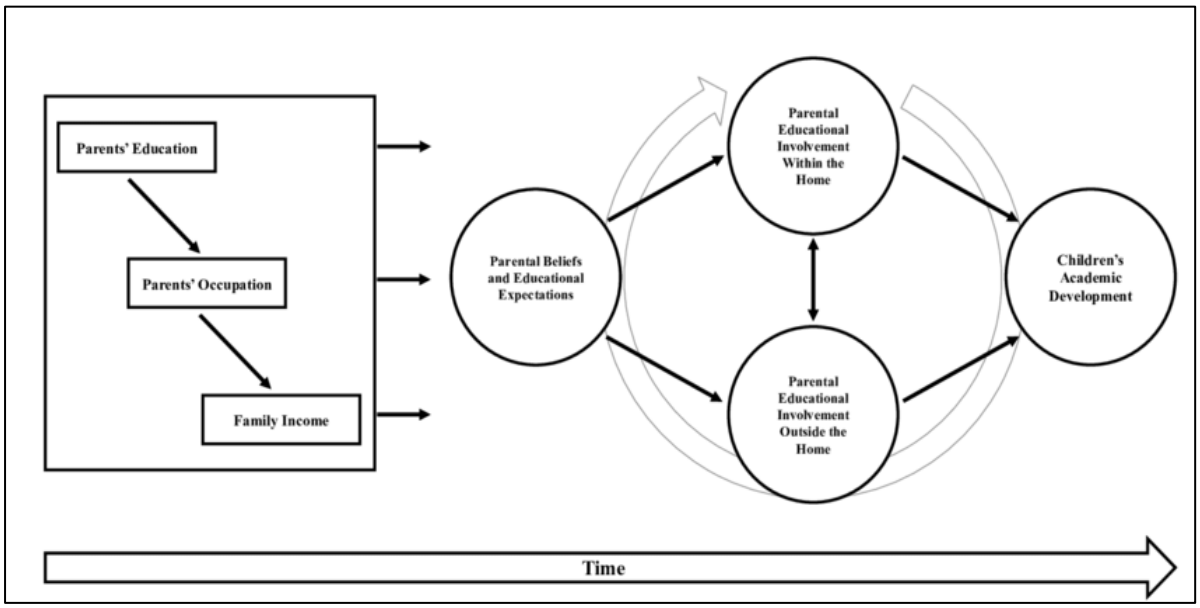

Figure 1.2: The influence of parents' education on children's academic development *[90]*

1.2.3.5 Impact of culture and religion on ECD

Culture and religion play an important role in shaping how parents or caregivers interact with their children. Parents who are rooted in culture and religion expect their children to follow suit. During the early stage of development, parents culturally and religiously expose their children to what they believe is good for their development. Character traits such as self-control, communication style, and interpersonal skills of parents can be informed by their culture and religious beliefs. The nature of the parents' character traits structures the dynamics of the relationship with their children. Good character traits facilitate a positive parent-child relationship, which makes parenting manageable and conducive to the child's development. Whereas bad character traits promote negative outcomes.

Culture contributes to cognitive development through social processes during everyday activities. It provides children with structured opportunities to learn [97]. Culture informs children of customs, beliefs, language, and religion; this influences the development of emotions, social, physical, and linguistic domains. Starting from birth, children partake in daily routines and rituals, which influence them to observe and practice. The repetition of such experiences enforces learning development around culturally acceptable values [98]. Parents direct their children's attention and involvement; this improves the social psychological

process of a child, which includes observation, imitation, demonstration, and attention regulation. The contribution of culture to cognitive development during ECD exists across all cultural spectrums, but the context differs; each culture has its norms, beliefs, and practices. Sociocultural experiences teach children what to attend to and how to behave; the caregiver's routines and kin relations influence this.

Religion has been proven as a valuable resource for promoting positive child developmental outcomes within households facing social disadvantage [99,100]. Religious parents remain faithful through difficult situations, which enables them to thrive. Religion commands parenting responsibilities as a covenant, in such a way that it is not prevalent for religious parents to abandon their children. Mostly religious parents believe a child is a blessing from God; this notion promotes better child nurturing. Previous studies have reported that religion has been observed to enhance the parent-child bond for both mothers and fathers [101–103]. Despite the positive contribution of religion to child development, associated adverse outcomes have also been recognized through previous research studies [99,104]. In a South African context, little is known about the positive and negative impact of religion on child development; therefore, this underscores the need for investigation.

1.2.3.6 Role of alcohol and substance abuse on ECD

The use of alcohol and substance abuse by parents or caregivers affects children directly and indirectly. The direct effect occurs during pregnancy, and this is considered a global public health concern [105]. Substance abuse during pregnancy disrupts fetal development and promotes life-threatening health-related problems [105–108]. The life-threatening health problems do not end during the fetal stage, but they propagate throughout the life course of the child.

Parents or caregivers who consume alcohol or abuse drugs are uncontrollable and indirectly affect ECD. This breeds stress during parenting and to the whole family structure. This promotes poor developmental outcomes for children [109,110]. The connection between alcohol misuse and the accumulation of adverse childhood experiences is considered a global public health crisis [111,112]. The intake of alcohol or drugs disrupts peace in families, it creates households that are consumed by high levels of chaos and conflicts. A chaotic and conflicting environment is not conducive to child development and well-being.

Substance abuse remains a growing challenge in South Africa [113–115]. A previous study, which aimed to investigate the effect of alcohol use amongst mothers/primary caregivers of children aged 7-11 in rural communities of South Africa, observed food insecurity as a variable that increased the odds of alcohol use [116]. The study researchers also observed that children of mothers or caregivers who were drinking excessively showed higher mean scores for psychological problems [116]. Such observations elicit the need for more studies to be conducted, to generate evidence-based information that could be used to create effective intervention programs, encourage advocacy, and emphasize practice to protect children against the implications of substance abuse by parents or primary caregivers.

1.2.3.7 The role of violence in ECD

Violence against children is a human rights violation and a global public health problem [117]. Some children experience violence early in life through corporal punishment from their parents, caregivers, and associated family members. The primary violence that children experience at home is normally not reported to the authorities since perpetrators are family and preschool teachers. This makes it difficult to estimate the prevalence of violence against children during early development. The South African government has recently passed a law that prohibits the spanking of children, as a way of protecting children from being physically abused by parents, caregivers, family, and community members. Despite the passing of this law, children are still subjected to violence at home and in preschool facilities. Criminal incidents happen every day at a high rate. Women and children are exposed to violence in their homes, at school and work, and in the surrounding community [118]. Children's exposure to violence promotes adverse outcomes that propagate to adulthood. The adverse outcomes include depression, disrupted cognitive skills, dropping out of school, suicide, alcohol and substance abuse, involvement in crime and violence, and possible further victimization [119].

Generally, the levels of violence in South African communities are increasing rapidly, and this limits the capacity of the citizens to thrive [120,121]. The violent environment affects children and future generations. Therefore, there is a need to study the root cause of violence in the country and how it affects children and prominent future generations so that effective intervention programs can be established to protect children. Using an ECD as an approach to prevent violence is considered a positive route to mitigate this burden [122]. Although there are policies advocating for the protection of children, gaps still exist between violence prevention policies and ECD in South Africa, and there is no proper national strategic plan to prevent violence [123].

1.2.4 Biological embedding during the early childhood development period

Early childhood development is an important period for brain development; it is the time when 90% of a child's brain development occurs, before the age of 5 [124]. When a child is born, the brain is underdeveloped; it develops during the early childhood period, where it follows a sequential development from bottom-up guided by life experiences [52,125–128]. The brain's plasticity makes the child capable of changing in response to experiences, especially repetitive experiences [126,127]. Good experiences during ECD are conducive to the better development of the brain, and for one to thrive throughout life. The occurrence of toxic stress during ECD promotes the architectural modification in neural connections, as indicated in Figure 1.3. On Figure 1.3, differences can be noted between the brain architecture of a normal individual and that of a person who has been exposed to toxic stress. In the brain architecture of a person who has been suppressed by stress, it can be seen that there is damage to neuron connections.

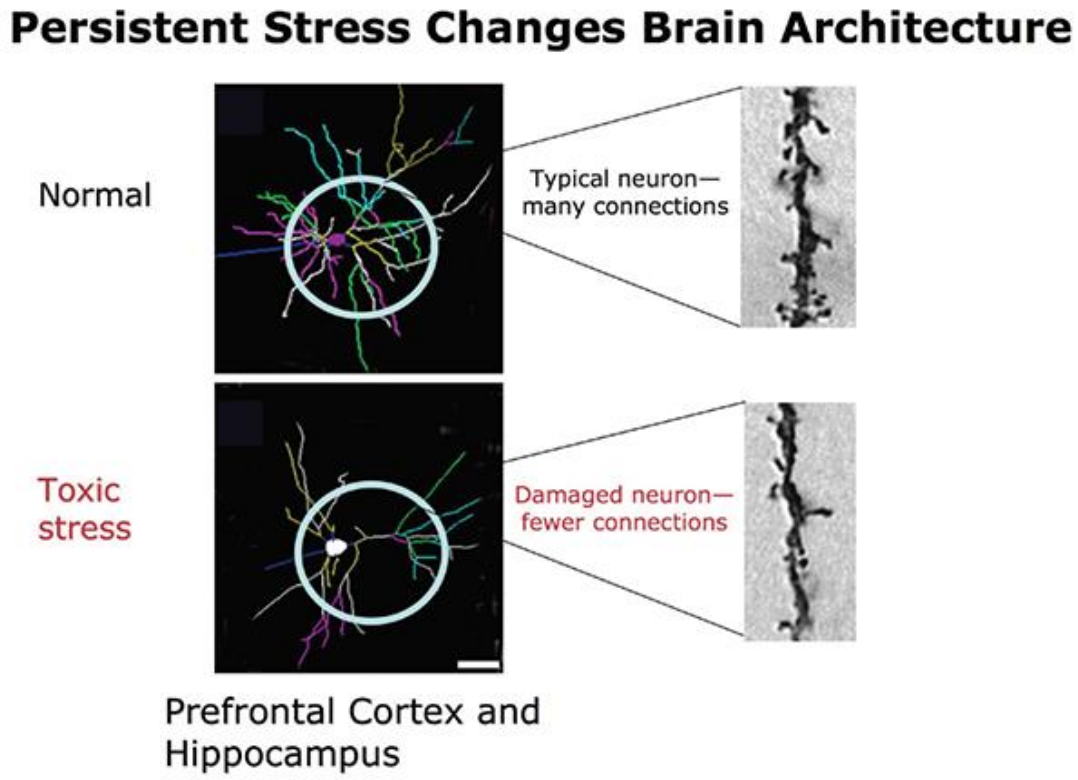

Figure 1.3: Depicts differences in brain architecture of a normal and toxic-stressed individual *[127,129]*

It has been noted that toxic stress affects the development of neural connections in the regions of the brain that are most significant for learning and behavior at home, school, and the workplace [130].

Biological embedding is defined as a process where life experiences cause alteration in biological systems to affect one's health and well-being later in life [131–138]. There is extensive literature linking adverse childhood experiences with changes in brain structure and functioning [129,139,140]. Brain modifications due to early childhood adverse experiences have been recognized to affect the most sensitive parts of the brain, which play a major role in memory, learning, and emotion regulation [141].

Changes in the central nervous system, immune system, and endocrine system promote alterations in gene expression. During ECD, gene and early childhood environmental experiences conspire to set long-term developmental trajectories of neurobiological systems underlying major cognitive, emotional, health, social, and behavioral function [134]. When a child is being raised in a non-conducive environment, there are high chances that the child's genes can be turned off during the process where epigenetic marks are added to the DNA [142,143]. This epigenetic mechanism is called DNA methylation, whereby the methyl groups are added onto to cytosine residue on the DNA. The addition of methyl groups on cytosine residues blocks gene expression, and this could remain unchanged throughout the course of life. DNA methylation underlies biological embedding. A previous study looked at biological embedding in rats, whereby rat babies were subjected to high maternal care by licking and grooming. The findings showed an association of high care with reduced cytosine methylation (mC) combination at a promoter of the glucocorticoid receptor gene involved in the regulation of stress response [144,145]. Furthermore, a previous study by McGowan et al. [146], observed that individuals who were exposed to child maltreatment had increased mC in the NR3C1 promoter in the hippocampal tissue. This study was conducted using adults who committed suicide.

Biological embedding is known to occur throughout the life course of a person; however, the severity depends on time. Aristizabal et al. [131] noted that early life social experiences are often associated with mC variations as compared to experiences later in life [147,148]. A child cohort study conducted in the UK found the links between exposure to adverse experiences with the changes in mC on 38 sites [149]. Site 38 is a DNA methylation site in the genomic region connected to stress, immune regulation, and brain function. Their observations showed that 35 of the 38 sites were informed by adverse experiences, which occurred at less than or equal to 3 years of age as compared to the time when the study was conducted. In light of the previous studies which have linked adverse childhood experiences with biological embedding,

it can be noted that early childhood development requires proper attention to protect children and to create a better community in the future.

In South Africa, there is limited information linking the brain development and function with adverse early childhood experiences. This shows that there is a need for studies to be conducted, so that early childhood development interventions could be guided by the evidence-based principles of brain development. This will also help with the prevention of early diseases, since early childhood adverse experience has been linked to the development of various diseases (obesity, diabetes, cancer, Alzheimer's, and others) later in life.

1.2.5 Politics and policy implications on early childhood development.

The South African political instabilities serve as a driving force for the country's current challenges. The instabilities place disadvantaged families under high pressure of living in difficult circumstances, which are not conducive to positive child development and well-being. The country's political sphere is characterized by high levels of corruption, poor service delivery, lack of accountability, and sympathy for the marginalized.

There are policies established to protect children and promote early childhood development in South Africa. However, these policies and accompanying government strategies are not sustainable to address the challenges faced by the marginalized children and their caregivers. The alarming challenges to child development policies are that politicians form part of the policy makers, and they have a final say on the establishment of policies that affect children. Most of the time, politicians are not well informed about the challenges faced by the marginalized children of South Africa on the ground level, which has implications for effective policy improvements, advocacy, and practice.

There is limited public knowledge or awareness of how positive child rearing promotes a better society and prevents diseases. There is a need to educate the public on matters relating to child rearing and its implications on the economy, crime and violence, and the development of diseases. This will improve the public perception of child rearing, which could help children receive better development. Furthermore, there is a need for the establishment of evidence-based policies aimed at protecting children and promoting early childhood development in marginalized communities of South Africa. This could be achieved by the generation of data,

sharing of information, and strategies by multifaceted stakeholders, which include the community, healthcare workers, epidemiologists, economists, social development, Department of Education, law enforcement department, policy makers, and politicians.

1.2.6 The benefits of investing in positive early childhood development

Positive early childhood development is the foundation of a prosperous community. Children from disadvantaged backgrounds have low chances of experiencing positive early childhood development due to various adverse experiences, which they are exposed to daily. The children's exposure to adverse experiences breeds adverse outcomes that do not affect the children, their families, and communities only, but the entire nation socially, economically, and health-wise. The strategies to create a better community warrant more attention to enforcing positive early childhood development. Several researchers have reported on how investing in early childhood development can produce returns that could be beneficial for the individuals, communities, and the country at large. The studies conducted by these researchers provide information that demonstrates how investing in early childhood development yields high public returns across domains such as educational performance and attainment, workforce earnings, behavior, social skills, and health [150–156]. Additional public returns include preventing gaps between the disadvantaged individuals and their counterparts, decreasing crime, and promoting a better society. Apart from the government, the biggest obstacle to investing in early childhood development for public returns is parents' responsibilities to primarily nurture and provide for their children. Parent awareness and intervention programs aimed at equipping parents with skills or tools for positive child rearing are necessary.

In South Africa, there are limited government programs and information on how investing in positive early childhood development could be beneficial for the citizens and future generations. This necessitates the need for investing in ECD studies, since the current strategies of building a better society are not sustainable. Investing in early childhood development should be part of policymakers' priorities to address the current challenges faced by children.

1.2.7 Conclusion

South Africa is a middle-income country with a high frequency of children from disadvantaged backgrounds. These children are vulnerable to various adverse psychosocial and health outcomes due to the high levels of poverty, unemployment, crime and violence, poor housing,

lack of clean water, and sanitation. There are human rights developed to protect children from early adverse experiences, but the status of the country infringes on these rights. Children are subjected to poor early development, which places them at high risk of experiencing difficult adulthood in the future. The early establishment of a relationship between children and their parents or caregivers is regarded as a very important foundation, which helps children to thrive throughout life. The nature of this relationship determines the psychosocial and health outcomes for the children. A good parent-child relationship breeds beneficial outcomes for the child, whereas a poor parent or caregiver relationship breeds adverse outcomes. In South African communities, the impact of the parent-child relationship during the development of ECD is not well understood. Due to the lack of studies that demonstrate how the status of these relationships helps or affects child development. The community lacks knowledge on how investing in ECD could decrease child mortality, crime, violence, the accumulation of health-related problems, and increase economic returns.

There is a need for studies to investigate the impact of parent-child relationships in South African communities, especially the marginalized ones, such as rural areas. In order to generate information that will be used to inform new evidence-based policies, advocacy, and practice, we need to nurture, teach, and promote early childhood development.

1.3 Problem statement

Dysfunctional parent-child relationships affect early childhood development; this has been proven to promote long-term adverse trajectories through adulthood [26,157–159]. In South Africa, there is limited knowledge on the influence of dysfunctional parent-child relationships on early childhood development. This is a challenge for the country because appropriate support or interventions for children under 5 years and their caregivers cannot be implemented if there is no information on the relationship between the challenges or adversity these populations face and the negative influence on developmental outcomes. Factors influencing dysfunctional parent-child relationships, such as family characteristics (e.g., financial resources, parents' education, employment) and home environment (e.g., time resources, learning environment, and nutrition) in rural areas may also be different or poorer than those in urban areas. The developmental delays and learning difficulties during childhood often have life-long consequences such as unemployment, lack of education, and mental health problems in adulthood [160]. It is important to understand the magnitude of the problem (i.e., prevalence of dysfunctional parent-child relationships in rural Limpopo and the impact of child development) so that appropriate interventions can be identified to support parents or

caregivers and improve early childhood development in children under 5 years. There is a growing body of evidence that suggests the negative impact of early adversity can be mitigated through appropriate early-life interventions [161]. The development of effective interventions requires better knowledge of exposures influencing dysfunctional parent-child relationships in South African communities. Putting more focus on communities that are disadvantaged by poor delivery service, high levels of unemployment, and domestic abuse, such as townships and rural areas, will improve the status of child development in the country.

1.4 Research justification

The lack of information on the role of dysfunctional-parent-child relationships on early childhood neurodevelopment in rural areas of South Africa highlights the need for studies to be conducted to generate information that will be used to inform policies to support parents or caregivers. Moreover, the development of knowledge will inform interventions that promote better psychosocial development in children through improving parent-child interactions. Conducting research that prioritizes the well-being of children is supported by the South African National Development Plan 2030 goal to reduce mortality in children under 5 years and to extend early childhood development services [162].

1.5 Research question

The current study sought to answer the following two questions:

1. Does a dysfunctional parent-child relationship affect early childhood neurodevelopment in children under 5 years living in rural Mopani District, Limpopo?
2. What are the determinants of a dysfunctional parent-child relationship among child-caregiver dyads living in rural Mopani District, Limpopo?

1.6 Research aims and objectives

This study aimed to investigate the impact of dysfunctional parent-child interactions (PCDI) and difficult child (DC) behaviors on early childhood neurodevelopment in rural Mopani District, Limpopo.

The study's aim was pursued through focusing on the three following objectives**:**

1. Assess the magnitude of stress in the parent-child system using the parent-child dysfunctional interaction (PCDI) and difficult child (DC) sub-scales of the Parental Stress Index (PSI) at 17 months of age in two rural areas of Limpopo Province (i.e., Greater Giyani and Greater Tzaneen – both in Mopani District, Limpopo).

2. Identify factors (at birth and at 17 months of age) associated with an elevated DC (raw score above 33) and PCDI (raw score above 27) when children are 17 months of age.
3. Determine the association between clinically elevated DC or PCDI and early childhood neurodevelopment, as measured using the Child Rearing and Early Development Inventory (CREDI)

1.7 References

[1] Shonkoff JP, Garner AS, THE COMMITTEE ON PSYCHOSOCIAL ASPECTS OF CHILD AND FAMILY HEALTH COEC ADOPTION, AND DEPENDENT CARE, AND SECTION ON DEVELOPMENTAL AND BEHAVIORAL PEDIATRICS, Siegel BS, Dobbins MI, Earls MF, et al. The Lifelong Effects of Early Childhood Adversity and Toxic Stress. Pediatrics 2012;129:e232–46. https://doi.org/10.1542/peds.2011-2663.

[2] Mustard J. Experience-based brain development: Scientific underpinnings of the importance of early child development in a global world. Paediatr Child Health 2006;11:571–2.

[3] Hertzman C, Boyce T. How Experience Gets Under the Skin to Create Gradients in Developmental Health. Annu Rev Public Health 2010;31:329-47 3p following 347. https://doi.org/10.1146/annurev.publhealth.012809.103538.

[4] Smith KE, Pollak SD. Early life stress and development: potential mechanisms for adverse outcomes. J Neurodev Disord 2020;12:34. https://doi.org/10.1186/s11689-020-09337-y.

[5] Jeong J, Franchett EE, Oliveira CVR de, Rehmani K, Yousafzai AK. Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. PLoS Med 2021;18:e1003602. https://doi.org/10.1371/journal.pmed.1003602.

[6] Jeong J, Bliznashka L, Sullivan E, Hentschel E, Jeon Y, Strong KL, et al. Measurement tools and indicators for assessing nurturing care for early childhood development: A scoping review. PLOS Glob Public Health 2022;2:e0000373. https://doi.org/10.1371/journal.pgph.0000373.

[7] Draper C, Cook C, Howard S, Makaula H, Merkley R, Mshudulu M, et al. Caregiver perspectives of risk and protective factors influencing early childhood development in low-income, urban settings: a social ecological perspective. 2022. https://doi.org/10.31234/osf.io/jquga.

[8] National Research Council (US) and Institute of Medicine (US) Committee on Integrating the Science of Early Childhood Development. From Neurons to Neighborhoods: The Science of Early Childhood Development. Washington (DC): National Academies Press (US); 2000.

[9] Angwenyi V, Abubakar A, Kabue M, Njoroge E, Nasambu C, Ssewanyana D, et al. Caregiving experiences and practices: qualitative formative research towards development of integrated early childhood development interventions targeting Kenyans and refugees in Nairobi's informal settlements. BMC Public Health 2024;24:2636. https://doi.org/10.1186/s12889-024-20018-6.

[10] Schmidt K, Tanga PT. Supporting good outcomes for early childhood home-visiting programmes: Guidelines for practice. South Afr J Child Educ 2024;14:12. https://doi.org/10.4102/sajce.v14i1.1403.

[11] Anda RF, Felitti VJ, Bremner JD, Walker JD, Whitfield C, Perry BD, et al. The enduring effects of abuse and related adverse experiences in childhood. Eur Arch Psychiatry Clin Neurosci 2006;256:174–86. https://doi.org/10.1007/s00406-005-0624-4.

