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Examining how factors from the Capability, Opportunity, Motivation, and Behavior (COM-B) model influence the number of households visited by frontline workers to deliver and counsel on micronutrient powders to children in Bihar, India

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Abstract

Examining how factors from the Capability, Opportunity, Motivation, and Behavior (COM-B) model influence the number of households visited by frontline workers to deliver and counsel on micronutrient powders to children in Bihar, India
By Tigidankay Kasanti Fadika

Objective: Bihar, India has some of the highest child malnutrition rates in the world in part due to poor infant and young child (IYCF) feeding practices. Home fortification with multiple micronutrient powders (MNP) is a strategy to increase the nutrient content of a child's food and improve nutritional outcomes. However, there is a lack of knowledge on the effectiveness of MNP programs and what factors influence FLWs to deliver these interventions effectively, especially in resource limited settings like Bihar. This study aims to examine what factors influence FLWs to deliver MNP services to children 6 to18 months in Bihar using the capability, opportunity, motivation, and behavior model as a performance guide.

Methods: An endline frontline worker survey was administered to 280 FLWs in the intervention arm (MNP delivery and IYCF counseling) and 280 FLWs in the non-intervention arm (IYCF counseling only). Data analysis focused on data from the intervention arm. Descriptive analyses (mean, SD, and %) were conducted using Statistical Analysis Software (SAS) 9.4. Poisson bivariate and multivariate adjusted regression was used to model the association between FLW capability, FLW opportunity, and FLW motivation and the delivery of MNP services as measured by the number of households visited in the past month to distribute and counsel on MNPs.

Results: Variables representing FLW capability, FLW opportunity, and FLW motivation were significantly associated with the number of households visited in the past month to distribute and counsel on MNPs. For FLW capability, proper MNP knowledge, receiving training on maternal and/or child health topics, and understanding the training on child feeding were all associated with an increase in the number of households visited (4%, 17%, and 26%, respectively). For FLW opportunity, receiving MNPs on a frequent basis and having a current supply of MNPs were associated with an increased number of households visited (38%, 16%) whereas slow replenishment of MNPs resulted in fewer households visited (-30%). Finally, for FLW motivation, the desire to help people or work with children, and reporting having an improved status in the community due to working in the MNP program were also associated an increase number of households visited (39% and 30%).

Conclusion: All three-behavior change inputs from the COM-B model factor into FLW performance. FLWs with higher reported capability, motivation, and opportunity had enhanced delivery of MNP services in intervention communities.

Examining how factors from the Capability, Opportunity, Motivation, and Behavior (COM-B) model influence the number of households visited by frontline workers to deliver and counsel on micronutrient powders to children in Bihar, India

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Acronyms

Accredited Social Health Activist	ASHA
Anganwadi Worker	AWW
Anganwadi Center	AWC
Auxiliary Nurse Midwife	ANM
Village Health Nutrition Days	VHNDs
Routine Immunization	RI
Low and Middle Income Countries	LMICs
Maternal and Child Health	MCH
Micronutrient Powders	MNPs
Frontline Health Worker	FLW
Integrated Family Health Initiative	IFHI
National Rural Health Mission	NRHM
Integrated Child Development Services	ICDS
Capability, Opportunity, Motivation, and Behavior Model	COM-B

