Complementarities Between Psychological and Technical Policy Interventions: Evidence from Child Health Programs in Rural Tanzania

by

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## Abstract

Child stunting is a public health issue that affects millions of children under five years of age around the world. This condition hinders cognitive development, posing challenges for academic success and future earning potential. Consequently, it perpetuates a cycle of poverty and malnutrition. Over the long term, stunting threatens overall health and economic development. The Empowered World View (EWV) is a faith-based psychological related to beliefs and practices that contribute to poverty, and negative outcomes for children's well-being such as stunting. The program is currently being carried out in rural Tanzania alongside technical interventions in the areas of health, livelihood and child protection.

My first objective is to evaluate the complementary impact of combining technical and psychological behavior change interventions compared to implementing technical interventions alone in improving Height-for-Age Z-scores (HAZ) for children under five in two years in rural Tanzania. Our second objective is to identify which components of technical interventions complement (or substitute) the psychological intervention in improving Height-for-Age Z-scores (HAZ) for children under the age of five in two years in rural Tanzania.

I employ a longitudinal quasi-experiment design among households with children aged 0-59 months [n=867 at baseline (2020) and n=867 at follow-up (2022)]. The treatment group received technical programs and psychological intervention. The control group received only technical programs. I derive difference-in-difference impact estimates to achieve our first objective and include interaction terms of components of technical intervention and treatment to achieve our second objective.

I observe a decrease in Height-for-Age Z-scores (HAZ) and an increase in stunting prevalence in the control group, while these measures remain constant in the treatment group. I find a significant differential improvement in Height-for-Age Z-scores (HAZ) of about 0.36 in the two years among boys and girls under the age of five in the treatment group. I also find complementarity between the psychological intervention and the following components of technical interventions: food security, maternal health, access to health services, and age-appropriate feeding practices for improving Height-for-Age Z-scores (HAZ) for children under the age of five years.

I conclude that the delivery of technical and psychological interventions simultaneously is more effective in reducing child stunting than delivering technical interventions alone. I also conclude that technical interventions which are tailored to address components such as food security, access to health services, and good complementary feeding practices will work best with psychological interventions in reducing stunting for children under the age of five years in rural Tanzania.

## Preface

This thesis is an original work by Innocent Bahati Katulunga. No part of this thesis has been previously published.

## Acknowledgments

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## Chapter 1: Introduction

Child stunting is a public health issue that affects millions of children under five years of age around the world (FAO, 2022). In 2022, approximately 22.3% of the global population in this age group, totalling about 148.1 million children, experienced moderate and severe stunting. Notably more prevalent in developing countries, stunting indicates persistent, chronic malnutrition over an extended period (WHO, 2020). The condition results in children being shorter than the expected height for their age. According to the definition by WHO (2020), a child is stunted if their height-for-age is more than two standard deviations below the WHO median child growth standard measure.

Stunted children are more susceptible to illness and infection due to weakened immune systems. A study by WHO in Tanzania found that stunted children are more than twice as likely to die before their fifth birthday compared to non-stunted children (WHO, 2017). In the long term, stunted children are more likely to have cognitive development delays, impacting their ability to learn and succeed in school (Hoddinott et al., 2008; Grantham et al., 2007; Walker et al., 2007). Furthermore, stunted children are at higher risk of chronic diseases such as obesity, diabetes and cardiovascular disease in adulthood (Victora et al., 2008; Ezzati et al., 2008), and mental health problems such as depression and anxiety (Walker et al., 2007).

Thus, the health impacts of stunting not only affect the child in the present period but also influence their future employment and earning potential, thereby perpetuating the cycle of poverty and malnutrition. In addition to the individual consequences, stunting can have a significant impact on the overall health and well-being of the population, as well as on the healthcare system (Black et al., 2013; Dewey et al.,2008; Victora et al., 2008; Grantham et al., 2007; Hoddinott et al., 2002) and economic development (Ezzati et al., 2008; Grantham et al., 2007).

Stunting has direct and indirect causes. Direct causes are poor diet and frequent sickness during the initial 1,000 days of life from conception (UNICEF, 2020). Practices like starting breastfeeding late, not breastfeeding exclusively for six months, not eating enough or consuming foods deficient in nutrients that promote growth, and poor care can lead to poor diet and diseases like diarrhea or lung infections. These practices are linked to stunting in empirical studies, such as those conducted by Dewey et al. (2008), Victora et al. (2008), and Yani et al. (2023). Indirect causes of stunting include maternal and socioeconomic factors. There is a wealth of empirical literature that establishes a connection between stunting and maternal factors like poor maternal health, low maternal education level, high birth rate, inadequate antenatal care visits, maternal age, and maternal autonomy (Christian et al., 2010; Kennedy et al., 2010; (Christian et al., 2010; Kennedy et al., 2010; Li Z et al.,2020). Similarly, numerous empirical studies have found a link between stunting and household socioeconomic factors such as poverty, food insecurity, lack of access to sanitation facilities, safe drinking water, healthcare, the social and cultural beliefs of a family, and the family system (Haddad et al., 2001; WHO, 2020; Yani et al., 2023), as well as child-specific factors such as child gender, child age, low birth weight, whether a child was delivered at health facility, birth complications, genetic redeposition and age-appropriate feeding (Dusingizimana et al., 2021; Delve et al., 2013).

Banerjee and Duflo (2012) emphasize the importance of understanding the poor's behavior and context and targeted evidence-based policies to address stunting. Following this new way of thinking about poverty and its manifestations, economists often address a single cause of stunting using interventions like supplementary feeding (Hoddinott et al., 2008), micronutrient supplementation (Hoddinott et al., 2008), improving access to clean water, sanitation, and healthcare (Walker et al., 2007), food security programs, targeted and conditional cash transfers (Hoop et al., 2010; WHO, 2011) and economic growth (Hoddinott et al., 2002). The majority of these interventions aim to assist low-income families in enhancing their environmental health and accessing nutritious foods for their children. Many studies, including those reviewed by Bhutta et al. (2013) and Hossain et al. (2017) have found that these interventions have had limited success.

The limited effectiveness could be because many of these interventions adopt a single-dimensional approach, overlooking the multiple causes of child stunting. Multifaceted approaches combining technical and behavioral change interventions, like those considered in studies by Kim et al. (2019) and Han et al. (2021), show better results, achieving around a 10% reduction in stunting in two years. Psychological behavior change interventions may also play a crucial role in shifting mindsets, beliefs and practices that contribute to stunting.

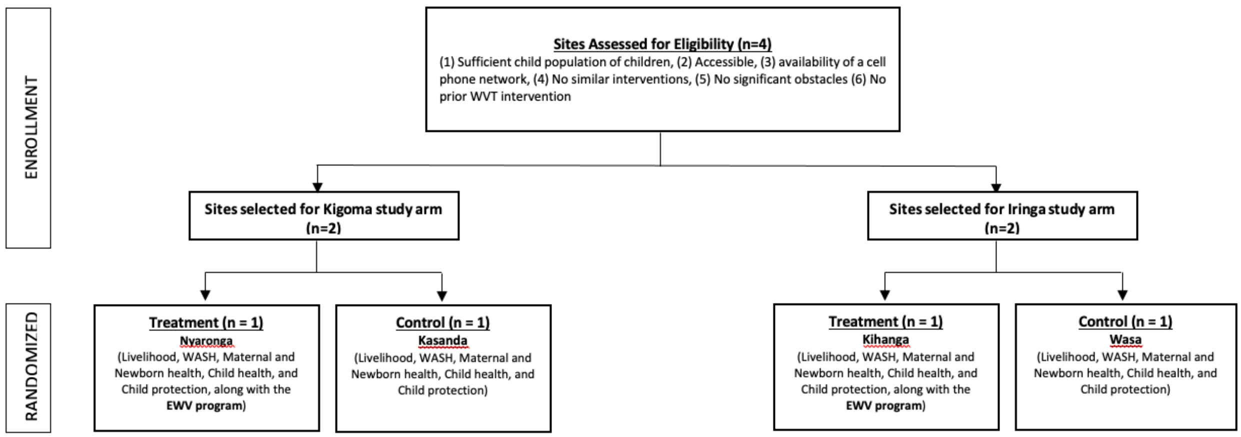
Given the limited effectiveness of single-dimensional technical interventions and the importance of coupling them with psychological behavior change interventions, it is important to test the effectiveness of combining technical and psychological behavior change interventions on improving child health and investigate how they complement (or substitute) each other (Ruel and Alderman, 2013; Bolier et al., 2013). However, there is currently no empirical evidence on this. Our study aims to address this gap.