[12] Pechtel P, Pizzagalli DA. Effects of Early Life Stress on Cognitive and Affective Function: An Integrated Review of Human Literature. Psychopharmacology (Berl) 2011;214:55–70. https://doi.org/10.1007/s00213-010-2009-2.
[13] Gallegos D, Eivers A, Sondergeld P, Pattinson C. Food Insecurity and Child Development: A State-of-the-Art Review. Int J Environ Res Public Health 2021;18:8990. https://doi.org/10.3390/ijerph18178990.
[14] Chilton M, Knowles M, Bloom SL. The Intergenerational Circumstances of Household Food Insecurity and Adversity. J Hunger Environ Nutr 2017;12:269–97. https://doi.org/10.1080/19320248.2016.1146195.
[15] Skinner G, Bywaters P, Kennedy E. A review of the relationship between poverty and child abuse and neglect: Insights from scoping reviews, systematic reviews and meta-analyses. Child Abuse Rev 2022;32. https://doi.org/10.1002/car.2795.
[16] Hosny N, Bovey M, Dutray F, Heim E. How is trauma-related distress experienced and expressed in populations from the Greater Middle East and North Africa? A systematic review of qualitative literature. SSM - Ment Health 2023;4:100258. https://doi.org/10.1016/j.ssmmh.2023.100258.
[17] Knopik VS, Marceau K, Bidwell LC, Rolan E. Prenatal substance exposure and offspring development: Does DNA methylation play a role? Neurotoxicol Teratol 2019;71:50–63. https://doi.org/10.1016/j.ntt.2018.01.009.
[18] Kenner C. Fetal Development: Environmental Influences and Critical Periods. Springer Publishing Company; 2023.
[19] National Academies of Sciences E, Division H and M, Practice B on PH and PH, Approach C on AN and S-BS from PTECDAHE, Negussie Y, Geller A, et al. Healthy Development from Conception Through Early Childhood. Vibrant Healthy Kids Aligning Sci. Pract. Policy Adv. Health Equity, National Academies Press (US); 2019.
[20] Mehta D, Kelly AB, Laurens KR, Haslam D, Williams KE, Walsh K, et al. Child Maltreatment and Long-Term Physical and Mental Health Outcomes: An Exploration of Biopsychosocial Determinants and Implications for Prevention. Child Psychiatry Hum Dev 2023;54:421–35. https://doi.org/10.1007/s10578-021-01258-8.
[21] DiLauro M. Psychosocial Factors Associated with Types of Child Maltreatment. Child Welfare 2004;83:69–99.
[22] Effects of child abuse and neglect for children and adolescents. Child Fam Community Aust 2014. https://aifs.gov.au/cfca/publications/effects-child-abuse-and-neglect-children-and-adolescents (accessed June 1, 2022).
[23] Metzler M, Merrick MT, Klevens J, Ports KA, Ford DC. Adverse childhood experiences and life opportunities: Shifting the narrative. Child Youth Serv Rev 2017;72:141–9. https://doi.org/10.1016/j.childyouth.2016.10.021.
[24] Nelson CA, Bhutta ZA, Burke Harris N, Danese A, Samara M. Adversity in childhood is linked to mental and physical health throughout life. The BMJ 2020;371:m3048. https://doi.org/10.1136/bmj.m3048.
[25] Hughes K, Lowey H, Quigg Z, Bellis MA. Relationships between adverse childhood experiences and adult mental well-being: results from an English national household survey. BMC Public Health 2016;16:222. https://doi.org/10.1186/s12889-016-2906-3.
[26] Bergmeier H, Paxton SJ, Milgrom J, Anderson SE, Baur L, Hill B, et al. Early mother-child dyadic pathways to childhood obesity risk: A conceptual model. Appetite 2020;144:104459. https://doi.org/10.1016/j.appet.2019.104459.
[27] Bengtsson J, Byberg S, Carstensen B, De Stavola BL, Svensson J, Jørgensen ME, et al. Accumulation of childhood adversities and type 1 diabetes risk: a register-based cohort study of all children born in Denmark between 1980 and 2015. Int J Epidemiol 2020;49:1604–13. https://doi.org/10.1093/ije/dyaa138.
[28] Kelly-Irving M, Lepage B, Dedieu D, Lacey R, Cable N, Bartley M, et al. Childhood adversity as a risk for cancer: findings from the 1958 British birth cohort study. BMC Public Health 2013;13:767. https://doi.org/10.1186/1471-2458-13-767.

[29] Lown EA, Lui CK, Karriker-Jaffe K, Mulia N, Williams E, Ye Y, et al. Adverse childhood events and risk of diabetes onset in the 1979 National longitudinal survey of youth cohort. BMC Public Health 2019;19:1007. https://doi.org/10.1186/s12889-019-7337-5.
[30] Holman DM, Ports KA, Buchanan ND, Hawkins NA, Merrick MT, Metzler M, et al. The Association Between Adverse Childhood Experiences and Risk of Cancer in Adulthood: A Systematic Review of the Literature. Pediatrics 2016;138:S81–91. https://doi.org/10.1542/peds.2015-4268L.
[31] Henley P, Lowthers M, Koren G, Fedha PT, Russell E, VanUum S, et al. Cultural and socio-economic conditions as factors contributing to chronic stress in sub-Saharan African communities. Can J Physiol Pharmacol 2014;92:725–32. https://doi.org/10.1139/cjpp-2014-0035.
[32] Blume J, Park S, Cox M, Mastergeorge AM. Explicating Child-Driven Patterns of Parent-Child Responsivity in Fragile Families: A Longitudinal Approach. Front Pediatr 2022;10.
[33] Mphaphuli LK. The Impact of Dysfunctional Families on the Mental Health of Children. Parent. Mod. Soc., IntechOpen; 2023. https://doi.org/10.5772/intechopen.110565.
[34] Wang Y. Effects of Parenting Style on Normal and Dysfunctional Emotional Behaviors in Small Children. Psychiatr Danub 2022;34:34–40. https://doi.org/10.24869/psyd.2022.34.
[35] What is early childhood development? | South African Government n.d. https://www.gov.za/faq/education/what-early-childhood-development (accessed June 1, 2022).
[36] Maluleke R. Mid-year population estimates 202 2021:35.
[37] Allen L, Kelly BB, Success C on the S of CB to A 8: D and B the F for, Board on Children Y, Medicine I of, Council NR. Child Development and Early Learning. National Academies Press (US); 2015.
[38] Teen pregnancies in South Africa jump 60% during COVID-19 pandemic - South Africa | ReliefWeb n.d. https://reliefweb.int/report/south-africa/teen-pregnancies-south-africa-jump-60-during-covid-19-pandemic (accessed July 13, 2022).
[39] Ngubane N, Maharaj P. Childbearing in the Context of the Child Support Grant in a Rural Area in South Africa. SAGE Open 2018;8:2158244018817596. https://doi.org/10.1177/2158244018817596.
[40] Section 28 - Children n.d. https://www.concourt.org.za/index.php/71-children-s-rights/section-28-children/133-section-28-children (accessed March 30, 2025).
[41] PromotingChildrensRights.pdf n.d.
[42] ZAF-Nutrition-brief-2020.pdf n.d.
[43] Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. Developmental potential in the first 5 years for children in developing countries. The Lancet 2007;369:60–70. https://doi.org/10.1016/S0140-6736(07)60032-4.
[44] Casale D, Desmond C. Recovery from stunting and cognitive outcomes in young children: evidence from the South African Birth to Twenty Cohort Study. J Dev Orig Health Dis 2016;7:163–71. https://doi.org/10.1017/S2040174415007175.
[45] Carpenter G, Stacks A. Developmental effects of exposure to Intimate Partner Violence in early childhood: A review of the literature. Child Youth Serv Rev 2009;31:831–9. https://doi.org/10.1016/j.childyouth.2009.03.005.
[46] Frosch CA, Schoppe-Sullivan SJ, O'Banion DD. Parenting and Child Development: A Relational Health Perspective. Am J Lifestyle Med 2019;15:45–59. https://doi.org/10.1177/1559827619849028.
[47] Laflamme D, Pomerleau A, Malcuit G. A Comparison of Fathers' and Mothers' Involvement in Childcare and Stimulation Behaviors During Free-Play with Their Infants at 9 and 15 Months. Sex Roles 2002;47:507–18. https://doi.org/10.1023/A:1022069720776.
[48] Schoppe-Sullivan SJ, Kotila L, Jia R, Lang SN, Bower DJ. Comparisons of levels and predictors of mothers' and fathers' engagement with their preschool aged children.

Early Child Dev Care 2013;183:498–514. https://doi.org/10.1080/03004430.2012.711596.
[49] Runcan PL, Constantineanu C, Ielics B, Popa D. The Role of Communication in the Parent-Child Interaction. Procedia - Soc Behav Sci 2012;46:904–8. https://doi.org/10.1016/j.sbspro.2012.05.221.
[50] Adolescent-Peer Relationships, Separation and Detachment From Parents, and Internalizing and Externalizing Behaviors: Linkages and Interactions - Justin Jager, Cynthia X. Yuen, Diane L. Putnick, Charlene Hendricks, Marc H. Bornstein, 2015 n.d. https://journals.sagepub.com/doi/abs/10.1177/0272431614537116 (accessed July 14, 2022).
[51] Lansford JE, Rothenberg WA, Jensen TM, Lippold MA, Bacchini D, Bornstein MH, et al. Bidirectional Relations Between Parenting and Behavior Problems From Age 8 to 13 in Nine Countries. J Res Adolesc 2018;28:571–90. https://doi.org/10.1111/jora.12381.
[52] Prado E, Dewey K. Nutrition and brain development in early life. Nutr Rev 2014. https://doi.org/10.1111/nure.12102.
[53] Aboud FE, Yousafzai AK. Very Early Childhood Development. In: Black RE, Laxminarayan R, Temmerman M, Walker N, editors. Reprod. Matern. Newborn Child Health Dis. Control Priorities Third Ed. Vol. 2, Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2016.
[54] Ip P, Tso W, Rao N, Ho FKW, Chan KL, Fu KW, et al. Rasch validation of the Chinese parent–child interaction scale (CPCIS). World J Pediatr 2018;14:238–46. https://doi.org/10.1007/s12519-018-0132-z.
[55] Africa SS. 2018 | Statistics South Africa n.d. https://www.statssa.gov.za/?m=2018&gclid=Cj0KCQjwnNyUBhCZARIsAI9AYlEPUXh4XtSPmQattQY6sBYI1By9n28m45NlTLyrcPwJFbtzfe1jgykaAtPkEALw_wcB (accessed June 1, 2022).
[56] Ling J, Robbins LB, Xu D. Food Security Status and Hair Cortisol among Low-income Mother-Child Dyads. West J Nurs Res 2019;41:1813–28. https://doi.org/10.1177/0193945919867112.
[57] Manning C, Gregoire A. Effects of parental mental illness on children. Psychiatry 2006;5:10–2. https://doi.org/10.1383/psyt.2006.5.1.10.
[58] Economic experiences and sustainable livelihoods of single mothers employed in the formal work sector in Germany and South Africa n.d. https://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0037-80542019000400003 (accessed March 30, 2025).
[59] Jacobs C, Andrews G. Disrupting Patriarchal Perceptions of Single-Mother Families: An Analysis of Adolescent Narratives. Educ Change 2021;25. https://doi.org/10.25159/1947-9417/8670.
[60] Golombok S, Zadeh S, Imrie S, Smith V, Freeman T. Single Mothers by Choice: Mother–Child Relationships and Children's Psychological Adjustment. J Fam Psychol 2016;30:409–18. https://doi.org/10.1037/fam0000188.
[61] Ray JA, Choi J-K, Jackson AP. Adverse childhood experiences and behavior problems among poor Black children: Nonresident father involvement and single mothers' parenting stress. Child Abuse Negl 2021;121:105264. https://doi.org/10.1016/j.chiabu.2021.105264.
[62] Barnett MA, Scaramella LV, Neppl TK, Ontai LL, Conger RD. Grandmother Involvement as a Protective Factor for Early Childhood Social Adjustment. J Fam Psychol JFP J Div Fam Psychol Am Psychol Assoc Div 43 2010;24:635–45. https://doi.org/10.1037/a0020829.
[63] Hawes D, Dadds M. Assessing Parenting Practices Through Parent-Report and Direct Observation During Parent-Training. J Child Fam Stud 2006;15:554–67. https://doi.org/10.1007/s10826-006-9029-x.

[64] Borrego J, Timmer SG, Urquiza AJ, Follette WC. Physically abusive mothers' responses following episodes of child noncompliance and compliance. J Consult Clin Psychol 2004;72:897–903. https://doi.org/10.1037/0022-006X.72.5.897.
[65] Abidin: The Parenting Stress Index--Clinical Trials. - Google Scholar n.d. https://scholar.google.com/scholar_lookup?title=The%20Parenting%20Stress%20Index-Clinical%20Trials&publication_year=1979&author=Abidin%2CR (accessed April 12, 2023).
[66] Abidin, R. R. Parenting stress index: Manual (3rd ed.). Odessa, FL: Psychological Assessment Resources. 1995.
[67] Abidin: Parenting Stress: Maternal & Child Health... - Google Scholar n.d.
[68] Wu J. Parenting Stress Index, Short Form. Natl Child Trauma Stress Netw 2017. https://www.nctsn.org/measures/parenting-stress-index-short-form (accessed June 6, 2022).
[69] Potterton J, Stewart A, Cooper P. Parenting stress of caregivers of young children who are HIV Positive. Afr J Psychiatry 2007;10:210–4. https://doi.org/10.4314/ajpsy.v10i4.30257.
[70] Mbatha NL, Mokwena KE. Parental Stress in Raising a Child with Developmental Disabilities in a Rural Community in South Africa. Int J Environ Res Public Health 2023;20:3969. https://doi.org/10.3390/ijerph20053969.
[71] Farran DC. Parent/Caregiver involvement scale: Workbook. Unpublished manuscript 1986.
[72] Clark R, Tluczek A, Moore EC, Evenson AL. Assessment of Early Parent–Child Relationships. In: DelCarmen-Wiggins R, Carter AS, editors. Oxf. Handb. Infant Toddler Presch. Ment. Health Assess. 2nd ed., Oxford University Press; 2019, p. 46–77. https://doi.org/10.1093/oxfordhb/9780199837182.013.3.
[73] Crittenden PM. Unpublishes CARE-index infants Codenig manual. 2006.
[74] Aber L, Morris P, Raver C. Children, Families and Poverty. Soc Policy Rep 2012;26:1–29. https://doi.org/10.1002/j.2379-3988.2012.tb00072.x.
[75] Effects of poverty, hunger and homelessness on children and youth. Https://WwwApaOrg n.d. https://www.apa.org/pi/families/poverty (accessed July 14, 2022).
[76] Brooks-Gunn J, Duncan GJ. The effects of poverty on children. Future Child 1997;7:55–71.
[77] Engle PL, Black MM. The Effect of Poverty on Child Development and Educational Outcomes. Ann N Y Acad Sci 2008;1136:243–56. https://doi.org/10.1196/annals.1425.023.
[78] Africa SS. South Africa's youth continues to bear the burden of unemployment. | Statistics South Africa 2022. https://www.statssa.gov.za/?p=15407 (accessed March 30, 2025).
[79] Alexander M. Mapping poverty in South Africa. South Afr Gatew 2024. https://southafrica-info.com/people/mapping-poverty-in-south-africa/ (accessed March 30, 2025).
[80] Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, et al. The South African National Health and Nutrition Examination Survey, 2012: SANHANES-1: the health and nutritional status of the nation. HSRC Press; 2015.
[81] District+Health+Barometer+2018-19+Web.pdf n.d.
[82] Hurley KM, Yousafzai AK, Lopez-Boo F. Early Child Development and Nutrition: A Review of the Benefits and Challenges of Implementing Integrated Interventions1234. Adv Nutr 2016;7:357–63. https://doi.org/10.3945/an.115.010363.
[83] Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. The Lancet 2008;371:340–57. https://doi.org/10.1016/S0140-6736(07)61692-4.
[84] Hohip C. SASSA confirms payment dates for April. EWN n.d. https://www.ewn.co.za/2025/03/27/early-payments-for-sassa-grants-in-april (accessed March 30, 2025).

[85] Bambra C, Gibson M, Sowden A, Wright K, Whitehead M, Petticrew M. Tackling the wider social determinants of health and health inequalities: evidence from systematic reviews. J Epidemiol Community Health 2010;64:284–91. https://doi.org/10.1136/jech.2008.082743.
[86] Mayosi B, Benatar S, Med D. Health and Health Care in South Africa-20 Years after Mandela. N Engl J Med 2014;371. https://doi.org/10.1056/NEJMsr1405012.
[87] Maphumulo WT, Bhengu BR. Challenges of quality improvement in the healthcare of South Africa post-apartheid: A critical review. Curationis 2019;42:1901. https://doi.org/10.4102/curationis.v42i1.1901.
[88] Behrman JR, Hoddinott J, Maluccio JA, Soler-Hampejsek E, Behrman EL, Martorell R, et al. What determines adult cognitive skills? Influences of pre-school, school, and post-school experiences in Guatemala. Lat Am Econ Rev 2014;23:1–32. https://doi.org/10.1007/s40503-014-0004-4.
[89] Mirowsky J, Ross C. Education, learned effectiveness and health. Lond Rev Educ 2005;3:205–20. https://doi.org/10.1080/14748460500372366.
[90] Davis-Kean P, Tighe L, Waters N. The Role of Parent Educational Attainment in Parenting and Children's Development. 2020. https://doi.org/10.31234/osf.io/ndmxb.
[91] Harding JF, Morris PA, Hughes D. The Relationship Between Maternal Education and Children's Academic Outcomes: A Theoretical Framework. J Marriage Fam 2015;77:60–76. https://doi.org/10.1111/jomf.12156.
[92] Social and Genetic Pathways in Multigenerational Transmission of Educational Attainment - Hexuan Liu, 2018 n.d. https://journals.sagepub.com/doi/abs/10.1177/0003122418759651 (accessed July 14, 2022).
[93] Tighe LA, Davis-Kean PE. The Influence of College Education on Parents and Children in Low-Income Families. Merrill-Palmer Q 2021;67:293–328.
[94] Africa SS. MEDIA RELEASE: Census 2022 Population Count Results 10 October 2023 | Statistics South Africa 2023. https://www.statssa.gov.za/?p=16716 (accessed March 30, 2025).
[95] Understanding Why Youth Drop Out of School in South Africa - Rachana Desai, Ansuyah Magan, Robert A.C. Ruiter, Priscilla S. Reddy, Liesbeth A.G. Mercken, 2024 n.d. https://journals.sagepub.com/doi/10.1177/21582440231219080 (accessed March 30, 2025).
[96] Full article: Learning Disrupted Through High School Dropouts: Perceptions of Access to Education in the Eastern Cape of South Africa n.d. https://www.tandfonline.com/doi/full/10.1080/21528586.2024.2417795 (accessed March 30, 2025).
[97] Rogoff B. The cultural nature of human development. Oxford: Oxford University Press; 2003.
[98] Bornstein MH. Culture, Parenting, and Zero-to-Threes. Zero Three 2015;35:2–9.
[99] Petts RJ. Parental Religiosity, Religious Homogamy, and Young Children's Well-Being. Sociol Relig 2011;72:389–414. https://doi.org/10.1093/socrel/srr021.
[100] Petts RJ. Single Mothers' Religious Participation and Early Childhood Behavior. J Marriage Fam 2012;74:251–68. https://doi.org/10.1111/j.1741-3737.2011.00953.x.
[101] The Impact of Family Religious Life on the Quality of Mother-Child Relations. Carol Popul Cent n.d. https://www.cpc.unc.edu/resources/publications/bib/2360/ (accessed July 14, 2022).
[102] King V. The Influence of Religion on Fathers' Relationships With Their Children. J Marriage Fam 2003;65:382–95. https://doi.org/10.1111/j.1741-3737.2003.00382.x.
[103] Bartkowski JP, Xu X. Distant patriarchs or expressive dads? The discourse and practice of fathering in conservative Protestant families. Sociol Q 2000;41:465–85. https://doi.org/10.1111/j.1533-8525.2000.tb00088.x.
[104] Bartkowski JP, Xu X, Levin ML. Religion and child development: Evidence from the Early Childhood Longitudinal Study. Soc Sci Res 2008;37:18–36. https://doi.org/10.1016/j.ssresearch.2007.02.001.

[105] Forray A. Substance use during pregnancy. F1000Research 2016;5:F1000 Faculty Rev-887. https://doi.org/10.12688/f1000research.7645.1.
[106] Louw K-A. Substance use in pregnancy: The medical challenge. Obstet Med 2018;11:54–66. https://doi.org/10.1177/1753495X17750299.
[107] Stone R. Pregnant women and substance use: fear, stigma, and barriers to care. Health Justice 2015;3:2. https://doi.org/10.1186/s40352-015-0015-5.
[108] Skagerström J. Alcohol consumption during pregnancy : Prevalence, predictors and prevention. vol. 1470. Linköping: Linköping University Electronic Press; 2015. https://doi.org/10.3384/diss.diva-122375.
[109] Pilowsky DJ, Keyes KM, Hasin DS. Adverse Childhood Events and Lifetime Alcohol Dependence. Am J Public Health 2009;99:258–63. https://doi.org/10.2105/AJPH.2008.139006.
[110] Haugland SH, Carvalho B, Stea TH, Strandheim A, Vederhus J-K. Associations between parental alcohol problems in childhood and adversities during childhood and later adulthood: a cross-sectional study of 28047 adults from the general population. Subst Abuse Treat Prev Policy 2021;16:47. https://doi.org/10.1186/s13011-021-00384-9.
[111] Global strategy to reduce the harmful use of alcohol n.d. https://www.who.int/publications-detail-redirect/9789241599931 (accessed July 14, 2022).
[112] Monteiro MG. The Road to a World Health Organization Global Strategy for Reducing the Harmful Use of Alcohol. Alcohol Res Health 2011;34:257–60.
[113] Oladeinde O, Mabetha D, Twine R, Hove J, Van Der Merwe M, Byass P, et al. Building cooperative learning to address alcohol and other drug abuse in Mpumalanga, South Africa: a participatory action research process. Glob Health Action 2020;13:1726722. https://doi.org/10.1080/16549716.2020.1726722.
[114] News n.d. https://www.netcare.co.za/News-Hub/Articles/understanding-substance-abuse-and-addiction (accessed July 14, 2022).
[115] Alcohol and drugs – Triangle Project n.d. https://triangle.org.za/what-were-here-for/alcohol-and-drugs/ (accessed July 14, 2022).
[116] Rochat TJ, Houle B, Stein A, Mitchell J, Bland RM. Maternal alcohol use and children's emotional and cognitive outcomes in rural South Africa. SAMJ South Afr Med J 2019;109:526–34. https://doi.org/10.7196/samj.2019.v109i6.13120.
[117] Violence against children n.d. https://www.who.int/news-room/fact-sheets/detail/violence-against-children (accessed July 14, 2022).
[118] Seedat M, Niekerk AV, Suffla S, Ratele K. Authors: R Jewkes, N Abrahams, S Mathews, MRC Gender & Health Research Unit n.d.:2.
[119] Messman TL, Long PJ. Child sexual abuse and its relationship to revictimization in adult women: A review. Clin Psychol Rev 1996;16:397–420. https://doi.org/10.1016/0272-7358(96)00019-0.
[120] Hsiao C, Fry D, Ward CL, Ganz G, Casey T, Zheng X, et al. Violence against children in South Africa: the cost of inaction to society and the economy. BMJ Glob Health 2018;3:e000573. https://doi.org/10.1136/bmjgh-2017-000573.
[121] Bandeira M, Higson-Smith C. Responding to the Smoke that Calls: Principles of community-level interventions for the prevention of collective violence. 2013.
[122] http://juta/nxt/print.asp?NXTScript=nxt/gateway.dll&NXTHost=jut n.d.:89.
[123] Phyfer J, Wakefield L. Calling for a comprehensive approach: Violence prevention and early childhood development. SA Crime Q 2015:23–9. https://doi.org/10.4314/sacq.v51i1.3.
[124] brain — Babies. Relavate n.d. https://www.relavate.org/babies/tag/brain (accessed July 15, 2022).
[125] Brain Development of Children from 0-6 years - Facts every parent should know. ADAM Mila 2017. https://www.adam-mila.com/brain-development-children-0-6-years/ (accessed July 15, 2022).