Chapter 1: Introduction

Child Malnutrition

"Children are our future" is a widely used phrase used to signify the important role of providing resources for children to be functional, successful adults, and make an impact in the world. However, poor nutrition due to nutritional deficiencies in the first five years of a child's life, especially during the first 1,000 days, can lead to poor growth and intellectual impairments (Bailey, West Jr, & Black, 2015) . "Good nutrition is the bedrock of child survival and child development. Well- nourished children are better able to grow and learn, to participate in their communities, and be resilient in the face of a disease or disaster" (UNICEF USA, 2019). For this reason, proper child development is vitally important, so that a child can prosper academically, socially, and economically. A diet adequate in micronutrients such as iron, vitamin A, zinc, iodine, and folate are essential for normal growth development and physiological function (UNICEF, 2018). Deficiencies in these micronutrients and other nutrients are a form malnutrition called undernutrition. Unfortunately, about 7,500 children under the age of five die from malnutrition every day and about 50% of child deaths around the world are due to undernutrition (Juma et al., 2016; UNICEF USA, 2019). The burden of malnutrition and micronutrient deficiencies is highest in low and middle-income countries (LMICs) such as Southeast Asia (Akombi, Agho, Merom, Renzaho, & Hall, 2017; Rivera, Hotz, González-Cossío, Neufeld, & García-Guerra, 2003). Some of the most likely causes of micronutrient deficiencies in LMICs are poor nutritious diets and poor bioavailability

(Rivera et al., 2003). Consequences of micronutrient deficiencies include anemia, restricted growth, poor cognitive and motor development, and affected immune function (Le et al., 2007; Lawless et al., 1994; Black, 2003; Thurnham, 1997). Increased risk for common infections and lower productivity later in life are additional consequences of child malnutrition (Bundy et al., 2017). With the significant amount of consequences highlighted above about child malnutrition, it is imperative that children in LMICs are provided with the resources to have access to highly nutritious foods. The main issue is that meeting the nutritional demands of children in regions like Southeast Asia is difficult because their diets are dominated by staple foods with low nutrient density and poor mineral bioavailability (Dewey, 2016). Interventions to increase the nutrient content of these staple foods are therefore, highly necessary. A variety of nutrition - specific and nutrition - sensitive programs exist to enhance the diets of malnourished children in these LMICs such as the promotion of optimum breast-feeding, complementary feeding and responsive feeding practices, micronutrient supplementation or fortification, and water, sanitation, and hygiene (Bhutta et al., 2013). However, the feasibility and effectiveness of these nutrition programs can impact the degree and distribution of micronutrient deficiencies in a population (Müller & Krawinkel, 2005a). Hence, performing critical evaluations of the effectiveness and feasibility of these programs is integral to the success of these programs, and consequently improving the nutrition status of children deficient in micronutrients.

Child Malnutrition in India and Bihar

In India, child malnutrition is a major public health dilemma with prevalence of underweight children being one of the highest in the world (Sahu et al., 2015). The prevalence of underweight children is even double that of Sub-Saharan Africa (Sahu et al., 2015). While undernutrition is widespread among all ages in India, 30% of children under five are underweight, 39% are stunted, 15% are wasted, and more than 70% are anemic (Kim et al., 2017). One of the major factors contributing to this high prevalence of malnourished children in India is poor infant and young child feeding (IYCF) practices Less than 55% of Indian children and mothers receive the essential health and nutrition inputs needed to improve child and maternal nutrition (Partnerships and Opportunities to Strengthen, 2013). These inputs include age-appropriate complementary feeding (timeliness, quantity, quality, and frequency for children 6 to 24 months), exclusive breastfeeding for the first 6 months of life, safety and hygienic practices with complementary foods, and preventing anemia, to name but a few. In addition, less than one-third of Indian children received adequate complementary feeding through consuming the minimum number of food groups (20%) or minimum meal frequency (60%) (Kim et al., 2017). Disparities in the health system both within and between states make matters worse (Paul et al., 2011). Bihar is one of the poorest states in India with alarming malnutrition rates (The World Bank, 2013). According to the latest National and Family Health Survey, 43.9% of children under the age of 5 are underweight, 48.3% under the age of 5 are stunted, and 63.5% of children ages 6 to 59 months are anemic

(Ministry of Health and Family Welfare - India, 2016). The dire malnutrition situation in Bihar calls for the need of sustained and effective nutrition interventions to get a handle of the situation.