In this study, our first objective is to evaluate the impact of combining technical and psychological behavior change interventions compared to technical interventions alone in improving Height-for-Age Z-scores (HAZ) for children under five in two years in rural Tanzania. Our second objective is to identify which components of technical interventions complement (or substitute) the psychological intervention in improving Height-for-Age Z-scores (HAZ) for children under five in two years in rural Tanzania. For example, technical and psychological behavior change interventions may complement each other in a scenario whereby improving health services alone does not suffice because misguided beliefs hinder usage (Author field observation) or in a scenario whereby implementing technical interventions without empowering mindsets creates dependency and hinders sustainable improvement in child health (World Bank, 2002).

Our study focuses on children under the age of five years. This age range is important because it allows us to examine the crucial first 1,000 days of life, starting from conception, when stunting typically occurs (WHO, 2020). This period also encompasses the weaning phase (around 4 to 18 months from birth), a significant time for child growth as exclusive breastfeeding becomes insufficient and complementary feeding starts (WHO, 2020). While stunting is generally considered irreversible (WHO, 2015), interventions during the weaning phase can prevent it, and early actions within the first 1,000 days may lead to catch-up growth (Leroy, 2015). Thereafter, it becomes increasingly difficult to prevent stunting, or for a child to catch up as they age (UNICEF, 2013). Nevertheless, even if stunting has occurred, interventions may still improve health, cognitive development, resilience, and other aspects of well-being (Dewey, 2011). Our primary outcome variable is the Height-for-Age Z-scores (HAZ), and our focus is on its alteration over the first two years of intervention. As demonstrated in the studies by Smith et al. (2011) and Kim et al. (2019), it is feasible to enhance and quantify the progress in Height-for-Age Z-scores (HAZ) and stunting within a two-year timeframe.

I employ a longitudinal quasi-experiment design among households with children under five. The treatment group received technical interventions and psychological behaviour change intervention called Empowered World View (henceforth, treatment). The control group received only technical interventions (henceforth, control). The technical interventions include Livelihood, WASH (Water, Sanitation, and Hygiene), Maternal and Newborn Health, Nutrition, and Child protection. Figure 1 summarizes the study design.

Figure 1. Study design




To achieve objectives one and two, I examine hypotheses one and two. Hypothesis one states that there is a significant differential effect of intervention on HAZ between the treatment and the control group during the intervention period. Hypothesis two states that components of technical interventions, like access to healthcare, sanitation facilities, food security, safe drinking water, maternal health, household wealth, and proper feeding practices for children, complement (or substitute) the effects of the treatment in improving HAZ during the intervention period.

I employ a difference-in-difference method to rule out the permanent differences in HAZ between treatment and control groups. I also adjust for other factors such as region, maternal age, food security, child gender, access to clean drinking water, sanitation, age-appropriate feeding practices for children, household wealth, maternal health, and access to health services that could cause variation in HAZ outcomes, even in absence of the treatment. To tackle the bias that may be caused by time-invariant unobserved variables such as genetic predispositions, birth complications, parental education, family social and cultural beliefs, and family system I include child-fixed effects in our empirical models. To test the second hypothesis, I include interaction terms to identify components of technical interventions that complement (or substitute) the effects of the treatment in improving HAZ. Our main data sources are baseline and follow-up surveys, each comprising 867 households and 954 children under five in two study regions in rural Tanzania.

I observe a decrease in Height-for-Age Z-scores (HAZ) and an increase in stunting prevalence in the control group but constant levels of these variables in the treatment group. I find a significant differential effect in Height-for-Age Z-scores (HAZ) by about 0.36 in the two years among boys and girls under five in the treatment group. I also find complementarity between psychological intervention and several components of technical interventions on improving Height-for-Age Z-scores (HAZ) for children under the age of five in two years period in rural Tanzania. These components include food security, mother's health, access to health services, and age-appropriate feeding practices for children.

The findings of this study render two main policy implications. First, delivery of technical and psychological interventions simultaneously is more effective in reducing stunting than delivering technical interventions alone. Second, technical interventions which are tailored to address factors such as food security, access to health services, and proper feeding practices for children will work best with psychological interventions in reducing stunting for children under the age of five.

This study contributes to three areas of literature. Firstly, I contribute to the literature on the impact of faith-based psychological behavior change intervention on reducing stunting. Secondly, I contribute to the expanding literature on the effectiveness of multifaceted interventions in addressing stunting. Thirdly, I add to the literature on components of technical interventions that complement psychological interventions. Our study uniquely uses the HAZ as the outcome variable, a superior measure of child growth compared to other metrics like Weight-age-ratio-score (WAZ) or Weight-height-ratio-score (WHZ), which only reflect short-term changes in nutritional status.

The rest of this study is organized as follows: In section 2, I cover the literature review and methods I use in this study. In section 3, I present the results and conclusions.

# Chapter 2: Methods

## 2.0 Introduction

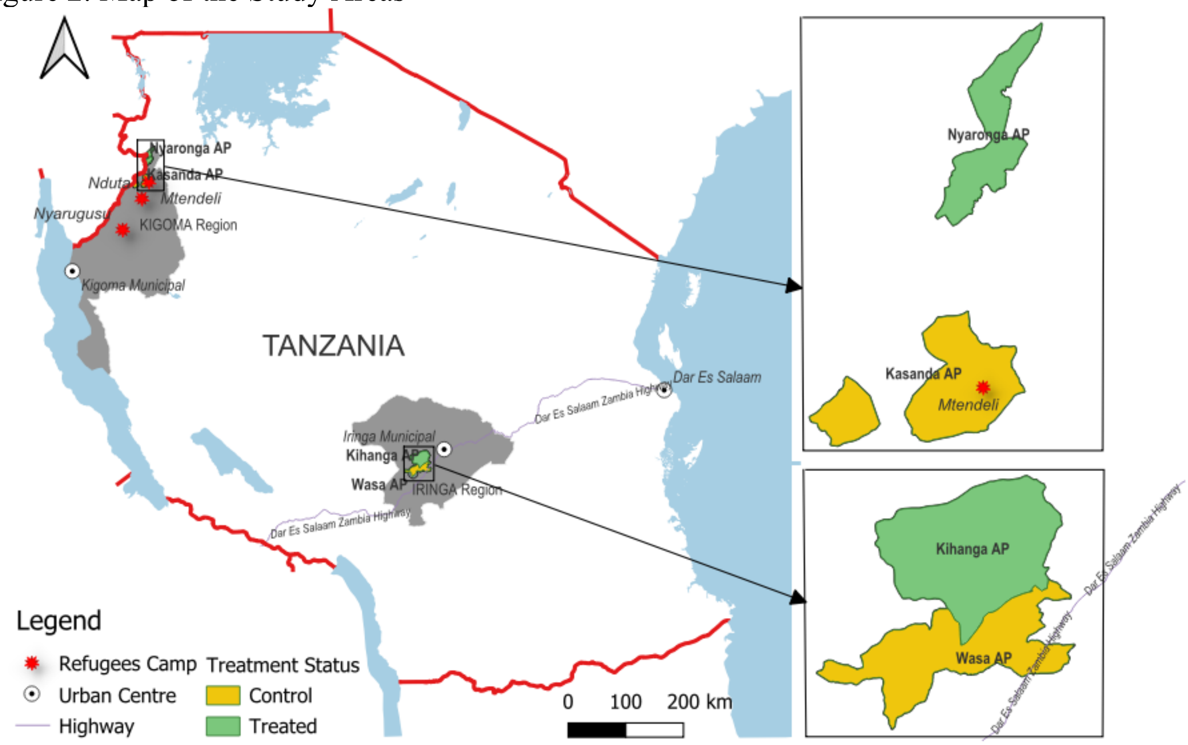
In this chapter, I discuss about two main things. First, I look at what other researchers have said about our topic. I discuss the context of the study, stunting in Tanzania, associated factors, and how it is studied using the HAZ. I also look at how psychological factors play a role in health and development. Second, I'll explain how I conducted our research. I discuss the intervention, the source of our data, and the empirical model I employ to examine our research hypothesis.

## 2.1 Study Context

Tanzania is one of the least developed countries in the world, with a GDP per capita of US$1,192 in 2022 (World Bank, 2023). According to FAO (2023), in 2022, Tanzania had a population of 61 million, with nearly 78 percent employed in agriculture, contributing only 28 percent of the gross domestic product. Although the country has sustained relatively high economic growth over the last decade, averaging 7 percent a year, and the poverty rate has declined, the absolute number of people (about 14 million) living in extreme poverty (earning less than US$ 1.9 per day) has not. This is because of high population growth (World Bank, 2019). As a result, children still face many challenges, including stunting, violence, and other basic needs.