[126] Kolb B, Gibb R. Brain plasticity and behaviour in the developing brain. J Can Acad Child Adolesc Psychiatry J Acad Can Psychiatr Enfant Adolesc 2011;20:265–76.
[127] Radley J, Morrison J. Repeated stress and structural plasticity in the brain. Ageing Res Rev 2005;4:271–87. https://doi.org/10.1016/j.arr.2005.03.004.
[128] Understanding the Effects of Maltreatment on Brain Development n.d.:19.
[129] Bock J, Gruss M, Becker S, Braun K. Experience-induced changes of dendritic spine densities in the prefrontal and sensory cortex: correlation with developmental time windows. Cereb Cortex N Y N 1991 2005;15:802–8. https://doi.org/10.1093/cercor/bhh181.
[130] InBrief: The Science of Early Childhood Development n.d. https://developingchild.harvard.edu/resources/inbrief-science-of-ecd/ (accessed July 15, 2022).
[131] Aristizabal MJ, Anreiter I, Halldorsdottir T, Odgers CL, McDade TW, Goldenberg A, et al. Biological embedding of experience: A primer on epigenetics. Proc Natl Acad Sci 2020;117:23261–9. https://doi.org/10.1073/pnas.1820838116.
[132] Berens AE, Jensen SKG, Nelson CA. Biological embedding of childhood adversity: from physiological mechanisms to clinical implications. BMC Med 2017;15:135. https://doi.org/10.1186/s12916-017-0895-4.
[133] Hertzman C. Putting the concept of biological embedding in historical perspective. Proc Natl Acad Sci 2012;109:17160–7. https://doi.org/10.1073/pnas.1202203109.
[134] Morgan B. Biological embedding of early childhood adversity: Toxic stress and the vicious cycle of poverty in South Africa n.d.:11.
[135] Nelson CA. Hazards to Early Development: The Biological Embedding of Early Life Adversity. Neuron 2017;96:262–6. https://doi.org/10.1016/j.neuron.2017.09.027.
[136] Biological embedding: evaluation and analysis of an emerging concept for nursing scholarship - PubMed n.d. https://pubmed.ncbi.nlm.nih.gov/27682606/ (accessed July 15, 2022).
[137] Nelson CA. Biological embedding of early life adversity. JAMA Pediatr 2013;167:1098–100. https://doi.org/10.1001/jamapediatrics.2013.3768.
[138] Nelson HJ, Kendall GE, Shields L. Neurological and Biological Foundations of Children's Social and Emotional Development: An Integrated Literature Review. J Sch Nurs 2014;30:240–50. https://doi.org/10.1177/1059840513513157.
[139] Hart H, Rubia K. Neuroimaging of child abuse: a critical review. Front Hum Neurosci 2012;6.
[140] Knickmeyer RC, Gouttard S, Kang C, Evans D, Wilber K, Smith JK, et al. A structural MRI study of human brain development from birth to 2 years. J Neurosci Off J Soc Neurosci 2008;28:12176–82. https://doi.org/10.1523/JNEUROSCI.3479-08.2008.
[141] McEwen BS, Gianaros PJ. Stress- and allostasis-induced brain plasticity. Annu Rev Med 2011;62:431–45. https://doi.org/10.1146/annurev-med-052209-100430.
[142] Lister R, Pelizzola M, Dowen RH, Hawkins RD, Hon G, Tonti-Filippini J, et al. Human DNA methylomes at base resolution show widespread epigenomic differences. Nature 2009;462:315–22. https://doi.org/10.1038/nature08514.
[143] Lister R, Mukamel EA, Nery JR, Urich M, Puddifoot CA, Johnson ND, et al. Global epigenomic reconfiguration during mammalian brain development. Science 2013;341:1237905. https://doi.org/10.1126/science.1237905.
[144] McGowan PO, Suderman M, Sasaki A, Huang TCT, Hallett M, Meaney MJ, et al. Broad epigenetic signature of maternal care in the brain of adult rats. PloS One 2011;6:e14739. https://doi.org/10.1371/journal.pone.0014739.
[145] Weaver ICG, Cervoni N, Champagne FA, D'Alessio AC, Sharma S, Seckl JR, et al. Epigenetic programming by maternal behavior. Nat Neurosci 2004;7:847–54. https://doi.org/10.1038/nn1276.
[146] McGowan PO, Sasaki A, D'Alessio AC, Dymov S, Labonté B, Szyf M, et al. Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. Nat Neurosci 2009;12:342–8. https://doi.org/10.1038/nn.2270.

[147] Lam LL, Emberly E, Fraser HB, Neumann SM, Chen E, Miller GE, et al. Factors underlying variable DNA methylation in a human community cohort. Proc Natl Acad Sci U S A 2012;109:17253–60. https://doi.org/10.1073/pnas.1121249109.
[148] Boyce WT, Kobor MS. Development and the epigenome: the “synapse” of gene-environment interplay. Dev Sci 2015;18:1–23. https://doi.org/10.1111/desc.12282.
[149] Dunn EC, Soare TW, Zhu Y, Simpkin AJ, Suderman MJ, Klengel T, et al. Sensitive Periods for the Effect of Childhood Adversity on DNA Methylation: Results From a Prospective, Longitudinal Study. Biol Psychiatry 2019;85:838–49. https://doi.org/10.1016/j.biopsych.2018.12.023.
[150] The Productivity Argument for Investing in Young Children on JSTOR n.d. https://www.jstor.org/stable/4624854 (accessed July 15, 2022).
[151] Africa SS. Investing in early childhood development is the future | Statistics South Africa n.d. https://www.statssa.gov.za/?p=10950 (accessed June 1, 2022).
[152] Heckman J, Grunewald R, Reynolds A. The Dollars and Cents of Investing Early: Cost-Benefit Analysis in Early Care and Education. Zero Three 2006;26:10–7.
[153] Chevalier A, Finn C, Harmon C, Heckman J. The microeconomics of early child investment. J Child Serv 2006;1:18–30. https://doi.org/10.1108/17466660200600011.
[154] Elango S, García JL, Heckman JJ, Hojman A. Early Childhood Education. Econ. Means-Test. Transf. Programs U. S. Vol. 2, University of Chicago Press; 2015, p. 235–97.
[155] Carneiro P, Ginja R. Long-Term Impacts of Compensatory Preschool on Health and Behavior: Evidence from Head Start. Am Econ J Econ Policy 2014;6:135–73.
[156] Boca DD, Martino EM, Piazzalunga D. Investments in Early Education and Child Outcomes: The Short and the Long Run n.d.:7.
[157] Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. Am J Prev Med 1998;14:245–58. https://doi.org/10.1016/s0749-3797(98)00017-8.
[158] Schechter DS, Willheim E, Hinojosa C, Scholfield-Kleinman K, Turner JB, McCaw J, et al. Subjective and objective measures of parent-child relationship dysfunction, child separation distress, and joint attention. Psychiatry 2010;73:130–44. https://doi.org/10.1521/psyc.2010.73.2.130.
[159] Hollenstein T, Granic I, Stoolmiller M, Snyder J. Rigidity in parent-child interactions and the development of externalizing and internalizing behavior in early childhood. J Abnorm Child Psychol 2004;32:595–607. https://doi.org/10.1023/b:jacp.0000047209.37650.41.
[160] Aro T, Eklund K, Eloranta A-K, Närhi V, Korhonen E, Ahonen T. Associations Between Childhood Learning Disabilities and Adult-Age Mental Health Problems, Lack of Education, and Unemployment. J Learn Disabil 2019;52:71–83. https://doi.org/10.1177/0022219418775118.
[161] Luby JL, Rogers C, McLaughlin KA. Environmental Conditions to Promote Healthy Childhood Brain/Behavioral Development: Informing Early Preventive Interventions for Delivery in Routine Care. Biol Psychiatry Glob Open Sci 2021. https://doi.org/10.1016/j.bpsgos.2021.10.003.
[162] National Development Plan 2030 | South African Government n.d. https://www.gov.za/issues/national-development-plan-2030 (accessed June 1, 2022).
[163] Gil-Hernández C. The (Unequal) Interplay Between Cognitive and Noncognitive Skills in Early Educational Attainment. Am Behav Sci 2021;65. https://doi.org/10.1177/0002764221996764.
[164] Shonkoff JP, Richter L, van der Gaag J, Bhutta ZA. An integrated scientific framework for child survival and early childhood development. Pediatrics 2012;129:e460-472. https://doi.org/10.1542/peds.2011-0366.
[165] Black MM, Walker SP, Fernald LCH, Andersen CT, DiGirolamo AM, Lu C, et al. Early childhood development coming of age: science through the life course. The Lancet 2017;389:77–90. https://doi.org/10.1016/S0140-6736(16)31389-7.

[166] Daelmans B, Darmstadt GL, Lombardi J, Black MM, Britto PR, Lye S, et al. Early childhood development: the foundation of sustainable development. The Lancet 2017;389:9–11. https://doi.org/10.1016/S0140-6736(16)31659-2.
[167] Munsell EP, Kilmer RP, Cook JR, Reeve CL. The Effects of Caregiver Social Connections on Caregiver, Child, and Family Well-Being. Am J Orthopsychiatry 2012;82:137–45. https://doi.org/10.1111/j.1939-0025.2011.01129.x.
[168] q-a-on-child-care.pdf n.d.
[169] Wang K, Qi Y, Wei Q, Shi Y, Zhang Y, Shi H. Responsive Caregiving and Opportunities for Early Learning Associated With Infant Development: Results From a Prospective Birth Cohort in China. Front Pediatr 2022;10.
[170] Scherer E, Hagaman A, Chung E, Rahman A, O'Donnell K, Maselko J. The relationship between responsive caregiving and child outcomes: evidence from direct observations of mother-child dyads in Pakistan. BMC Public Health 2019;19:252. https://doi.org/10.1186/s12889-019-6571-1.
[171] Lucas J, Richter L, Daelmans B. Care for Child Development: an intervention in support of responsive caregiving and early child development: Care for Child Development. Child Care Health Dev 2018;44:41–9. https://doi.org/10.1111/cch.12544.
[172] Ameyaw R, Ameyaw E, Agbenorhevi JK, Hammond CK, Arhin B, Afaa TJ. Assessment of knowledge and socioeconomic status of caregivers of children with malnutrition at a district hospital in Ghana. Afr Health Sci 2023;23:693–703. https://doi.org/10.4314/ahs.v23i1.74.
[173] carergivers socioeconomic status and early childhood development - Google Search n.d. https://www.google.com/search?q=carergivers+socioeconomic+status+and+early+childhood+development&rlz=1C1GCEU_enZA858ZA858&oq=carergivers+socioeconomic+status+and+early+childhood+development&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCTM1MTk4ajBqN6gCALACAA&sourceid=chrome&ie=UTF-8#ip=1 (accessed October 2, 2023).
[174] Slemming W, Norris SA, Kagura J, Saloojee H, Richter L. Child development at age 5 years: The effects of maternal education, socioeconomic status and early-life growth examined prospectively in a low-resource setting. South Afr J Child Health 2022;16:111–6. https://doi.org/10.7196/SAJCH.2022.v16i2.1846.
[175] Moore TG, McDonald M, Carlon L, O'Rourke K. Early childhood development and the social determinants of health inequities. Health Promot Int 2015;30:ii102–15. https://doi.org/10.1093/heapro/dav031.
[176] Hekli P. EFFECT OF SOCIOECONOMIC STATUS ON CAREGIVERS' KNOWLEDGE AND BELIEFS REGARDING CHILD HEALTH CARE IN SAVELUGU NANTON, GHANA n.d.
[177] Gao Y, Zhang L, Kc A, Wang Y, Zou S, Chen C, et al. Housing environment and early childhood development in sub-Saharan Africa: A cross-sectional analysis. PLOS Med 2021;18:e1003578. https://doi.org/10.1371/journal.pmed.1003578.
[178] How Socioeconomic Status Impacts Early Childhood Development - Video & Lesson Transcript. StudyCom n.d. https://study.com/academy/lesson/how-socioeconomic-status-impacts-early-childhood-development.html (accessed October 2, 2023).
[179] Lopez Boo F. Socio-economic status and early childhood cognitive skills: A mediation analysis using the Young Lives panel. Int J Behav Dev 2016;40:500–8. https://doi.org/10.1177/0165025416644689.
[180] Wong KLM, Restrepo-Méndez MC, Barros AJD, Victora CG. Socioeconomic inequalities in skilled birth attendance and child stunting in selected low and middle income countries: Wealth quintiles or deciles? PLoS ONE 2017;12:e0174823. https://doi.org/10.1371/journal.pone.0174823.
[181] De Wet N. The association between mother's socioeconomic status and non-orphan kinship care arrangements in South Africa. Child Youth Serv Rev 2019;103:79–86. https://doi.org/10.1016/j.childyouth.2019.05.015.

[182] Drago F, Scharf RJ, Maphula A, Nyathi E, Mahopo TC, Svensen E, et al. Psychosocial and environmental determinants of child cognitive development in rural south africa and tanzania: findings from the mal-ed cohort. BMC Public Health 2020;20:505. https://doi.org/10.1186/s12889-020-08598-5.
[183] Cavalcante MCV, Lamy ZC, França AKTC, Pereira MUL, Ferraro AA, Barbieri MA, et al. Psychological distress and mother-child relationship: influence of life context on a population sample (BRISA) through the use of directed acyclic graphs (DAG). Braz J Med Biol Res 2020;54:e10080. https://doi.org/10.1590/1414-431X202010080.
[184] Mothers caring for children living with cerebral palsy: Suggestions for psycho-social support n.d. http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0037-80542021000300008 (accessed October 2, 2023).
[185] Zafar S, Sikander S, Haq Z, Hill Z, Lingam R, Skordis-Worrall J, et al. Integrating maternal psychosocial well-being into a child-development intervention: the five-pillars approach. Ann N Y Acad Sci 2014;1308:107–17. https://doi.org/10.1111/nyas.12339.
[186] Narvaez D, Wang L, Cheng A, Gleason TR, Woodbury R, Kurth A, et al. The importance of early life touch for psychosocial and moral development. Psicol Reflex E Crítica 2019;32:16. https://doi.org/10.1186/s41155-019-0129-0.
[187] How Culture Influences a Child's Development | Psychology Paper Example. PsychologyWriting n.d. https://psychologywriting.com/how-culture-influences-a-childs-development/ (accessed October 2, 2023).
[188] Pumariega AJ, Joshi SV. Culture and Development in Children and Youth. Child Adolesc Psychiatr Clin N Am 2010;19:661–80. https://doi.org/10.1016/j.chc.2010.08.002.
[189] Cultural Influences on Child Development. Maryville Online 2021. https://online.maryville.edu/blog/cultural-influences-on-child-development/ (accessed October 2, 2023).
[190] Ball J. Culture and Early Childhood Education n.d.
[191] Culture: Early childhood education | Encyclopedia on Early Childhood Development 2023. https://www.child-encyclopedia.com/culture/according-experts/culture-and-early-childhood-education (accessed October 2, 2023).
[192] CodeIT, NDFAuthors. The Role of Culture in Early Childhood Development. Novak Djokovic Found 2021. https://novakdjokovicfoundation.org/the-role-of-culture-in-early-childhood-development/ (accessed October 2, 2023).
[193] Yang W, Li H. The role of culture in early childhood curriculum development: A case study of curriculum innovations in Hong Kong kindergartens. Contemp Issues Early Child 2020;23. https://doi.org/10.1177/1463949119900359.
[194] Alhosani N. The Influence of Culture on Early Childhood Education Curriculum in the UAE. ECNU Rev Educ 2022;5:284–98. https://doi.org/10.1177/20965311221085984.
[195] Kuusisto A, editor. The Routledge International Handbook of the Place of Religion in Early Childhood Education and Care. London: Routledge; 2022. https://doi.org/10.4324/9781003017783.
[196] Sociologists study the impact religion has on child development. ScienceDaily n.d. https://www.sciencedaily.com/releases/2019/02/190207123220.htm (accessed October 2, 2023).
[197] Religions | Free Full-Text | Developmental Implications of Children's Early Religious and Spiritual Experiences in Context: A Sociocultural Perspective n.d. https://www.mdpi.com/2077-1444/10/11/631 (accessed October 2, 2023).
[198] Bartkowski JP, Xu X, Levin ML. Religion and child development: Evidence from the Early Childhood Longitudinal Study. Soc Sci Res 2008;37:18–36. https://doi.org/10.1016/j.ssresearch.2007.02.001.
[199] How Does Religion Impact Child Development? n.d. https://psychcentral.com/news/2019/02/09/how-does-religion-impact-child-development (accessed October 2, 2023).
[200] Akrim A, Junaidi J. A study of the role of religious development in childhood on psychological health in Indonesia. HTS Teol Stud Theol Stud 2021;77:6.

[201] Chung EO, Fernald LCH, Galasso E, Ratsifandrihamanana L, Weber AM. Caregiver perceptions of child development in rural Madagascar: a cross-sectional study. BMC Public Health 2019;19:1256. https://doi.org/10.1186/s12889-019-7578-3.
[202] Ayob Z, Christopher C, Naidoo D. Exploring Caregivers' Perceptions on Their Role in Promoting Early Childhood Development. Early Child Dev Care 2022;192:1462–76. https://doi.org/10.1080/03004430.2021.1888943.
[203] Ayob Z, Christopher C, Naidoo D. Caregivers' Perception of their Role in Early Childhood Development and Stimulation Programmes in the Early Childhood Development Phase within a Sub-Saharan African Context: An Integrative Review. South Afr J Occup Ther 2021;51:84–92. https://doi.org/10.17159/2310-3833/2021/vol51n3a10.
[204] Chung EO, Fernald LCH, Galasso E, Ratsifandrihamanana L, Weber A. Caregiver Perceptions of Child Development: A Cross-Sectional Study. The World Bank; 2019. https://doi.org/10.1596/1813-9450-9030.
[205] Miller P, Votruba-Drzal E. Early academic skills and childhood experiences across the urban–rural continuum. Early Child Res Q 2013;28:234–48. https://doi.org/10.1016/j.ecresq.2012.12.005.
[206] Parent–child interactions and child outcomes: Evidence from randomized intervention - ScienceDirect n.d. https://www.sciencedirect.com/science/article/abs/pii/S092753711830085X (accessed March 8, 2025).
[207] Africa SS. Five facts about poverty in South Africa | Statistics South Africa 2019. https://www.statssa.gov.za/?p=12075 (accessed August 11, 2024).
[208] PROFILE: Mopani DISTRICT municipality n.d.
[209] McKerrow N, Mulaudzi M, Boon G, ferris A, Gaede B, Mabuza F, et al. 2 ND TRIENNIAL REPORT OF THE COMMITTEE ON MORBIDITY AND MORTALITY IN CHILDREN UNDER 5 YEARS (COMMIC): 2014. 2014. https://doi.org/10.13140/RG.2.2.33374.89928.
[210] Rockers PC, Leppänen JM, Tarullo A, Coetzee L, Fink G, Hamer DH, et al. Evaluation of a community health worker home visit intervention to improve child development in South Africa: A cluster-randomized controlled trial. PLOS Med 2023;20:e1004222. https://doi.org/10.1371/journal.pmed.1004222.
[211] McCoy DC, Waldman M, Fink G. Measuring early childhood development at a global scale: Evidence from the Caregiver-Reported Early Development Instruments. Early Child Res Q 2018;45:58–68. https://doi.org/10.1016/j.ecresq.2018.05.002.
[212] Citations – REDCap n.d. https://projectredcap.org/resources/citations/ (accessed March 8, 2025).
[213] Wealth-Quintile-Guide.pdf n.d.
[214] WHO Multicentre Growth Reference Study (MGRS) n.d. https://www.who.int/tools/child-growth-standards/who-multicentre-growth-reference-study (accessed August 10, 2024).
[215] Abidin R, Flens JR, Austin WG. The Parenting Stress Index. Forensic Uses Clin. Assess. Instrum., Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers; 2006, p. 297–328. https://doi.org/10.1037/14643-020.
[216] Mental health related determinants of parenting stress among urban mothers of young children – results from a birth-cohort study in Ghana and Côte d'Ivoire | BMC Psychiatry n.d. https://link.springer.com/article/10.1186/1471-244X-14-156 (accessed August 18, 2024).
[217] Oburu: Parenting stress and self-reported discipline... - Google Scholar n.d. https://scholar.google.com/scholar_lookup?title=Parenting+stress+and+self-reported+discipline+strategies+of+Kenyan+caregiving+grandmothers&author=Oburu,+P.O.&author=Palmerus,+K.&publication_year=2003&journal=Int.+J.+Behav.+Dev.&volume=27&pages=505%E2%80%935012&doi=10.1080/01650250344000127 (accessed August 18, 2024).

[218] Brathwaite R, Magorokosho N, Namuwonge F, Tutlam N, Neilands TB, McKay MM, et al. Typology and correlates of parental stress among caregivers of children with DBDs in low-resourced communities in Uganda. PLOS Glob Public Health 2023;3:e0002306. https://doi.org/10.1371/journal.pgph.0002306.
[219] Esan O, Akinsulore A, Yusuf MB, Adegbehingbe OO. Assessment of emotional distress and parenting stress among parents of children with clubfoot in south-western Nigeria. SA Orthop J 2017;16:26–31. https://doi.org/10.17159/2309-8309/2017/v16n2a2.
[220] Mbatha NL, Mokwena KE. Parental Stress in Raising a Child with Developmental Disabilities in a Rural Community in South Africa. Int J Environ Res Public Health 2023;20:3969. https://doi.org/10.3390/ijerph20053969.
[221] J P, A S, P C. Parenting stress of caregivers of young children who are HIV Positive. Afr J Psychiatry 2007;10. https://doi.org/10.4314/ajpsy.v10i4.30257.
[222] The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education | Research in Science Education n.d. https://link.springer.com/article/10.1007/s11165-016-9602-2 (accessed April 8, 2024).
[223] Altafim ERP, McCoy DC, Brentani A, Escobar AM de U, Grisi SJFE, Fink G. Measuring early childhood development in Brazil: validation of the Caregiver Reported Early Development Instruments (CREDI). J Pediatr Engl Ed 2020;96:66–75. https://doi.org/10.1016/j.jped.2018.07.008.
[224] New in Stata 18 | Stata n.d. https://www.stata.com/new-in-stata/ (accessed August 11, 2024).
[225] Flouri E, Midouhas E, Joshi H. Family poverty and trajectories of children's emotional and behavioural problems: the moderating roles of self-regulation and verbal cognitive ability. J Abnorm Child Psychol 2014;42:1043–56. https://doi.org/10.1007/s10802-013-9848-3.
[226] Adynski H, Propper C, Beeber L, Gilmore JH, Zou B, Santos HP. The role of social adversity on emotional dysregulation during infancy and early childhood. J Pediatr Nurs 2023;72:26–35. https://doi.org/10.1016/j.pedn.2023.03.010.
[227] Yu D, Caughy MO, Smith EP, Oshri A, Tresch M. Severe Poverty and Growth in Behavioral Self-Regulation: The Mediating Role of Parenting. J Appl Dev Psychol 2020;68:101135. https://doi.org/10.1016/j.appdev.2020.101135.
[228] Webster EM. The Impact of Adverse Childhood Experiences on Health and Development in Young Children. Glob Pediatr Health 2022;9:2333794X221078708. https://doi.org/10.1177/2333794X221078708.
[229] Perry EW, Hwang S, Marah B, Kondowulay Mansaray Y, Self-Brown S, Kim ET, et al. "If you take care of that child, tomorrow it will be a profit to you and an entire generation": A qualitative evaluation of a program to prevent ACEs and promote child development in Northern Sierra Leone. Child Prot Pract 2025;4:100090. https://doi.org/10.1016/j.chipro.2024.100090.
[230] Aye E, Nwakaego A, Adimora D, Offorka T, Robinson A, Nwosu P, et al. Family Conflict and Managing Strategies: Implication for Understanding Emotion and Power Struggles. Glob J Psychol Res New Trends Issues 2017;6. https://doi.org/10.18844/gjpr.v6i3.1454.
[231] Ambhore A, Ashtaputre A, Aurangabad B, Puri P, Bhutekar S. Communication Problem and Conflicts in Parent Child Relationship. 2022.
[232] Ekholuenetale M, Barrow A, Ekholuenetale CE, Tudeme G. Impact of stunting on early childhood cognitive development in Benin: evidence from Demographic and Health Survey. Egypt Pediatr Assoc Gaz 2020;68:31. https://doi.org/10.1186/s43054-020-00043-x.
[233] Chavez AE, Troxel M, Sheldrick RC, Eisenhower A, Brunt S, Carter AS. Child social-emotional and behavioral problems and competencies contribute to changes in developmental functioning during Early Intervention. Early Child Res Q 2024;66:245–54. https://doi.org/10.1016/j.ecresq.2023.10.009.