Nutrition Interventions: Home Fortification with Micronutrient Powders

A few main strategies are commonly used to address child malnutrition: exclusive breast feeding for the first six months of a child's life, continued breastfeeding after 6 months and the introduction of complementary food items, dietary diversification, micronutrient supplementation, and micronutrient fortification. In Bihar, only 53.4% of the infants under 6 months are exclusively breast-fed, 30.8% of infants start receiving semi-solid food at 6 to 8 months while still being breastfed, 7.3% of breastfeeding children 6 to 23 months receive an adequate diet, and 7.5% of children 6 to 23 months receive an adequate diet (Ministry of Health and Family Welfare - India, 2016). As evident in the survey statistics, infant and young child feeding practices are not strictly practiced in Bihar. Home fortification with MNPs has evolved as a strategy to ensure that populations such as Bihar with "implementation bottlenecks" receive quality nutrition interventions that are effective (World Health Organization, 2019b). For example, a cluster randomized effectiveness trial was conducted in West Champaran, Bihar to children 6 to 18 months to examine the impact of home fortification of complementary foods with MNPs on child feeding and nutrition indicators such as anemia and stunting (Melissa Fox Young et al., 2017). Home fortification is a process whereby micronutrient powders are added to staple or complementary foods to increase its nutrient content. Micronutrient powders (MNPs) are single-serving packets of powdered vitamins and

minerals that are to be mixed into semi-solid food before consumption (World Health Organization, 2019b). They have been highly acceptable due to the fact that they do no change the taste or texture if the food to which they are added, they are inexpensive compared to supplements, and they are easy to store, use, and transport (Suchdev et al., 2012).

Home fortification programs with MNPs have been evaluated for their efficacy and effectiveness. In regards to efficacy studies, a Cochrane review discovered that home fortification with MNPs reduced anemia in young children by 51% and iron deficiency by 31% (Suchdev, Jefferds, Ota, da Silva Lopes, & De-Regil, 2020). In a similar study, a systematic review summarized multiple efficacy studies (45 controlled trials and 7 meta-analyses) on multiple micronutrient interventions (MMN) that were conducted in a number of developing countries. The trials investigated the effect of MMNs on child morbidity, anemia, and growth. MMNs were shown to improve hemoglobin concentrations, reduce anemia, and improve linear growth. Findings on the effects on morbidity were mixed, but benefits were seen in diarrhea and respiratory illnesses with fortified foods (Ramakrishnan, Goldenberg, & Allen, 2011). A multitude of positive outcomes have been seen through conducting efficacy trials. While efficacy trials have done a good job at measuring the impact of multiple micronutrient fortification programs on child nutritional outcomes, effectiveness studies are fundamental for measuring the sustainability of these programs and evaluating them for scale up. The dilemma is that more evidence can be found for efficacy studies on home fortification with MNPs compared to effectiveness studies on home fortification with MNPs

(*Executive Summary of The Lancet Maternal and Child Nutrition Series*, 2008). Evidence is even more limited in resource- poor countries such as India.

The Role of Frontline Workers and their Significance in Delivering Nutrition Interventions

Frontline workers (FLWs) are healthcare workers that directly provide services to the people in their communities. For some remote areas, they are either the first point of contact or only point of contact in receiving health and nutrition services or resources. In India, two governmental programs have been established to address child malnutrition, the Integrated Child Development Services (ICDS), and the National Rural Health Mission (NRHM). Two main types of FLWs have been employed to deliver nutrition services through these programs, accredited social health activists, (ASHAs) and Anganwadi workers (AWWs) (Kosec et al., 2015). AWWs are part-time workers that receive both a fixed monthly allowance for their work based on their education qualifications and incentives depending on the activity performed. They work in Anganwadi centers (AWCs) with a catchment population of 1,000 and provide a range of services such as nutrition and health education, immunizations, and distribution of food supplements, etc. ASHAs are volunteers with at least 10^{th} grade education and do not receive a salary. They work part-time through the NRHM sometimes in catchment populations of 1,000 people and receive performance-based incentives for their work promoting immunizations, instructional deliveries for pregnant women, and providing information on pregnancy and newborn care such as maternal and child nutrition. AWWs and ASHAs sometimes work together to organize immunization and Village Health and

Nutrition Days (VHNDs) (Kosec et al., 2015). Auxiliary nurse-midwives are a third type of FLW employed through ICDS and NRHM and they receive two years of training (Molina et al., 2020).