This research is conducted in Iringa and Kigoma regions. These regions are among those with the highest prevalence of stunting in the country. As per the 2018 joint report by MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF, 47% of all children under five in Iringa and 42% in Kigoma were stunted. Iringa is located in the southern part of the country along the Tanzania-Zambia highway. The region is characterized by significant production of commercial crops such as Irish potatoes, horticultural crops (like tomatoes and carrots), and food crops like corn and beans. The region has relatively higher diversification and irrigation practices facilitated by abundant rivers and dams. Additionally, its strategic location along a major highway ensures that Iringa's produce easily reaches the market, and access inputs at relatively low prices. As a result, Iringa exhibits a higher average household yearly income of US$3,118, compared to the national average of US$2,225 as of 2019 (NBS, 2019). On the other hand, Kigoma, which is located in the northwest bordering Burundi, is characterized by lower production and diversification. The Kigoma region relies less on irrigation due to limited available rivers and dams. Consequently, the region is characterized by some of the lowest incomes nationwide, with an average annual household income of just US$482 in 2019 (NBS, 2019). Figure 2 below shows the map of the study areas.

Figure 2. Map of the Study Areas



## 2.2 Stunting in Tanzania

Over the past 25 years, Tanzania has made significant progress in reducing the prevalence of stunting in children under five by 30 percent (UNICEF, WHO & World Bank, 2023). However, stunting remains a significant issue, with about 32 percent of children under five still affected in 2022 (UNICEF, WHO & World Bank, 2023). This rate is significantly higher than the average rates for Africa, the world, and neighbouring Kenya, which stand at 30, 22.3, and 18.4 percent respectively (FAO, 2023). The situation is even more severe in rural areas of Tanzania, where the stunting rates for children under five were as high as 47 and 42 percent in Iringa and Kigoma respectively in 2018 (MoHCDGEC, MoH, TFNC, NBS, OCGS, and UNICEF, 2018). Despite Tanzania's progress, the current rate of stunting reduction is not sufficient to meet the World Health Assembly's target of a 40% reduction from 2015 to 2025 (Headey et al. in 2019).

Research by WHO (2023) and Jordyn (2021) indicates that proper breastfeeding and complementary feeding practices are crucial for optimal child growth and development. However, these practices are not good enough and improving slowly in Tanzania. Data collected jointly by MoHCDGEC, MoH Zanzibar, NBS, OCGS, and ICF from 2010 to 2016 shows that early initiation of breastfeeding improved by only 2 percent over the six years, from 49 percent in 2010 to 51 percent in 2016. Exclusive breastfeeding for children aged 0–5 months improved from 50 percent in 2010 to just 59 percent in 2016, while exclusive breastfeeding for children aged 4–5 months improved from 23 percent in 2010 to just 27 percent in 2016. Complementary feeding practices are also lacking, with only 10 percent of breastfed children aged 6 to 23 months receiving a minimum acceptable diet in 2016.

Empirical studies suggest that factors contributing to malnutrition and stunting in Tanzania include demographic characteristics such as region, lower maternal age, household wealth, feeding practices, maternal and child health care, and access to water, sanitation, hygiene, and food (Headey et al., 2019; Mbwana et al, 2017; Moffat et al, 2022; Sunguya et al, 2019).

To meet the World Health Assembly target, Headey et al., 2019 recommend a rapid and coordinated approach, including both nutrition-specific and a broad range of nutrition-sensitive actions.

**2.3 Psychological Factors and Empowered World View Intervention (EWV)**

Psychological factors are aspects of a person's thoughts and emotions that can affect how they think, feel, and behave (Harold, 2018). These include beliefs, hope, identity, self-esteem, and aspirations (Harold, 2018; Snyder, 2002; Orenstein, 2022; Tafarodi, 1995; Frank, 1935). These factors play a big role in various parts of life like health, education, decision-making, and relationships (Feldman et al., 2014; Bowers et al., 2023; Fraser et al., 2022; Stevens et al., 2018; Bright et al., 2011; Eaves et al., 2016; Orth et al., 2022; Supervia et al., 2022; Du et al., 2017; Mann et al., 2004). Scholars such as Rosenberg (1965), Erikson (1968), and Bandura (1997) studied how these factors influence individual beliefs and actions. In economics, they are seen as crucial in making choices and achieving economic well-being, especially for those with fewer resources (World Bank, 2007; IPA, 2018).

Low endowments of psychological capital can make it difficult for people to take actions that improve their economic well-being. Hence, interventions have sought to boost psychological capital, helping individuals develop positive mindsets and beliefs for pursuing economic opportunities and improving their overall well-being (Snyder et al., 1991; Markus et al., 1986). There is evidence that “psychological interventions” can positively impact psychological factors and contribute to economic well-being (World Bank, 2007; IPA, 2018). Such interventions have been used to address mental health issues and development challenges like Ebola, Malaria, and HIV/AIDS (Blevins et al., 2019; World Bank, 2007).

The Empowered World View (EWV) is one such faith-based program implemented in rural Tanzania by World Vision Tanzania. It focuses on enhancing psychological factors by shifting individuals' mindsets and world views related to beliefs, values, attitudes, and practices that contribute to poverty and negative outcomes for children's well-being. The program involves training and mentoring trainers, including faith leaders, influencers, and village leaders. Initial trainers use biblical and Quran principles to engage trainers on issues of identity, self-esteem, hope, and envisioning a better future. The training aims to shift trainers' mindsets from pessimism, jealousy, and dependence to hope, improved relationships, and self-reliance. These trainers are then facilitated to train and mentor other community members through outreach programs in credit groups, farmer groups, churches, mosques, and house-to-house training. Figure 3 illustrates the EWV intervention.

**2.4 Data**

The primary data for this study were obtained through baseline and follow-up surveys, as well as focus group discussions with village leaders.

The study spans two years, with the baseline survey conducted between July and August 2020, before the intervention program began, and the follow-up survey carried out from June to July 2022. The focus of the research is on children under the age of five, with data collected from 32 villages, 869 households, and 954 children. The same children from randomly selected households in both the treatment and control groups were surveyed during both the baseline and follow-up phases. A detailed breakdown of the data is presented in Figure 4.

Figure 3. The Empowered World View Intervention

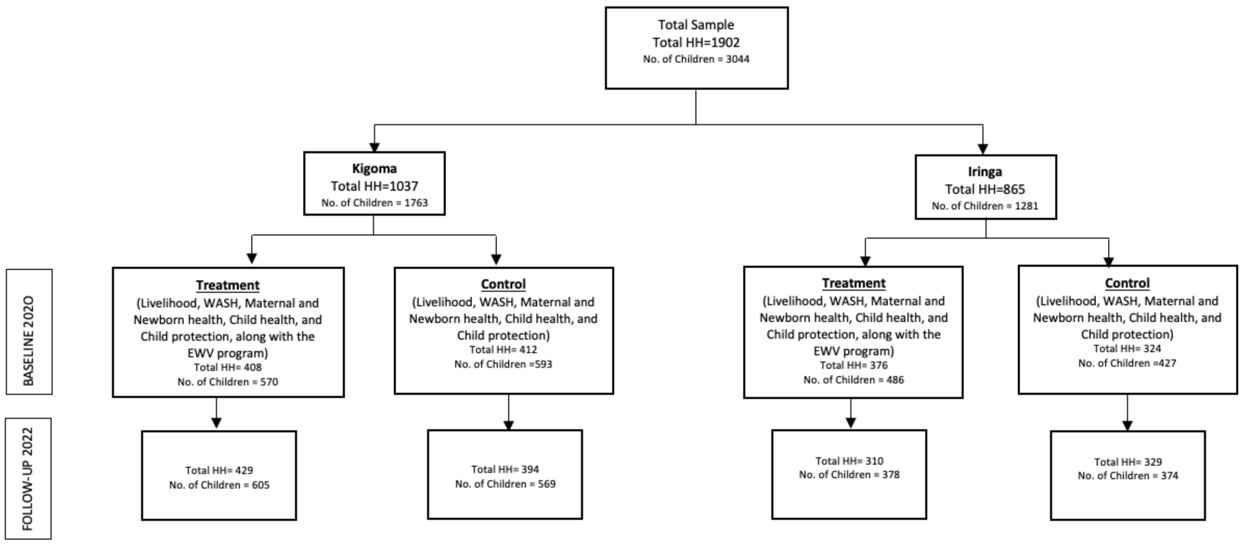

Developed by Daniel Muvengi (PhD), World Vision East Africa

Both surveys employed identical questionnaires, translated into Swahili, the local language spoken across all study sites. Detailed anthropometric measurements (height, weight, and mid-upper arm circumference) were collected for all children under five, along with household-level information on food security, wealth, sanitation, access to safe drinking water, healthcare access, and maternal health indicators, such as the mother's age and health status. Demographic information for all household members was also recorded.

Additionally, focus group discussions with village leaders were conducted during the follow-up survey to identify any significant external shocks or events, aside from the intervention, that might have influenced child health outcomes.

The author visited the research sites twice, actively participated in the Empowered World View sessions during the program's implementation, received training on survey administration, and took part in the follow-up survey.