[234] Löytömäki J, Laakso M-L, Huttunen K. Social-Emotional and Behavioural Difficulties in Children with Neurodevelopmental Disorders: Emotion Perception in Daily Life and in a Formal Assessment Context. J Autism Dev Disord 2023;53:4744–58. https://doi.org/10.1007/s10803-022-05768-9.
[235] Miller AR, Gardiner E, Harding L. Behavioural and emotional concerns reported by parents of children attending a neurodevelopmental diagnostic centre. Child Care Health Dev 2018;44:711–20. https://doi.org/10.1111/cch.12594.
[236] The Neurodevelopmental Basis of Early Childhood Disruptive Behavior: Irritable and Callous Phenotypes as Exemplars n.d. https://doi.org/10.1176/appi.ajp.2017.17010045.
[237] Castro M, Fernández V, Martínez A, Alcántara M, Campillo A, López-Soler C. Relationship Between Neurodevelopmental Areas and Difficulties in Emotional-Behavioural Variables in Children With Typical Development Under 2 Years of Age: Sex Differences. Psychol Belg 2024;64. https://doi.org/10.5334/pb.1203.
[238] Baker BL, Blacher J, Crnic KA, Edelbrock C. Behavior Problems and Parenting Stress in Families of Three-Year-Old Children With and Without Developmental Delays. Am J Ment Retard 2002;107:433–44. https://doi.org/10.1352/0895-8017(2002)107<0433:BPAPSI>2.0.CO;2.
[239] Preventing exclusion from the Child Support Grant | UNICEF South Africa 2013. https://www.unicef.org/southafrica/reports/preventing-exclusion-child-support-grant (accessed August 13, 2024).
[240] Patel L, Knijn T, Wel FW. Child Support Grants in South Africa: A Pathway to Women's Empowerment and Child Well-being? J Soc Policy 2015;44:377–97. https://doi.org/10.1017/S0047279414000919.
[241] Nzuza K. Barriers contributing to the exclusion of eligible child support grant beneficiaries in Umzinto rural community of KwaZulu-Natal, South Africa n.d.

2 Chapter Two: Manuscript

The role of Parent–Child Dysfunctional Interaction and Difficult Child on Early Childhood Neurodevelopment in Rural Community of Limpopo, South Africa

Nelisiwe Mkize[1], Lezanie Coetzee[2], Jukka Leppänen[3], Peter Rockers[4], Denise Evans[2]

1 School of Public Health, University of the Witwatersrand, Johannesburg, South Africa.

2 Health Economics and Epidemiology Research Office, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa.

3 Department of Psychology and Speech-Language Pathology, University of Turku, Turku, Finland.

4 Department of Global Health, Boston University School of Public Health, Boston, Massachusetts, United States of America.

Abstract

Background: Parent-child dysfunctional interaction (PCDI) can adversely affect child neurodevelopment domains, overall health outcomes, and their future success. In the context of South Africa, there is a lack of understanding about how parent-child dysfunctional interactions and difficult child behaviours affect a child's neurodevelopment.

Objectives: We assessed the prevalence of elevated neuro parent-child dysfunctional interaction (PCDI) and difficult child (DC) scores and their association with neurodevelopmental outcomes from rural Limpopo Province, South Africa.

Methodology: This cross-sectional analysis was part of a larger “Birth-to-2” cohort study (PACTR 201710002683810) conducted in rural Limpopo Province, South Africa. Trained fieldworkers conducted surveys with caregivers (aged 18 and older) at the household. Neuro

PCDI and DC were measured using the Parenting Stress Index Short Form (PSI™-4-SF) at 17 months of age. We used multivariate regression to investigate the effect of clinically elevated neuro PCDI scores (>27) and DC scores (>33) on neurodevelopmental outcomes.

Results: The study included 178 mother-child dyads, with 72 pairs from the control arm and 106 pairs from the intervention arm. The mean PCDI scores for the intervention and control arms were 0.14 (±0.35) and 0.19 (±0.40), respectively. In terms of DC scores, the means were 0.29 (±0.46) for the intervention arm and 0.28 (±0.45) for the control arm. The study found that elevated PCDI scores were significantly associated with negative cognitive development, while elevated DC scores were linked to significant social-emotional challenges.

Conclusion: The findings highlight the significant impact of negative parent-child interactions, stunting, and financial hardships on neurodevelopment in rural settings. This study underscores the importance of early interventions targeting parent-child interactions and socioeconomic support to mitigate developmental delays in rural South African children. Further research is needed to address the barriers to CSG access and other factors affecting child development in these communities.

Keywords: Early childhood development, Parent-child Interaction,

2.1 Introduction

Early childhood development (ECD) is a critical stage in one's life, as it is the period when neuroplasticity facilitates learning and adaptability, significantly influenced by interactions with the environment [8]. Neurodevelopmental domains such as cognitive, communicative, social-emotional, physical, and adaptive development serve as foundational building blocks during the ECD period and are considered key indicators that predict later life outcomes [163–165]. These domains play a vital role in shaping an individual's trajectory in terms of behaviour, health, economic success, and academic achievement [166]. Among the most influential factors in shaping these early childhood neurodevelopmental domains are parent-child interactions, particularly those that are dysfunctional, as well as the temperamental characteristics of the child, especially when the child displays challenging behaviours.

Dysfunctional caregiver-child interactions, such as inconsistent parenting, neglect, or harsh discipline, are known to disrupt the formation of secure attachments, thereby impacting neural

development. Nurturing interactions, on the other hand, have been shown to support positive neurodevelopmental outcomes. Conversely, dysfunctional interactions can contribute to negative developmental outcomes. It is important to note that the success of the caregiver-child relationship does not solely depend on the caregiver's efforts. It is a bidirectional relationship that involves the regulated interpersonal behaviour of both parties. While the caregiver's characteristics typically play a dominant role, the child's temperament also influences neurodevelopment. A child exhibiting difficult behaviours can strain the caregiver-child relationship, potentially leading to negative neurodevelopmental outcomes The dynamics of this relationship are further shaped by factors such as the caregivers age, gender, responsiveness [167–171], socioeconomic status [172–181], politics, crime and violence, psychosocial capacity [182–186], and contextual beliefs, which include culture [187–194], religion [195–200], and perception regarding parenthood [7,201–204].

Despite the availability of global and national policy frameworks aimed at safeguarding the holistic early childhood development (ECD) period, children from low- and middle-income countries (LMIC) continue to face the challenges of neurodevelopmental delays. In the South African context, it is estimated that 71% of children under the age of 5 live below the upper-bound poverty line. Additionally, about 21% of children do not live with their parents, and 42% live only with their mothers. Furthermore, half of the children under 5 are not enrolled in any early learning development programs, leaving them without adequate stimulation. Among those enrolled in early learning programs, 55% are not developmentally on track.

PCDI and DC behaviours are key early childhood neurodevelopment indicators that have received limited study, particularly in rural contexts. While most studies have explored the impact of parent-child relationships on early childhood development, they have largely focused on urban areas [5,205]. Most of these studies were centered on school-age children and adolescents [206], with a notable lack of research specifically examining PCDI and DC and its impact on early childhood neurodevelopment among children at 17 months of age, particularly in impoverished populations.

Limpopo is one of the rural provinces in South Africa that has the highest headcount of adult poverty [207]. In this context, the current study aimed to investigate the magnitude of elevated parent-child dysfunctional interaction and difficult child (DC) and factors influencing the PCDI and DC scores when children are 17 months of age in rural Limpopo. Furthermore, we aimed

to determine the association between clinically elevated PCDI and DC on early childhood development, as measured using CREDI-z-scores, in children at 17 months of age.

2.2 Methods

2.2.1 Study design

This cross-sectional analysis is part of the larger "Birth-to-2" cohort study (PACTR 201710002683810), conducted in rural Limpopo Province, South Africa. A cross-sectional design was selected for this component because it focused solely on a single time point when the children were 7 months old. The data is owned by the Health Economics and Epidemiology Research Office (HE^2RO), and permission for its use was facilitated by DE, the Principal Investigator. The co-investigators on the primary intervention trial have approved the study's aims, objectives, and the use of trial data, with the condition that data transfer, storage, and processing adhere to the requirements outlined in the study protocol and HE^2RO's Data Management SOPs. Before any data transfer took place, the new co-investigator signed a data use agreement and a confidentiality agreement with HE^2RO.

2.2.2 Study site and population

The trial's study area was in the Mopani District, Limpopo Province, South Africa, specifically covering two full sub-districts: Greater Tzaneen and Greater Giyani. Demographic data shows that children under the age of 5 make up 13-15% of the overall population in this region [208]. Mopani, one of the five districts of Limpopo, faces significant socioeconomic challenges, including high levels of poverty, unemployment, domestic violence, and limited access to healthcare [209]. Most families in the region live below the poverty line, with many relying on government grants or remittances from relatives working in urban areas. These conditions create complex family dynamics that are essential to understanding how PCDI and DC influence early childhood neurodevelopment. Given the socioeconomic and environmental stressors experienced by families in this region, it's critical to explore the factors contributing to PCDI and DC. Ultimately, understanding the role of these factors on early childhood neurodevelopment is crucial for identifying effective interventions to support families in this underserved region.

2.2.3 Primary study

The primary study focused on a cohort of 1,094 caregiver-child dyads, enrolled between December 2017 and March 2018, to assess the impact of an early childhood intervention package delivered by community health workers (CHWs) during routine home visits, as detailed by Rockers et al. [210]. The recruitment of CHWs was based on several criteria: they needed to be part of a ward-based outreach team (WBOT) operating within the two subdistricts of Greater Tzaneen and Greater Giyani, have been working for more than 3 months, be over 18 years old, and be willing to participate in the trial. Additionally, the CHWs needed to have prospective caregiver-child dyads in their catchment area, not be using the mHealth application, and have completed the standard Phase I training, which includes essential skills for delivering community-based healthcare. All CHWs worked under the supervision of an Outreach Team Leader, usually a professional nurse, based within a primary care facility in the community ward.

The recruitment of caregivers and their children was facilitated by eligible CHWs. Caregiver-child dyads were eligible if they resided in Greater Tzaneen or Greater Giyani in the Mopani District, had a child born after December 15, 2017, and met other criteria, such as the caregiver being at least 18 years old and willing to participate in the home visits. The recruitment process targeted low-resource settings to ensure diverse family representation. Once enrolled, the dyads were followed up during the intervention trial.

2.2.4 The neuro sub-study

During the enrolment, a subset from Greater Tzaneen was invited for assessments of neural function at 17 months of age from April to August 2019. This assessment was limited to one subdistrict due to financial constraints, and children with low birth weight (<2.5 kg) or diagnosed developmental disorders were excluded from this subsample. The purpose of this neural function study was to explore the impact of the intervention trial and neurodevelopmental outcomes, such as language, social-emotional, motor, and cognitive development. Caregiver-child dyads were contacted by phone to schedule appointments for the neural assessment at the lab. On the day of the appointment, transport with a designated driver was provided to ensure that the caregiver-child dyads could travel to and from the lab.

2.2.5 Current analysis

For the current analysis, we excluded caregivers who were not biological mothers. This decision was made because the study aimed to assess the impact of PCDI and DC, specifically within the context of biological mother-child relationships on early childhood neurodevelopment. Mother-child dyads who did not have the exposure and outcome of interest were also excluded. The exposure in this study was the Parent Stress Index-Short Form (PSI-SF), which was used to measure PCDI and DC, and the outcome of interest was neurodevelopmental outcomes at 17 months, which were measured using CREDI z-scores [211]. PCDI and DC raw scores were derived from caregiver responses using PSI-SF when the children were 17 months old. By focusing on these specific criteria, the study aimed to investigate the effect of elevated scores of PCDI and DC on neurodevelopment within a cohort of 178 biological mother-child dyads.

2.2.6 Data collection and management

Data were collected by trained CHWs who were part of the WBOTs operating in the Greater Tzaneen and Greater Giyani subdistricts. Before starting the study, the CHWs underwent training to ensure they were familiar with the study protocols, data collection tools, and ethical guidelines.

All participating CHWs conducted home visits to gather data, using standardized data collection tools. These tools were available in English but were also verbally translated into the local languages (Sepedi and Xitsonga) to ensure accurate understanding and administration, given the linguistic diversity of the study area. The data collection process initially followed a paper-based approach, with a household survey conducted at baseline to collect demographic and household assets information. In addition, the exposure data, related to neuro PSI-SF, was collected using a standardized instrument, following the implementer's guidelines. The outcome data, assessing early childhood neurodevelopment, was measured using CREDI z-scores at the lab by trained professionals.

Once the paper-based forms were completed, the data were entered into the Research Electronic Data Capture (REDCap) system. REDCap is a licensed, web-based application designed to manage research data. Data entry was performed by the research team's data capturers, ensuring that all data were accurately transferred from paper forms to the electronic database [212]. This was performed to maintain data integrity and accuracy.

Additionally, the data underwent a quality control (QC) process to ensure high standards. All completed data entry forms were reviewed by senior researchers for consistency and completeness before being finalized in REDCap. Any discrepancies or missing data were flagged for clarification and correction, and regular spot-checks were conducted on random samples of forms to verify the accuracy of the data entry process. Once the data were entered into REDCap, it was exported into STATA version 18 for analysis.

2.2.7 Variables

The study focused on variables that were collected at baseline and at endline when the children were 17 months of age. The baseline data were collected at the onset of enrolment, a few days after the child was born. During enrolments, data on the caregiver's household demographics, income, and household assets, as well as child demographic information, prenatal and early childhood health, family food security, caregiver demographics, the child's anthropometry, and information from the Road to Health Booklet (RTHB) were recorded.

2.2.7.1 Maternal measures

- **Demographic information**: Mothers' demographic information, such as age, marital status, education level, employment, and child's grant, was used as categorical variables. In addition, the household wealth index was calculated by the value of their assets. The household index was categorized into five quintiles, from poorest (wealth quintile 1) to richest (wealth quintile 5) [213].
- **Food insecurity**: Food insecurity was assessed with a question which asked if; "in the past 30 days, was there ever no food to eat of any kind in your house because of lack of resources to get food?". The answer was either yes or no.

2.2.7.2 Child measures

- **Demographic information**: The child's demographic information was recorded (age, sex, birthweight, number of siblings).
- **Anthropometry**: Child anthropometry measures, such as Length-for-Age z-scores (LAZ), Weight-for-Age *Z*-score (WAZ), Weight-for-Height *Z*-score (WHZ), and Mid-upper arm circumference (MUAC), were measured by following the child growth standards stipulated by WHO [214]. Child anthropometry measures were taken closer to birth and when the children were 17 months old of age.

- **Stunting**: The Length-for-Age z-scores of less than -2 standard deviations were used as a criterion for child stunting.
- **Road to health**: The Road to Health booklet was used to source information related to child vaccinations, such as Bacille Calmette-Guérin (BCG), oral poliomyelitis vaccine at baseline (opv0), and oral poliomyelitis vaccine at 6 months (opv1).
- **Overall health**: The overall health of a child was assessed by asking the caregiver to rate the child's health on the day of the screening. The following question was asked: "Overall, how would you rate the child's health today?"; and the caregiver was made to choose an option from "poor", "fair", "good", "very good", or "excellent". For statistical analysis, these options were categorized into three groups: "poor or fair," "good, and "very good," and "excellent."

Main exposure: Parent-child interaction was measured using the Parenting Stress Index-Short Form (PSI-SF) screening tool [215]. The PSI-SF is a validated and reliable tool to assess the magnitude of parent-child dysfunctional interactions (PCDI) and difficult child (DC). Parent-Child Dysfunctional Interaction assessed the extent to which parents feel satisfied with their child and their interactions with them, and DC assessed how a parent perceives their child to be, whether the child is easy or difficult to take care of. Parents reported their level of agreement with 24 items of the PSI-SF. In essence, there are normally three subscales, but the Parent Distress (PD) subscale was not included in the current study's survey. It was not possible to calculate the total score and, therefore, the percentile, because we did not have all three subscale scores. Instead, raw scores for PCDI and DC were calculated by adding items 1 to 12 for PCDI and items 13 to 24 for DC. For PCDI, the cut-off conditions were set to above 27 and ≤27. A score above 27 indicated clinically elevated PCDI. Furthermore, the cut-off conditions for DC were set to 33 and ≤33, and a score above 33 indicated clinically elevated DC. The parental distress was not calculated because the survey did not focus on this domain; however, the PSI-SF was successful in measuring raw scores PCDI and DC domains as intended. The PSI-SF was a suitable tool for the current study; it has been previously used in the African context [216–219] and the South African population [220,221]. Apart from raw scores, principal component analysis was computed to identify patterns in a data set. Kaiser-Meyer Olkin (KMO) test and Cronbach's alpha [222] measured sample adequacy and internal consistency reliability, respectively.

Main outcome: The Child Rearing and Early Development Inventory (CREDI) was the outcome of interest. The CREDI is a comprehensive tool used to assess neurodevelopment

across various domains in children up to 3 years of age. At 17 months, the CREDI evaluates key neurodevelopmental areas, including cognitive, language, motor, and social-emotional development [211,223]. The CREDI produces domain-specific scores and an overall developmental score, providing a detailed assessment of early childhood development. This tool has been validated in multiple settings and is widely used in research focused on early childhood development. The CREDI data were presented as domain-specific z-scores to capture variations in neurodevelopmental outcomes at 17 months.

2.2.8 Statistical approach

All analyses were conducted using Stata/MP Version 18.0 [224]. Descriptive statistics were calculated separately for mothers and children, with categorical variables being reported as counts and percentages, while continuous variables were summarized as means with standard deviations (SD).

To compare the characteristics of mothers versus non-mothers (i.e., those included versus not included in the study), as well as by geographic location (Giyani vs. Tzaneen), we performed appropriate statistical tests. For continuous variables, we used the t-test to assess differences between groups, while categorical variables were compared using the chi-square test. This allowed us to identify any significant differences in the characteristics of the two groups, depending on maternal status and location.

Subsequently, bivariate and multivariable logistic regression analyses were performed to independently determine factors influencing PCDI and DC. A p-value less than 0.25 under a bivariate analysis (unadjusted odds ratio and 95% CI) was used to select variables for the multivariate analysis. Based on existing literature, the multivariate model (adjusted odds ratio and 95% CI) included the selected variables and additional variables known to influence PCDI and DC, but were not statistically significantly associated with PCDI and DC in the bivariate analysis. Multiple models were tested per domain (3 models each), and the best models were chosen based on the AIC values (the lowest AIC value indicated a better-fit model), with a significance level of p-value < 0.05. Lastly, the final models for PCDI and DC domains were subjected to diagnostic testing.

Finally, regression models were employed to evaluate the impact of elevated PCDI and DC scores on neurodevelopment at 17 months. The analyses were only performed independently on clinically elevated groups for PCDI and DC. The independent variables were the neurodevelopmental domain scores for language, social-emotional, motor, and cognitive development. Control variables, such as mothers' age, child's sex, mother's education status, family size, and family wealth, were included to adjust for potential confounding factors.

2.2.9 Ethics considerations

The primary intervention trial was approved by the Human Research Ethics Committee of the University of the Witwatersrand (M160251) and registered with the South African Clinical Trials Registry (SANCTR) under reference number PACTR201710002683810. All participants provided written informed consent to take part in the study and agreed that their de-identified data could be shared with co-investigators for research purposes. The current study utilized secondary data extracted from the primary trial. Additionally, this cross-sectional study received ethical approval from the Human Research Ethics Committee of the University of the Witwatersrand (M220670).

2.3 Results

Figure 2.1 outlines the participant flow throughout the study, clearly illustrating the key stages of participant selection, exclusion, and retention. Initially, 1,095 caregivers were assessed for eligibility, but 540 were excluded because they were not biological mothers. This left 607 participants in the intervention group (IG) and 488 in the control group (CG). After this exclusion, the remaining dataset included 555 participants, with 311 in the IG and 244 in the CG (see Table 2 for further details). Of these, 377 participants were excluded from the neuro sub-study, including 205 from the IG and 172 from the CG. Finally, 178 participants remained eligible for the downstream analyses, including 106 from the IG and 72 from the CG.

CONSORT DIAGRAM

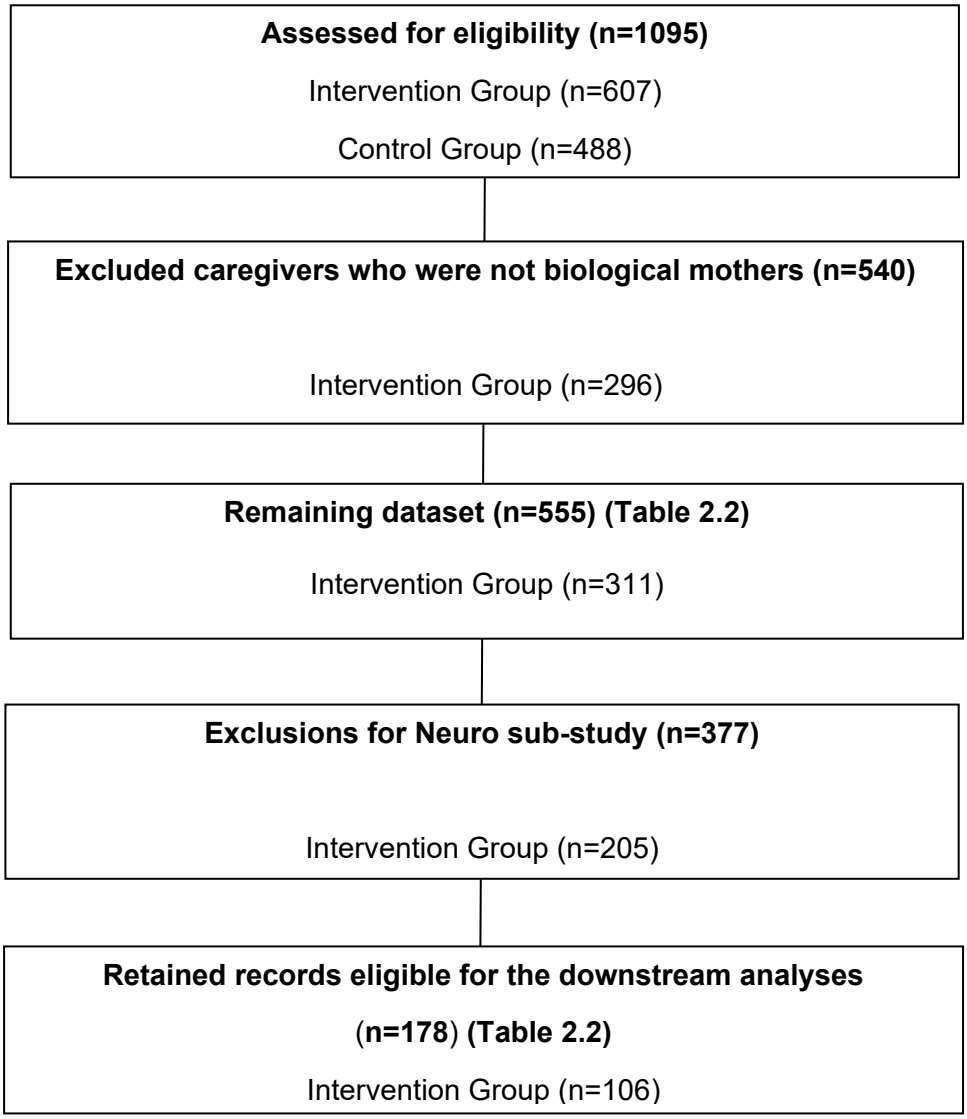

Figure 2.1: Consort diagram showing data management

Parent-child interaction using the Parental Stress Index

Table 2.1 shows that at 17 months, assessment using the Parental Stress Index indicated moderate levels of stress in parent-child relationships. For the PCDI sub-scale, most participants fell within the normal range. No significant group difference was observed between the control and intervention arms, suggesting the intervention had no measurable impact on dysfunctional interaction scores at this stage.