FLWs have become key players in scaling up nutrition programs and delivering nutrition interventions effectively. For example, the association between the delivery of maternal and child health (MCH) nutrition behavior change messages through FLWs (ASHAs, AWWs, and ANMs) and community level indicators of complementary feeding practices were examined in 9 to 11 month old children. Data for the study was provided from a survey conducted in eight districts of Bihar through the Integrated Family Health Initiative (IFHI), a program focused on improving MCH outcomes (Das, Mahapatra, Sai Mala, Chaudhuri, & Mahapatra, 2016). A positive association was found between the nutrition counseling services in the following indicators: breastfeeding, and the frequency and quantity of complementary feeding (Das et al., 2016). MNP programs have also been using FLWs to deliver their products and services. For instance, in a study that examined acceptability of Iron Folic Acid Syrup (IFAS) versus MNPs in children 6 to 23 months in Bihar, FLWs were instrumental in delivering the products, and there was a greater than 80% adherence and acceptability for both products (Melissa F. Young et al., 2018). As seen through this study, FLW performance is significant, and poor FLW performance including barriers to effective FLW service delivery can greatly impact the effectiveness of a nutrition program. Another study recently demonstrated the importance of FLW performance for effective service delivery. A qualitative study that investigated what factors influence FLW's ability to implement home fortification of complimentary foods with MNPs in Bihar also revealed some significant findings on FLW's ability to perform.

Work burden, supportive supervision, and MNP supply and distribution all influenced FLW's motivation to implement services successfully. FLW performance is therefore important to implementing and delivering effective MNP programs (Hoenig, 2019).

Rationale and Public Health Significance

As described throughout this section, home fortification of complimentary foods with MNPs can improve the nutrition status of children, but the amount of evidence available on the efficacy of home fortification programs using MNPs outweighs the amount of evidence available on the effectiveness of home fortification programs. A desk review of ICDS and NRHM, India's two largest national programs for delivering evidence based nutrition interventions, revealed that the situation is even worse in the Indian context (Rasmi Avula, 2013). Upon reviewing 22 model programs that aimed to improve breastfeeding practices and timely initiation of complementary feeding, very few were comprehensive in scope. The review concluded that very little evidence exists on both efficacy and effectiveness studies or program evaluations for the delivery of nutrition interventions in India. Evidence is far more lacking for effectiveness. Hence, there is a need to fill in the knowledge gaps and one method can be through evaluating the scale up of these programs using FLWs as a delivery channel. Very few studies have researched the nutritional impact of this intervention on children through FLW service delivery, specifically in highly malnourished populations like the children in Bihar. Not only does Bihar have high rates of child malnutrition and high infant mortality rates, but also Bihar has weak health systems in place for delivering essential health and nutrition services (CARE, 2020; Kosec et al., 2015). With all these drawbacks, it is necessary to

