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Exploring the Program Impact Pathways of a Grandmother-inclusive Approach
on Improved Infant and Young Child Feeding Outcomes at Endline:
A Mediation Analysis of the Mamanieva Project in Southern Sierra Leone

By

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Abstract

Exploring the Program Impact Pathways of a Grandmother-inclusive Approach
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By: Rebecca Wee

Sierra Leone faces significant challenges with poor nutrition. There is high prevalence of stunting (38%) and wasting (9%) and underweight (16%) among children under-5 years of age. In rural Sierra Leone, grandmothers and elder women play vital roles in maternal and child nutrition as caretakers and advisors. However, many traditional nutrition interventions do not utilize grandmothers as agents of change, but focus on health systems delivery of nutrition messages to pregnant women and mothers of young children. World Vision, in partnership with The Grandmother Project and Emory University, implemented the Mamanieva Project in Bum Chiefdom, Bonthe District, Sierra Leone. The project was a 3-year proof-of-concept study implemented from April 2013 – November 2016 aimed to empower grandmothers as key players of promoting positive change surrounding optimal maternal child and nutrition knowledge, attitudes, and practices.

This thesis project shows results of a mediation analysis done to explore the program impact pathways. Relationships between mediators and significant infant and young child feeding (IYCF) outcomes at endline were assessed. IYCF outcomes statistically significant at endline were exclusive breastfeeding during the first week of life, minimum dietary diversity, and minimum acceptable diet. Mediators assessed for this thesis were knowledge of mothers with children under-2 (MU2) and grandmothers (GM) and GM self-efficacy. A total of 291 MU2 and 148 GMs were included in the mediation analysis.

To assess the effect of mediators, associations were first examined between the intervention and key mediators, and then between significant IYCF outcomes at endline and key intervention mediators for significance at p<0.05. The results of the mediation analysis for the Mamanieva proof-of-concept study indicate that targeted intervention mediators were not key mediators in achieving the IYCF outcomes significant at endline. However, a key limitation of this analysis was small sample size. Additional mediation analyses with other project mediators should be performed, in addition to more complex pathway analyses, to identify critical components of the Mamanieva Project intervention on IYCF outcomes as well as other outcomes of interest, such as maternal nutrition indicators. Results from more complex pathway analyses will allow better allocation of resources to improve intervention effectiveness and efficiency.

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GLOSARRY OF ACRONYMS

GMP – The Grandmother Project
IYCF – Infant and Young Child Feeding
WHO – World Health Organization
WRA – Women of Reproductive Age
WV – World Vision

MAMANIEVA INTERVENTION ACRONYMS

GM – Grandmother or elder female relative over 45 years of age
MU2 – Mother with children under-2
PW – Pregnant women

INTRODUCTION

Globally, undernutrition is the cause of almost one-half of deaths in children under-five years of age, resulting in more than 3 million under-five deaths per year (Black, Bhutta, et al., 2013). The first 1000 days of life, or the time from conception through the first 2 years of life, is a critical period as almost all child stunting, an indicator of undernutrition, occurs within this time period (Black, Victora, et al., 2013). Children who are stunted, wasted, or underweight are at higher risk of dying from diarrhea, pneumonia, and other infectious diseases (Black, Victora, et al., 2013). Moreover, stunted children are less productive in adulthood because they are compromised cognitively and physically (Black, Bhutta, et al., 2013). Reduction in adulthood productivity due to child undernutrition is estimated to affect a country's economic advancement by at least 8% (Black, Bhutta, et al., 2013). Though stunting has decreased globally, stunting in sub-Saharan Africa has deviated from the global trend in the past two decades and increased from 19.9 million to 28.3 million stunted children (UNICEF, WHO, & World Bank Group, 2015).

Sierra Leone faces significant challenges with poor nutrition, as evidenced by the proportion of children under-five who were classified as stunted, wasted, and underweight (World Food Programme, 2017). The 2013 Sierra Leone Demographic and Health Survey (DHS) showed high rates of stunting (38%) and wasting (9%) and underweight (16%) among children less than 5 years of age (Statistics Sierra Leone - SSL & ICF International, 2014). When ranked from lowest to highest stunting prevalence, Sierra Leone ranks it as 110 out of 132 countries included in the 2016 Global Nutrition Report (International Food Policy Research Institute, 2016). The country's high prevalence of stunting, wasting and underweight among children under-five can be attributed to maternal malnutrition and suboptimal child feeding practices.

In rural communities in Sierra Leone and similar communities across the globe, grandmothers and elder women play a vital role in maternal and child nutrition with the support they provide during pregnancy, labor, delivery and the postpartum period (Aubel, 2012). These elder women (hereafter referred to as "grandmothers" or GMs) include grandmothers, mother-in-laws, female relatives, and other elder women in the community. GMs provide various forms of support from sharing knowledge to caring directly for the mother and child, thus serving as a significant influence on maternal and child health nutrition (MCHN) practices. The influence of GMs falls within WHO's Childhood Stunting Conceptual Framework, which shows that child stunted growth and development is a consequence of maternal factors, home environment, inadequate complementary feeding, suboptimal breastfeeding practices, and infections (Stewart, Iannotti, Dewey, Michaelsen, & Onyango, 2013). Still, GMs represent an untapped resource in advancing the goals of MCHN programs. Traditionally, many nutrition interventions do not include GMs nor utilize their capacity as agents of change, but solely focus on pregnant women and mothers of young children (Aubel, 2012).

The *Grandmother Project (GMP): Change Through Culture*, founded by Judi Aubel, is a grandmother-inclusive approach that recognizes the role of GMs and their ability to enact change in their communities. Aubel's community-based, ethnographic, research validated the tremendous potential GMs possess in positively influencing maternal nutrition and child feeding practices (Aubel, 2012). The approach utilizes adult education methods, including participatory dialogue, to increase knowledge and strengthen intergenerational communication for the purposes of promoting positive change in the well-being of women and children (Aubel & Rychtarik, 2015).

World Vision/Sierra Leone, in partnership with World Vision/Germany, GMP, and Emory University, used The Grandmother Project framework to design and implement the Mamanieva Project in Bum Chiefdom, Bonthe District, Sierra Leone. The Mamanieva Project was a 3-year proof-of-concept study implemented from April 2013 – November 2016. The quasi-experimental study utilized the grandmother-engaged approach and built on GMs' culturally traditional roles as caregivers and advisors. Following mixed methods formative research conducted in April 2013, World Vision implemented the Mamanieva Project to positively impact maternal and child nutrition outcomes through empowering GMs as key players of promoting positive change surrounding optimal maternal child and nutrition knowledge, attitudes, and practices. The intervention used adult education methods to engage and empower GMs through dialogue. Activities included monthly participatory education sessions promoting key nutrition messages and quarterly intergenerational community praise sessions affirming GMs as change agents for maternal and child health.

Key objectives of the Mamanieva Project were to improve maternal health and infant and young child feeding (IYCF) outcomes in the study site through the following mediators: increased maternal and GM knowledge and enhanced GM self-efficacy. Maternal health outcomes that were statistically significant at endline included maternal dietary diversity, increased meal frequency and decreased work during their most recent pregnancy, attending ANC at least 4 times, and delivering in a health facility (Webb-Girard, 2016). IYCF outcomes that were statistically significant at endline included exclusive breastfeeding during the first week of life and greater percentage achieving minimum dietary diversity and minimum acceptable diet (Wee, 2016).

This thesis project seeks to explore the program impact pathways by delineating relationships between the mediators and significant IYCF outcomes, conducting a Mediation analysis of the project model. Results from the Mediation analysis will give insight into the effects of the project model on desired outcomes and whether those outcomes are being achieved through the intended impact pathways. This analysis is valuable as there has been a shift in recent years to integrate social and behavioral change strategies into IYCF intervention in low-resource settings (Pelto, Martin, Van Liere, & Fabrizio, 2016). Results from this analysis will allow researchers to validate the incorporation of the social components of the intervention as well as identify critical components of the Mamanieva Project. Evidence from the analysis should be used to modify the intervention accordingly so that resources are not spent on ineffective components and can be allocated to the most effective components of the Mamanieva Project.

LITERATURE REVIEW

Global Child Malnutrition

The global burden of child malnutrition is preventable yet it affects around one-third of children in developing countries worldwide. Undernutrition is also the cause of almost one-half of deaths in children under-five around the world, resulting in more than 3 million under-five deaths per year (Black, Bhutta, et al., 2013). Children who are stunted, wasted, or underweight, all indicators of malnutrition, are at higher risk of dying from diarrhea, pneumonia, and other infectious diseases compared to non-malnourished children (Black, Victora, et al., 2013). The prevalence of wasting in children under-five in West Africa has crossed the threshold criteria for a public health emergency was recently categorized as a "serious" public health problem

(UNICEF et al., 2015). Globally, the number of stunted children under-five decreased between 1990-2015 from 255 million to 156 million. Stunting in sub-Saharan Africa, however, has deviated from the global trend in the past two decades and increased from 19.9 million to 28.3 million stunted children (UNICEF et al., 2015). Studies have shown that stunted children are less productive in adulthood because they are compromised cognitively and physically (Black, Bhutta, et al., 2013). Reduction in adulthood productivity due to child undernutrition is estimated to affect a country's economic advancement by at least 8% (Black, Bhutta, et al., 2013). The United Nation Sustainable Development Goals acknowledge and seek to address child malnutrition under Goal 2, and more specifically Goal 2.2, which seeks to "end all forms of malnutrition by 2030" and achieve the "internationally agreed target on stunting and wasting in children under-five" by 2025 (United Nations, 2016).

Sierra Leone Child Malnutrition

Sierra Leone ranks 179 out of 188 countries and territories on the United Nations' Human Development Index, a country-level summary measure of key indicators of human development (United Nations Development Programme, 2016). Per the United Nations' World Food Programme country brief on Sierra Leone, the country faces significant challenges with poor nutrition, which is attributable to almost half of all child mortality in Sierra Leone (World Food Programme, 2017). The 2013 Sierra Leone Demographic Health Survey (DHS) reported 92 infant deaths per 1,000 live births and 156 under-five deaths per 1,000 in the five-year period before the 2013 survey (Statistics Sierra Leone - SSL & ICF International, 2014). The proportions of children under-five who were classified as stunted, wasted, and underweight in 2013 were 38%, 9%, and 16%, respectively (Statistics Sierra Leone - SSL & ICF International,

2014). Stunting in children under-five in Sierra Leone increased from 36% in 2008 to 38% in Sierra Leone, following the sub-Saharan trend of increasing numbers of stunted children over time (Statistics Sierra Leone - SSL & ICF Macro, 2009; UNICEF et al., 2015).

Etiology of Child Undernutrition

According to WHO's Childhood Stunting Conceptual Framework, child stunted growth and development can be attributed to numerous factors. It is a consequence of maternal factors, home environment, inadequate complementary feeding, suboptimal breastfeeding practices, and infections (Stewart et al., 2013). The causes are affected by community and societal factors, such as the political and cultural factors, education, healthcare, as well as physical environment (Stewart et al., 2013). An action framework for achieving optimum fetal and child nutrition and development integrates action steps and interventions for targeting all levels of the determinants of childhood stunting (Black, Victora, et al., 2013). Almost all child stunting occurs within the first 1000 days of life, or the first two years of life from a child's conception (Black, Victora, et al., 2013). Strong evidence exists for reduction in child stunting through promotion of maternal nutrition and appropriate IYCF practices, including exclusive breastfeeding to 6 months and adequate complementary feeding (Black, Victora, et al., 2013).