In contrast, results from the DC sub-scale indicated a significant group difference was observed between the control and intervention arms. This suggests that children in the intervention group were more often perceived as difficult, although the difference in proportions was modest.

Table 2.1: Parent-child dysfunctional interaction (PCDI) and difficult child (DC) sub-scales at 17 months of age (n=178).

	Mean (±SD)	**Elevated n, (%)**	**Normal n, (%)**	**P-value**
Total				
PCDI	24.3 (±4.9)	29/178 (16.3)	149/178 (83.7)	-
DC	29.4 (±7.5)	51/178 (28.7)	127/178 (71.3)	
Parent-child dysfunctional interaction				
CG	25.5 (±5.1)	14/72 (19.4)	58/72 (80.6)	0.881
IG	23.5 (±4.6)	15/106 (14.2)	91/106 (85.8)	
Difficult child				
CG	29.0 (±7.1)	20/72 (27.8)	52/72 (72.2)	0.045
IG	29.6 (±7.8)	31/106 (29.2)	75/106 (70.8)	

Abbreviations: SD -standard deviation, CG- Control Group, IG- Intervention Group

Characteristics at baseline in the primary cohort

Descriptive statistics (Table 2.2) showed that baseline characteristics of the cohort revealed several key socio-demographic and regional differences. Mothers in Greater Giyani were generally older, more likely to be married, and more dependent on child grants than their counterparts in Greater Tzaneen. Educational attainment, employment status, and household size were similar across sub-districts, although wealth distribution varied notably.

Among children, boys were more common in Greater Giyani. While average birth measurements were similar, children in Greater Tzaneen had larger head circumferences and

higher rates of stunting. Vaccination coverage was high but differed by region, with Greater Tzaneen reporting better coverage for both BCG and OPV0. Health status indicators also varied, with more children in Greater Tzaneen reported as being in good or excellent health.

Table 2.2: Socio-demographic characteristics of mothers and children pairs enrolled in the main study, by sub-district (n=555).

Variable		**Primary cohort (Mothers)**	**Greater Giyani**	**Greater Tzaneen**	**p-value***	**Primary cohort (not mothers)**	**p-value#**	**Included in analysis**
		N=555	N=296	N=259		N=540		N=178
Treatment	Control Group	244 (44.0)	131 (44.3)	113 (43.6)	0.882	243 (45.0)	0.092	72 (40.4%)
	Intervention Group	311 (56.0)	165 (55.7)	146 (56.4)		297 (55.0)		106 (59.6%)
Age, years	Mean (±SD)	30.9 (±8.2)	31.9 (±8.5)	29.9 (±7.8)	**0.004**	32.6 (±12.1)	0.260	30.1 (7.5)
	18-34	384 (69.2)	190 (64.2)	194 (74.9)	0.127	367 (68.0)	0.504	132 (74.2%)
	35-40	110 (19.8)	66 (22.3)	44 (17.0)		67 (12.4)		31 (17.4%)
	41-50	40 (7.2)	27 (9.1)	13 (5.0)		51 (9.4)		10 (5.6%)
	51-60	9 (1.6)	6 (2.0)	3 (1.2)		25 (4.6)		2 (1.1%)
	61-70	6 (1.1)	4 (1.4)	2 (0.8)		19 (3.5)		1 (0.6%)
	70-100	0 (0.0)	0 (0.0)	0 (0.0)		6 (1.1)		0 (0.0)
	Missing	6 (1.1)	3 (1.0)	3 (1.2)		5 (0.9)		2 (1.1%)
Marital status	Married or Permanent partner	306 (55.1)	193 (65.2)	113 (43.6)	**<0.001**	246 (45.6)	**<0.001**	79 (44.4%)
	Divorced or separated	8 (1.4)	3 (1.0)	5 (1.9)		9 (1.7)		2 (1.1%)
	Single	229 (41.3)	94 (31.8)	135 (52.1)		253 (46.9)		93 (52.2%)
	Widowed	6 (1.1)	5 (1.7)	1 (0.4)		17 (3.1)		1 (0.6%)
	Missing	6 (1.1)	1 (0.3)	5 (1.9)		15 (2.8)		3 (1.7%)
Years of education completed	0-7	78 (14.1)	50 (16.9)	28 (10.8)	0.192	102 (18.9)	**0.017**	21 (11.8%)
	8-11	267 (48.1)	134 (45.3)	133 (51.4)		219 (40.6)		87 (48.9%)
	≥12	200 (36.0)	107 (36.1)	93 (35.9)		207 (38.3)		67 (37.6%)
	Missing	10 (1.8)	5 (1.7)	5 (1.9)		12 (2.2)		3 (1.7%)
Employment	Unemployed	495 (89.2)	271 (91.6)	224 (86.5)	0.125	468 (86.7)	0.098	156 (87.6%)
	Employed	56 (10.1)	24 (8.1)	32 (12.4)		71 (13.1)		20 (11.2%)

	Missing	4 (0.7)	1 (0.3)	3 (1.2)		1 (0.2)		2 (1.1%)
Child grant	No	287 (51.7)	113 (38.2)	174 (67.2)	**<0.001**	309 (57.2)	**<0.001**	125 (70.2%)
	Yes	268 (48.3)	183 (61.8)	85 (32.8)		231 (42.8)		53 (29.8%)
Family size	0-4	144 (25.9)	82 (27.7)	62 (23.9)	**0.029**	127 (23.5)	0.114	43 (24.2%)
	5-7	284 (51.2)	159 (53.7)	125 (48.3)		276 (51.1)		88 (49.4%)
	≥8	124 (22.3)	55 (18.6)	69 (26.6)		134 (24.8)		46 (25.8%)
	Missing	3 (0.5)	0 (0.0)	3 (1.2)		3 (0.6)		1 (0.6%)
Family wealth	Poorest	120 (21.6)	80 (27.0)	40 (15.4)	**<0.001**	111 (20.6)	**0.009**	27 (15.2%)
	Poorer	117 (21.1)	62 (20.9)	55 (21.2)		89 (16.5)		35 (19.7%)
	Middle	108 (19.5)	63 (21.3)	45 (17.4)		111 (20.6)		32 (18.0%)
	Rich	113 (20.4)	53 (17.9)	60 (23.2)		106 (19.6)		44 (24.7%)
	Richest	97 (17.5)	38 (12.8)	59 (22.8)		123 (22.8)		40 (22.5%)
Children characteristics								
		Primary cohort (Mothers)	**Greater Giyani**	**Greater Tzaneen**	**p-value**	**Primary cohort (not mothers)**	**p-value**	**Included in analysis**
Close to birth		N=555	N=296	N=259		N=540		N=178
Treatment	Control Group	244 (44.0)	131 (44.3)	113 (43.6)	0.882	243 (45.0)	0.092	72 (40.4%)
	Intervention Group	311 (56.0)	165 (55.7)	146 (56.4)		297 (55.0)		106 (59.6%)
Sex	Male	284 (51.2)	170 (57.4)	114 (44.0)	**0.002**	147 (27.2)	**<0.001**	76 (42.7%)
	Female	271 (48.8)	126 (42.6)	145 (56.0)		162 (30.0)		102 (57.3%)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)		231 (42.8)		0 (0.0)
Age, days		57.6 (±37.2)	58.8 (±37.6)	56.3 (±36.7)	0.435	58.2 (±36.4)	0.142	57.1 (37.3)
Birth weight (cm)	Mean (SD)	3.1 (±0.5)	3.1 (±0.5)	3.0 (±0.5)	0.535	3.0 (±0.5)	0.125	3.1 (0.4)
Birth head (cm)	Mean (SD)	33.9 (±1.8)	33.7 (±1.7)	34.2 (1.8)	**0.002**	33.8 (±1.7)	0.784	34.3 (1.5)
Birth length (cm)	Mean (SD)	49 (±4)	49 (±4)	49 (±4)	0.194	49 (±4)	0.100	50 (3)
BCG vaccination at birth	No	23 (4.1)	9 (3.0)	14 (5.4)	0.252	3 (0.6)	**0.016**	8 (4.5%)
	Yes	482 (86.8)	257 (86.8)	225 (86.9)		173 (32.0)		161 (90.4%)
	Missing	50 (9.0)	30 (10.1)	20 (7.7)		364 (67.4)		9 (5.1%)

OPV0	No	7 (1.3)	4 (1.4)	3 (1.2)	0.968	1 (0.2)	**0.024**	1 (0.6%)
	Yes	502 (90.5)	267 (90.2)	235 (90.7)		175 (32.4)		167 (93.8%)
	Missing	46 (8.3)	25 (8.4)	21 (8.1)		364 (67.4)		10 (5.6%)
OPV1 (at 6 months)	No	9 (1.6)	6 (2.0)	3 (1.2)	0.566	3 (0.6)	**0.008**	1 (0.6%)
	Yes	494 (89.0)	260 (87.8)	234 (90.3)		172 (31.9)		167 (93.8%)
	Missing	52 (9.4)	30 (10.1)	22 (8.5)		365 (67.6)		10 (5.6%)
Twin	No	524 (94.4)	281 (94.9)	243 (93.8)	0.571	512 (94.8)	0.724	172 (96.6%)
	Yes	31 (5.6)	15 (5.1)	16 (6.2)		28 (5.2)		6 (3.4%)
Sibling		1.6 (±1.3)	1.7 (±1.3)	1.4 (±1.2)	**0.004**	1.2 (±1.3)	0.316	1.4 (1.2)
At 17 months								
Age, days	Mean (SD)	496.5 (±14.7)	-	496.5 (±14.7)		499.9 (±17.4)		496.5 (±14.7)
Weight (cm)	Mean (SD)	10.3 (±1.3)	-	10.3 (±1.3)		10.7 (±1.4)		10.3 (1.3)
Length (cm)	Mean (SD)	77 (±3)	-	77 (±3)		78 (±3)		77 (3)
Head (cm)	Mean (SD)	45.8 (±1.6)	-	45.8 (±1.6)		46.3 (±1.6)		45.8 (1.6)
LAZ score	Mean (SD)	-1.0 (±1.3)	-	-1.0 (±1.3)		-0.6 (±1.3)		-1.0 (1.3)
WAZ score	Mean (SD)	0.1 (±1.1)	-	0.1 (±1.1)		0.3 (±1.1)		0.1 (1.1)
WHZ score	Mean (SD)	0.7 (±1.1)	-	0.7 (±1.1)		0.8 (±1.2)		0.7 (1.1)
Stunting	No	137 (24.7)	-	137 (52.9)		122 (22.6)	**<0.001**	137 (77.0%)
	Yes	41 (7.4)	-	41 (15.8)		17 (3.1)		41 (23.0%)
	Missing	377 (67.9)	-	81 (31.3)		401 (74.3)		0 (0.0)
Overall health	Poor	5 (0.9)	-	5 (1.9)			**<0.001**	5 (2.8%)
	Fair	2 (0.4)	-	2 (0.8)		2 (0.4)		2 (1.1%)
	Good	91 (16.4)	-	91 (35.1)		6 (1.1)		91 (51.1%)
	Very good	47 (8.5)	-	47 (18.1)		68 (12.6)		47 (26.4%)
	Excellent	33 (5.9)	-	33 (12.7)		43 (8.0)		33 (18.5%)
	Missing	377 (67.9)	-	81 (31.3)		21 (3.9)		0 (0.0)

Data are presented as mean (±SD) for continuous measures, and n (%) for categorical measures. Abbreviations: LAZ- Length-for-Age z-score; WHZ- Weight-for-Height z-score; WAZ- Weight-for-Age z-score; BCG- Bacille Calmette-Guérin; OPO0- Oral poliomyelitis vaccine at baseline; OPV1- Oral poliomyelitis vaccine at 6 months. Additionally, * is comparing the total included by sub-district (Greater Giyani vs Greater Tzaneen) and # is comparing groups (included vs. not included).

Factors influencing elevated scores, PCDI, and DC

Table 2.3 presents the factors associated with an elevated PCDI score at 17 months of age. Multivariate analysis showed that child health was a critical predictor of elevated PCDI scores. Children reported to be in good health were significantly less likely to have elevated dysfunctional interaction scores, while stunted children were at increased risk. No significant associations were found with maternal education, employment, marital status, or household characteristics.

Table 2.3: Factors associated with an elevated PCDI at 17 months.

Variable	Category	Proportion with the outcome (n= 29)	OR (95% CI)	P-Value	Adjusted OR (95% CI)	P value
Treatment	Control Group	14/72 (19.4%)	1.00 (ref)	-	-	-
	Intervention Group	15/106 (14.2%)	0.68 (0.31 - 1.53)	0.349	-	-
Mothers' Age	18-34	22/132 (16.7%)	1.00 (ref)	-	-	-
	≥35 years	6/44 (13.6%)	0.79 (0.30 - 2.34)	0.635		
Marital Status	Not married or don't have permanent partner	19/99 (19.2%)	1.00 (ref)	-	1.00 (ref)	-
	Married or permanent partner	10/79 (12.7%)	0.61 (0.26 - 1.41)	0.242	0.59 (0.24 - 1.46)	0.250
Education Status	0-7	3/21 (14.73%)	1.00 (ref)	-	1.00 (ref)	-
	8-11	17/87 (19.5%)	1.46 (0.38 - 5.57)	0.580	1.52 (0.33 - 6.81)	0.584
	≥12	8/67 (11.9%)	0.81 (0.19 - 3.42)	0.778	0.76 (0.16 - 3.71)	0.736
Employment	Unemployed	24/156 (15.4%)	1.00 (ref)	-	-	-
	Employed	5/20 (25.0%)	1.83 (0.61 - 5.56)	0.277	-	-
Child Grant	No	20/125 (16.0%)	1.00 (ref)	-	-	-
	Yes	9/53 (17.0%)	1.07 (0.45 - 2.55)	0.872	-	-
Family Size	0-4	6/43 (14.0%)	1.00 (ref)	-	-	-
	5-7	17/88 (19.3%)	1.48 (0.53 - 4.09)	0.450	-	-
	≥8	5/46 (10.9%)	0.75 (0.21 - 2.69)	0.661	-	-

Child's Sex	Male	11/76 (14.5%)	1.00 (ref)	.	1.00 (ref)	-
	Female	18/102 (17.6%)	1.27 (0.56 - 2.88)	0.572	1.85 (0.72 - 4.72)	0.197
Food Insecurity	No	26/159 (16.4%)	1.00 (ref)	.	-	-
	Yes	3/18 (16.7%)	1.02 (0.28 - 3.80)	0.973	-	-
Wealth	Poorest	4/27 (14.8%)	1.00 (ref)	.	-	-
	Poorer	8/35 (22.9%)	1.70 (0.45 - 6.51)	0.431	-	-
	Middle	6/32 (18.8%)	1.33 (0.33 - 5.37)	0.691	-	-
	Rich	7/44 (15.9%)	1.09 (0.28 - 4.17)	0.902	-	-
	Richest	4/40 (10.0%)	0.64 (0.14 - 2.85)	0.554	-	-
Child's Health	Poor or Fair	3/7 (42.9%)	1.00 (ref)	-	1.00 (ref)	-
	Good or Very Good	20/138 (14.5%)	0.22 (0.05 - 1.12)	0.046	0.13 (0.02 - 0.82)	**0.030**
	Excellent	6/33 (18.2%)	0.21 (0.03 - 1.43)	0.161	0.19 (0.03 - 1.47)	0.113
Stunted	No	19/137 (13.9%)	1.00 (ref)	-	1.00 (ref)	-
	Yes	10/41 (24.4%)	2.00 (0.84 - 4.79)	0.111	2.63 (1.01 - 6.89)	**0.049**

For elevated DC scores (Table 2.4), the only significant predictor was marital status. Children of married or permanently partnered mothers were more likely to be perceived as difficult. Other maternal or household variables, including age, education, employment, and wealth, did not significantly influence this outcome.

Table 2.4: Factors associated with an elevated neuro DC at 17 months.

Variable	Category	Proportion with the outcome (n= 51)	OR (95% CI)	P-Value	Adjusted OR (95% CI)	P-Value
Treatment	Control Group	20/72 (27.8%)	1.00 (ref)	-	-	-
	Intervention Group	31/106 (29.2%)	1.07 (0.55 - 2.09)	0.832	-	-

Mothers' Age	18-34	38/132 (28.8%)	1.00 (ref)	-	1.00 (ref)	-
	≥35 years	11/44 (25.0%)	0.82 (0.38 - 1.803)	0.628	0.53 (0.12 - 2.36)	0.402
Marital Status	Married or permanent partner	29/79 (36.7%)	2.03 (1.04 - 3.96)	0.034	2.28 (1.34 - 5.56)	**0.020**
	Not married and not permanent partner	22/99 (22.2%)	1.00 (ref)	-	1.00 (ref)	
Education Status	0-7	5/21 (23.8%)	1.00 (ref)	-	-	-
	8-11	27/87 (31.0%)	1.44 (0.47 - 4.37)	0.517	-	-
	>12	17/67 (25.4%)	1.09 (0.34 - 3.44)	0.886	-	-
Employment	Unemployed	44/156 (28.2%)	1.00 (ref)	-	-	-
	Employed	7/20 (35.0%)	1.37 (0.51 - 3.68)	0.530	-	-
Child Grant	No	37/125 (29.6%)	1.00 (ref)	-	-	-
	Yes	14/53 (26.4%)	0.85 (0.41 - 1.76)	0.668	-	-
Family Size	0-4	16/43 (37.2%)	1.00 (ref)	-	1.00 (ref)	-
	5-7	26/88 (29.5%)	0.71 (0.33 - 1.54)	0.379	0.66 (0.30 - 1.45)	0.298
	8-max	9/46 (19.6%)	0.41 (0.15 - 1.09)	0.066	0.42 (0.16 - 1.07)	0.069
Child's Sex	Male	18/76 (23.7%)	1.00 (ref)	-	1.00 (ref)	-
	Female	18/76 (23.7%)	1.54 (0.78 - 3.03)	0.207	1.42 (0.70 - 3.86)	0.329
Food Insecurity	No	47/159 (29.6%)	1.00 (ref)	-	-	-
	Yes	4/18 (22.2%)	0.68 (0.21 - 2.19)	0.516	-	-
Wealth	Poorest	8/27 (29.6%)	1.00 (ref)	-	-	-
	Poorer	7/35 (20.0%)	0.59 (0.18 - 1.95)	0.384	-	-
	Middle	8/32 (25.0%)	0.79 (0.25 - 2.53)	0.693	-	-
	Rich	13/44 (29.5%)	1.00 (0.35 - 2.87)	0.994	-	-
	Richest	15/40 (37.5%)	1.43 (0.50 - 4.10)	0.509	-	-
Child's Health	Poor or Fair	3/7 (42.9%)	1.00 (ref)	-		
	Good or Very Good	39/138 (28.3%)	0.53 (0.11 - 2.34)	0.408	-	-
	Excellent	9/33 (27.3%)	0.510(0.09 - 2.79)	0.420	-	-
Stunted	No	38/137 (27.7%)	1.00 (ref)	-	-	-
	Yes	13/41 (31.7%)	1.21 (0.57 - 2.58)	0.623	-	-

The effect of elevated scores of PCDI and DC on neurodevelopment outcomes

Table 2.5 presents mean z-scores across four neurodevelopmental domains in Tzaneen. The intervention and control groups demonstrated comparable scores across all domains, with only marginal differences observed. The intervention group showed slightly higher mean scores in the motor and social-emotional domains; however, these differences were minimal and not statistically significant. No meaningful group differences were evident in cognitive, language, or overall development scores.

Table 2.5: Neurodevelopment mean z-scores for development domains in Tzaneen.

Domain	Treatment	N	Mean z-score (±SD)
Cognitive	0	73	-0.13 (±1.03)
	1	106	-0.06 (±0.87)
Language	0	72	-0.12 (±0.90)
	1	106	-0.06 (±0.87)
Motor	0	72	0.38 (±1.22)
	1	106	0.47 (±0.97)
Social-emotional	0	72	-0.26 (±0.99)
	1	106	-0.17 (±0.86)
Overall	0	72	0.04 (±0.75)
	1	106	0.05 (±0.84)

Figure 2.2 shows the distribution of neurodevelopmental scores at 17 months stratified by PCDI scores. Children exposed to elevated PCDI scores consistently scored lower across all assessed domains compared to those with normal PCDI scores. These differences were statistically significant.

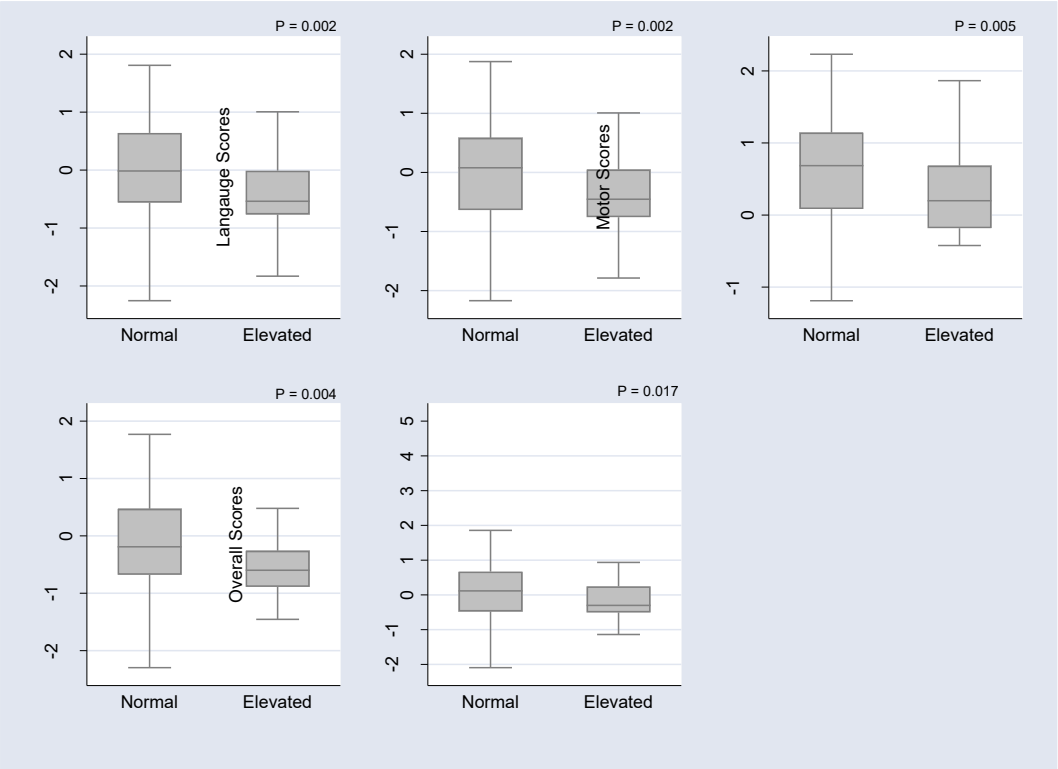

Figure 2.2: Distribution of neurodevelopment at 17 months by PCDI. Data are presented as median, IQR, and range.