Figure 4. Breakdown of the Survey Data




## 2.5 Measuring Stunting

As recommended by (WHO and UNICEF Global Nutrition Monitoring Framework, 2017), researchers use anthropometric indicators Height-for-age (HAZ), Weight-for-height (WHZ), and Weight-for-age (WAZ) to measure nutritional status and growth trends for children under the age of five years. According to (WHO, 2023), Height-for-Age Z score (HAZ), is a measure of a child's linear growth or height in relation to their age and sex. Specifically, it compares a child's height to the median height of children of the same age and sex in a reference population such as those provided by the World Health Organization (WHO, 2023). It is used to assess stunting, which is the measure of chronic malnutrition and impaired linear growth in children. Children with low HAZ below -2 and -3 standard deviations from the median are considered stunted and severe stunted respectively, indicating impaired growth (WHO, 2023). Here I focus on stunting.

Weight-for-height (WHZ) is a measure of acute malnutrition or wasting, which indicates recent weight loss or failure to gain weight and Weight-for-age (WAZ) is a measure of underweight. Both WHZ and WAZ are calculated using standard statistical methods that compare a child's weight to the median weight of children of the same age and sex in a reference population. Children with low scores (typically below -2 standard deviations from the median) are considered wasted and underweight respectively (WHO, 2023).

In this study, I use HAZ because it offers several advantages over WHZ and WAZ. While WHZ and WAZ may indicate acute malnutrition or recent changes in nutritional status, HAZ is less affected by short-term fluctuations in weight or weight-for-height ratios. Therefore, HAZ is particularly useful for assessing chronic malnutrition (stunting) and long-term growth trends. This is ideal for this study because I focus on measuring the impact of a two-year-long intervention. Additionally, HAZ is associated with factors such as sanitation, access to health care, access to safe drinking water, household wealth, food security, maternal health, maternal age, and proper feeding practices for children (Christian et al., 2010; Kennedy et al., 2010; UNICEF, 2020; Haddad et al., 2001; WHO, 2020; Delve et al., 2013). This makes it ideal to examine the second objective of this study.

Furthermore, HAZ has been linked with an increased risk of mortality, cognitive impairment, and reduced economic productivity later in life (Hoddinott et al., 2008; Grantham et al., 2007; Walker et al., 2007). Therefore, the policy recommendations from the findings of this study can help target interventions to prevent long-term negative health and developmental outcomes.

### 2.6 Components of Technical Interventions for Improving HAZ

The components of technical interventions are related to determinants of child stunting that have been identified in the literature, specifically the UNICEF Conceptual Framework on

Maternal and Child Nutrition (UNICEF, 2020). I categorized these determinants into household-level, mother-level and child-level factors. Household-level factors include household wealth, access to sanitation facilities, food security, access to safe drinking water, access to health care, family system, and social and cultural beliefs of the family. Mother--level factors include maternal age, maternal health, maternal education, antenatal visit, inter-pregnancy interval, and maternal autonomy Child-level factors include child gender, child age, low birth weight, whether a child was delivered at a health facility, birth complications, genetic deposition and age-appropriate feeding. Notably, factors such as household wealth, access to sanitation facilities, food security, safe drinking water, access to healthcare, maternal health, maternal age, and age-appropriate feeding practices for children are often the focal points in child health interventions. These factors are of significant policy interest.

***Food Security***

Food insecurity affects child stunting by limiting access to nutrients, heightening vulnerability to infections, and hence promoting malnutrition which leads to stunting (Gundersen & Kreider, 2009). The Livelihoods and Resilience program, implemented by World Vision Tanzania during the intervention period, likely reduced food insecurity. The program aims to enhance household food security, increase income, and improve the community's capacity to withstand shocks through providing essential skills, technologies, and initial capital to support sustainable food cultivation or initiate income-generating activities for vulnerable individuals. Food security in Kigoma has worsened recently, likely attributed to decreased food production due to drought and rising input prices (authors' field observations). This decline is exacerbated by limited diversification, gardening, and irrigation, resulting in a twofold increase in cereal crop prices. On the contrary, Iringa has experienced an improvement in food security despite drought conditions during the implementation period. The increase is likely due to decreased reliance on rainfall-dependent agriculture, increased diversification and emphasis on horticultural crops.

***Access to Health Care and Maternal Health***

Access to health services improves stunting through timely disease treatment, vaccinations, nutritional support, and addressing underlying health issues in children (UNICEF, 1990). There is a noticeable improvement in access to health services across all study sites. The improvement is due to the establishment of new health facilities, upgrading existing infrastructure, and increasing the number of health workers (authors' field observations). The advancements were done by World Vision Tanzania in collaboration with the government of Tanzania through "Maternal and Newborn Health". However, it is crucial to note that the closure of the Mtendeli refugee camp in Kigoma and its health center adversely affected access to healthcare for numerous households in Kigoma (authors' field observations). This impact is particularly noteworthy as, unlike other health centers Mtendeli refugee camp health center provided free of charge health services to its neighbouring villages (Danish Refugees Council, 2017).

***Complementary Feeding Practices***

Complementary feeding is very important to a child of six months and older. During this period, breastfeeding alone is no longer sufficient to meet a child's nutritional requirements (WHO, 2023). Poor complementary feeding practices such as inadequate meal frequency, less diverse foods, and limited quantity and quality of food result in inadequate nutrient intake and subsequent stunting (Christian et al., 2023). The Child Health and Nutrition program, implemented by World Vision Tanzania across all study sites improved child feeding practices (authors' field observations). The program provides parents with resources, knowledge, and skills related to food preservation and appropriate feeding.

### *Access to Sanitation Facilities and Safe Drinking Water*

Access to sanitation facilities and safe drinking water prevents waterborne diseases and enhances hygiene and sanitation practices. This improves overall child health and reduces stunting (Spears, 2013). The WASH (Water, Sanitation, and Hygiene) program implemented by World Vision Tanzania in partnership with local government improved access to sanitation facilities and safe drinking water throughout the study area (authors' field observations). The program facilitates the building of wells, provides drinking water buckets and toilet sinks to vulnerable households, and promotes the protection of water sources and hygiene practices.

## 2.7 Empirical Model

Our goal in this section is to specify a model that allows us to (1) test hypothesis one – that there is a significant differential effect of intervention on HAZ between the treatment and the control group during the intervention period, and (2) test hypothesis two -- that components of technical interventions, like access to healthcare, sanitation facilities, food security, access to safe drinking water, maternal health, maternal age, household wealth, and age-appropriate feeding practices for children complement (or substitute) the effects of the treatment in improving HAZ during the intervention period.

During the enrollment and preparatory stage, each study arm had only two study areas, one was randomly assigned to the treatment group and the other to the control group (see Figure 1). Due to the small sample size, this setup doesn't meet the criteria of a random controlled trial. There is a chance that the way treatment groups were assigned to treatment and control could be correlated with factors such as household wealth, access to health services, sanitation, food security, access to safe drinking water, household wealth, maternal health, maternal age, age-appropriate feeding practices for children and other unobserved factors which influence HAZ.

This can create selection bias which may lead to bias in estimation of the treatment effect. To mitigate this potential bias in our estimation of the treatment effect on HAZ, I consider a two-way fixed effect difference-in-difference econometric specification (Wooldridge, 2021):

$$y_{it} = \alpha + \gamma P_t + \beta( P_t \, x \, EWV_{it}) + c_i + e_{it} \quad (1)$$

Where the outcome variable $y_{it}$ denotes HAZ for a child i at period t (0=pre intervention, 1=post intervention). The intercept term α, represents the average HAZ for the control group before the intervention. $P_t$ is a dummy variable denoting the post-intervention period, and its coefficient γ represents how much the average HAZ of the control group has changed in the post-intervention period. $EWV_{it}$ is a dummy variable indicating the outcome was observed in the treatment group. The coefficient β is the key parameter of interest. It represents how much the average HAZ of the treatment group has changed in the period after the treatment, compared to what would have happened to the same group had the intervention not occurred. ci denotes child-specific time-invariant factors that may influence HAZ. Finally, $e_{it}$ denotes the identical and independently distributed error term for child i at period t (0=pre intervention, 1=post intervention). Table 1 illustrates the overall difference-in-difference approach and its coefficients as specified in equation (1).

Table 1. Overall Difference-in-Difference Approach and its Coefficients as Specified in equation (1)

| | Before Treatment | After Treatment | After Treatment -Before Treatment |
|---|---|---|---|
| Control Group | $\alpha + c_i$ | $\alpha + \gamma + c_i$ | $\gamma$ |
| Treatment Group | $\alpha + c_i$ | $\alpha + \gamma + \beta + c_i$ | $\gamma + \beta$ |
| | | Difference-in-Difference | $\beta$ |

Using the estimated parameter from models specified in (1) I use a t-test to test hypothesis one -- that there is a significant differential effect of intervention on HAZ between the treatment and the control group during the intervention period by evaluating the null hypothesis:

$$Ho: \beta = 0$$

If $\beta = 0$, I conclude that there is no differential effect, indicating that treatment has not affected HAZ. If I reject the null hypothesis i.e. $\beta \neq 0$, I conclude that there is a significant differential effect, indicating that treatment has affected HAZ.