Nutrition Behavior Change Interventions

Traditionally, nutrition interventions to improve maternal and child health focuses on the mother-child dyad (Aubel, 2012). Mothers are targeted and taught positive nutritional messages and those messages are meant to be translated into practices that directly affect their own health and their child's health positively. For example, because most breastfeeding interventions are

built off the WHO guidelines of exclusive breastfeeding, these interventions directly address

mothers and share educational messages around exclusive breastfeeding to increase the

proportion of children under 6 months who exclusively breastfeed (Aboud, 2012).

Aside from targeting the mother-child dyad, many interventions targeting reduction of

child undernutrition have historically focused on the health sector and have not been

multidisciplinary nor program specific in key messages on positive nutrition (Lutter et al., 2013).

There has been a shift in recent years to integrate social and behavioral change strategies into

IYCF interventions in low-resource settings (Pelto et al., 2016). A critical component of

developing these nutrition behavior change interventions is formative research, as it allows

researchers to identify key factors that affect child nutrition in a specific setting, and facilitates

the tailoring of generic messages to messages that are context-specific for a target population

(Pelto et al., 2016). Thus, nutrition interventions can be improved in the planning process

through the practice of formative research.

With the implementation of integrated interventions with complex pathways, there is a

need to evaluate a program's theory of action by examining these complex pathways (Webb,

2013). Assessment of program impact pathways has the ability to connect direct program inputs

to desired outcomes, and elucidate the reasons as to why intervention might be successful in

some contexts while failing in others (Avula et al., 2013). Program impact pathway analysis is a

powerful tool that can be used through various stages of program implementation to strengthen

the intervention delivery as it identifies key mediators or modifiers of the intervention (Mbuya et

al., 2015).

Maternal Autonomy/Empowerment

A systematic review of recent literature on the effects of maternal autonomy on child health outcomes generally suggested that raising maternal autonomy improved child nutrition (Carlson, Kordas, & Murray-Kolb, 2015). Women's autonomy refers to a woman's ability to influence or make decisions that affect her or her family, including choices around work, healthcare, and childcare (Carlson et al., 2015). When a woman is not autonomous, she may be unable to make the best choices for her children, such as not being to give the child a proper diet because food priorities are elsewhere (Carlson et al., 2015). Gender equality and women's empowerment was built into the United Nations' Millennium Development Goals and it is an important goal for ensuring human rights. Recent literature, however, goes farther beyond the goal itself by showing the positive health consequences associated with raised maternal autonomy (Carlson et al., 2015).

A study in Pakistan showed that the inability of women to make their own decisions in a household affects the utilization of health services by pregnant women (Zakar, Zakar, Aqil, Chaudhry, & Nasrullah, 2016). Women who had autonomy were more likely to go to ANC visits and have delivery assistance by a skilled health worker than women who did not identify themselves as being autonomous (Zakar et al., 2016). Research has also shown that women of reproductive age who are not autonomous because of cultural standards often do not have the ability to choose to seek healthcare. This decision usually lies with the patriarch or a senior member of the household, such as the mother-in-law or father-in-law (Gupta et al., 2015). Women who had to bypass a gatekeeper, such as a grandmother, to access healthcare were more likely to have children who died than those women who had autonomy in health seeking decision (Gupta et al., 2015).

However, the literature also acknowledged the limitations on the varying measures of maternal autonomy across studies, as well as the cross-cultural comparability of findings as they differed across different regional areas (Carlson et al., 2015). The authors suggest further research to understand definitions of maternal autonomy within different cultural contexts (Carlson et al., 2015).

The results of a systematic review of women's empowerment as a social determinant of maternal and child health outcomes generally found that women's empowerment was significantly associated with health outcomes of mothers and children (Pratley, 2016). Though the challenge of uniform measures of empowerment is an issue, the author concludes that a large number of the 67 studies included in the review provides evidence for the need to include the social determinant of women's empowerment when strategizing how to improve maternal and child health outcomes (Pratley, 2016). Maternal health indicators used to measure association between women's empowerment include the utilization of health services, reproductive health behavior, women's health outcomes, and child health outcomes (Pratley, 2016).

Social Support Theory – Collectivist Societies and Decision Making

Again, women's autonomy refers to a woman's ability to influence or make decisions that affect her or her family. Social environment may restrict a woman's ability to influence of make decisions because of disagreement with other key players in the woman's life. In contrast to Western societies, many non-Western societies are collectivist societies (Aubel, 2012). This means that the individual mindset is less emphasized and there is a group mentality and perspective to many, if not all aspects of life, including health and nutrition. In non-Western,

multigenerational families, other members of the family influence maternal and child nutrition outside of the mother (Aubel, 2012).

A sequential explanatory design study in Bangladesh found that household power structure was an influential factor in a mother's ability to adapt new behaviors around IYCF practices. Many of the women in this study lived in multi-generational households and the views of other household members either facilitated or hindered the uptake of new beliefs and behaviors (Affleck & Pelto, 2012). Nutrition interventions in culturally similar environments need to account for the mothers' social support networks and utilize them to bring about positive and sustainable changes around maternal and child nutrition.

Social research shows that traditional nutrition interventions targeting only the mother-child dyad are limited in their impact and sustainability (Aubel, 2012). The mothers that are being targeted by these interventions are not the only ones that influence their children's health and nutrition. Household decision making usually lie with the male figures in the household, but because child care normally falls outside of the purview of men, it is the senior women in the household that hold great influence over a mother's care of her child, especially if the mothers is a first-time mother (Aubel, 2012).

Influence of Culture on Nutrition

Maternal malnutrition and suboptimal IYCF practices can also be attributed to cultural beliefs and practices. Results from focus group discussions conducted among Maasai pastoralists in Kenya showed that cultural practices hindered mothers from exclusively breastfeeding for 6 months (Chege, Kimiywe, & Ndungu, 2015). Tribal practices included feeding herbs, animal's milk, and blood to children less than 6 months of age. Other cultural influences, such as

prioritizing men's diet over the children's and keeping livestock as a sign of wealth, also adversely affected the nutrition of children under 6 months (Chege et al., 2015). Belief in traditional medicine was a barrier to accessing health facilities and thus receiving knowledge on optimal IYCF practices (Chege et al., 2015).

As mentioned above, acknowledging and utilizing the culture of collectivism and family support is key for deviating from traditional knowledge and methods to new practices (Aboud, 2012). Therefore, interventions targeting only the knowledge of mothers are not enough to change toward positive health behaviors. Interventions should target families and household dynamics to effect change (Aboud, 2012). Rarely have nutrition interventions incorporated social environment and social structures that feed into problem areas, such as child malnutrition. Researchers should apply theories from multiple disciplines, such as social theories, to create more effective interventions that can effect change at the individual level and beyond to the interpersonal and community level (Aboud, 2012).

Grandmothers as Agents of Change

Grandmothers contribute to the care and production of healthy children as they are considered important and active caregivers in many contexts (Simon, Rosen, Claeson, Breman, & Tulloch, 2001). However, they are an untapped resource when it comes to maternal and child nutrition interventions. Many nutrition interventions do not include grandmothers nor utilize their capacity as agents of change, but solely focus on mothers and children (Aubel, 2012). As stated above, households may have a hierarchy of authority, and in many cultural settings, grandmothers play important roles in the household. Thus, they have the ability to influence household decisions, including child nutrition.

Grandmothers play key roles as advisors, especially for first-time mothers (Aubel, 2012; Gupta et al., 2015). Grandmothers are culturally seen as wiser and more knowledgeable and respected as guardians of tradition, including traditions of caregiving (Aubel, 2012). Optimal IYCF practices may be eclipsed by traditional practices, even when those practices run contrary to recommended maternal and child health practices and have adverse effects. For example, many grandmothers, as keepers of tradition, possess knowledge of traditional herbal medicine and when to administer these medicine. These traditional medicinal practices may be detrimental to a newborn's health, but because of the senior role of grandmothers in the home as advisors and caregivers, these harmful practices override the recommended practices shared by community health workers (Gupta et al., 2015). Qualitative data from a study in northern Malawi found that even if taught positive health practices, young mothers may be reluctant to ignore the advice of elderly women, break tradition, and cause conflict within the community (Bezner Kerr, Dakishoni, Shumba, Msachi, & Chirwa, 2008). Similar findings on the authority of senior women were seen in a qualitative study in rural Ghana, which showed that ultimately grandmothers decided where a mother should deliver a baby, the urgency of a mother or child's health problem, and how the sick mother or child should be treated (Gupta et al., 2015).

The *Grandmother Project (GMP): Change Through Culture* is a grandmother-inclusive approach that recognizes the role of grandmothers as traditional caregivers and advisers and utilizes their ability to enact change in their communities. The approach utilizes adult education methods, including participatory dialogue, to increase knowledge and strengthen intergenerational communication for the purposes of promoting positive change in the well-being of women and children (Aubel & Rychtarik, 2015). Aubel's community-based, ethnographic,

research validated the tremendous potential grandmothers possess in positively influencing

maternal nutrition and child feeding practices (Aubel, 2012).

The Mamanieva Project Baseline Findings – GMs' and mothers' knowledge of nutrition and health seeking behaviors

World Vision/Sierra Leone, in partnership with World Vision/Germany, GMP, and

Emory University, used The Grandmother Project framework to design and implement the

Mamanieva Project from in 2013-2016 in the Torma section of Bum Chiefdom. Development of

the intervention and its implementation followed formative qualitative research and a baseline

survey conducted in April 2013. The intervention was a proof-of-concept study, and the design

was quasi-experimental with the aims of examining the potential effects of the grandmother-

engaged strategy on maternal and child nutrition in rural Sierra Leone and inform aspects related

to implementation, sustainability and scale up. Program activities included dialogue sessions

with GMs to validate practices, praise sessions which build the reputation of and respect for GMs

as supporters of maternal and child health, training sessions of GM leaders to lead other GMs,

and intergenerational dialogue sessions between mothers and GMs on maternal and child

nutrition and health topics led by GM leaders. Results from the formative research and baseline

survey conducted by Njala Universtiy confirmed the role of grandmothers as important child

caregivers and advisors to mothers. The baseline survey measured knowledge of GMs, mothers

with children under-2 (MU2), and pregnant women (PW) on maternal and child health. Overall

the results showed lower, if not the same, knowledge performance of women in the intervention

group than women in the control group at baseline. The results showed that traditional

misinformation was a huge knowledge barrier. GMs and women surveyed at baseline possessed

knowledge that hindered adequate nutrition during pregnancy and the uptake of optimal IYCF

practices. For example, women in the community believed that if a pregnant woman ate too

much, the child would grow too big and the woman would have a difficult time during delivery.

They also believed that when children are born, they should be given traditional herbs before

breastmilk to cleanse the stomach. Moreover, they believed breastmilk was not enough food for a

child, and so other foods needed to be given during the first 6 months of a child's life. Another

common belief found in the baseline findings was the expressing and throwing away the first

breastmilk, which is high in nutritional value for the newborn. Other baseline findings included

low intentions of positive health behaviors during pregnancy. Women reported that they intended

to work the same amount even when they were pregnant. Women also had low intentions to go

to ANC, take iron-folate pills, and deliver in a clinic.

The Mamanieva Project Endline Findings

The endline survey implemented in May 2016 utilized a census based sampling strategy

and surveyed all who met the study's eligibility criteria. Data were collected from PW, MU2,

and GMs on household sociodemographics, maternal diet and IYCF knowledge, attitudes, and

intentions / practices. Analyses examined differences in proportions between intervention and

comparison participants with chi-square and logistic regression analysis.