Abbreviations: IQR interquartile range; PCDI Parent-child dysfunctional interaction

Similarly, Figure 2.3 illustrates the distribution of neurodevelopmental outcomes by DC scores. Children with elevated DC scores had significantly lower scores across all developmental domains relative to those with normal DC scores.

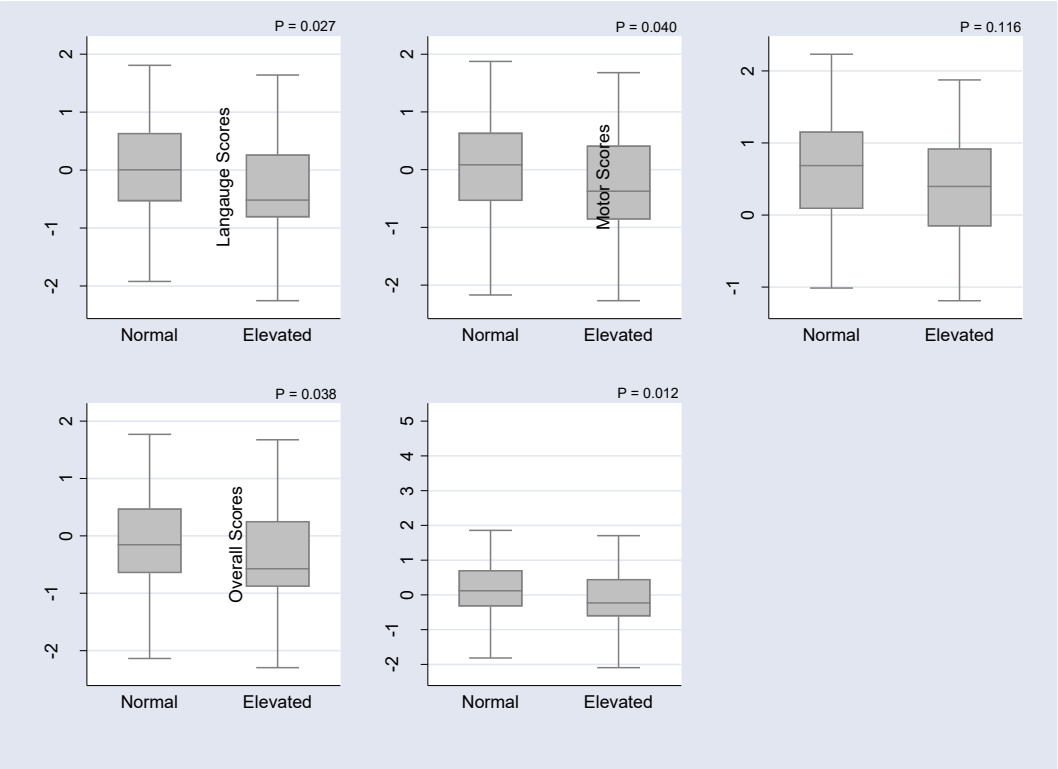

Figure 2.3: Distribution of neurodevelopment at 17 months by DC. Data are presented as median, IQR, and range.

Abbreviations: IQR interquartile range; DC difficult child

Multivariable linear regression analysis assessed the association between elevated PCDI and DC scores and neurodevelopmental outcomes (Table 2). Elevated PCDI was significantly associated with lower cognitive development scores, while elevated DC was significantly associated with poorer social-emotional development. No other statistically significant associations were observed between elevated PCDI or DC and the remaining developmental domains.

Table 2.6: The impact of elevated PCDI and DC raw scores on neurodevelopment CREDI z-scores.

	Elevated PCDI		**Elevated DC**	
Development Domain	β (95% CI)	P-value	Domain	β (95% CI)
Language	6.52 (-1.25 - 14.29)	0.095	-0.30 (-4.00 - 3.41)	0.871
Social-Emotional	-0.43 (-1.31 - 0.44)	0.313	-0.26 (-0.50 - -0.01)	0.043
Motor	-9.22 (-19.11 - 0.68)	0.066	0.14 (-4.60 - 4.87)	0.954
Cognitive	-1.53 (-2.56 to -0.51)	0.006	0.12 (-0.36 - 0.60)	0.610

2.4 Discussion

This study explored the associations between parent-child interaction, child behavioural difficulties, and neurodevelopmental outcomes among children in two rural sub-districts of Limpopo Province, South Africa. At 17 months, 16.3% of children exhibited clinically elevated Parent-Child Dysfunctional Interaction (PCDI) scores, suggesting strained relational dynamics between caregivers and children. Additionally, 28.7% showed elevated Difficult Child (DC) scores, indicating behavioural or self-regulatory challenges. These findings align with previous studies that have reported elevated relational stress and behavioural dysregulation in early childhood among socioeconomically vulnerable populations [225–227].

The association between elevated PCDI scores and poor child health and stunting suggests a bidirectional relationship between physical development and caregiver-child interactions. Children with stunted growth or poor health may exhibit irritability or lower responsiveness, making engagement more difficult, while caregivers may also experience stress or diminished capacity for nurturing interaction due to socioeconomic burdens. This echoes findings from previous studies, which noted that children with health-related issues often face adverse experiences such as neglect, harsh disciplinary actions, and inconsistent caregiving [228,229]. The observed findings support UNICEF's assertion that stunting is not only a marker for malnutrition but it is also a predictor of developmental disadvantages if not addressed early.

Elevated DC scores were significantly associated with caregivers' marital status, with higher odds of difficult behaviour observed in children of married or partnered caregivers. This counters the widely held assumption that single parenthood is consistently associated with poorer child outcomes. However, it is evident in the literature that children born to married parents or parents in permanent partnerships can also exhibit difficult behaviours [33,230]. This could be influenced by various factors, including financial strain, relationship stress, differing parenting styles, or a lack of social support. Moreover, the presence of unresolved conflicts between parents, even in stable partnerships, may affect the child's emotional well-being and contribute to behavioural challenges. Children often learn how to interact with others based on what they observe in their parents' relationship. If parents model unhealthy relationship behaviours (such as poor communication, anger, or lack of conflict resolution), children might replicate these behaviours in their own interactions, leading to challenging behaviours like tantrums or defiance [33,203,230,231]. These findings reinforce the idea that family structure alone is not a reliable predictor of developmental risk; instead, family dynamics and stress exposure play critical roles.

In terms of neurodevelopmental outcomes, this study found that elevated PCDI scores were associated with poorer cognitive development, while elevated DC scores were linked to poorer social-emotional development. These domain-specific patterns are consistent with the transactional model of development, which posits that early child outcomes are shaped by continuous and reciprocal exchanges between caregivers and children. In this cohort, elevated scores of PCDI were influenced by stunting, which may help explain the negative impact of elevated PCDI scores on cognitive neurodevelopment. A recent study by Ekholuenetale et al. [232] reported that in their cohort, stunted children exhibited a 7% reduction in cognitive development compared to non-stunted children. This underscores the crucial role stunting plays in shaping cognitive outcomes in young children and highlights the need for further research in this area. Furthermore, the observed findings related to elevated levels of DC scores align with previous research suggesting a strong link between poor social-emotional neurodevelopmental bases and difficult child behaviours [233–238].

The underutilization of Child Support Grants (CSG) among eligible caregivers, as revealed in this study, further points to structural challenges that impede access to essential support. Child support grant is a South African government initiative that provides financial assistance to low-income caregivers with children under the age of 18 years. The eligibility for CSG is for the caregiver to earn less than R3100 per month, have an identity document, and a childbirth certificate [239]. The main goal for CSG is to alleviate eligible caregivers from financial challenges; however, across the country, some caregivers are still struggling to access CSG. Previous research studies have noted that the exclusion of some caregivers from receiving CSG is attributed to administrative technicalities, corruption, lack of information, and logistical reasons [240,241]. Specific challenges related to the high number of caregivers not receiving CSG were never probed in the current study population. Therefore, it is crucial to investigate the barriers contributing to the lack of jobs and the exclusion of eligible caregivers from receiving CSG in Limpopo, specifically in Greater Tzaneen and Giyani. So that appropriate interventions could be constituted to help the caregivers and children by alleviating them from spells of financial hardships and building a better society. Public health initiatives in this context must go beyond service provision to include policy reforms and outreach strategies aimed at maximizing grant coverage and minimizing bureaucratic exclusions.

Overall, many studies have explored factors contributing to negative neurodevelopment, but most have focused primarily on socioeconomic (SES) factors. They have largely overlooked a deeper examination of the role parent-child interactions play in this process. While SES

factors are undoubtedly important because they influence family structure and environmental dynamics, less attention has been given to the role of negative parent-child interactions and difficult child behaviours in rural contexts. These factors may have a significant impact on neurodevelopment, yet they remain underexplored in research. The current study uncovered the impact of negative parent-child interactions and difficult behaviours on neurodevelopmental domains. These findings contribute to the growing body of knowledge and, in a South African context, could serve as baseline information for further research aimed at understanding how these factors affect child development, particularly in rural settings.

Importantly, our findings provide valuable insights into the clinical outcomes for PCDI and DC scores and their role in various neurodevelopmental domains in young children from the Mopani District, Limpopo Province. This highlights the importance of studying the impact of PCDI and DC in rural communities. Investigating these factors' contribution to neurodevelopment in early childhood will help generate context-specific information, which can inform the design and implementation of psychosocial intervention programs tailored to the unique challenges faced by rural communities in South Africa.

The strength of this study lies in the use of secondary birth cohort data that was structured into intervention and control groups, allowing for a meaningful comparison of outcomes between the groups. The dynamics of this data enabled the current study’s specific objectives to be explored, offering new insights into the effect of elevated scores of PCDI and DC on neurodevelopmental domains in two rural regions of Limpopo. Additionally, the study focused on children at 17 months of age, which is a significant period for brain elasticity. To our knowledge, is the first of its kind, as most related studies have primarily focused on preschool children, mostly from urban areas.

2.5 Limitations and future direction

The instruments used were self-reporting, and there were possibilities for parents to respond defensively to sound competent cannot be ruled out. Furthermore, the study focused on the aspect where the tools were administered at one time point, limiting their ability to capture dynamic interactions over time. To account for this, we suggest the inclusion of other methodologies to increase the rigor of the study.

Regarding the Parenting Stress Index (PSI), the Parental Distress (PD) scale was not measured. This omission limits a comprehensive understanding of overall parenting stress, as PD is a core component of the total stress score. Future studies should consider estimating the total score or percentile ranks to allow for more robust interpretation of parenting stress and its relationship with developmental outcomes.

Parent-child dyads did not include people living with disabilities. Future studies need to include people with disabilities. In addition, the PCDI and DC domains can be bidirectional; they also need to be studied longitudinally in the future to understand direction. The study was conducted in Limpopo, which is characterized by different economic and social development levels and cultural customs when compared with other provinces. Therefore, our results cannot be generalized to other provinces of South Africa. We recommend that such studies be conducted in other parts of the country. Lastly, our findings give a perspective, but do not warrant causal inference, as it was focused on one point when the children were 17 months old. This underscores the need for more studies to be conducted to understand the causal links between PCDI and DC and development domains in children under 5 years of age across South Africa. More studies will promote the implementation of informed context-relevant interventions that will directly target the challenges faced by rural communities.

2.6 Conclusion

In conclusion, this study provides valuable insights into the complex factors affecting child neurodevelopment in rural South Africa, particularly within the Limpopo Province. The findings highlight the significant role that socioeconomic challenges, including stunting and limited access to child support grants, play in shaping child development outcomes. Elevated scores on the PCDI were found to have a direct impact on cognitive development, while DC scores primarily affected social-emotional outcomes, emphasizing the need for focused interventions in these areas. The study also underscores the importance of examining parent-child interactions and difficult child behaviours, as these factors appear to have a considerable influence on developmental domains that have often been overshadowed by socioeconomic factors in prior research.

The findings suggest that addressing stunting, improving access to financial support programs like the child support grant, and enhancing parent-child interactions can have a profound impact on child development. Early intervention programs tailored to these specific needs could help mitigate the risks associated with poor neurodevelopment, offering an opportunity

to improve long-term outcomes for children in rural communities. Additionally, the study's focus on children at 17 months provides a unique contribution, as this critical stage for brain development is often overlooked in research predominantly focused on older children. Overall, the study contributes to a growing body of knowledge and emphasizes the need for targeted, context-specific interventions to address the challenges faced by rural children and their families in South Africa. Further research is needed to explore the underlying barriers to financial assistance and access to healthcare in rural areas, which will help inform the development of more effective strategies to support these vulnerable populations.

2.7 Contributions

DE, PR, JL, and LC were responsible for the primary study, conceptualizing of the current study, and planning its design. NM conducted data analysis and the initial drafting of the manuscript, with oversight from DE and LC. All authors critically reviewed, revised, and approved the final version of the manuscript.

2.8 Acknowledgements

The authors would like to acknowledge everyone who contributed to the success of the study.

2.9 Competing interest

None.

2.10 References

[1] Shonkoff JP, Garner AS, THE COMMITTEE ON PSYCHOSOCIAL ASPECTS OF CHILD AND FAMILY HEALTH COEC ADOPTION, AND DEPENDENT CARE, AND SECTION ON DEVELOPMENTAL AND BEHAVIORAL PEDIATRICS, Siegel BS, Dobbins MI, Earls MF, et al. The Lifelong Effects of Early Childhood Adversity and Toxic Stress. Pediatrics 2012;129:e232–46. https://doi.org/10.1542/peds.2011-2663.

[2] Mustard J. Experience-based brain development: Scientific underpinnings of the importance of early child development in a global world. Paediatr Child Health 2006;11:571–2.

[3] Hertzman C, Boyce T. How Experience Gets Under the Skin to Create Gradients in Developmental Health. Annu Rev Public Health 2010;31:329-47 3p following 347. https://doi.org/10.1146/annurev.publhealth.012809.103538.

[4] Smith KE, Pollak SD. Early life stress and development: potential mechanisms for adverse outcomes. J Neurodev Disord 2020;12:34. https://doi.org/10.1186/s11689-020-09337-y.

[5] Jeong J, Franchett EE, Oliveira CVR de, Rehmani K, Yousafzai AK. Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. PLoS Med 2021;18:e1003602. https://doi.org/10.1371/journal.pmed.1003602.
[6] Jeong J, Bliznashka L, Sullivan E, Hentschel E, Jeon Y, Strong KL, et al. Measurement tools and indicators for assessing nurturing care for early childhood development: A scoping review. PLOS Glob Public Health 2022;2:e0000373. https://doi.org/10.1371/journal.pgph.0000373.
[7] Draper C, Cook C, Howard S, Makaula H, Merkley R, Mshudulu M, et al. Caregiver perspectives of risk and protective factors influencing early childhood development in low-income, urban settings: a social ecological perspective. 2022. https://doi.org/10.31234/osf.io/jquga.
[8] National Research Council (US) and Institute of Medicine (US) Committee on Integrating the Science of Early Childhood Development. From Neurons to Neighborhoods: The Science of Early Childhood Development. Washington (DC): National Academies Press (US); 2000.
[9] Angwenyi V, Abubakar A, Kabue M, Njoroge E, Nasambu C, Ssewanyana D, et al. Caregiving experiences and practices: qualitative formative research towards development of integrated early childhood development interventions targeting Kenyans and refugees in Nairobi's informal settlements. BMC Public Health 2024;24:2636. https://doi.org/10.1186/s12889-024-20018-6.
[10] Schmidt K, Tanga PT. Supporting good outcomes for early childhood home-visiting programs: Guidelines for practice. South Afr J Child Educ 2024;14:12. https://doi.org/10.4102/sajce.v14i1.1403.
[11] Anda RF, Felitti VJ, Bremner JD, Walker JD, Whitfield C, Perry BD, et al. The enduring effects of abuse and related adverse experiences in childhood. Eur Arch Psychiatry Clin Neurosci 2006;256:174–86. https://doi.org/10.1007/s00406-005-0624-4.
[12] Pechtel P, Pizzagalli DA. Effects of Early Life Stress on Cognitive and Affective Function: An Integrated Review of Human Literature. Psychopharmacology (Berl) 2011;214:55–70. https://doi.org/10.1007/s00213-010-2009-2.
[13] Gallegos D, Eivers A, Sondergeld P, Pattinson C. Food Insecurity and Child Development: A State-of-the-Art Review. Int J Environ Res Public Health 2021;18:8990. https://doi.org/10.3390/ijerph18178990.
[14] Chilton M, Knowles M, Bloom SL. The Intergenerational Circumstances of Household Food Insecurity and Adversity. J Hunger Environ Nutr 2017;12:269–97. https://doi.org/10.1080/19320248.2016.1146195.
[15] Skinner G, Bywaters P, Kennedy E. A review of the relationship between poverty and child abuse and neglect: Insights from scoping reviews, systematic reviews and meta-analyses. Child Abuse Rev 2022;32. https://doi.org/10.1002/car.2795.
[16] Hosny N, Bovey M, Dutray F, Heim E. How is trauma-related distress experienced and expressed in populations from the Greater Middle East and North Africa? A systematic review of qualitative literature. SSM - Ment Health 2023;4:100258. https://doi.org/10.1016/j.ssmmh.2023.100258.
[17] Knopik VS, Marceau K, Bidwell LC, Rolan E. Prenatal substance exposure and offspring development: Does DNA methylation play a role? Neurotoxicol Teratol 2019;71:50–63. https://doi.org/10.1016/j.ntt.2018.01.009.
[18] Kenner C. Fetal Development: Environmental Influences and Critical Periods. Springer Publishing Company; 2023.
[19] National Academies of Sciences E, Division H and M, Practice B on PH and PH, Approach C on AN and S-BS from PTECDAHE, Negussie Y, Geller A, et al. Healthy Development from Conception Through Early Childhood. Vibrant Healthy Kids Aligning Sci. Pract. Policy Adv. Health Equity, National Academies Press (US); 2019.
[20] Mehta D, Kelly AB, Laurens KR, Haslam D, Williams KE, Walsh K, et al. Child Maltreatment and Long-Term Physical and Mental Health Outcomes: An Exploration

of Biopsychosocial Determinants and Implications for Prevention. Child Psychiatry Hum Dev 2023;54:421–35. https://doi.org/10.1007/s10578-021-01258-8.
[21] DiLauro M. Psychosocial Factors Associated with Types of Child Maltreatment. Child Welfare 2004;83:69–99.
[22] Effects of child abuse and neglect for children and adolescents. Child Fam Community Aust 2014. https://aifs.gov.au/cfca/publications/effects-child-abuse-and-neglect-children-and-adolescents (accessed June 1, 2022).
[23] Metzler M, Merrick MT, Klevens J, Ports KA, Ford DC. Adverse childhood experiences and life opportunities: Shifting the narrative. Child Youth Serv Rev 2017;72:141–9. https://doi.org/10.1016/j.childyouth.2016.10.021.
[24] Nelson CA, Bhutta ZA, Burke Harris N, Danese A, Samara M. Adversity in childhood is linked to mental and physical health throughout life. The BMJ 2020;371:m3048. https://doi.org/10.1136/bmj.m3048.
[25] Hughes K, Lowey H, Quigg Z, Bellis MA. Relationships between adverse childhood experiences and adult mental well-being: results from an English national household survey. BMC Public Health 2016;16:222. https://doi.org/10.1186/s12889-016-2906-3.
[26] Bergmeier H, Paxton SJ, Milgrom J, Anderson SE, Baur L, Hill B, et al. Early mother-child dyadic pathways to childhood obesity risk: A conceptual model. Appetite 2020;144:104459. https://doi.org/10.1016/j.appet.2019.104459.
[27] Bengtsson J, Byberg S, Carstensen B, De Stavola BL, Svensson J, Jørgensen ME, et al. Accumulation of childhood adversities and type 1 diabetes risk: a register-based cohort study of all children born in Denmark between 1980 and 2015. Int J Epidemiol 2020;49:1604–13. https://doi.org/10.1093/ije/dyaa138.
[28] Kelly-Irving M, Lepage B, Dedieu D, Lacey R, Cable N, Bartley M, et al. Childhood adversity as a risk for cancer: findings from the 1958 British birth cohort study. BMC Public Health 2013;13:767. https://doi.org/10.1186/1471-2458-13-767.
[29] Lown EA, Lui CK, Karriker-Jaffe K, Mulia N, Williams E, Ye Y, et al. Adverse childhood events and risk of diabetes onset in the 1979 National longitudinal survey of youth cohort. BMC Public Health 2019;19:1007. https://doi.org/10.1186/s12889-019-7337-5.
[30] Holman DM, Ports KA, Buchanan ND, Hawkins NA, Merrick MT, Metzler M, et al. The Association Between Adverse Childhood Experiences and Risk of Cancer in Adulthood: A Systematic Review of the Literature. Pediatrics 2016;138:S81–91. https://doi.org/10.1542/peds.2015-4268L.
[31] Henley P, Lowthers M, Koren G, Fedha PT, Russell E, VanUum S, et al. Cultural and socio-economic conditions as factors contributing to chronic stress in sub-Saharan African communities. Can J Physiol Pharmacol 2014;92:725–32. https://doi.org/10.1139/cjpp-2014-0035.
[32] Blume J, Park S, Cox M, Mastergeorge AM. Explicating Child-Driven Patterns of Parent-Child Responsivity in Fragile Families: A Longitudinal Approach. Front Pediatr 2022;10.
[33] Mphaphuli LK. The Impact of Dysfunctional Families on the Mental Health of Children. Parent. Mod. Soc., IntechOpen; 2023. https://doi.org/10.5772/intechopen.110565.
[34] Wang Y. Effects of Parenting Style on Normal and Dysfunctional Emotional Behaviors in Small Children. Psychiatr Danub 2022;34:34–40. https://doi.org/10.24869/psyd.2022.34.
[35] What is early childhood development? | South African Government n.d. https://www.gov.za/faq/education/what-early-childhood-development (accessed June 1, 2022).
[36] Maluleke R. Mid-year population estimates 202 2021:35.
[37] Allen L, Kelly BB, Success C on the S of CB to A 8: D and B the F for, Board on Children Y, Medicine I of, Council NR. Child Development and Early Learning. National Academies Press (US); 2015.
[38] Teen pregnancies in South Africa jump 60% during COVID-19 pandemic - South Africa | ReliefWeb n.d. https://reliefweb.int/report/south-africa/teen-pregnancies-south-africa-jump-60-during-covid-19-pandemic (accessed July 13, 2022).