To test hypothesis two --that components of technical interventions complement (or substitute) the effects of treatment in improving HAZ during the intervention period, I include two variables for each component of technical interventions in a model specified in (1). The two variables are $z_{it}$ and $EWV_{it}*\dot{z}_{it}$, indicating the component and its interaction with $EWV_{it}$ as shown in (2):

$$y_{it} = \alpha + \gamma P_t + \beta( P_t \, x \, EWV_{it} ) + \phi_j z_{it} + (P_t \, x \, EWV_{it} \, x \, *\dot{z}_{it}{}^{1})\delta_j + c_i + e_{it} \qquad (2)$$

Where $\phi_j$ is a row vector of coefficients representing the direct effects (not through the treatment) of a component of technical interventions. $\delta_j$ denotes a row vector of coefficients of interactions between a component of technical interventions $z_{it}$ and the treatment effect. In addition to coefficient $\beta$, $\delta_j$ is also the key parameter of interest. It represents the additional average treatment effect on HAZ for the treated sub-population with a higher value in a component j.

Zit includes food security, access to health services, sanitation, household wealth, access to safe drinking water, maternal health, age-appropriate feeding practices for children, male child, and region.

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[1] $\dot{z}_{it} = (z_{it} - \mu_1)$ *is a demeaned* $z_{it}$, where $\mu_1 = E(z_{it}/treated=1)$ is the average of the covariates over the treated subpopulation (e.g., see Wooldridge, 2021; Tymon, 2020).

Using the estimated parameter from the model specified in (2) I use a t-test to test hypothesis two-- that component of technical interventions j complement (or substitute) the effects of the treatment in improving HAZ during the intervention period by evaluating the null hypothesis:

$$Ho: \delta_j = 0$$

If $\delta_j = 0$, I conclude that there is no complementarity (or substitute) effect between treatment and a component of technical interventions j, but if I reject the null hypothesis i.e. $\beta \neq 0$, I conclude that there is complementarity (or substitute) effect between treatment and a component of technical interventions j.

To establish the evidence that the impact is caused by treatment and not by unobserved variation in household-specific, mother-specific, child-specific or religious affiliation-specific characteristics, in addition to child fixed effect as specified in (1), I estimate household, mother, and religious affiliation fixed effect models specified in (3), (4) and (5) respectively and compare the results. These fixed effects control for variation in time-invariant unobserved child-specific, household-specific, mother-specific, and religious affiliation-specific characteristics that may influence HAZ respectively. Household fixed effect controls for household-specific factors such as social and cultural practices of a family, as well as the family system. Mother-fixed effect controls for the mother-specific factors such as maternal autonomy. Child fixed effect controls for child-specific factors such as genetic predispositions and birth complications. Because the intervention is faith-based, religious affiliation fixed effect control for the possibility that the intervention affected Christians and Muslims differently.

$$Yi_{iht} = \alpha + \gamma P_t + \beta( P_t \, x \, EWV_{iht} ) + + c_h + e_{iht} \qquad (3)$$

$$Y_{imt} = \alpha + \gamma P_t + \beta( P_t \, x \, EWV_{imt} ) + c_m + e_{imt} \qquad (4)$$

$$y_{ihmrt} = \alpha + \gamma P_t + \beta( P_t \, x \, EWV_{ihmrt} ) + + c_r + e_{ihmrt} \quad (5)$$

Where the outcome variable $y_{iht}$ denotes the HAZ for a child from household *h* at period *t* (0=pre intervention, 1=post intervention) and the outcome variable $y_{imt}$ denotes HAZ for a child of mother *m* at period *t* (0=pre intervention, 1=post intervention). $c_{h,}$, $c_{m,}$ and $c_r$ denote household, mother, and religious affiliation-specific time-invariant factors that may influence HAZ respectively.

The two-way fixed effect difference-in-difference models specified in (1) through (5) above attribute any differences in HAZ trends between treatment and control groups that occurred during the intervention period to the treatment while accounting for time-invariant factors that may influence HAZ. However, doesn't account for time-varying factors that may influence HAZ as results treatment effect may be biased. Children differ in some characteristics, which may lead to variation in HAZ outcomes even in the absence of treatment. For instance, in a pre-intervention period, households in the treatment group were on average wealthier than households in the control group. According to Hong et al. (2006), children from wealthier households are more likely to have higher improvement in their health than their counterparts from poorer households. Therefore, the treatment group would likely have experienced better HAZ outcomes than the control group, even in the absence of the treatment. In this scenario, the treatment effect coefficient is likely biased, as it's composed of the treatment effect plus the direct and indirect effect of household wealth on HAZ.

To correct for the bias, I include the interaction term between the period variable ($p_t$) and each factor ($x_{it}$), ($p_t$*$x_{it}$) (e.g. see Paul et al. 2016; Zeldow and Hatfield 2021; Wooldridge 2021), leading to the specification in (6) which I use to test hypothesis one and specification in (7) which I use to test hypothesis two. The inclusion of the interaction term controls for the main and time-varying effect of the factor on HAZ, isolating the treatment effect.

$$y_{it} = \alpha + \gamma P_t + \beta( P_t \times EWV_{it} ) + (T_t * x_{it})\lambda + c_i + e_{it} \tag{6}$$

Where λ indicates a row vector of the time-varying effect of $x_{it}$ that is assumed common to all cross-section units.

$$y_{it} = \alpha + \gamma P_t + \beta( P_t \times EWV_{it} ) + \phi_j z_{it} + (P_t \times EWV_{it} * \dot{z}_{it}^{2})\delta_j + (T_t * x_{it})\lambda + c_i + e_{it} \tag{7}$$

Xit includes food security, access to sanitation facilities, access to safe drinking water, access to health services, maternal health, maternal age, and age-appropriate feeding practices for children. I assume time-invariant factors that may influence HAZ like child gender, child age, low birth weight, whether a child was delivered at a health facility, age-appropriate feeding practices for children, maternal age, number of antenatal visits, inter-pregnancy interval, and maternal education don't have a time-varying effect and are therefore taken out by the child fixed effect. Moreover, the results from the operational research carried out by World Vision Tanzania in October 2021 and June 2022 indicated that traditional World Vision initiatives (Livelihood, WASH, maternal and newborn health, child health, and child protection) were executed and functioning comparably in both control and treatment areas. Additionally, organizational aspects such as workload, monitoring systems, logistics, and staff attributes were consistent across both control and treatment groups. Thus, I rule out the possibility that the estimated treatment effect is due to organisational or implementation factors other than EWV. Table 2 reports descriptive statistics, definitions, and predicted signs of determinants of HAZ, including demographics.

[2] $\dot{z}_{it} = (z_{it} - \mu_1)$ *is a demeaned* $z_{it}$, where $\mu_1 = E(z_{it}/treated=1)$ is the average of the covariates over the treated subpopulation (e.g., see Wooldridge, 2021; Tymon, 2020).

Table 2. Variable Definitions, Descriptive Statistics, and Predicted Signs

| Variable | Mean | SD | Predicted sign | Definition |
|---|---|---|---|---|
| HAZ | -1.765 | 2.939 | | Child's height-for-age standardized against the WHO reference population. |
| Stunting | 0.443 | 0.497 | | Dummy variable; 1= HAZ is -2 or less, 0 otherwise |
| Food Security | 0.000 | 1.776 | + | Food security index derived from indicators related to household food security (food production, purchase, coping strategy, days without food, and night without eating) using the statistical technique known as Principal Component Analysis. |
| Access to Health Services | 1.352 | 0.927 | + | Categorical variable: "In the last year were you able to provide medical treatment for all children (5-18 years)? 2-yes, 1-only with assistance, 0-unable to provide |
| Household Wealth | 0.000 | 1.247 | + | The Household Wealth Index is derived from indicators related to household assets and amenities, using the statistical technique known as Principal Component Analysis. |

| | | | | |
|---|---|---|---|---|
| Sanitation | 0.403 | 0.491 | + | Dummy variable; 1=Household use Pit latrine with slap, flush or ventilated improved pit latrine toilet, 0=Pit latrine with no slap, open pit latrine, or no toilet (bush/field),0 otherwise |
| Safe drinking water | 0.638 | 0.481 | + | Dummy Variable; 1=A household access to water from a protected source, 0 otherwise |
| Mother Health | 0.52 | 0.499 | + | Dummy variable; 1=Mother Body Mass Index (BMI) falls under the normal range (18.5 and 24.9), 0 otherwise |
| Age-appropriate Feeding Practices for children | .026 | 0.158 | + | Dummy variable; 1=Child consumer a minimum of 3 food groups a day for a child over 6 months of age, Exclusive breastfeeding for a child under six months, 0 otherwise |
| Male Child | 0.483 | 0.499 | Ambiguous | Dummy variable; 1=Boy, 0=Girl |
| Mother's Age | 31.772 | 7.137 | + | Age of mother in years |
| Child Age | 32.734 | 14.401 | + | Age of a child in months |
| Region | 0.604 | .489 | Ambiguous | Dummy variable; 1=Kigoma region, 0=Iringa region |
| Household Size | 5.856 | 1.996 | - | Number of people who live in the household |