Briefly, the endline survey noted statistically significant differences between the

intervention and control community surrounding practices of MU2 on the amount of food

consumed, the frequency of meals, and workload during their most recent pregnancy.

Additionally, there were statistically significant differences in achievement of minimum meal

frequency and dietary diversity adequacy between women (PW and MU2) respondents in the

intervention and control community.

Table 1. Health seeking, diet and nutrition practices of 291 mothers with children < 2 years during their most recent pregnancy as reported in the Mamanieva endline survey, Bum ADP; data presented as n (%). *Reproduced with permission from WV Endline Report, 2017.*				
	Overall (n=291)	Intervention (n=184)	Control (n=107)	P-value
Attended ANC at clinic/health Facility (at least once)	284 (97.6)	178 (96.7)	106 (99.1)	0.21
Attended ANC at least 4 times at clinic/ health facility (n= 238)	215 (90.3)	135 (97.1)	80 (80.8)	< 0.001
Average length of pregnancy at first ANC visit (in weeks) (n=282)	10.28±6.54	9.13 ± 5.65	12.21 ± 7.43	<0.001
Delivered at Health Facility	275 (94.5)	178 (96.7)	97 (90.7)	0.03
Increased amount of food during pregnancy	242 (83.2)	174 (94.6)	68 (63.6)	<0.001
Increased frequency of meals during pregnancy	239 (82.1)	176 (95.7)	63 (58.9)	<0.001
Decreased workload during pregnancy	249 (85.6)	168 (91.3)	81 (75.7)	<0.001
Received/purchased iron tablets	284 (97.6)	183 (99.5)	101 (94.4)	0.01
Of those who received iron tablets, took iron tablets daily	244 (85.9)	169 (92.4)	75 (74.3)	<0.001

Table 2. Meal frequency and diet diversity adequacy (≥5 food groups) for pregnant women and mothers with children < 2 years in the 24 hours prior to the Mamanieva endline survey, Bum ADP. Data presented as n (%) or mean ± SD. *Reproduced with permission from WV Endline Report, 2017.*				
	Overall	Intervention	Control	P-value
Diet Diversity Adequacy, all women respondents (n=375)	311 (82.9)	213 / 225 (94.7)	98/150 (65.3)	<0.001
Mothers with children < 2 years (n= 274)	246 (84.5)	174/ 184 (94.6)	72 / 107 (67.3)	<0.001
Pregnant women (n=101)	81 (80.2)	52 / 54 (96.3)	29 / 47 (61.7)	<0.001
Meal Frequency, all women (n=375)	2.2 ± 1.4	2.6 ± 1.4	1.6 ± 1.3	<0.001
Mothers with children < 2 years (n= 274)	2.3 ± 1.5	2.7 ± 1.4	1.7 ± 1.3	<0.001
Pregnant women (n=101)	2.2 ± 1.4	2.8 ± 1.3	1.5 ± 1.3	<0.001

Improved child outcomes during the first 2 years of life were key desired outcomes of the

intervention as nutrition during the first 2 years of a life is a critical determinant of stunting

(Black, Victora, et al., 2013). At endline, infants were on average 11.8± 6.9 months of age and

52.2% were female. The proportion of 0-23 month olds exclusively breastfed during the first

week of life was significantly higher in the intervention group, but there were no statistically

significant differences in other breastfeeding practices. Among infants 6-23 months, the proportion achieving minimum dietary diversity and minimum acceptable diet was significantly higher in the intervention group. After adjusting for influential variables, the proportion of children achieving minimum dietary diversity and acceptable diet in the intervention group than control group remained significant (Table 4).

Table 3. IYCF practices of 291 children 0-23 months of age participating in the Mamanieva endline survey, Bum ADP; data presented as n (%). *Reproduced with permission from WV Endline Report, 2017.*				
	Overall (n=291)	Intervention (n=184)	Control (n=107)	P-value
Children 0-24 mos old put to breast within one hour of delivery	198 (68.0)	119 (64.7)	79 (73.8)	0.12
Children 0-24 mos old exclusively breastfed during the first week of life	251 (86.3)	166 (90.2)	85 (79.4)	**0.01**
	Overall (n=72)	Intervention (n=48)	Control (n=24)	P-value
Children 0-6 mos old exclusively breastfed in the previous 24 hours	65 (90.3)	43 (89.6)	22 (91.7)	0.78
	Overall (n=219)	Intervention (n=136)	Control (n=83)	P-value
Children 6-23 mos old who are continuing to breastfeed in addition to complementary foods	161 (73.5)	101 (74.3)	60 (72.3)	0.75
Children 6-23 mos old achieving minimum dietary diversity (≥4 food groups yesterday)	148 (67.6)	105 (77.2)	43 (51.8)	**<0.001**
Children 6-23 mos achieving the recommended minimum meal frequency for their age	125 (57.1)	83 (61.0)	42 (50.6)	0.13
Children 6-23 mos achieving minimum acceptable diet (n=168)	71 (42.3)	57 (53.8)	14 (22.6)	**0.001**

Table 4. Adjusted point estimates and 95% confidence intervals for complementary feeding outcomes for 6-23 month olds from the Mamanieva endline survey. *Reproduced with permission from WV Endline Report, 2017.*			
	Intervention (n=136)	Control (n=83)	Adjusted estimate and 95% CI, p-value
Infant diet diversity adequacy[1], n=208	105 (77.2)	43 (51.8)	3.5 (1.5, 8.3), p=0.005
Infant minimum acceptable diet[1], n=208	57 (53.8)	14 (22.6)	3.5 (1.5, 8.1), p=0.003
[1] Model adjusted for child age and sex, maternal schooling and parity; schooling and occupation of household head; and household hunger category. Analyses restricted to 219 infants 6-23 mos olds; 11 infants excluded due to missing outcome or covariate data.			

Mediation Analysis

Mediators are intermediate variables between an exposure and outcomes. They are affected by the independent variable, or the exposure or intervention (Lockwood, DeFrancesco, Elliot, Beresford, & Toobert, 2010). Mediation analysis is valuable as it allows researchers to make evidence-based decisions to modify and improve interventions by identifying and refining the critical mediators of the intervention (Lockwood et al., 2010).

Mediating variables are normally defined prior to analysis, during the conceptual design stage of an intervention. Mediators differ from confounders, moderators, and covariates (Lockwood et al., 2010). Confounders are variables that are not in the causal pathway but relate to both the exposure and the outcome and thus affect the pathway between exposure and outcome. Covariates are variables that are not changed by the exposure, do not affect the relationship between the exposure and outcome, and improves prediction of the outcome. Moderators are variables that affect the pathway between exposure and outcome, but like confounders, moderators are not affected by the exposure (Lockwood et al., 2010).

Because there is no statistical test for causation and cause and effect can only be determined by a prospective randomized experiment, an alternative is to examine relationships between variables in the potential causal pathway. Mediation analysis is a statistical tool employing regression analysis to determine the effect of the mediator variables on the outcomes, thus allowing one to determine the contribution of the mediator to the intervention (Lockwood et al., 2010).

There are multiple ways to perform statistical tests for a mediation analysis. One way is to recalculate the crude association between the exposure and outcome by adding in the association between the exposure and mediator and the mediator and the outcomes. If both the

association between the exposure and mediator and the mediator and the outcome are significant, then the mediator can be established as being a significant mediator of the intervention. The causal assumption of mediation is strongest when the study is a randomized, longitudinal design. However, though the case of causation is weaker comparatively, mediation analysis can be conducted on cross-sectional study designs also (Lockwood et al., 2010).

This thesis project will utilize mediation analysis to explore the pathways of the Mamanieva Project model. The relationships between mediators and significant IYCF outcomes from the project's endline survey will inform whether the outcomes are being achieved through the intended impact pathways.

METHODS

Summary

This mediation analysis will evaluate the program impact pathways of the Mamanieva Project by examining the effect of the intervention on the project mediators and then examining the effect of the project mediators on the significant IYCF results found at endline.
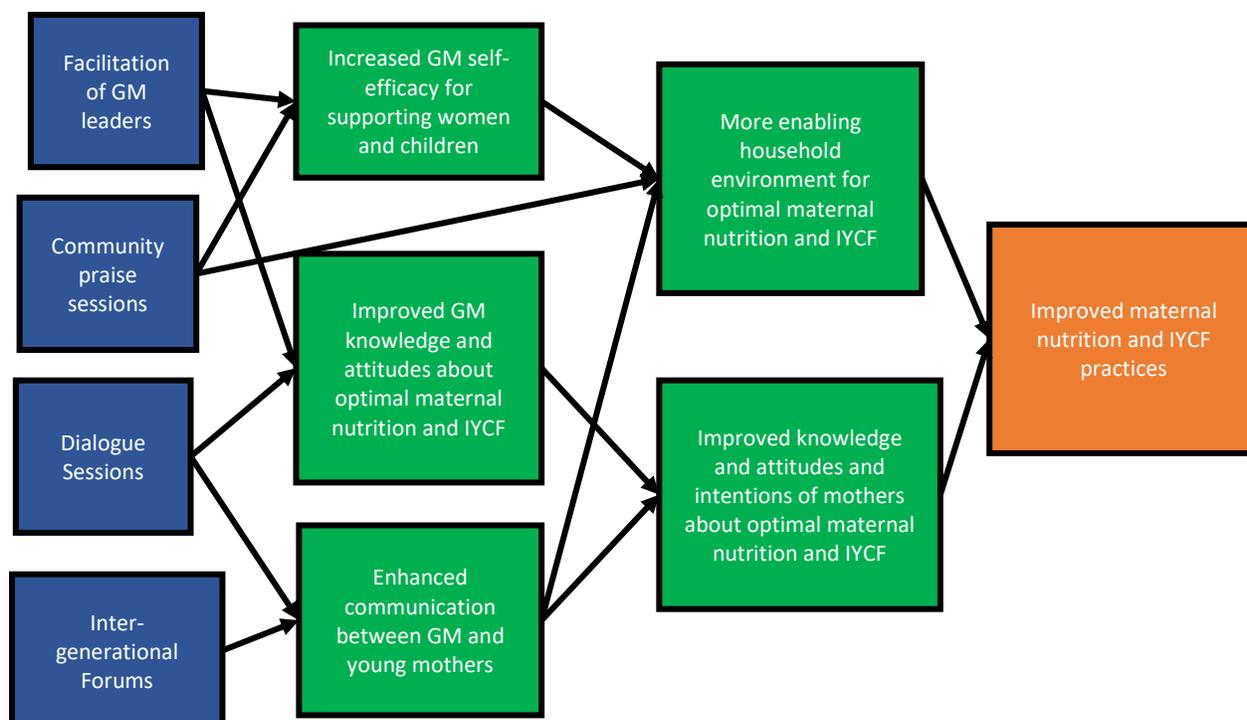

Figure 1: Simplified Mamanieva theory of change diagram, *Reproduced with permission from WV Endline Report, 2017.*

Study Site

The Mamanieva Project was a proof-of-concept study being implemented by World Vision in two sections of World Vision's Bum Chiefdom Area Development from April 2013 – November 2016. Bum Chiefdom is in Bonthe District in the southern province of Sierra Leone and is predominantly made up of the Mende tribe. The population is approximately 23,000 and the main economic activities are agriculture, fishing, and petty trading. The land is comprised of

two main habitats, the main land and the riverine areas, with most the population living on the main land. Torma section and Fikie section, acting as intervention and control, were selected for the study because of their near year-round accessibility.