[39] Ngubane N, Maharaj P. Childbearing in the Context of the Child Support Grant in a Rural Area in South Africa. SAGE Open 2018;8:2158244018817596. https://doi.org/10.1177/2158244018817596.
[40] Section 28 - Children n.d. https://www.concourt.org.za/index.php/71-children-s-rights/section-28-children/133-section-28-children (accessed March 30, 2025).
[41] PromotingChildrensRights.pdf n.d.
[42] ZAF-Nutrition-brief-2020.pdf n.d.
[43] Grantham-McGregor S, Cheung YB, Cueto S, Glewwe P, Richter L, Strupp B. Developmental potential in the first 5 years for children in developing countries. The Lancet 2007;369:60–70. https://doi.org/10.1016/S0140-6736(07)60032-4.
[44] Casale D, Desmond C. Recovery from stunting and cognitive outcomes in young children: evidence from the South African Birth to Twenty Cohort Study. J Dev Orig Health Dis 2016;7:163–71. https://doi.org/10.1017/S2040174415007175.
[45] Carpenter G, Stacks A. Developmental effects of exposure to Intimate Partner Violence in early childhood: A review of the literature. Child Youth Serv Rev 2009;31:831–9. https://doi.org/10.1016/j.childyouth.2009.03.005.
[46] Frosch CA, Schoppe-Sullivan SJ, O'Banion DD. Parenting and Child Development: A Relational Health Perspective. Am J Lifestyle Med 2019;15:45–59. https://doi.org/10.1177/1559827619849028.
[47] Laflamme D, Pomerleau A, Malcuit G. A Comparison of Fathers' and Mothers' Involvement in Childcare and Stimulation Behaviors During Free-Play with Their Infants at 9 and 15 Months. Sex Roles 2002;47:507–18. https://doi.org/10.1023/A:1022069720776.
[48] Schoppe-Sullivan SJ, Kotila L, Jia R, Lang SN, Bower DJ. Comparisons of levels and predictors of mothers' and fathers' engagement with their preschool aged children. Early Child Dev Care 2013;183:498–514. https://doi.org/10.1080/03004430.2012.711596.
[49] Runcan PL, Constantineanu C, Ielics B, Popa D. The Role of Communication in the Parent-Child Interaction. Procedia - Soc Behav Sci 2012;46:904–8. https://doi.org/10.1016/j.sbspro.2012.05.221.
[50] Adolescent-Peer Relationships, Separation and Detachment From Parents, and Internalizing and Externalizing Behaviors: Linkages and Interactions - Justin Jager, Cynthia X. Yuen, Diane L. Putnick, Charlene Hendricks, Marc H. Bornstein, 2015 n.d. https://journals.sagepub.com/doi/abs/10.1177/0272431614537116 (accessed July 14, 2022).
[51] Lansford JE, Rothenberg WA, Jensen TM, Lippold MA, Bacchini D, Bornstein MH, et al. Bidirectional Relations Between Parenting and Behavior Problems From Age 8 to 13 in Nine Countries. J Res Adolesc 2018;28:571–90. https://doi.org/10.1111/jora.12381.
[52] Prado E, Dewey K. Nutrition and brain development in early life. Nutr Rev 2014. https://doi.org/10.1111/nure.12102.
[53] Aboud FE, Yousafzai AK. Very Early Childhood Development. In: Black RE, Laxminarayan R, Temmerman M, Walker N, editors. Reprod. Matern. Newborn Child Health Dis. Control Priorities Third Ed. Vol. 2, Washington (DC): The International Bank for Reconstruction and Development / The World Bank; 2016.
[54] Ip P, Tso W, Rao N, Ho FKW, Chan KL, Fu KW, et al. Rasch validation of the Chinese parent–child interaction scale (CPCIS). World J Pediatr 2018;14:238–46. https://doi.org/10.1007/s12519-018-0132-z.
[55] Africa SS. 2018 | Statistics South Africa n.d. https://www.statssa.gov.za/?m=2018&gclid=Cj0KCQjwnNyUBhCZARIsAI9AYlEPUXh4XtSPmQattQY6sBYI1By9n28m45NITLyrcPwJFbtzfe1jgykaAtPkEALw_wcB (accessed June 1, 2022).
[56] Ling J, Robbins LB, Xu D. Food Security Status and Hair Cortisol among Low-income Mother-Child Dyads. West J Nurs Res 2019;41:1813–28. https://doi.org/10.1177/0193945919867112.

[57] Manning C, Gregoire A. Effects of parental mental illness on children. Psychiatry 2006;5:10–2. https://doi.org/10.1383/psyt.2006.5.1.10.
[58] Economic experiences and sustainable livelihoods of single mothers employed in the formal work sector in Germany and South Africa n.d. https://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0037-80542019000400003 (accessed March 30, 2025).
[59] Jacobs C, Andrews G. Disrupting Patriarchal Perceptions of Single-Mother Families: An Analysis of Adolescent Narratives. Educ Change 2021;25. https://doi.org/10.25159/1947-9417/8670.
[60] Golombok S, Zadeh S, Imrie S, Smith V, Freeman T. Single Mothers by Choice: Mother–Child Relationships and Children's Psychological Adjustment. J Fam Psychol 2016;30:409–18. https://doi.org/10.1037/fam0000188.
[61] Ray JA, Choi J-K, Jackson AP. Adverse childhood experiences and behavior problems among poor Black children: Nonresident father involvement and single mothers' parenting stress. Child Abuse Negl 2021;121:105264. https://doi.org/10.1016/j.chiabu.2021.105264.
[62] Barnett MA, Scaramella LV, Neppl TK, Ontai LL, Conger RD. Grandmother Involvement as a Protective Factor for Early Childhood Social Adjustment. J Fam Psychol JFP J Div Fam Psychol Am Psychol Assoc Div 43 2010;24:635–45. https://doi.org/10.1037/a0020829.
[63] Hawes D, Dadds M. Assessing Parenting Practices Through Parent-Report and Direct Observation During Parent-Training. J Child Fam Stud 2006;15:554–67. https://doi.org/10.1007/s10826-006-9029-x.
[64] Borrego J, Timmer SG, Urquiza AJ, Follette WC. Physically abusive mothers' responses following episodes of child noncompliance and compliance. J Consult Clin Psychol 2004;72:897–903. https://doi.org/10.1037/0022-006X.72.5.897.
[65] Abidin: The Parenting Stress Index--Clinical Trials. - Google Scholar n.d. https://scholar.google.com/scholar_lookup?title=The%20Parenting%20Stress%20Index-Clinical%20Trials&publication_year=1979&author=Abidin%2CR (accessed April 12, 2023).
[66] Abidin, R. R. Parenting stress index: Manual (3rd ed.). Odessa, FL: Psychological Assessment Resources. 1995.
[67] Abidin: Parenting Stress: Maternal & Child Health... - Google Scholar n.d.
[68] Wu J. Parenting Stress Index, Short Form. Natl Child Trauma Stress Netw 2017. https://www.nctsn.org/measures/parenting-stress-index-short-form (accessed June 6, 2022).
[69] Potterton J, Stewart A, Cooper P. Parenting stress of caregivers of young children who are HIV Positive. Afr J Psychiatry 2007;10:210–4. https://doi.org/10.4314/ajpsy.v10i4.30257.
[70] Mbatha NL, Mokwena KE. Parental Stress in Raising a Child with Developmental Disabilities in a Rural Community in South Africa. Int J Environ Res Public Health 2023;20:3969. https://doi.org/10.3390/ijerph20053969.
[71] Farran DC. Parent/Caregiver involvement scale: Workbook. Unpublished manuscript 1986.
[72] Clark R, Tluczek A, Moore EC, Evenson AL. Assessment of Early Parent–Child Relationships. In: DelCarmen-Wiggins R, Carter AS, editors. Oxf. Handb. Infant Toddler Presch. Ment. Health Assess. 2nd ed., Oxford University Press; 2019, p. 46–77. https://doi.org/10.1093/oxfordhb/9780199837182.013.3.
[73] Crittenden PM. Unpublishes CARE-index infants Codenig manual. 2006.
[74] Aber L, Morris P, Raver C. Children, Families and Poverty. Soc Policy Rep 2012;26:1–29. https://doi.org/10.1002/j.2379-3988.2012.tb00072.x.
[75] Effects of poverty, hunger and homelessness on children and youth. Https://WwwApaOrg n.d. https://www.apa.org/pi/families/poverty (accessed July 14, 2022).

[76] Brooks-Gunn J, Duncan GJ. The effects of poverty on children. Future Child 1997;7:55–71.
[77] Engle PL, Black MM. The Effect of Poverty on Child Development and Educational Outcomes. Ann N Y Acad Sci 2008;1136:243–56. https://doi.org/10.1196/annals.1425.023.
[78] Africa SS. South Africa's youth continues to bear the burden of unemployment. | Statistics South Africa 2022. https://www.statssa.gov.za/?p=15407 (accessed March 30, 2025).
[79] Alexander M. Mapping poverty in South Africa. South Afr Gatew 2024. https://southafrica-info.com/people/mapping-poverty-in-south-africa/ (accessed March 30, 2025).
[80] Shisana O, Labadarios D, Rehle T, Simbayi L, Zuma K, Dhansay A, et al. The South African National Health and Nutrition Examination Survey, 2012: SANHANES-1: the health and nutritional status of the nation. HSRC Press; 2015.
[81] District+Health+Barometer+2018-19+Web.pdf n.d.
[82] Hurley KM, Yousafzai AK, Lopez-Boo F. Early Child Development and Nutrition: A Review of the Benefits and Challenges of Implementing Integrated Interventions1234. Adv Nutr 2016;7:357–63. https://doi.org/10.3945/an.115.010363.
[83] Victora CG, Adair L, Fall C, Hallal PC, Martorell R, Richter L, et al. Maternal and child undernutrition: consequences for adult health and human capital. The Lancet 2008;371:340–57. https://doi.org/10.1016/S0140-6736(07)61692-4.
[84] Hohip C. SASSA confirms payment dates for April. EWN n.d. https://www.ewn.co.za/2025/03/27/early-payments-for-sassa-grants-in-april (accessed March 30, 2025).
[85] Bambra C, Gibson M, Sowden A, Wright K, Whitehead M, Petticrew M. Tackling the wider social determinants of health and health inequalities: evidence from systematic reviews. J Epidemiol Community Health 2010;64:284–91. https://doi.org/10.1136/jech.2008.082743.
[86] Mayosi B, Benatar S, Med D. Health and Health Care in South Africa-20 Years after Mandela. N Engl J Med 2014;371. https://doi.org/10.1056/NEJMsr1405012.
[87] Maphumulo WT, Bhengu BR. Challenges of quality improvement in the healthcare of South Africa post-apartheid: A critical review. Curationis 2019;42:1901. https://doi.org/10.4102/curationis.v42i1.1901.
[88] Behrman JR, Hoddinott J, Maluccio JA, Soler-Hampejsek E, Behrman EL, Martorell R, et al. What determines adult cognitive skills? Influences of pre-school, school, and post-school experiences in Guatemala. Lat Am Econ Rev 2014;23:1–32. https://doi.org/10.1007/s40503-014-0004-4.
[89] Mirowsky J, Ross C. Education, learned effectiveness and health. Lond Rev Educ 2005;3:205–20. https://doi.org/10.1080/14748460500372366.
[90] Davis-Kean P, Tighe L, Waters N. The Role of Parent Educational Attainment in Parenting and Children's Development. 2020. https://doi.org/10.31234/osf.io/ndmxb.
[91] Harding JF, Morris PA, Hughes D. The Relationship Between Maternal Education and Children's Academic Outcomes: A Theoretical Framework. J Marriage Fam 2015;77:60–76. https://doi.org/10.1111/jomf.12156.
[92] Social and Genetic Pathways in Multigenerational Transmission of Educational Attainment - Hexuan Liu, 2018 n.d. https://journals.sagepub.com/doi/abs/10.1177/0003122418759651 (accessed July 14, 2022).
[93] Tighe LA, Davis-Kean PE. The Influence of College Education on Parents and Children in Low-Income Families. Merrill-Palmer Q 2021;67:293–328.
[94] Africa SS. MEDIA RELEASE: Census 2022 Population Count Results 10 October 2023 | Statistics South Africa 2023. https://www.statssa.gov.za/?p=16716 (accessed March 30, 2025).
[95] Understanding Why Youth Drop Out of School in South Africa - Rachana Desai, Ansuyah Magan, Robert A.C. Ruiter, Priscilla S. Reddy, Liesbeth A.G. Mercken, 2024

n.d. https://journals.sagepub.com/doi/10.1177/21582440231219080 (accessed March 30, 2025).
[96] Full article: Learning Disrupted Through High School Dropouts: Perceptions of Access to Education in the Eastern Cape of South Africa n.d. https://www.tandfonline.com/doi/full/10.1080/21528586.2024.2417795 (accessed March 30, 2025).
[97] Rogoff B. The cultural nature of human development. Oxford: Oxford University Press; 2003.
[98] Bornstein MH. Culture, Parenting, and Zero-to-Threes. Zero Three 2015;35:2–9.
[99] Petts RJ. Parental Religiosity, Religious Homogamy, and Young Children's Well-Being. Sociol Relig 2011;72:389–414. https://doi.org/10.1093/socrel/srr021.
[100] Petts RJ. Single Mothers' Religious Participation and Early Childhood Behavior. J Marriage Fam 2012;74:251–68. https://doi.org/10.1111/j.1741-3737.2011.00953.x.
[101] The Impact of Family Religious Life on the Quality of Mother-Child Relations. Carol Popul Cent n.d. https://www.cpc.unc.edu/resources/publications/bib/2360/ (accessed July 14, 2022).
[102] King V. The Influence of Religion on Fathers' Relationships With Their Children. J Marriage Fam 2003;65:382–95. https://doi.org/10.1111/j.1741-3737.2003.00382.x.
[103] Bartkowski JP, Xu X. Distant patriarchs or expressive dads? The discourse and practice of fathering in conservative Protestant families. Sociol Q 2000;41:465–85. https://doi.org/10.1111/j.1533-8525.2000.tb00088.x.
[104] Bartkowski JP, Xu X, Levin ML. Religion and child development: Evidence from the Early Childhood Longitudinal Study. Soc Sci Res 2008;37:18–36. https://doi.org/10.1016/j.ssresearch.2007.02.001.
[105] Forray A. Substance use during pregnancy. F1000Research 2016;5:F1000 Faculty Rev-887. https://doi.org/10.12688/f1000research.7645.1.
[106] Louw K-A. Substance use in pregnancy: The medical challenge. Obstet Med 2018;11:54–66. https://doi.org/10.1177/1753495X17750299.
[107] Stone R. Pregnant women and substance use: fear, stigma, and barriers to care. Health Justice 2015;3:2. https://doi.org/10.1186/s40352-015-0015-5.
[108] Skagerström J. Alcohol consumption during pregnancy : Prevalence, predictors and prevention. vol. 1470. Linköping: Linköping University Electronic Press; 2015. https://doi.org/10.3384/diss.diva-122375.
[109] Pilowsky DJ, Keyes KM, Hasin DS. Adverse Childhood Events and Lifetime Alcohol Dependence. Am J Public Health 2009;99:258–63. https://doi.org/10.2105/AJPH.2008.139006.
[110] Haugland SH, Carvalho B, Stea TH, Strandheim A, Vederhus J-K. Associations between parental alcohol problems in childhood and adversities during childhood and later adulthood: a cross-sectional study of 28047 adults from the general population. Subst Abuse Treat Prev Policy 2021;16:47. https://doi.org/10.1186/s13011-021-00384-9.
[111] Global strategy to reduce the harmful use of alcohol n.d. https://www.who.int/publications-detail-redirect/9789241599931 (accessed July 14, 2022).
[112] Monteiro MG. The Road to a World Health Organization Global Strategy for Reducing the Harmful Use of Alcohol. Alcohol Res Health 2011;34:257–60.
[113] Oladeinde O, Mabetha D, Twine R, Hove J, Van Der Merwe M, Byass P, et al. Building cooperative learning to address alcohol and other drug abuse in Mpumalanga, South Africa: a participatory action research process. Glob Health Action 2020;13:1726722. https://doi.org/10.1080/16549716.2020.1726722.
[114] News n.d. https://www.netcare.co.za/News-Hub/Articles/understanding-substance-abuse-and-addiction (accessed July 14, 2022).
[115] Alcohol and drugs – Triangle Project n.d. https://triangle.org.za/what-were-here-for/alcohol-and-drugs/ (accessed July 14, 2022).

[116] Rochat TJ, Houle B, Stein A, Mitchell J, Bland RM. Maternal alcohol use and children's emotional and cognitive outcomes in rural South Africa. SAMJ South Afr Med J 2019;109:526–34. https://doi.org/10.7196/samj.2019.v109i6.13120.
[117] Violence against children n.d. https://www.who.int/news-room/fact-sheets/detail/violence-against-children (accessed July 14, 2022).
[118] Seedat M, Niekerk AV, Suffla S, Ratele K. Authors: R Jewkes, N Abrahams, S Mathews, MRC Gender & Health Research Unit n.d.:2.
[119] Messman TL, Long PJ. Child sexual abuse and its relationship to revictimization in adult women: A review. Clin Psychol Rev 1996;16:397–420. https://doi.org/10.1016/0272-7358(96)00019-0.
[120] Hsiao C, Fry D, Ward CL, Ganz G, Casey T, Zheng X, et al. Violence against children in South Africa: the cost of inaction to society and the economy. BMJ Glob Health 2018;3:e000573. https://doi.org/10.1136/bmjgh-2017-000573.
[121] Bandeira M, Higson-Smith C. Responding to the Smoke that Calls: Principles of community-level interventions for the prevention of collective violence. 2013.
[122] http://juta/nxt/print.asp?NXTScript=nxt/gateway.dll&NXTHost=jut n.d.:89.
[123] Phyfer J, Wakefield L. Calling for a comprehensive approach: Violence prevention and early childhood development. SA Crime Q 2015:23–9. https://doi.org/10.4314/sacq.v51i1.3.
[124] brain — Babies. Relavate n.d. https://www.relavate.org/babies/tag/brain (accessed July 15, 2022).
[125] Brain Development of Children from 0-6 years - Facts every parent should know. ADAM Mila 2017. https://www.adam-mila.com/brain-development-children-0-6-years/ (accessed July 15, 2022).
[126] Kolb B, Gibb R. Brain plasticity and behaviour in the developing brain. J Can Acad Child Adolesc Psychiatry J Acad Can Psychiatr Enfant Adolesc 2011;20:265–76.
[127] Radley J, Morrison J. Repeated stress and structural plasticity in the brain. Ageing Res Rev 2005;4:271–87. https://doi.org/10.1016/j.arr.2005.03.004.
[128] Understanding the Effects of Maltreatment on Brain Development n.d.:19.
[129] Bock J, Gruss M, Becker S, Braun K. Experience-induced changes of dendritic spine densities in the prefrontal and sensory cortex: correlation with developmental time windows. Cereb Cortex N Y N 1991 2005;15:802–8. https://doi.org/10.1093/cercor/bhh181.
[130] InBrief: The Science of Early Childhood Development n.d. https://developingchild.harvard.edu/resources/inbrief-science-of-ecd/ (accessed July 15, 2022).
[131] Aristizabal MJ, Anreiter I, Halldorsdottir T, Odgers CL, McDade TW, Goldenberg A, et al. Biological embedding of experience: A primer on epigenetics. Proc Natl Acad Sci 2020;117:23261–9. https://doi.org/10.1073/pnas.1820838116.
[132] Berens AE, Jensen SKG, Nelson CA. Biological embedding of childhood adversity: from physiological mechanisms to clinical implications. BMC Med 2017;15:135. https://doi.org/10.1186/s12916-017-0895-4.
[133] Hertzman C. Putting the concept of biological embedding in historical perspective. Proc Natl Acad Sci 2012;109:17160–7. https://doi.org/10.1073/pnas.1202203109.
[134] Morgan B. Biological embedding of early childhood adversity: Toxic stress and the vicious cycle of poverty in South Africa n.d.:11.
[135] Nelson CA. Hazards to Early Development: The Biological Embedding of Early Life Adversity. Neuron 2017;96:262–6. https://doi.org/10.1016/j.neuron.2017.09.027.
[136] Biological embedding: evaluation and analysis of an emerging concept for nursing scholarship - PubMed n.d. https://pubmed.ncbi.nlm.nih.gov/27682606/ (accessed July 15, 2022).
[137] Nelson CA. Biological embedding of early life adversity. JAMA Pediatr 2013;167:1098–100. https://doi.org/10.1001/jamapediatrics.2013.3768.