**2.8 Parallel Trend Assumption**

The plausibility of the difference-in-difference approach I specified in (1), (3), (4), and (5) and illustrated in Table 1 relies on assuming that, in the absence of the intervention, the average HAZ for treatment and control group would have followed the same trend over time. If this assumption is violated, the estimate of treatment effect will be biased. Since I only collected data for two periods, I cannot conduct statistical tests for parallel trends. However, some studies suggest that testing for parallel trends is neither necessary nor sufficient to validate the difference-in-difference approach (Kahn, 2018; Roth, 2022). These studies suggest that the approach is generally more plausible if the treatment and control groups are similar in levels of outcome variables in the pre-intervention period (Kahn, 2018). Furthermore, logical reasoning is deemed crucial, and cannot be replaced by parallel trends tests (Kahn, 2018). In our study, pre-intervention HAZ levels were similar (not statistically different) between the treatment and control groups. Additionally, interviews with village leaders did not reveal any significant events or shocks other than the intervention that could disrupt the HAZ trend in only one group. This similarity may be because the treatment and control groups for each study arm are located in the same district, thus sharing similar social, cultural, and economic characteristics. Moreover, I include additional control variables such as region, male child, food security, sanitation access, safe drinking water, access to health services, maternal health, maternal age, and age-appropriate feeding practices for children and child fixed effects into the difference-in-difference models specified in (6) and (7) to address potential confounding and time-invariant unobserved heterogeneity effects that might have influenced the HAZ trend during the intervention respectively. Furthermore, following the recommendation of Richard et al. (2009), I matched children based on relevant baseline characteristics, and applied difference-in-differences to those with propensity scores of above 0.5. This ensured that only children with similar relevant characteristics before the intervention are compared – for whom a parallel trends assumption seems more plausible. Similar technique is employed in John and David (2014).

# Chapter 3: Results

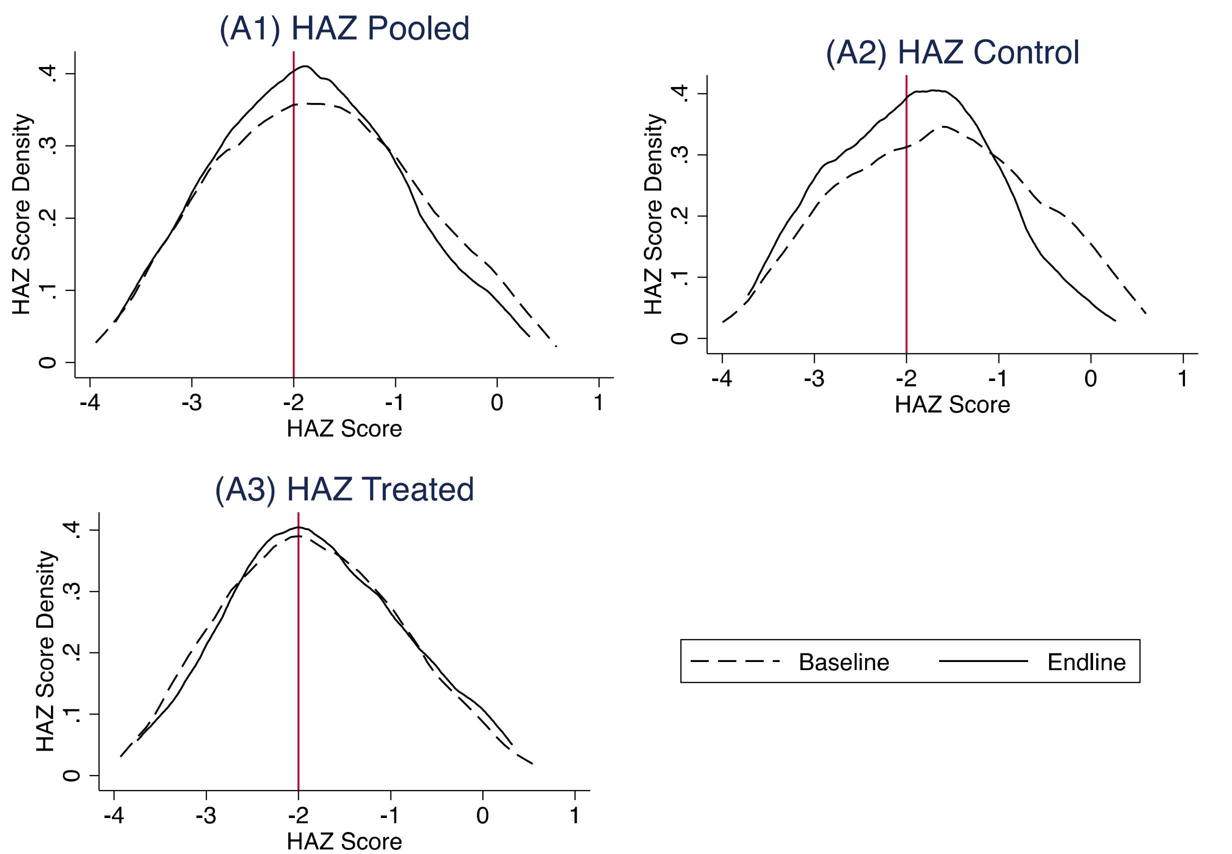
## 3.0 Introduction

I divide the discussion of our results into three sections. The initial section covers the outcomes of the first hypothesis which suggests that there is a significant differential effect of intervention on HAZ between the treatment and the control group during the intervention period. The second section delves into the results of the second hypothesis suggesting that some components of technical interventions may complement (or substitute) the effects of the treatment in improving HAZ during the intervention period. The third section concludes the findings of our study.

## 3.1 The Impacts of the Treatment on HAZ

Figure 5 presents the distribution of HAZ across study arms in control, treated and pooled groups. The red vertical line at -2 is the cut-off point, below which a child is considered stunted. The study population is generally highly stunted compared to the WHO reference population. Its HAZ distribution centered around -2 compared to the WHO reference population with its distribution centering at 0 HAZ (WHO, 2023). An overall decrease in HAZ during the intervention period is observed as illustrated by a leftward shift in the HAZ distribution of control (A2), treated (A2), and pooled (A1), this is also illustrated by descriptive statistics showing the overall decrease in average HAZ from -1.81 to -1.94. Stunting prevalence increased from 43% to 48% over the intervention period. This decrease in HAZ and increase in stunting prevalence is attributed to factors such as drought and the closure of a refugee camp in the Kigoma study arm. The presence of the refugee camp diversified the local economy and improved access to health services for local residents in Kigoma. Additionally, findings from qualitative studies in the same area suggest that the decline is due to generational tensions, such as youth disrespecting elders, youth drinking, sexual activity, and laziness, especially in the Kigoma study arm where the proportion of the youth population is higher. One notable finding from Figure 5 is that the HAZ distribution for the control group (A2) has shifted leftward considerably, in particular, if compared to the treated group (A3) where the HAZ distribution has almost remained unchanged.

Figure 5. Kernel density graphs showing the distribution of HAZ for pooled, control, and treated group




*Note*. This figure presents kernel density graphs showing the distribution of HAZ for pooled (A1), control (A2) and treated group (A3). The red vertical line represents -2 SD in the HAZ distribution which is the threshold below which a child is considered stunted (WHO, 2023). HAZ Trimmed at 95 percentiles.

The observations from Figure 5 provide a compelling visual representation of the changes in HAZ and stunting prevalence over the intervention period. The leftward shift in the HAZ distribution, particularly for the control group, indicates an increase in stunting prevalence. However, the relatively stable HAZ distribution for the treated group suggests that the treatment may have mitigated this trend. These findings raise important questions about the differential impacts of the intervention on the control and treated groups, and other potential factors contributing to these differences.