Intervention Description

The project utilized the grandmother-engaged approach developed by Judi Aubel. The approach is grounded in formative research and builds on GMs' culturally traditional roles as caregivers and advisors. Following mixed methods formative research conducted in April 2013 (Webb-Girard & Mui, 2015) , World Vision implemented the Mamanieva Project to positively impact maternal and child nutrition outcomes through empowering GMs as key players of promoting positive change surrounding optimal maternal child and nutrition knowledge, attitudes, and practices. The intervention used adult education methods to engage and empower GMs through dialogue. Key activities included monthly participatory education sessions (Mui, 2015) promoting key nutrition messages and quarterly intergenerational community praise sessions affirming GMs as change agents for maternal and child health.

Evaluation Strategy

A quasi-experimental study design was used to evaluate the program's potential effects. World Vision allocated one section and its villages in the Bum Chiefdom World Vision Area Development Program (ADP) as the intervention group while a second section in its Bum Chiefdom ADP was allocated as the comparison group. Villages in the intervention section received the grandmother-inclusive approach in addition to the standard of care provided by the Ministry of Health and World Vision (MOH/WV) which included World Vision's nutrition

education model of timed and targeted counseling. Villages in the control section, received only

the MOH/WV program of timed and targeting counseling. Project evaluation utilized

quantitative data collected through repeat cross-sectional surveys at baseline (January-March

2013) and endline (May 2016) in control and intervention sections.

Endline Survey Tool

The endline survey was created in partnership with Emory University and World Vision

International. The survey queried respondents on knowledge, attitudes, and practices surrounding

maternal and child nutrition.

Key maternal nutrition practices assessed include 1) eating more, 2) working less, and 3)

receiving and consuming iron and folic acid tablets and vitamin A during pregnancy.

Breastfeeding practices include 1) initiation and maintenance of early exclusive breastfeeding,

2) duration of exclusive breastfeeding using 24-hour and since birth recall methods, and 3)

duration of any breastfeeding.

Complementary feeding practices of infants include 1) consumption of semi-solid, soft foods

at 6-8 months; 2) meal frequency; 3) dietary diversity 4) feeding practices of children while

ill, and 5) receipt of vitamin A supplementation and provision of iron drops.

Current pregnancy and/or obstetric history data including ANC uptake, delivery location,

complications during delivery and birthweight were collected to assess the outcomes above.

Additional outcomes assessed focused on sources of information and kinds of advice given to

women of reproductive age (WRA) by GMs and other community members on nutrition and

infant feeding and uptake and participation in program activities.

Sampling and Participant Eligibility

The target population for the endline survey PW, MU2, and GMs residing with eligible participants in the intervention and control sections. Respondents had to meet one of the following criteria to be considered eligible for the survey:

1) pregnant woman over 17 years of age,

2) mother over 17 years of age with at least one child under 2 years of age,

3) GM (or elder female relative) over 45 years of age living in households with eligible women,

4) GM leader (only in the intervention section)

In the event where there was more than one eligible elder woman in the household, the senior woman most involved in maternal and child health and nutrition decision-making was selected. If there was more than one child under 2 years of age in the household, one child was randomly chosen as the index child by flipping a coin. Screening questions for eligibility were also asked at the beginning of the survey to ensure the respondent was eligible for the survey. In the intervention section, GM leaders of the intervention were also surveyed even if they lived alone and did not live with any eligible women. Sample sizes for PW and MU2 were approximated using based on 2015 population estimates for the two sections and assumptions that 3% of the population in Bum Chiefdom are PW and 9% are MU2 (Table 5). After accounting for 10% refusal or ineligible rates, the total eligible population expected was 143 PW and 428 MU2.

Table 5. Estimated sample sizes available for cross-sectional endline surveys, pregnant women and mothers with young children (<24 months) based on 2015 population estimates for the two sections.					
Section	Total population (2015 estimates)	PW		MU2	
		Assuming 3% of population is pregnant women	Population available assuming 10% refusal /ineligible rate	Assuming 9% of population is children 0-24 mos	Population available assuming 10% refusal / ineligible rate
Intervention	2527	76	69	227	205
Control	2747	82	74	247	223
Final Sample			**143**		**428**

Due to the limited number of potentially eligible respondents in each section, exhaustive census-based sampling measures were employed for the endline survey. Household listing and respondent screenings in each village were done a week prior to the administration of the survey to identify eligible respondents. Final sample sizes are found in Table 6.

Table 6. Actual sample size by eligible respondent type for cross-sectional endline surveys, pregnant women and women with young children (<24 months) for the two sections.			
	PW	MU2	GM
Intervention	54	184	157
Control	47	107	62
Total	101	291	219

Survey Data Collection

World Vision and Emory University implemented the endline survey from May 16 – May 22, 2016. Fourteen enumerators and 1 translator who were competent in the local Mende language were hired by World Vision Sierra Leone to administer the endline survey and underwent a 5-day didactic and field-based training. Questions were translated in real time by the enumerators and asked in Mende as the local language is not a written language. Enumerators employed the use of mobile data collection using the platform, Open Data Kit (ODK) and used tablets to collect survey data. Survey data was uploaded to the ODK server at the end of each

day. The survey took 1-1.5 hours to complete per respondent and were completed in the respondent's home.

IRB and Informed Consent

Protocols were reviewed and approved by Emory University Internal Review Board (IRB) and Sierra Leone national review boards. All eligible participants provided written consent prior to completing the survey. Participants were informed of the nature and purpose of the research, the expectation of the participants, and the potential risks/benefits of the study. Participants were also informed that their participation is completely voluntary and that they could withdraw at any time or refuse to answer questions without penalty. A copy of the consent document and research team contact information was provided to the participants.

Endline Data Analysis for World Vision's Mamanieva Project Final Report

Survey data were downloaded from the ODK served and cleaned to remove duplicates using the household listing. Descriptive statistics were conducted using Excel and SASv9.4. Questions relating to pregnancy and IYCF knowledge were aggregated to create maternal and child nutrition (MCN) knowledge scores and GM self-efficacy questions were aggregated to create a self-efficacy score. Proportion of women respondents who achieved minimum dietary diversity were calculated by using FAO's definition. Proportion of children who achieved minimum dietary diversity and proportion of children who achieved minimum meal frequency were calculated using UNICEF IYCF indicator definitions. Normally distributed continuous variables were analyzed using T-tests and F-tests; non-normally distributed continuous variables were analyzed using Wilcoxon Rank Sum test. Categorical variables were analyzed with chi-

square test. Differences between the intervention and control sections were considered

significant at p<0.05. Endline survey results can be found in the World Vision Final Report on

the Mamanieva Project (Webb-Girard et al., 2017).

Mediation Analysis for Thesis Project

Mediators assessed for this thesis project were MU2 knowledge, GM knowledge, and

GM self-efficacy. All 291 MU2 were included in the Mediation analysis between IYCF

outcomes and MU2 knowledge. Analysis for GM-related predictors only included GMs who

lived in households with a MU2 (n=148). GM and MU2 data, collected separately, were merged

using section, village, and household number identifiers.

First, associations between the intervention and key mediators were examined for

statistical significance at p<0.05. The key intervention mediators included in this Mediation

analysis were MU2 knowledge, GM knowledge, and GM self-efficacy. All three continuous

mediators were analyzed using linear regression models. Independent socio-demographic

variables that were statistically different between the two groups at endline, were included in

adjusted models. MU2 knowledge models were adjusted for maternal schooling and parity,

schooling and occupation of household head, and household hunger category. Parity, though not

significantly different at endline, was included because of its potential influence on MU2

knowledge of maternal and child nutrition practices. GM knowledge and self-efficacy models

were adjusted for number of grandchildren, as well as GM schooling and parity. GM schooling

and parity, though not significantly different at endline, were included because of their potential

influence on GM knowledge of maternal and child nutrition practices.

Associations between significant IYCF outcomes at endline and key intervention mediators were then examined. The IYCF outcomes that were significantly different at endline were exclusive breastfeeding in the first week, minimum dietary diversity, and minimum acceptable diet. Binary IYCF outcomes were analyzed using logistic regression models, unadjusted and adjusted for the confounders outlined above. Additionally, the association between GM knowledge and MU2 knowledge and GM knowledge and GM self-efficacy were examined. Linear regression was used to analyze MU2 knowledge and GM self-efficacy as outcomes of GM knowledge.

Limitations

Limitations for this study include lack of certain outcome data at baseline, a small sample size, and low statistical power. The Mamanieva Project was a proof-of-concept pilot study conducted to understand feasibility in Sierra Leone. It was not designed for evaluation of effectiveness. The lack of outcome data, namely maternal nutrition and IYCF practices at baseline, further limited attribution of the effect of the project. In attempts to reach a larger sample size, an exhaustive sampling procedure was done, but the total number of respondents did not reach the sample size estimated based on the available population from census estimates. Lack of power restricted the ability to detect statistically significant differences between the intervention and control group, especially for IYCF outcomes for 6-23 month olds where the sample size decreased to N=219. Despite low power, some outcomes were still statistically significant in adjusted models suggesting the potential of this approach.

In addition to sample size, limitations may be related to data collection and data quality. Child dietary questions on the survey were answered using a 24-hour recall method, which

enumerators then transferred to the electronic survey form by filling in food groups that matched the recall form. Recall bias may have occurred as respondents had to recall foods their child had eaten in the past 24 hours, and response error may have occurred when enumerators were recording answers in ODK. Data quality could also be affected by social desirability bias. IYCF questions were asked to MU2 and GMs and respondents may have given answers that they believed World Vision wanted to hear than what actually occurred.

Moreover, the project activities were implemented occurred from 2013-2016. Activities were halted for a few months during the Ebola crisis in the country. Potential effects from the crisis, including no educational sessions and ability to acquire adequate food, may have had an influence on the results.

Role of Student

The author supported the Principle Investigator in the development of the endline survey and training materials used to facilitate the endline evaluation of the project. Upon arrival in Sierra Leone, the author trained 15 local enumerators and supervised survey administration and data collection in 22 communities. Data was cleaned to remove duplicates using the household listing. Preliminary analyses were also done in the field, and results were presented to the World Vision/Sierra Leon National Office leadership team. After returning to Emory, the author conducted further descriptive statistics to be included in the Mamanieva Project Final Report.

RESULTS

A. RESPONDENT DEMOGRAPHICS

A total of 291 MU2 participated in the endline evaluation survey and were included in the mediation analysis. Of these respondents, 291 were from the intervention group and 84 were from the control. The overall average maternal age was 26.2 ± 5.9 years and over 70% of the mothers had given birth to two or more children. Over 80% of MU2 in both communities worked in agriculture and over 70% reported being in monogamous relationships. Sixty-six percent of MU2 overall lived with the respondent's own parents or with her husband's parents (p=0.44), (Table 7).

Of the respondents, 60% had never received a formal education; a significantly higher proportion of women in the control group never attended school compared to the intervention community (70.1% vs 53.8 %, p=0.02). Similarly, education level for the head of household was significantly different between the two communities. Of the known responses, 70.2% of the head of households in the intervention community and 88.7% in the control community had never attended school (p=0.002). Though the main occupation of the head of households in both communities was agriculture, the proportion engaged in agriculture in the control community was significantly higher than the intervention community (91.5% vs 83.4%, p=0.03). Finally, the proportion of households categorized as "moderated to severe hunger" on the household hunger scale was significantly higher in the control community than the intervention (50.9% vs. 7.6%, p<0.001), (Table 7).