[138] Nelson HJ, Kendall GE, Shields L. Neurological and Biological Foundations of Children's Social and Emotional Development: An Integrated Literature Review. J Sch Nurs 2014;30:240–50. https://doi.org/10.1177/1059840513513157.
[139] Hart H, Rubia K. Neuroimaging of child abuse: a critical review. Front Hum Neurosci 2012;6.
[140] Knickmeyer RC, Gouttard S, Kang C, Evans D, Wilber K, Smith JK, et al. A structural MRI study of human brain development from birth to 2 years. J Neurosci Off J Soc Neurosci 2008;28:12176–82. https://doi.org/10.1523/JNEUROSCI.3479-08.2008.
[141] McEwen BS, Gianaros PJ. Stress- and allostasis-induced brain plasticity. Annu Rev Med 2011;62:431–45. https://doi.org/10.1146/annurev-med-052209-100430.
[142] Lister R, Pelizzola M, Dowen RH, Hawkins RD, Hon G, Tonti-Filippini J, et al. Human DNA methylomes at base resolution show widespread epigenomic differences. Nature 2009;462:315–22. https://doi.org/10.1038/nature08514.
[143] Lister R, Mukamel EA, Nery JR, Urich M, Puddifoot CA, Johnson ND, et al. Global epigenomic reconfiguration during mammalian brain development. Science 2013;341:1237905. https://doi.org/10.1126/science.1237905.
[144] McGowan PO, Suderman M, Sasaki A, Huang TCT, Hallett M, Meaney MJ, et al. Broad epigenetic signature of maternal care in the brain of adult rats. PloS One 2011;6:e14739. https://doi.org/10.1371/journal.pone.0014739.
[145] Weaver ICG, Cervoni N, Champagne FA, D'Alessio AC, Sharma S, Seckl JR, et al. Epigenetic programming by maternal behavior. Nat Neurosci 2004;7:847–54. https://doi.org/10.1038/nn1276.
[146] McGowan PO, Sasaki A, D'Alessio AC, Dymov S, Labonté B, Szyf M, et al. Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. Nat Neurosci 2009;12:342–8. https://doi.org/10.1038/nn.2270.
[147] Lam LL, Emberly E, Fraser HB, Neumann SM, Chen E, Miller GE, et al. Factors underlying variable DNA methylation in a human community cohort. Proc Natl Acad Sci U S A 2012;109:17253–60. https://doi.org/10.1073/pnas.1121249109.
[148] Boyce WT, Kobor MS. Development and the epigenome: the "synapse" of gene-environment interplay. Dev Sci 2015;18:1–23. https://doi.org/10.1111/desc.12282.
[149] Dunn EC, Soare TW, Zhu Y, Simpkin AJ, Suderman MJ, Klengel T, et al. Sensitive Periods for the Effect of Childhood Adversity on DNA Methylation: Results From a Prospective, Longitudinal Study. Biol Psychiatry 2019;85:838–49. https://doi.org/10.1016/j.biopsych.2018.12.023.
[150] The Productivity Argument for Investing in Young Children on JSTOR n.d. https://www.jstor.org/stable/4624854 (accessed July 15, 2022).
[151] Africa SS. Investing in early childhood development is the future | Statistics South Africa n.d. https://www.statssa.gov.za/?p=10950 (accessed June 1, 2022).
[152] Heckman J, Grunewald R, Reynolds A. The Dollars and Cents of Investing Early: Cost-Benefit Analysis in Early Care and Education. Zero Three 2006;26:10–7.
[153] Chevalier A, Finn C, Harmon C, Heckman J. The microeconomics of early child investment. J Child Serv 2006;1:18–30. https://doi.org/10.1108/17466660200600011.
[154] Elango S, García JL, Heckman JJ, Hojman A. Early Childhood Education. Econ. Means-Test. Transf. Programs U. S. Vol. 2, University of Chicago Press; 2015, p. 235–97.
[155] Carneiro P, Ginja R. Long-Term Impacts of Compensatory Preschool on Health and Behavior: Evidence from Head Start. Am Econ J Econ Policy 2014;6:135–73.
[156] Boca DD, Martino EM, Piazzalunga D. Investments in Early Education and Child Outcomes: The Short and the Long Run n.d.:7.
[157] Felitti VJ, Anda RF, Nordenberg D, Williamson DF, Spitz AM, Edwards V, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. Am J Prev Med 1998;14:245–58. https://doi.org/10.1016/s0749-3797(98)00017-8.
[158] Schechter DS, Willheim E, Hinojosa C, Scholfield-Kleinman K, Turner JB, McCaw J, et al. Subjective and objective measures of parent-child relationship dysfunction, child

separation distress, and joint attention. Psychiatry 2010;73:130–44. https://doi.org/10.1521/psyc.2010.73.2.130.
[159] Hollenstein T, Granic I, Stoolmiller M, Snyder J. Rigidity in parent-child interactions and the development of externalizing and internalizing behavior in early childhood. J Abnorm Child Psychol 2004;32:595–607. https://doi.org/10.1023/b:jacp.0000047209.37650.41.
[160] Aro T, Eklund K, Eloranta A-K, Närhi V, Korhonen E, Ahonen T. Associations Between Childhood Learning Disabilities and Adult-Age Mental Health Problems, Lack of Education, and Unemployment. J Learn Disabil 2019;52:71–83. https://doi.org/10.1177/0022219418775118.
[161] Luby JL, Rogers C, McLaughlin KA. Environmental Conditions to Promote Healthy Childhood Brain/Behavioral Development: Informing Early Preventive Interventions for Delivery in Routine Care. Biol Psychiatry Glob Open Sci 2021. https://doi.org/10.1016/j.bpsgos.2021.10.003.
[162] National Development Plan 2030 | South African Government n.d. https://www.gov.za/issues/national-development-plan-2030 (accessed June 1, 2022).
[163] Gil-Hernández C. The (Unequal) Interplay Between Cognitive and Noncognitive Skills in Early Educational Attainment. Am Behav Sci 2021;65. https://doi.org/10.1177/0002764221996764.
[164] Shonkoff JP, Richter L, van der Gaag J, Bhutta ZA. An integrated scientific framework for child survival and early childhood development. Pediatrics 2012;129:e460-472. https://doi.org/10.1542/peds.2011-0366.
[165] Black MM, Walker SP, Fernald LCH, Andersen CT, DiGirolamo AM, Lu C, et al. Early childhood development coming of age: science through the life course. The Lancet 2017;389:77–90. https://doi.org/10.1016/S0140-6736(16)31389-7.
[166] Daelmans B, Darmstadt GL, Lombardi J, Black MM, Britto PR, Lye S, et al. Early childhood development: the foundation of sustainable development. The Lancet 2017;389:9–11. https://doi.org/10.1016/S0140-6736(16)31659-2.
[167] Munsell EP, Kilmer RP, Cook JR, Reeve CL. The Effects of Caregiver Social Connections on Caregiver, Child, and Family Well-Being. Am J Orthopsychiatry 2012;82:137–45. https://doi.org/10.1111/j.1939-0025.2011.01129.x.
[168] q-a-on-child-care.pdf n.d.
[169] Wang K, Qi Y, Wei Q, Shi Y, Zhang Y, Shi H. Responsive Caregiving and Opportunities for Early Learning Associated With Infant Development: Results From a Prospective Birth Cohort in China. Front Pediatr 2022;10.
[170] Scherer E, Hagaman A, Chung E, Rahman A, O'Donnell K, Maselko J. The relationship between responsive caregiving and child outcomes: evidence from direct observations of mother-child dyads in Pakistan. BMC Public Health 2019;19:252. https://doi.org/10.1186/s12889-019-6571-1.
[171] Lucas J, Richter L, Daelmans B. Care for Child Development: an intervention in support of responsive caregiving and early child development: Care for Child Development. Child Care Health Dev 2018;44:41–9. https://doi.org/10.1111/cch.12544.
[172] Ameyaw R, Ameyaw E, Agbenorhevi JK, Hammond CK, Arhin B, Afaa TJ. Assessment of knowledge and socioeconomic status of caregivers of children with malnutrition at a district hospital in Ghana. Afr Health Sci 2023;23:693–703. https://doi.org/10.4314/ahs.v23i1.74.
[173] carergivers socioeconomic status and early childhood development - Google Search n.d. https://www.google.com/search?q=carergivers+socioeconomic+status+and+early+childhood+development&rlz=1C1GCEU_enZA858ZA858&oq=carergivers+socioeconomic+status+and+early+childhood+development&gs_lcrp=EgZjaHJvbWUyBggAEEUYOdIBCTM1MTk4ajBqN6gCALACAA&sourceid=chrome&ie=UTF-8#ip=1 (accessed October 2, 2023).

[174] Slemming W, Norris SA, Kagura J, Saloojee H, Richter L. Child development at age 5 years: The effects of maternal education, socioeconomic status and early-life growth examined prospectively in a low-resource setting. South Afr J Child Health 2022;16:111–6. https://doi.org/10.7196/SAJCH.2022.v16i2.1846.
[175] Moore TG, McDonald M, Carlon L, O'Rourke K. Early childhood development and the social determinants of health inequities. Health Promot Int 2015;30:ii102–15. https://doi.org/10.1093/heapro/dav031.
[176] Hekli P. EFFECT OF SOCIOECONOMIC STATUS ON CAREGIVERS' KNOWLEDGE AND BELIEFS REGARDING CHILD HEALTH CARE IN SAVELUGU NANTON, GHANA n.d.
[177] Gao Y, Zhang L, Kc A, Wang Y, Zou S, Chen C, et al. Housing environment and early childhood development in sub-Saharan Africa: A cross-sectional analysis. PLOS Med 2021;18:e1003578. https://doi.org/10.1371/journal.pmed.1003578.
[178] How Socioeconomic Status Impacts Early Childhood Development - Video & Lesson Transcript. StudyCom n.d. https://study.com/academy/lesson/how-socioeconomic-status-impacts-early-childhood-development.html (accessed October 2, 2023).
[179] Lopez Boo F. Socio-economic status and early childhood cognitive skills: A mediation analysis using the Young Lives panel. Int J Behav Dev 2016;40:500–8. https://doi.org/10.1177/0165025416644689.
[180] Wong KLM, Restrepo-Méndez MC, Barros AJD, Victora CG. Socioeconomic inequalities in skilled birth attendance and child stunting in selected low and middle income countries: Wealth quintiles or deciles? PLoS ONE 2017;12:e0174823. https://doi.org/10.1371/journal.pone.0174823.
[181] De Wet N. The association between mother's socioeconomic status and non-orphan kinship care arrangements in South Africa. Child Youth Serv Rev 2019;103:79–86. https://doi.org/10.1016/j.childyouth.2019.05.015.
[182] Drago F, Scharf RJ, Maphula A, Nyathi E, Mahopo TC, Svensen E, et al. Psychosocial and environmental determinants of child cognitive development in rural south africa and tanzania: findings from the mal-ed cohort. BMC Public Health 2020;20:505. https://doi.org/10.1186/s12889-020-08598-5.
[183] Cavalcante MCV, Lamy ZC, França AKTC, Pereira MUL, Ferraro AA, Barbieri MA, et al. Psychological distress and mother-child relationship: influence of life context on a population sample (BRISA) through the use of directed acyclic graphs (DAG). Braz J Med Biol Res 2020;54:e10080. https://doi.org/10.1590/1414-431X202010080.
[184] Mothers caring for children living with cerebral palsy: Suggestions for psycho-social support n.d. http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0037-80542021000300008 (accessed October 2, 2023).
[185] Zafar S, Sikander S, Haq Z, Hill Z, Lingam R, Skordis-Worrall J, et al. Integrating maternal psychosocial well-being into a child-development intervention: the five-pillars approach. Ann N Y Acad Sci 2014;1308:107–17. https://doi.org/10.1111/nyas.12339.
[186] Narvaez D, Wang L, Cheng A, Gleason TR, Woodbury R, Kurth A, et al. The importance of early life touch for psychosocial and moral development. Psicol Reflex E Crítica 2019;32:16. https://doi.org/10.1186/s41155-019-0129-0.
[187] How Culture Influences a Child's Development | Psychology Paper Example. PsychologyWriting n.d. https://psychologywriting.com/how-culture-influences-a-childs-development/ (accessed October 2, 2023).
[188] Pumariega AJ, Joshi SV. Culture and Development in Children and Youth. Child Adolesc Psychiatr Clin N Am 2010;19:661–80. https://doi.org/10.1016/j.chc.2010.08.002.
[189] Cultural Influences on Child Development. Maryville Online 2021. https://online.maryville.edu/blog/cultural-influences-on-child-development/ (accessed October 2, 2023).
[190] Ball J. Culture and Early Childhood Education n.d.

[191] Culture: Early childhood education | Encyclopedia on Early Childhood Development 2023. https://www.child-encyclopedia.com/culture/according-experts/culture-and-early-childhood-education (accessed October 2, 2023).
[192] CodeIT, NDFAuthors. The Role of Culture in Early Childhood Development. Novak Djokovic Found 2021. https://novakdjokovicfoundation.org/the-role-of-culture-in-early-childhood-development/ (accessed October 2, 2023).
[193] Yang W, Li H. The role of culture in early childhood curriculum development: A case study of curriculum innovations in Hong Kong kindergartens. Contemp Issues Early Child 2020;23. https://doi.org/10.1177/1463949119900359.
[194] Alhosani N. The Influence of Culture on Early Childhood Education Curriculum in the UAE. ECNU Rev Educ 2022;5:284–98. https://doi.org/10.1177/20965311221085984.
[195] Kuusisto A, editor. The Routledge International Handbook of the Place of Religion in Early Childhood Education and Care. London: Routledge; 2022. https://doi.org/10.4324/9781003017783.
[196] Sociologists study the impact religion has on child development. ScienceDaily n.d. https://www.sciencedaily.com/releases/2019/02/190207123220.htm (accessed October 2, 2023).
[197] Religions | Free Full-Text | Developmental Implications of Children's Early Religious and Spiritual Experiences in Context: A Sociocultural Perspective n.d. https://www.mdpi.com/2077-1444/10/11/631 (accessed October 2, 2023).
[198] Bartkowski JP, Xu X, Levin ML. Religion and child development: Evidence from the Early Childhood Longitudinal Study. Soc Sci Res 2008;37:18–36. https://doi.org/10.1016/j.ssresearch.2007.02.001.
[199] How Does Religion Impact Child Development? n.d. https://psychcentral.com/news/2019/02/09/how-does-religion-impact-child-development (accessed October 2, 2023).
[200] Akrim A, Junaidi J. A study of the role of religious development in childhood on psychological health in Indonesia. HTS Teol Stud Theol Stud 2021;77:6.
[201] Chung EO, Fernald LCH, Galasso E, Ratsifandrihamanana L, Weber AM. Caregiver perceptions of child development in rural Madagascar: a cross-sectional study. BMC Public Health 2019;19:1256. https://doi.org/10.1186/s12889-019-7578-3.
[202] Ayob Z, Christopher C, Naidoo D. Exploring Caregivers' Perceptions on Their Role in Promoting Early Childhood Development. Early Child Dev Care 2022;192:1462–76. https://doi.org/10.1080/03004430.2021.1888943.
[203] Ayob Z, Christopher C, Naidoo D. Caregivers' Perception of their Role in Early Childhood Development and Stimulation Programmes in the Early Childhood Development Phase within a Sub-Saharan African Context: An Integrative Review. South Afr J Occup Ther 2021;51:84–92. https://doi.org/10.17159/2310-3833/2021/vol51n3a10.
[204] Chung EO, Fernald LCH, Galasso E, Ratsifandrihamanana L, Weber A. Caregiver Perceptions of Child Development: A Cross-Sectional Study. The World Bank; 2019. https://doi.org/10.1596/1813-9450-9030.
[205] Miller P, Votruba-Drzal E. Early academic skills and childhood experiences across the urban–rural continuum. Early Child Res Q 2013;28:234–48. https://doi.org/10.1016/j.ecresq.2012.12.005.
[206] Parent–child interactions and child outcomes: Evidence from randomized intervention - ScienceDirect n.d. https://www.sciencedirect.com/science/article/abs/pii/S092753711830085X (accessed March 8, 2025).
[207] Africa SS. Five facts about poverty in South Africa | Statistics South Africa 2019. https://www.statssa.gov.za/?p=12075 (accessed August 11, 2024).
[208] PROFILE: Mopani DISTRICT municipality n.d.
[209] McKerrow N, Mulaudzi M, Boon G, ferris A, Gaede B, Mabuza F, et al. 2 ND TRIENNIAL REPORT OF THE COMMITTEE ON MORBIDITY AND MORTALITY IN

CHILDREN UNDER 5 YEARS (COMMIC): 2014. 2014. https://doi.org/10.13140/RG.2.2.33374.89928.
[210] Rockers PC, Leppänen JM, Tarullo A, Coetzee L, Fink G, Hamer DH, et al. Evaluation of a community health worker home visit intervention to improve child development in South Africa: A cluster-randomized controlled trial. PLOS Med 2023;20:e1004222. https://doi.org/10.1371/journal.pmed.1004222.
[211] McCoy DC, Waldman M, Fink G. Measuring early childhood development at a global scale: Evidence from the Caregiver-Reported Early Development Instruments. Early Child Res Q 2018;45:58–68. https://doi.org/10.1016/j.ecresq.2018.05.002.
[212] Citations – REDCap n.d. https://projectredcap.org/resources/citations/ (accessed March 8, 2025).
[213] Wealth-Quintile-Guide.pdf n.d.
[214] WHO Multicentre Growth Reference Study (MGRS) n.d. https://www.who.int/tools/child-growth-standards/who-multicentre-growth-reference-study (accessed August 10, 2024).
[215] Abidin R, Flens JR, Austin WG. The Parenting Stress Index. Forensic Uses Clin. Assess. Instrum., Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers; 2006, p. 297–328. https://doi.org/10.1037/14643-020.
[216] Mental health related determinants of parenting stress among urban mothers of young children – results from a birth-cohort study in Ghana and Côte d'Ivoire | BMC Psychiatry n.d. https://link.springer.com/article/10.1186/1471-244X-14-156 (accessed August 18, 2024).
[217] Oburu: Parenting stress and self-reported discipline... - Google Scholar n.d. https://scholar.google.com/scholar_lookup?title=Parenting+stress+and+self-reported+discipline+strategies+of+Kenyan+caregiving+grandmothers&author=Oburu,+P.O.&author=Palmerus,+K.&publication_year=2003&journal=Int.+J.+Behav.+Dev.&volume=27&pages=505%E2%80%935012&doi=10.1080/01650250344000127 (accessed August 18, 2024).
[218] Brathwaite R, Magorokosho N, Namuwonge F, Tutlam N, Neilands TB, McKay MM, et al. Typology and correlates of parental stress among caregivers of children with DBDs in low-resourced communities in Uganda. PLOS Glob Public Health 2023;3:e0002306. https://doi.org/10.1371/journal.pgph.0002306.
[219] Esan O, Akinsulore A, Yusuf MB, Adegbehingbe OO. Assessment of emotional distress and parenting stress among parents of children with clubfoot in south-western Nigeria. SA Orthop J 2017;16:26–31. https://doi.org/10.17159/2309-8309/2017/v16n2a2.
[220] Mbatha NL, Mokwena KE. Parental Stress in Raising a Child with Developmental Disabilities in a Rural Community in South Africa. Int J Environ Res Public Health 2023;20:3969. https://doi.org/10.3390/ijerph20053969.
[221] J P, A S, P C. Parenting stress of caregivers of young children who are HIV Positive. Afr J Psychiatry 2007;10. https://doi.org/10.4314/ajpsy.v10i4.30257.
[222] The Use of Cronbach's Alpha When Developing and Reporting Research Instruments in Science Education | Research in Science Education n.d. https://link.springer.com/article/10.1007/s11165-016-9602-2 (accessed April 8, 2024).
[223] Altafim ERP, McCoy DC, Brentani A, Escobar AM de U, Grisi SJFE, Fink G. Measuring early childhood development in Brazil: validation of the Caregiver Reported Early Development Instruments (CREDI). J Pediatr Engl Ed 2020;96:66–75. https://doi.org/10.1016/j.jped.2018.07.008.
[224] New in Stata 18 | Stata n.d. https://www.stata.com/new-in-stata/ (accessed August 11, 2024).
[225] Flouri E, Midouhas E, Joshi H. Family poverty and trajectories of children's emotional and behavioural problems: the moderating roles of self-regulation and verbal cognitive ability. J Abnorm Child Psychol 2014;42:1043–56. https://doi.org/10.1007/s10802-013-9848-3.

[226] Adynski H, Propper C, Beeber L, Gilmore JH, Zou B, Santos HP. The role of social adversity on emotional dysregulation during infancy and early childhood. J Pediatr Nurs 2023;72:26–35. https://doi.org/10.1016/j.pedn.2023.03.010.
[227] Yu D, Caughy MO, Smith EP, Oshri A, Tresch M. Severe Poverty and Growth in Behavioral Self-Regulation: The Mediating Role of Parenting. J Appl Dev Psychol 2020;68:101135. https://doi.org/10.1016/j.appdev.2020.101135.
[228] Webster EM. The Impact of Adverse Childhood Experiences on Health and Development in Young Children. Glob Pediatr Health 2022;9:2333794X221078708. https://doi.org/10.1177/2333794X221078708.
[229] Perry EW, Hwang S, Marah B, Kondowulay Mansaray Y, Self-Brown S, Kim ET, et al. "If you take care of that child, tomorrow it will be a profit to you and an entire generation": A qualitative evaluation of a program to prevent ACEs and promote child development in Northern Sierra Leone. Child Prot Pract 2025;4:100090. https://doi.org/10.1016/j.chipro.2024.100090.
[230] Aye E, Nwakaego A, Adimora D, Offorka T, Robinson A, Nwosu P, et al. Family Conflict and Managing Strategies: Implication for Understanding Emotion and Power Struggles. Glob J Psychol Res New Trends Issues 2017;6. https://doi.org/10.18844/gjpr.v6i3.1454.
[231] Ambhore A, Ashtaputre A, Aurangabad B, Puri P, Bhutekar S. Communication Problem and Conflicts in Parent Child Relationship. 2022.
[232] Ekholuenetale M, Barrow A, Ekholuenetale CE, Tudeme G. Impact of stunting on early childhood cognitive development in Benin: evidence from Demographic and Health Survey. Egypt Pediatr Assoc Gaz 2020;68:31. https://doi.org/10.1186/s43054-020-00043-x.
[233] Chavez AE, Troxel M, Sheldrick RC, Eisenhower A, Brunt S, Carter AS. Child social-emotional and behavioral problems and competencies contribute to changes in developmental functioning during Early Intervention. Early Child Res Q 2024;66:245–54. https://doi.org/10.1016/j.ecresq.2023.10.009.
[234] Löytömäki J, Laakso M-L, Huttunen K. Social-Emotional and Behavioural Difficulties in Children with Neurodevelopmental Disorders: Emotion Perception in Daily Life and in a Formal Assessment Context. J Autism Dev Disord 2023;53:4744–58. https://doi.org/10.1007/s10803-022-05768-9.
[235] Miller AR, Gardiner E, Harding L. Behavioural and emotional concerns reported by parents of children attending a neurodevelopmental diagnostic centre. Child Care Health Dev 2018;44:711–20. https://doi.org/10.1111/cch.12594.
[236] The Neurodevelopmental Basis of Early Childhood Disruptive Behavior: Irritable and Callous Phenotypes as Exemplars n.d. https://doi.org/10.1176/appi.ajp.2017.17010045.
[237] Castro M, Fernández V, Martínez A, Alcántara M, Campillo A, López-Soler C. Relationship Between Neurodevelopmental Areas and Difficulties in Emotional-Behavioural Variables in Children With Typical Development Under 2 Years of Age: Sex Differences. Psychol Belg 2024;64. https://doi.org/10.5334/pb.1203.
[238] Baker BL, Blacher J, Crnic KA, Edelbrock C. Behavior Problems and Parenting Stress in Families of Three-Year-Old Children With and Without Developmental Delays. Am J Ment Retard 2002;107:433–44. https://doi.org/10.1352/0895-8017(2002)107<0433:BPAPSI>2.0.CO;2.
[239] Preventing exclusion from the Child Support Grant | UNICEF South Africa 2013. https://www.unicef.org/southafrica/reports/preventing-exclusion-child-support-grant (accessed August 13, 2024).
[240] Patel L, Knijn T, Wel FW. Child Support Grants in South Africa: A Pathway to Women's Empowerment and Child Well-being? J Soc Policy 2015;44:377–97. https://doi.org/10.1017/S0047279414000919.
[241] Nzuza K. Barriers contributing to the exclusion of eligible child support grant beneficiaries in Umzinto rural community of KwaZulu-Natal, South Africa n.d.

3 Appendices

PLAGIARISM DECLARATION TO BE SIGNED BY ALL HIGHER DEGREE STUDENTS

SENATE PLAGIARISM POLICY: APPENDIX ONE

I **Nelisiwe Mkize (Student number: 2455074)** am a student registered for the degree

of **Master of Science in Epidemiology** in the academic year **2025**.

I hereby declare the following:

- I am aware that plagiarism (the use of someone else's work without their permission and/or without acknowledging the original source) is wrong.
- I confirm that the work submitted for assessment for the above degree is my own unaided work except where I have explicitly indicated otherwise.
- I have followed the required conventions in referencing the thoughts and ideas of others.
- I understand that the University of the Witwatersrand may take disciplinary action against me if there is a belief that this is not my own unaided work or that I have failed to acknowledge the source of the ideas or words in my writing.
- I have included as an appendix a report from "Turnitin" (or other approved plagiarism detection) software indicating the level of plagiarism in my research document.

Signature: Date: 31 March 2025

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R49 Ms N Mkize

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M220670

NAME: (Principal Investigator)	Ms N Mkize
DEPARTMENT:	School of Public Health Division of Epidemiology and Biostatistics Medical School University
PROJECT TITLE:	*The relationship between parent-child interaction and early childhood development in rural Limpopo Province, South Africa*
DATE CONSIDERED:	2022/06/24
DECISION:	Approved unconditionally
CONDITIONS:	
NOTE:	If contact information regarding student study participants is required, please contact the Registrar's office - <Nicoleen.Potgieter@wits.ac.za>
SUPERVISOR:	Dr D Evans
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2022/09/14

This Clearance Certificate is valid for 5 years from the date of approval. An extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office secretariat on the 3rd floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.

I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **June** and therefore reports and re-certification will be due in the month of **June** each year. Unreported changes to the study may invalidate the clearance given by the HREC (Medical).

Signature of Principal Investigator _____ Date _____

Project_report_NMkize_2025.do cx

by Nelisiwe Mkize

Submission date: 31-Mar-2025 09:31AM (UTC+0200)
Submission ID: 2630637566
File name: Project_report_NMkize_2025.docx (667.18K)
Word count: 19086
Character count: 108997

Project_report_NMkize_2025.docx

ORIGINALITY REPORT

11%	9%	9%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

Denise Evans 31

March 2025