Now I shift from the visual analysis and descriptive statistics provided by Figure 5 to Table 3. Table 3 presents a more rigorous, econometric analysis of the data. This analysis allows us to control for possible sources of variation in HAZ outcomes other than the treatment. These sources include child, mother, and household characteristics that may affect HAZ and vary systematically across treatment and control groups as summarized in models specified in (1), (3), (4), (5) and (6). Therefore, the estimates focus on the variation of HAZ outcomes between children from treatment and control groups that have similar child, mother, and household characteristics. I use these estimates to test the first hypothesis.

Column 1 of Table 3 reports estimate of the model specified in (1). The treatment effect coefficient is 0.363 and highly statistically significant, at a 1 percent significance level. This indicates that the treatment significantly improved HAZ by 0.363 during the intervention period compared to what would have happened in absent of the treatment. Moreover, the mean HAZ across all children in the pre-intervention period was -1.801, so the treatment improved HAZ in the treated group by about 20 percent of the average HAZ.

The central results remain unchanged for models specified in (3), (4), (5) and (6). Column 3 of Table 3 presents estimate of the model specified in (3). In this model, I used the household fixed effect to control for unobserved heterogeneity caused by variation of time-invariant household-specific characteristics such as social and cultural practices of a family, as well as the family system that may affect HAZ. The treatment effect is 0.377 and highly statistically significant, at a 1 percent significant level. Column 4 of Table 3 presents estimate of the model specified in (4). Here, I used the mother fixed effect to control for unobserved heterogeneity caused by variation of time-invariant mother-specific characteristics that may affect HAZ such as maternal autonomy. The treatment effect is 0.414 and highly statistically significant, at a 1 percent significant level. Column 5 of Table 3 presents estimate of the model specified in (5). In this model, I used religious affiliation fixed effect to control for the possibility that, the intervention affected Christians and Muslims differently. The treatment effect is 0.354 and highly statistically significant, at a 1 percent significant level. Column 2 of Table 3 presents estimate of the model specified in (6). In this model, in addition to child fixed effect which controls for unobserved time-invariant child-specific factors such as genetic predispositions and birth complications, I included confounders to control food security, household wealth, access to health services, sanitation, access to safe drinking water, maternal health, and age-appropriate feeding practices for children. The treatment effect is 0.351 and highly statistically significant, at a 1 percent significant level.

Overall, the econometric analysis provides a rigorous, quantitative confirmation of the positive differential effect on HAZ for the treatment group, supporting our first hypothesis. This indicates the positive effect of treatment and confirms that the delivery of technical and psychological interventions simultaneously is more effective in improving HAZ than delivering technical interventions alone.

Interestingly, the analysis shows no significant difference between the findings from the Iringa and Kigoma study arms. Given the dissimilarity of economics and social contexts of the two regions, this finding could suggest that the treatment was consistent across different geographical contexts.

Table 3. Effects of the treatment on HAZ

| | Child Fixed Effect | | Household Fixed Effect | Mother Fixed Effect | Religion Fixed Effect |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| Post-Intervention | -0.289**** | -1.456 | -0.298**** | -0.301**** | -0.280**** |
| | (0.0538) | (0.332) | (0.0534) | (0.056) | (0.0546) |
| EWV | 0.363**** | 0.351**** | 0.377**** | 0.414**** | 0.354**** |
| | (0.0722) | 0.06 | 0.0721 | 0.0755 | 0.0731 |
| Constant | -1.752**** | -0.82 | -1.757**** | -1.769**** | -1.757**** |
| | (0.0179) | (0.229) | (0.0180) | (0.019) | (0.01817) |
| R-squared | 0.741 | 0.796 | 0.719 | 0.723 | 0.742 |
| Obversions | 1358 | 1358 | 1383 | 1264 | 1338 |
| Controls | No | Yes | No | No | No |

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

*Note*. This table reports results on effect of the treatment on HAZ. HAZ Trimmed at 95 percentiles. Robust standard errors clustered at the child level in parentheses.

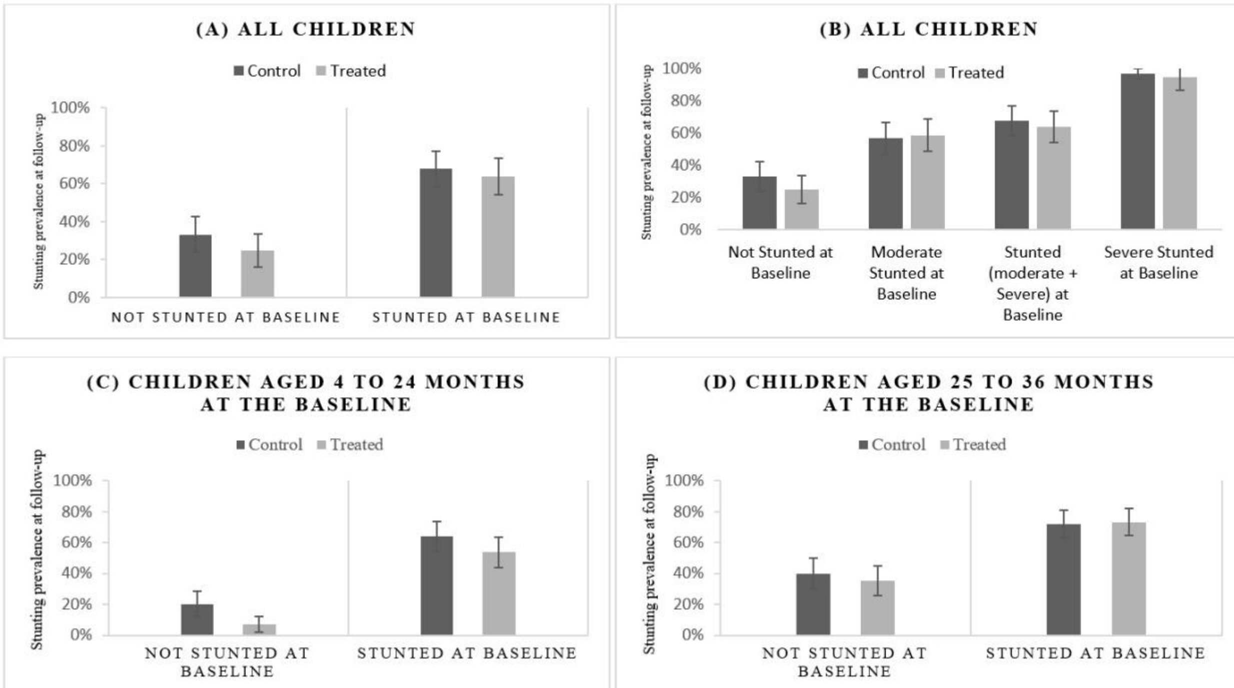
The results show no significant difference between the findings for boys and girls under the age of five. These findings contradict the belief that in Tanzania, parents allocate additional resources in favour of boys over girls. Given that the treatment also tackles gender biases and customs, this finding could suggest that the treatment contributed to equal benefits for both boys and girls.

**3.2 Mechanism**

To provide insight on how the intervention positively impacted the treated group compared to the control group, I conducted subgroup analysis. Our findings indicate that the impact is primarily driven by the success of the treatment in preventing younger children (aged 4 to 24 months) from experiencing stunting. In Panel A of Figure 6, I illustrate that the disparity in stunting prevalence at follow-up between the treated and control groups is more pronounced for children who were not stunted at baseline (8%) compared to those who were already stunted at the intervention's onset (4%). Furthermore, Panel C and D of Figure 6 demonstrates that this disparity was even greater among younger children aged 4 to 24 months, with a 14% difference, in contrast to approximately 4% for children aged 25 to 36 months at baseline. These findings align with the visual analysis presented in Figure 6 and are consistent with existing evidence emphasizing the critical importance of early intervention during the first 1,000 days of life from conception (WHO, 2020; Ruel et al., 2008; Leroy, 2015).

Moreover, panel B of figure 6 reveals that although there was no significant difference in the percentage of children who recovered from stunting between the treated and control groups, both groups exhibited a higher rate of recovery among moderately stunted children (HAZ scores between -3 and -2) compared to severely stunted children (HAZ scores below -3). This suggests that as a child becomes more stunted, the difficulty of catching up or reversing stunting increases. These findings are consistent with established evidence indicating that severe stunting is generally irreversible (WHO, 2015; UNICEF, 2013).

Figure 6. Stunting Prevalence at Follow-up by Stunting Status at the Baseline




### 3.3 Complementarity Between Components of Technical Interventions and the Psychological Treatment

Now that I have confirmed that combining psychological and technical interventions is more effective in improving HAZ than implementing the technical interventions alone, I turn our attention to the second hypothesis -- that components of technical interventions, like access to healthcare, sanitation facilities, food security, safe drinking water, maternal health, household wealth, and proper feeding practices for children, complement (or substitute) the effects of the treatment in improving HAZ during the intervention period.