Table 7. Descriptive statistics for mothers with children <24 months of age (MU2) included in the Mamanieva endline survey, Bum ADP; data presented as mean±SD or n (%). P-values estimated using chi square or tests of the mean. *Reproduced with permission from WV Endline Report, 2017.*				
	Overall (n=291)	Intervention (n=184)	Control (n=107)	P-value
Average maternal age in years[1]	26.2 ± 5.9	26.0 ± 6.0	26.5 ± 5.8	0.61
Number of children respondent has given birth to				0.26
1	52 (17.9)	38 (20.7)	14 (13.1)	
2-3	105 (36.1)	65 (35.3)	40 (37.4)	
>3	134 (46.1)	81 (44.0)	53 (49.5)	
Sex of Index Child, % male	139 (47.8)	85 (46.2)	54 (50.5)	0.48
Age of Index Child, months[2]	11.8 ± 6.9	11.9 ± 6.9*	11.6 ± 7.0	0.70
Child age category				
0-5.9 months	71 (24.7)	48 (26.4)	24 (22.4)	0.76
6-8.9 months	42 (14.6)	24 (13.2)	18 (16.8)	
9-11.9 months	36 (12.5)	22 (12.1)	14 (13.1)	
12-17.9 months	69 (24.0)	41 (22.5)	28 (26.2)	
18-23.9 months	70 (24.3)	47 (25.8)	23 (21.5)	
Schooling				**0.02**
Never attended	174 (59.8)	99 (53.8)	75 (70.1)	
Some primary but did not complete	37 (12.7)	26 (14.1)	11 (10.3)	
Completed primary or more	80 (27.5)	59 (32.1)	21 (19.6)	
Employment				0.49
Does not work outside of home	17 (5.8)	12 (6.5)	5 (4.7)	
Agriculture	249 (85.6)	154 (83.7)	95 (88.8)	
Other	25 (8.9)	18 (9.8)	7 (6.5)	
Marital Status				0.18
Married/Partnered, monogamous	222 (76.3)	144 (78.3)	78 (72.9)	
Married/Partnered, polygamous	45 (15.5)	29 (15.8)	16 (15.0)	
Single, Widowed, Divorced, or Separated	24 (8.3)	11 (6.0)	13 (12.2)	
Lives with own or husband's parents	193 (66.3)	119 (64.7)	74 (69.1)	0.44
Head of household				0.49
Husband	139 (47.8)	83 (45.1)	56 (52.3)	
Respondent	4 (1.4)	3 (1.6)	1 (0.9)	
Mother-in-law	23 (7.9)	18 (9.8)	5 (4.7)	
Father-in-law	31 (10.7)	20 (10.9)	11 (10.3)	
Respondent's father	41 (14.1)	26 (14.1)	15 (14.0)	
Respondent's mother	18 (6.2)	14 (7.6)	4 (3.7)	
Other	35 (12.0)	20 (10.9)	15 (14.0)	
Head of Household Schooling (n=284)[3]				**0.002**
Never attended	219 (77.1)	125 (70.2)	94 (88.7)	
Some primary but did not complete	11 (3.9)	9 (5.1)	2 (1.9)	
Completed primary or more	54 (19.0)	44 (24.7)	10 (9.4)	
Head of Household Occupation (n=287)[4]				**0.05**
Agriculture	248 (86.4)	151 (83.4)	97 (91.5)	
Other	39 (13.6)	30 (16.6)	9 (8.5)	
Household Hunger Category (n=290)[5]				**<0.001**
Little to no hunger	222 (76.6)	170 (92.4)	52 (49.1)	
Moderate to severe hunger	68 (23.5)	14 (7.6)	54 (50.9)	
[1] 168 women could recall age: Intervention, n=108, Control, n=60				
[2] *age unknown for n=3*				
[3] 4 women respondents are heads of their household; 3 women did not know if head of household attended school				
[4] 4 women respondents are heads of their household				
[5] missing n=1				

Of the 219 GMs who participated in the endline survey, a total of 148 GMs lived in households with a MU2 and were included in the mediation analysis; 105 GM respondents were from the intervention group and 43 GMs from the control. Aside from the number of grandchildren, there were no significant associations between any of the GM demographic characteristics and community. The average age of GMs overall was 57.6 years and GMs had an average of 5.6 children. The average number of grandchildren was significantly higher in the control group than the intervention group (8.9 vs 6.6, p=0.02). As with the MU2 and the head of households, most GMs worked in agriculture: 85.7% in the intervention group and 79.1% in the control group. Moreover, most GMs in both communities had not received formal schooling. Eighty-five percent of GMs in the intervention group and 93% of GMs in the control group had never attended school (Table 8).

Table 8. Descriptive statistics for GMs included in the Mamanieva endline survey, Bum ADP; data presented as mean±SD or n (%). P-values estimated using chi square or tests of the mean.

	Overall (n=148)	Intervention (n=105)	Control (n=43)	P-value
Mean number of years in household (n=86)[1]	32.5 ± 20.4	30.5 ± 19.6	38.1 ± 21.8	0.13
Number of children (n=141)[2]	5.6 ± 2.5	5.4 ± 2.3	6.0 ± 2.8	0.15
Mean number of grandchildren (n=141)[2]	7.2 ± 5.7	6.6 ± 4.7	8.9 ± 7.2	**0.02**
Mean age in years (n=40)[3]	57.6 ± 11.1	57.1 ± 10.2	60.3 ± 16.2	0.51
Employment				0.48
Does not work	10 (6.8)	7 (6.7)	3 (7.0)	
Agriculture	124 (83.8)	90 (85.7)	34 (79.1)	
Other	14 (9.5)	8 (7.6)	6 (14.0)	
Schooling				0.39
Never Attended	130 (87.8)	90 (85.7)	40 (93.0)	
At least some Primary	3 (2.0)	2 (1.9)	1 (2.3)	
More than Primary	15 (10.1)	13 (12.4)	2 (4.7)	
Marital Status				0.30
Married monogamous	57 (38.5)	38 (36.2)	19 (44.2)	
Married polygamous	31 (21.0)	26 (24.8)	5 (11.6)	
Widowed	55 (37.2)	37 (35.2)	18 (41.9)	
Other: Single, Divorced, or Separated	5 (3.4)	4 (3.8)	1 (2.3)	

[1] 86 GMs knew number of years the lived in household (Intervention n=63, Control n=23)
[2] 141 GMs have children and grandchildren (Intervention n=99, Control n=42)
[3] 40 GMs knew age (Intervention n=34, Control n=6)

B. EFFECT OF INTERVENTION ON MEDIATORS
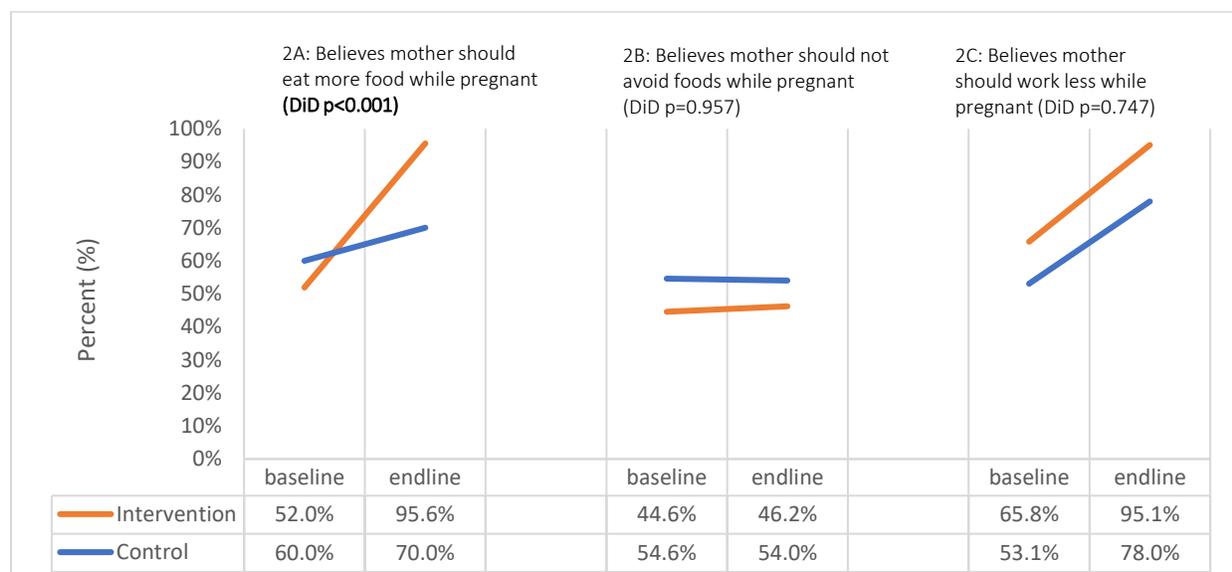
Effect of Intervention on MU2 Knowledge

At endline, MU2 in the intervention community had significantly higher average maternal child nutrition knowledge scores than the control community (11.7 vs. 10.5, p<0.001, Table 9). After adjustment, MU2 knowledge in the intervention community remained significantly higher by 1.1 (95% CI = 0.4 to 1.7) units than the control community (p<0.001, Table 9). Additionally, results reported in World Vision's Final Report for preliminary difference in difference analyses done for selected indicators of MU2 knowledge and beliefs, for which both baseline and endline data were available, showed significant improvements among intervention MU2 for increased consumption of food during pregnancy (Figure 2A), early breastfeeding (Figure 2D, 2F), and exclusive breastfeeding (Figure 2G-2H) (Webb-Girard et al., 2017).

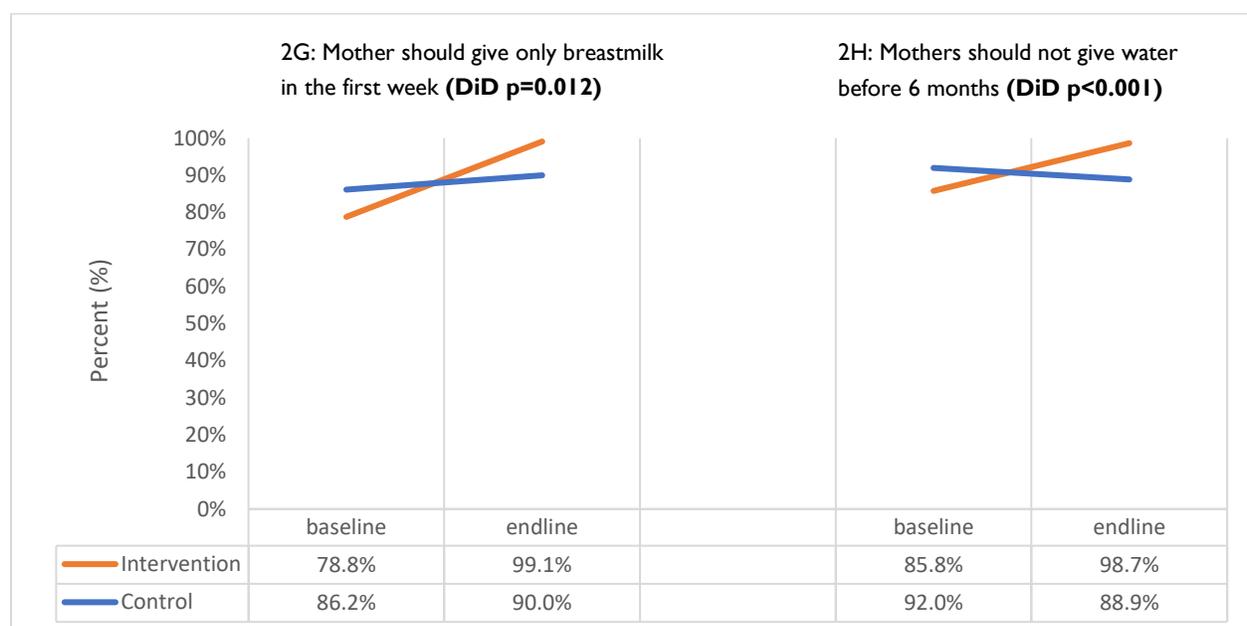| Table 9. Maternal and child nutrition knowledge scores of mothers with children < 2 years included in the Mamanieva endline survey (n=291); data presented as mean ± standard deviation. Unadjusted and Adjusted point estimates and 95% confidence intervals (CI) of Intervention for outcome of MU2 Knowledge from the Mamanieva endline survey				
	Average maternal child nutrition score		Point Estimate (95% CI), p-value	
	Intervention (n=184)	Control (n=107)	Unadjusted (n=208)	Adjusted[2] (n=208)
MU2 Knowledge[1], max=16	11.7 ± 1.9	10.5 ± 2.7	1.2 (0.6, 1.7), p<0.001	1.1 (0.4, 1.7), **p=0.0008**
[1] The total number of correct responses to nutrition knowledge questions were summed. [2] Model adjusted for maternal schooling and parity; schooling and occupation of household head; and household hunger category.				

Figure 2A-C: Difference in difference (DiD) analyses between intervention and control of attitudes of MU2 towards diet practices during pregnancy at baseline (n=348) and endline (n=291). *Reproduced with permission from WV Endline Report, 2017.*

Figure 2D-F: Difference in difference analyses of MU2 attitudes towards early breastfeeding practices at baseline (n=348) and endline (n=291). *Reproduced with permission from WV Endline Report, 2017.*
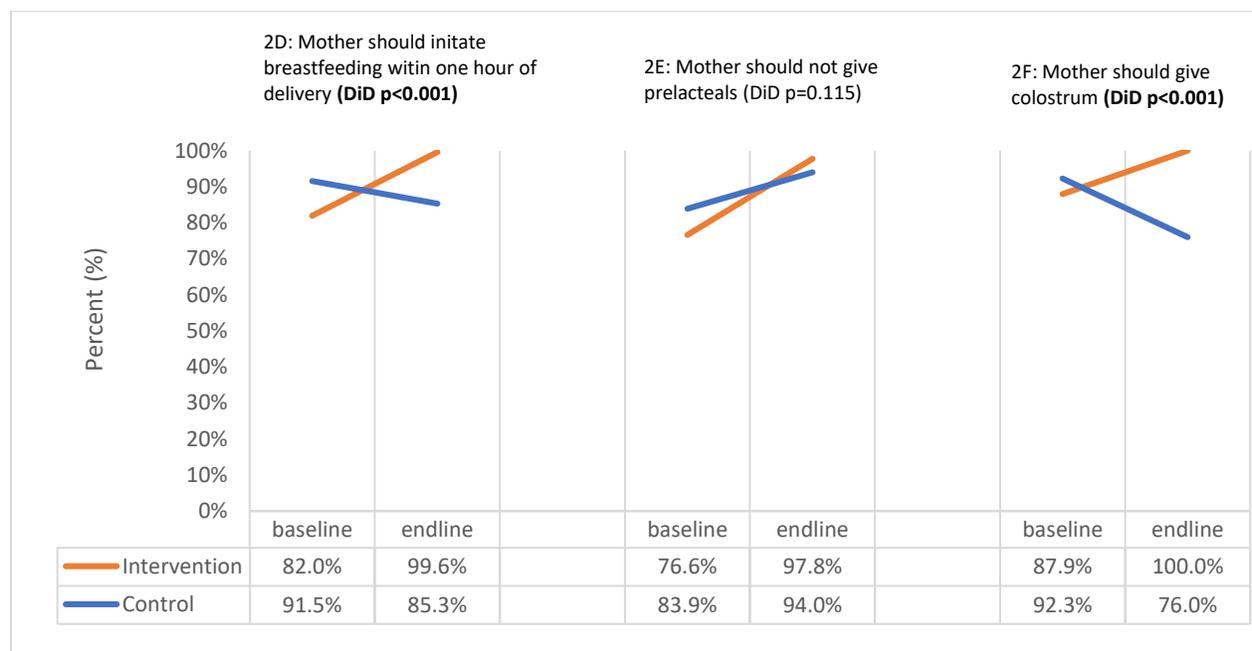
Figure 2G-H: Difference in difference analyses of MU2 attitudes towards early breastfeeding practices baseline (n=348) and endline (n=291). *Reproduced with permission from WV Endline Report, 2017.*

		2G: Mother should give only breastmilk in the first week **(DiD p=0.012)**			2H: Mothers should not give water before 6 months **(DiD p<0.001)**	
		baseline	endline		baseline	endline
Intervention		78.8%	99.1%		85.8%	98.7%
Control		86.2%	90.0%		92.0%	88.9%

Effect of Intervention on GM Knowledge and GM Self-Efficacy

At endline, GMs in the intervention community had significantly higher average maternal child nutrition knowledge scores than the control community (12.0 vs. 10.1, p<0.001, Table 10). After adjustment, GM knowledge in the intervention community remained significantly higher by 1.9 (95% CI = 1.2 to 2.7) units than the control community (p<0.001, Table 10). Additionally, results reported in World Vision's Final Report for preliminary difference in difference analyses done for selected indicators of GM knowledge and beliefs, for which both baseline and endline data were available, showed significant improvements among intervention GM for positive maternal diet practices in pregnancy (Figure 3A, 3C), early breastfeeding (Figure 3D-3F), and exclusive breastfeeding (Figure 3G-H) (Webb-Girard et al., 2017).
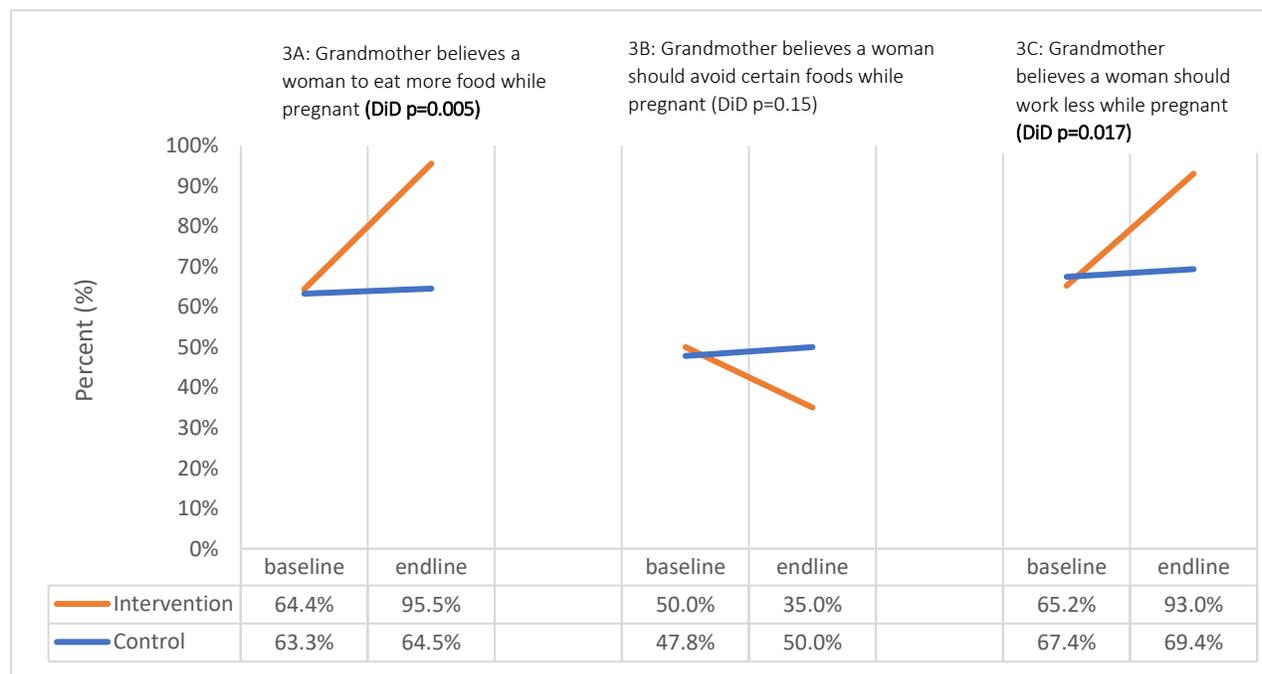
Average GM self-efficacy scores were also significantly higher in the intervention group at endline (19.6 vs 14.6, p<0.001). After adjustment, GM self-efficacy remained significantly

higher by 5.1 (95% CI = 3.7 to 6.5) units in the intervention community than the control

(p<0.001), (Table 10).

| Table 10. Maternal and child nutrition knowledge and self-efficacy scores of GMs living with children < 2 years included in the Mamanieva endline survey (n=148); data presented as mean ± standard deviation. Unadjusted and Adjusted point estimates and 95% confidence intervals of Intervention for outcomes of GM Knowledge and GM Self-Efficacy from the Mamanieva endline survey				
	Average scores		Point Estimate (95% CI), p-value	
	Intervention (n=105)	Control (n=43)[3]	Unadjusted	Adjusted[4]
GM Knowledge[1], max=16, n=148	12.0 ± 1.7	10.1 ± 2.8	1.9 (1.1, 2.6), p<0.001	1.9 (1.2, 2.7), **p<0.001**
GM Self-Efficacy[2], max=20, n=147	19.6 ± 1.6	14.6 ± 6.6	5.0 (3.7, 6.4), p<0.001	5.1 (3.7, 6.5), **p<0.001**
[1] The total number of correct responses to nutrition knowledge questions were summed. [2] Self-efficacy scores calculated based on responses to self-efficacy questions where "Not at all true" and "Don't know" were marked as 0 and "Somewhat true" and Exactly true" were marked as 1 for each question. A more detailed breakdown of responses to self-efficacy questions is provided in appendix X. [3] For the self-efficacy scores, N=42 for control group. [4] Model adjusted for GM schooling, parity, and number of grandchildren.				