Table 4 presents estimates derived from models specified in (7). The treatment effect in Table 4 is 0.295 and significant at a 1 percent significant level. This coefficient holds a distinct interpretation compared to the treatment effects in Table 3. The treatment effects in Table 3 reflect the average treatment effect across the entire treated population without considering their variation in the technical interventions. The treatment effect in Table 4 accommodates heterogeneity in treatment effects, thus it indicates the average treatment effect for the treated group while accounting for differences in treatment effects resulting from variations in technical interventions. The coefficient of interaction between treatment and a component of technical intervention indicates the additional treatment effect for the sub-population with a higher value in those technical interventions. I examined the following technical interventions for complementarity or substitution with the psychological intervention: food security, access to health services, sanitation, household wealth, maternal health, maternal age, and age-appropriate feeding practices for children. Out of the seven technical interventions I tested, four were shown to have significantly complementary effect with psychological treatments. These include food security, good maternal health, access to health services, and proper feeding practices for a child.

### 3.3.1 Complementarity with Food Security

Table 4 shows that the coefficient of interaction between treatment and household food security is 0.523 and statistically significant (at a 5 percent significant level), after controlling for independent effect food security. The significant positive coefficient of interaction between treatment effect and food security confirms the complementarity effect between treatment and food security. On average, treated children residing in a food secure households improved their HAZ by additional 0.523 compared to their counterpart residing in a food-insecure households. This means improving psychological factors and food security simultaneously leads to a larger improvement in HAZ than the sum of improving each alone. Psychological treatment likely empowers household members to make better decisions about food choices, preparation, and allocation for children, leading to even greater improvements in HAZ, particularly when there is food to allocate. This emphasizes the effectiveness of interventions that enhance psychological factors and food security together.

### 3.3.2 Complementarity with access to health services

Table 4 reveals that the interaction of the treatment and access to health services has a significant (at 5 percent significant level) positive coefficient of 0.21, after controlling for independent effect of access to health services. This means there's an additional 0.21 improvement in HAZ for treated children living in households with access to health services compared to their treated counterparts from households lacking access to health services. This confims the complementarity between psychological treatment and access to health service—improving both psychological factors and access to health service simultaneously leads to a larger improvement in HAZ than the sum of improving each alone. The psychological treatment empowered households to recognize and utilize the available health resources such as nearby health centers and health cards provided by World Vision (author's observation). Also, changing mindsets and beliefs to favour seeking medical care over traditional practices like visiting a witch doctor or shaman contributed to greater improvements in HAZ, particularly for households located near health centres. This finding underscores the enhanced effectiveness of interventions targeting both psychological factors and access to health services.

### 3.3.3 Complementarity with Maternal Health

Table 4 shows that the coefficient of interaction between treatment and maternal health is positive and statistically significant (at a 5 percent significant level), after controlling for independent effect of maternal health. It indicates that on average, treated children born by mother who maintain good health improved their HAZ by 0.319 compared to their treated counterparts born by mother who does not maintain good health. This means although children born by mother who does not maintain good health experience a positive impact of psychological treatment on HAZ, children born when their mothers are in good health experience an even larger impact. This confirms the complementarity between psychological treatment and maternal health—improving psychological factors and maternal health simultaneously leads to a larger improvement in HAZ than the total impact of improving each factor alone. The psychological factors likely improved the psychological health of a mother, influencing her caregiving behaviour, particularly in breastfeeding and care (Author observation). This is more effective when coupled with good technical health, enabling the mother to perform these actions effectively. This emphasizes the need to integrate intervention targeting to improve maternal healthcare and psychological factors for optimal impact on HAZ.

### 3.3.4 Complementarity with Age-appropriate Feeding Practices for Children

Table 4 shows that the coefficient of interaction between treatment and age-appropriate feeding practices for children is 0.441, which is positive and statistically significant (at a 5 percent significant level), after controlling for independent effect of age-appropriate feeding practices for children. This means there's an additional 0.441 improvement in HAZ for treated children getting age-appropriate feeding practices for children compared to their treated counterparts lacking age-appropriate feeding practices for children. This confirms the complementarity between psychological treatment and age-appropriate feeding practices for children —improving both psychological factors and age-appropriate feeding practices for children simultaneously results in a larger improvement in HAZ than the total impact of improving each factor alone. It is likely that psychological treatment improved positive mindset, influencing caregiving behavior and leading to greater improvements in HAZ, particularly for well-fed children. This underscores the importance of integrating interventions that target to improve each and those targeting to improve psychological factors for enhanced impact on HAZ.

Table 4. Interaction between the impact of the treatment and technical interventions influencing HAZ.

| | (1) |
|---|---|
| Post Treatment | 0.071 |
| | (0.29) |
| EWV | 0.495*** |
| | (0.19) |
| EWV*Food Security | 0.523** |
| | (0.235) |
| EWV*Access to Health Services | 0.21** |
| | (0.11) |
| EWV*Sanitation | 0.191 |
| | (0.14) |
| EWV*Household Wealth | -0.060 |
| | (0.09) |
| EWV*Male Child | 0.114 |
| | (0.12) |
| EWV*Maternal Health | 0.319** |
| | (0.15) |
| EWV*Maternal Age | (0.008) |
| | (0.01) |
| EWV*Age-appropriate Feeding Practices for Children | 0.441*** |

| | |
|---|---|
| | (0.14) |
| EWV*Kigoma | -0.067 |
| | (0.12) |
| Kigoma | - |
| | - |
| Food Security | 0.368**** |
| | (0.03) |
| Access to Health Services | 0.008**** |
| | (0.06) |
| Sanitation | -0.048 |
| | (0.12) |
| Household Wealth | 0.032 |
| | (0.07) |
| Mother's Health | -0.100 |
| | (0.11) |
| Mother's Age | -0.006 |
| | (0.01) |
| Proper Feeding Practices for Children | 0.232* |
| | (0.12) |
| Constant | -1.828**** |
| | (0.01) |
| Controls | Yes |
| Household Controls | Yes |

| | |
|---|---|
| Mother's controls | Yes |
| Child Fixed Effect | Yes |
| R-squared | 0.890 |

* p<0.10, ** p<0.05, *** p<0.01, **** p<0.001

*Note*. This table reports results on effect of interaction between psychological intervention and technical intervention on HAZ. HAZ Trimmed at 95 percentiles. Robust standard errors clustered at the child level in parentheses.

Technical interventions aimed at improving sanitation and household wealth did not demonstrate a significant complementary effect alongside psychological interventions.

**3.4 Other results**

Table 4 presents estimate of the model specified in (2). In addition to the treatment and complementarity effect, it reports estimates of other variables that may affect HAZ. Out of the ten control variables included in the model, I found two to be significant determinants of HAZ independently of the treatment. These variables include food security and age-appropriate feeding practices for a child.

Based on the estimates, residing in a food-secure household significantly (at a 1 percent significance level) enhanced HAZ by about 0.368. These results align with research conducted by Beyene (2023). Similarly, adopting age-appropriate feeding practices for a child significantly (at a 5 percent significance level) enhanced HAZ by 0.232. These findings are consistent with a study by Weber et al. (2023).

**3.5 Conclusion**

Stunting results in impaired cognitive development, impacting their future earning potential, thereby perpetuating the cycle of poverty and malnutrition (Hoddinott et al., 2008; Grantham et al., 2007; Walker et al., 2007). Consequently, this has a negative effect on the overall health and economic development (Black et al., 2013; Dewey et al.,2008; Ezzati et al., 2008; Grantham et al., 2007; Victora et al., 2008).

Numerous studies, including those reviewed by Bhutta et al. (2013) and Hossain et al. (2017), that target single causes have often found limited effects on reducing stunting. Interventions that address multidimensional causes of stunting, such as those that combine technical interventions (like child health and nutrition, livelihood, WASH, and child protection) and psychological intervention, may be more effective for improving Height-for-Age Z-scores (HAZ).

I evaluated this by examining the intervention that combined technical interventions and faith-based psychological behaviour change intervention implemented in rural Tanzania to address stunting for children under five.

I find that delivery of technical and psychological interventions simultaneously is more effective in reducing stunting than delivering technical interventions alone. I also find that technical interventions which are tailored to address factors such as food security, access to health services, and proper feeding practices for children will work best with psychological intervention in reducing stunting for children under the age of five.

The findings of this study contribute to three areas of literature. Firstly, I contribute to the literature on the impact of faith-based psychological behavior change intervention on reducing stunting. Secondly, I contribute to the expanding literature on the effectiveness of multifaceted interventions in addressing stunting. Thirdly, I add to the literature on components of technical interventions that complement psychological interventions. By implementing the recommendations of this study, policymakers and practitioners can enhance the effectiveness of interventions to reduce stunting, ultimately contributing to improved child health and development.

As the next step for this study, falsification tests will be conducted, and parallel trend tests will be performed if data from a third survey becomes available. The study will then be updated accordingly.

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