Figure 3A-C. Difference in difference (DiD) analyses of attitudes of grandmothers towards diet practices in pregnancy at baseline (n=100) and endline (n=219). *Reproduced with permission from WV Endline Report, 2017.*

	baseline	endline		baseline	endline		baseline	endline
Intervention	64.4%	95.5%		50.0%	35.0%		65.2%	93.0%
Control	63.3%	64.5%		47.8%	50.0%		67.4%	69.4%

3A: Grandmother believes a woman to eat more food while pregnant **(DiD p=0.005)**

3B: Grandmother believes a woman should avoid certain foods while pregnant (DiD p=0.15)

3C: Grandmother believes a woman should work less while pregnant **(DiD p=0.017)**

Figure 3D-F. Difference in difference (DiD) analyses of attitudes of grandmothers towards early breastfeeding practices at baseline (n=100) and endline (n=219). *Reproduced with permission from WV Endline Report, 2017.*
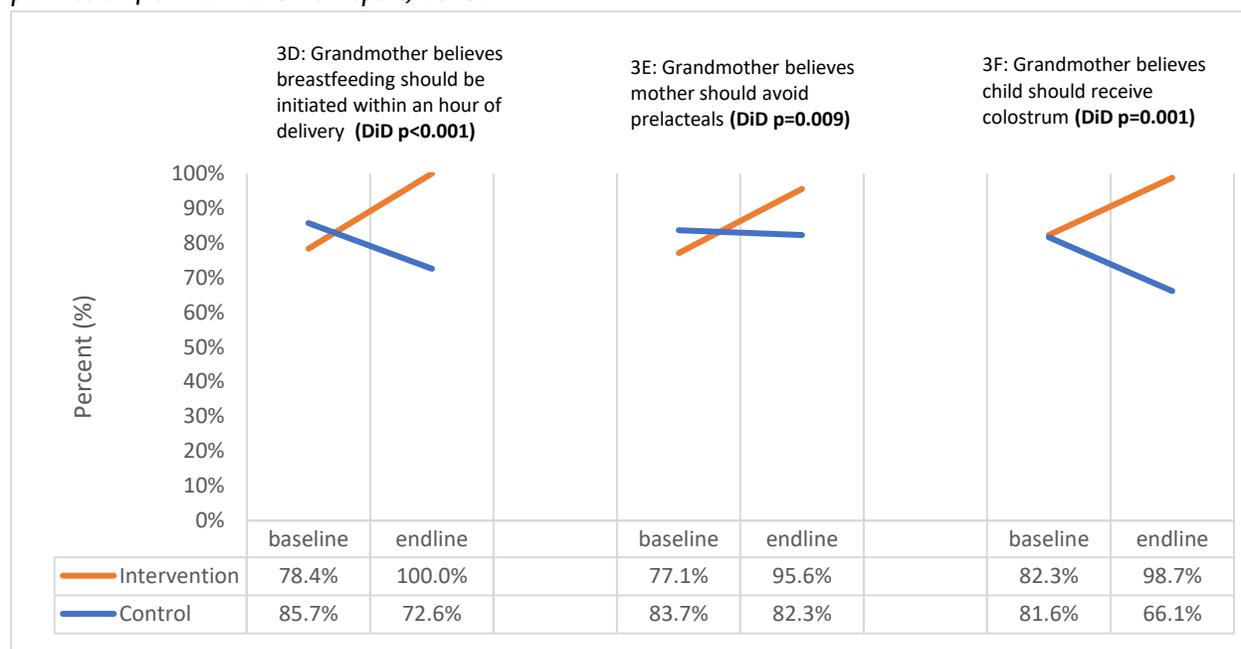
Figure 3G-H. Difference in difference (DiD) analyses of attitudes of grandmothers about exclusive breastfeeding at baseline (n=100) and endline (n=219). *Reproduced with permission from WV Endline Report, 2017.*
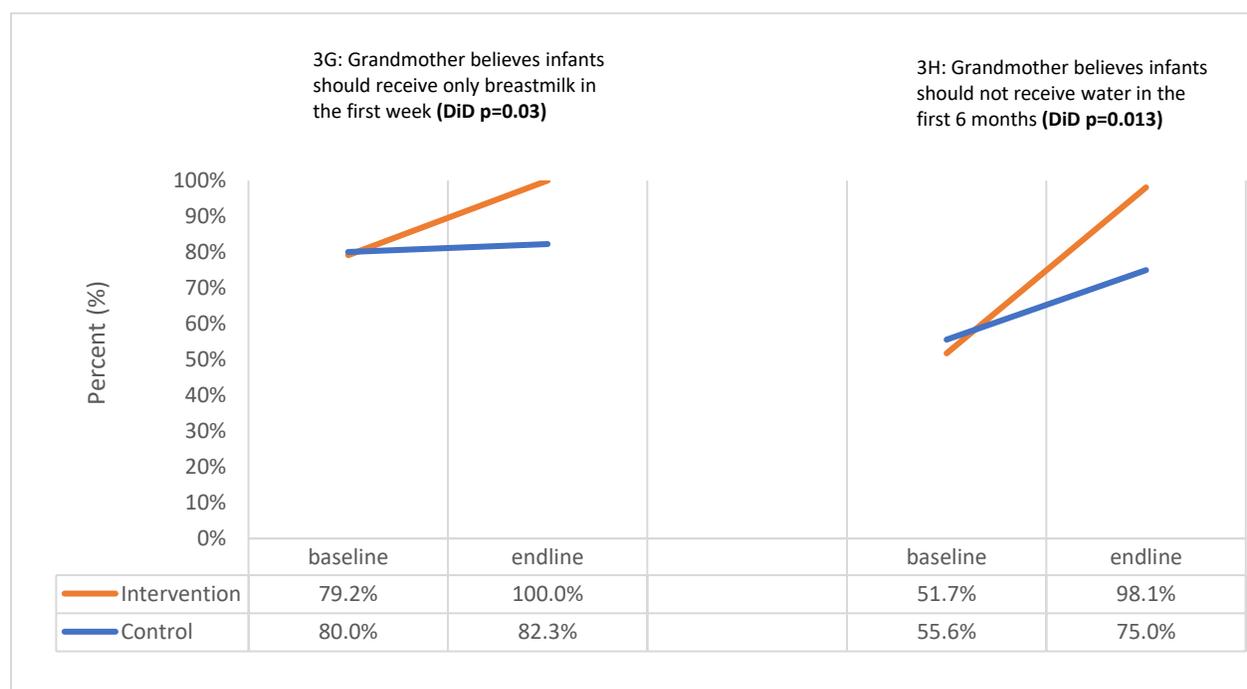
Significant IYCF Outcomes at Endline

Results from the endline evaluation showed that there were significantly higher proportions in the intervention community for the following IYCF practices: exclusive breastfeeding during the first week of life (90.2% vs. 79.4%, p=0.01), achievement of minimum dietary diversity (77.2% vs 51.8%, p<0.001), and achievement of minimum acceptable diet (53.8% vs 22.6%, p=0.001), (Table 11).

Table 11. IYCF practices of 291 children 0-23 months of age participating in the Mamanieva endline survey, Bum ADP; data presented as n (%) and odds ratios and 95% confidence intervals for complementary feeding outcomes. *Reproduced with permission from WV Endline Report, 2017.*					
	Overall (n=291)	Intervention (n=184)	Control (n=107)	P-value	Adjusted estimate and 95% CI, p-value[1]
Children 0-23 mos old put to breast within one hour of delivery	198 (68.0)	119 (64.7)	79 (73.8)	0.12	-
Children 0-23 mos old exclusively breastfed during the first week of life	251 (86.3)	166 (90.2)	85 (79.4)	**0.01**	-
	Overall (n=72)	Intervention (n=48)	Control (n=24)	P-value	
Children 0-6 mos old exclusively breastfed in the previous 24 hours	65 (90.3)	43 (89.6)	22 (91.7)	0.78	-
	Overall (n=219)	Intervention (n=136)	Control (n=83)	P-value	
Children 6-23 mos old who are continuing to breastfeed in addition to complementary foods	161 (73.5)	101 (74.3)	60 (72.3)	0.75	-
Children 6-23 mos old achieving minimum dietary diversity (≥4 food groups yesterday)	148 (67.6)	105 (77.2)	43 (51.8)	**<0.001**	3.5 (1.5, 8.3), p=0.005
Children 6-23 mos achieving the recommended minimum meal frequency for their age	125 (57.1)	83 (61.0)	42 (50.6)	0.13	-
Children 6-23 mos achieving minimum acceptable diet (n=168)	71 (42.3)	57 (53.8)	14 (22.6)	**0.001**	3.5 (1.5, 8.1), p=0.003
[1] Model adjusted for child age and sex, maternal schooling and parity; schooling and occupation of household head; and household hunger category. Analyses restricted to 219 infants 6-23 mos olds; 11 infants excluded due to missing outcome or covariate data.					

Adjusted effects of the intervention on proportion achievement of minimum dietary diversity and minimum acceptable diet remained significant (Table 11). After adjusting for child age and sex, maternal schooling and parity, schooling and occupation of household head, and household hunger category, children 6-23 months old in the intervention community had 3.5 greater odds of achieving minimum dietary diversity and minimum acceptable diet than those in the control community (Table 11).

C. EFFECT OF MEDIATORS ON OUTCOMES

Effect of MU2 Knowledge on Significant IYCF Outcomes

To explore the effect of MU2 knowledge on significant IYCF outcomes at endline, crude associations between MU2 knowledge and IYCF outcomes were measured. After running adjusted analyses, for every unit increase in MU2 knowledge, children under 24 months were 1.2 times more likely to be exclusively breastfed during the first week of life (p=0.04). Unadjusted and adjusted odds ratio estimates of achieving infant dietary diversity and minimum acceptable diet were not significant (Table 12).

Table 12. Proportions of children achieving IYCF outcomes and Unadjusted and Adjusted associations between **MU2 Knowledge** and IYCF outcomes from the Mamanieva endline survey, data are presented as N (%) and odds ratios and 95% confidence intervals			
	Overall (n=291)	Unadjusted estimate and 95% CI, p-value	Adjusted estimate and 95% CI, p-value[1]
Exclusive Breastfeed in the first week, n=291	251 (86.3)	1.2 (1.0, 1.4), p=0.02	1.2 (1.0, 1.4), **p=0.04**
Infant diet diversity adequacy, n=208[2]	148 (67.6)	1.1 (1.0, 1.2), p=0.28	1.0 (0.9, 1.1), p=0.90
Infant minimum acceptable diet, n=208[2]	71 (53.8)	1.1 (1.0, 1.3), p=0.09	1.0 (0.9, 1.2), p=0.66
[1] Model adjusted for child age and sex, maternal schooling and parity; schooling and occupation of household head; and household hunger category. [2]Analyses restricted to 219 infants 6-23 mos olds; 11 infants excluded due to missing outcome or covariate data.			

Effect of GM Knowledge on Significant IYCF Outcomes

To explore the effect of GM knowledge on significant IYCF outcomes at endline, crude associations between GM knowledge and IYCF outcomes were measured. Unadjusted and adjusted results for the effect of GM knowledge on all explored IYCF outcomes were between 1.0-1.2 and were not significant. Children under 24 months of age were 1.2 times more likely to achieve minimum acceptable diet for every unit increase in GM knowledge score; this effect was borderline significant (p=0.06) at the p<0.05 level (Table 13).

Table 13. Proportions of children achieving IYCF outcomes and Unadjusted and Adjusted associations between GM Knowledge and IYCF outcomes from the Mamanieva endline survey, data are presented as N (%) and odds ratios and 95% confidence intervals			
	Overall (n=148)	Unadjusted estimate and 95% CI, p-value	Adjusted estimate and 95% CI, p-value[1]
Exclusive Breastfeed in the first week, n=148	126 (85.1)	1.1 (0.9, 1.3), p=0.28	1.1 (0.9, 1.4), p=0.37
Infant diet diversity adequacy, n=117[2]	85 (57.4)	1.1 (0.9, 1.3), p=0.37	1.0 (0.9, 1.3), p=0.46
Infant minimum acceptable diet, n=117[2]	43 (29.1)	1.2 (1.0, 1.4), p=0.06	1.2 (1.0, 1.5), p=0.06
[1] Model adjusted for GM schooling, parity, and number of grandchildren. [2]Analyses restricted to 117 infants 6-23 mos olds, N=36 for control group			

Effect of GM Self-Efficacy on Significant IYCF Outcomes

To explore the effect of GM self-efficacy on significant IYCF outcomes at endline, crude associations between GM self-efficacy and IYCF outcomes were measured. Unadjusted and adjusted results for the effect of GM self-efficacy on all explored IYCF outcomes were between 1.0-1.1 and were not significant (Table 14).

Table 14. Proportions of children achieving IYCF outcomes and Unadjusted and Adjusted associations between GM Self-Efficacy and IYCF outcomes from the Mamanieva endline survey, data are presented as N (%) and odds ratios and 95% confidence intervals			
	Overall (n=148)	Unadjusted estimate and 95% CI, p-value	Adjusted estimate and 95% CI, p-value[1]
Exclusive Breastfeed in the first week, n=148	126 (85.1)	1.1 (1.0, 1.2), p=0.24	1.1 (1.0, 1.2), p=0.13
Infant diet diversity adequacy, n=117[2]	85 (57.4)	1.0 (0.9, 1.1), p=0.54	1.0 (0.9, 1.1), p=0.58
Infant minimum acceptable diet, n=117[2]	43 (29.1)	1.1 (1.0, 1.2), p=0.14	1.1 (1.0, 1.2), p=0.18
[1] Model adjusted for GM schooling, parity, and number of grandchildren. [2]Analyses restricted to 117 infants 6-23 mos olds, N=36 for control group			

Effect of GM Knowledge on GM Self-Efficacy and on MU2 Knowledge

To explore correlations between GM knowledge and GM self-efficacy at endline, the crude association between GM self-efficacy and GM knowledge was measured. Before and after adjusting, the effect of GM self-efficacy on GM knowledge was significant (p=0.01). For every unit increase in GM knowledge, there was a 0.4 unit increase in GM self-efficacy. To explore correlations between GM knowledge and MU2 knowledge at endline, the crude association between GM knowledge and MU2 knowledge was measured. Before and after adjusting, the effect of GM knowledge on MU2 knowledge was significant (p<0.001). For every unit increase in GM knowledge, there was a half unit increase in MU2 knowledge (Table 15).

Table 15. Unadjusted and Adjusted associations between GM and GM Self-Efficacy Knowledge from the Mamanieva endline survey, data are presented as N (%) and odds ratios and 95% confidence intervals			
	Overall (n=148)[2]	Unadjusted estimate and 95% CI, p-value	Adjusted estimate and 95% CI, p-value[1]
GM Self-Efficacy, max=20, n=147	18.2 ± 4.4	0.4 (0.1, 0.7), p=0.01	0.5 (0.1, 0.8), p=0.01
MU2 Knowledge, max=16, n=148	11.4 ± 2.2	0.5 (0.4, 0.6), p<0.001	0.5 (0.4, 0.7), p<0.001
[1] Model adjusted for GM schooling, parity, and number of grandchildren. [2]For the self-efficacy scores, N=42 for control group			

DISCUSSION

Sierra Leone has a high prevalence of child malnutrition, and though prevalence has reduced from 2008 to 2013, still 38% of children under-five are stunted (Statistics Sierra Leone - SSL & ICF International, 2014; Statistics Sierra Leone - SSL & ICF Macro, 2009). Literature shows traditional nutrition behavior change interventions that solely target pregnant women and mothers with young children have not been highly effective because they fail to acknowledge the social structures of where the interventions are implemented (Aubel, 2012). In the case of Sierra Leone, the culture of collectivism exists and there are important influencers of maternal and child nutrition outside of the mothers themselves. Utilizing The Grandmother Project approach based on formative research done in Senegal, the Mamanieva Project sought to incorporate social and cultural structures in Sierra Leone into a nutrition behavior change intervention to improve maternal and child health through GMs as key agents. Formative research was conducted at the study sites in April 2013 before the development of the intervention, and results of the formative research confirmed GMs' roles as important child caregivers and advisors of mothers. Baseline results of GMs' knowledge showed that GMs did not possess knowledge of optimal IYCF practices, such as exclusive breastfeeding, but rather followed traditional or community-based norms of IYCF practices (Webb-Girard & Mui, 2015). At endline, there were significant differences between the children under-2 in the intervention and control communities for three indicators of IYCF practices: exclusive breastfeeding during the first week of life, minimum dietary diversity, and minimum acceptable diet (Webb-Girard et al., 2017).

In order to understand the intended impact pathways of the intervention, a mediation analysis was performed for IYCF practices that were significant at endline. Mediation analysis is a valuable evaluation tool that allows researchers to identify critical components of an

intervention by evaluating the relationships between 1) intervention and mediators and 2) mediators and desired outcomes (Lockwood et al., 2010). The results, summarized in Table 16, show that the Mamanieva Project intervention had significant effects on the key mediators the intervention was targeting, which were MU2 knowledge, GM knowledge, and GM self-efficacy; knowledge of MU2 and GMs and self-efficacy of GMs were higher in the intervention community than the control community. However, the results showed that these mediators were not significantly associated with the IYCF outcomes that were significant at endline. The one exception was MU2 knowledge for exclusive breastfeeding during the first week of a child's life (Table 16).

Table 16. Exploration of Program Effects Through Crude Mediation Analysis		
Mediator	**Intervention → Mediator (Is intervention related to mediator?)**	**Mediator → Outcome (Is mediator related to outcome?)**
IYCF Outcomes		
MU2 Knowledge	**Intervention related to MU2 knowledge: yes**	**MU2 knowledge related to EBF in first week: yes**
		MU2 knowledge related to child minimum dietary diversity: no
		MU2 knowledge related to child minimum acceptable diet: no
GM Knowledge	**Intervention related to GM knowledge: yes**	GM knowledge related to EBF in first week: no
		GM knowledge related to child minimum dietary diversity: no
		GM knowledge related to child minimum acceptable diet: no
GM Self-Efficacy	**Intervention related to GM Self-Efficacy: yes**	GM self-efficacy related to EBF in first week: no
		GM self-efficacy related to child minimum dietary diversity: no
		GM self-efficacy related to child minimum acceptable diet: no
Other Outcomes of Interest		
GM Knowledge	**Intervention related to GM Knowledge: yes**	**GM knowledge related to GM Self-Efficacy: yes**
GM Knowledge	**Intervention related to GM Knowledge: yes**	**GM knowledge related to MU2 Knowledge: yes**
		Table adapted from (Lockwood et al., 2010)

In addition to project pathways for IYCF outcomes, other mediation pathways of interest were examined. MU2 knowledge and GM self-efficacy were examined as outcomes being mediated through GM knowledge. The results showed a significant association between the intervention and GM knowledge and then GM knowledge and MU2 knowledge, in addition to GM knowledge and self-efficacy (Table 16). Though causal assumptions cannot be made, the results show evidence for 1) increased MU2 knowledge through increased GM knowledge and 2) increased GM self-efficacy through increased GM knowledge.

The results of the mediation analysis for the Mamanieva proof-of-concept study indicate that the targeted intervention mediators were not key mediators, or at least not key mediators acting alone, in achieving the IYCF outcomes that were significant at endline. Possible reasons for these findings are numerous. One limitation of the Mamanieva Project study was small sample size and low power. Though exhaustive sampling was used, lack of power restricted the ability to detect statistically significant differences between the intervention and control group, especially for IYCF outcomes for 6-23 month olds where the sample size decreased to N=219 at endline. The small sample size is also a concern for the mediation analysis; the sample size may not have been adequate for a mediation analysis for IYCF outcomes. Therefore, although this mediation analysis does not provide evidence for the effect of the intervention mediators on IYCF outcomes, seeing that some IYCF outcomes were still statistically significant suggest the potential of this approach.

Another reason for the results seen is increased knowledge may not be the mediator that is driving improvements in IYCF outcomes. The results showed an increase in knowledge and an improvement in certain IYCF practices at endline, but no significant relationship between the two, signifying that education to increase knowledge may not be driving the change, or that

knowledge alone does not lead to adoption of practices. A program impact pathway analysis for a behavior change communication intervention promoting infant and child feeding practices in Bangladesh found that though improved maternal knowledge of practices was a crucial determinant, without the availability of time and resources, family support, and maternal and family perceptions of child feeding, mothers were less likely to adopt recommended breastfeeding practices (Avula et al., 2013). Similarly, a pathway analysis of a social franchise model in Vietnam recommended that in addition to increasing knowledge, other behavioral determinants, such as self-efficacy, attitudes, and social norms, should be addressed to improve complementary feeding practices (Nguyen et al., 2014). Other targeted mediators of the intervention should be analyzed for its relationship with the IYCF outcomes. Another potential mediator to examine could be the attitudes of the mothers and GMs (Nguyen et al., 2014). Attitudes could better capture probability that the respondent will put knowledge into practice. Data on attitudes were collected and available in this dataset but not explored in this thesis project. Future analysis will consider attitudes as mediators of intervention impact.

An additional reason for the results seen could be that increased knowledge may not be necessary to see practice. The social environment of the MU2 may have influenced practices (Avula et al., 2013), and MU2 may be practicing positive child feeding practices without knowing the reason. Social desirability bias also needs to be acknowledged. During the endline survey, respondents may have given answers they knew to be correct but were not practicing because they may seek approval from the organization. This type of response bias may have affected the mediator of knowledge, but also IYCF outcomes that were found significant at endline, ultimately leading to the downstream effect of findings from the mediation analysis being an inaccurate evaluation of the explored program impact pathways.

In summary, the project's endline findings indicated improvements in IYCF practices, even with small sample size, and thus make a case for further testing of the grandmother-inclusive approach with more rigorously designed research studies. However, the results from the crude mediation analysis suggests that the intended mediators of the intervention, some which were analyzed in this thesis project, may not necessarily be driving change of IYCF outcomes in the target population. Additional mediation analyses with other key mediators of the project, such as the aforementioned attitudes of mothers and GMs, should be performed, in addition to more complex pathway analyses, to identify critical components of the Mamanieva Project intervention on IYCF outcomes as well as other outcomes of interest, such as maternal nutrition indicators. Causal pathways of public health interventions are complex and intertwined. The mediation analysis done in this thesis project was crude with only one mediator. Realistically, there is probably more than one mediator in the causal pathway and relationships between multiple mediators and the exposure and outcome should be examined. For example, the endline data results also showed better maternal health seeking behaviors in the intervention than control community. Examining the relationship between knowledge of mothers and GMs and maternal health outcomes and then adding in maternal health behaviors as an additional mediator for IYCF outcomes could be a next step to identifying critical components of the intervention. It will be interesting to see if it is the uptake of maternal health behaviors that lead to increased positive IYCF outcomes.

Generally, performing mediation analyses and complex pathway analyses are valuable for improving public health interventions (Lockwood et al., 2010). Evidence from such analyses should be used to modify interventions to target the important mediators for desired health outcomes. This allows more efficient and effective interventions as resources are kept from being

spent on ineffective components and instead be allocated to the necessary components of the

intervention. Ultimately, correctly utilizing pathway analyses will better serve the target

population in addition to facilitating financial responsibility by organizations. Therefore, it will

be of great value to perform a complex pathway analysis for the Mamanieva Project, which has

shown numerous benefits evidenced the endline evaluation, including the uptake of optimal

maternal and child health practices, an increase in knowledge of maternal health and IYCF

practices, and increase in self-efficacy of grandmothers in the community, to identify key

determinants of the integrated approach utilizing the culturally-designated role of grandmothers

and other context-specific social and behavioral structures.

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