make sure FLWs are equipped with the best tools to implement MNP programs in Bihar. Additional evidence is needed to understand what factors influence FLW's ability to deliver effective home fortification interventions with MNPs. In doing so, a better plan can be developed on how to strengthen poor IYCF practices in Bihar using FLWs. Ultimately this can lead to improved anemia and improved child development outcomes in children in Bihar. In an effort to achieve these outcomes, CARE's IFHI partnered with the government of Bihar in 2011 to address the disparities of poor health and poor nutrition in Bihar, and increase the coverage of interventions that improve health outcomes for women and their children, especially during the first 1,000 days (CARE, 2020). A select number of core interventions have been enacted in the state to improve nutrition outcomes such as iron and folic acid uptake during pregnancy, early and exclusive breastfeeding, and appropriate complementary feeding. IFHI have also made it a mission to integrate better service delivery platforms and equip FLWs with the tools they need. IFHI have collaborated with Emory University to implement this strategy in West Champaran, Bihar and evaluate the feasibility and effectiveness of home fortification of complementary foods through a cluster randomized pilot study (Larson et al., 2017). The main study intervention was to provide enhanced IYCF counseling and home fortification services through the delivery of MNPs to families of children 6 to 18 months, and evaluate the program's impact. Evidence from this study is needed in an effort provide more information on how home fortification of complementary foods could improve child anemia, child growth, and IYCF practices. To evaluate the importance of FLWs in the scale up of this intervention, a secondary analysis was performed through a FLW survey that aimed to assess the FLW experience and examine

what motivated FLWs to deliver enhanced IYCF counseling and MNP distribution (Hoenig, 2019).

Study Purpose

The purpose of this study will be to assess the findings from the FLW survey and determine what predicts FLW performance with guidance from a behavior change model known as the Capability, Opportunity, and Behavior (COM-B) model. The COM-B model was developed as a comprehensive framework to understand what influences behavior and can help in the design of interventions that comprise of behavior change components such as interventions analyze FLW performance (Jatau et al., 2019). The model consists of four components where capability opportunity, and motivation interact to influence behavior (Michie, van Stralen, & West, 2011). Using this theory, the objective of the study is to:

1. Examine how factors from the COM-B model influence frontline worker's ability to deliver and counsel on micronutrient powders to children in Bihar, India. While many indicators should be used to accurately measure the effectiveness of any intervention, this study will not directly measure the effectiveness of the intervention, and only focus on one aspect of FLW performance to help in future evaluation of the effectiveness of the home fortification of complementary foods using FLW delivery.

Chapter 2: Literature Review

Introduction

Malnutrition and its Impact Globally

Combatting world hunger is a global health challenge that has yet to be solved. Fortunately, of the 17 sustainable development goals (SDGs) to be achieved by 2030, attaining 'zero hunger' is one of them (Food and Agriculture Organization (FAO) of The United Nations., 2015)An important target for this goal includes eliminating malnutrition of all types. Malnutrition, otherwise known as the "silent emergency" is a significant public health problem for many countries worldwide (Hadley & Stevenson, 2018). According to the United Nations, the majority of people suffering from hunger live in developing countries and 12.9 % of this population is undernourished (Food and Agriculture Organization (FAO) of The United Nations., 2015). Low- and middle-income countries (LMICs) in Sub-Saharan Africa and South-East Asia such as India suffer greatly from this nutrition emergency (Müller & Krawinkel, 2005b; Pal, Pari, Sinha, & Dhara, 2017). Malnutrition is an excess, deficiency or imbalance in nutrients and exists in two forms: undernutrition and overnutrition. While overnutrition refers to a diet of excess poor nutrients and is associated with diet-related non-communicable diseases such as obesity, heart disease, diabetes, and stroke, undernutrition consists of protein - energy malnutrition and micronutrient deficiencies (World Health Organization, 2016). There are two forms of protein-energy malnutrition: acute (wasting), low weight for height and chronic (stunting), low height for age. Micronutrient deficiency, also called 'hidden hunger' refers to a lack in the diet of essential micronutrients, that is, the vitamins and minerals needed for normal growth, physiological function, and development in humans

such as vitamin A, folic acid, calcium, and iron (Centers for Disease Control and Prevention (CDC), 2020; World Health Organization, 2018b).

Overview of Child Malnutrition

Many infants and young children around the world are heavily affected by and at risk for malnutrition since they are most vulnerable to micronutrient deficiencies because of the high vitamin and mineral requirements needed to support their fast growth and development (World Health Organization, 2019a). Micronutrient deficiencies, especially deficiencies in vitamin A, iron, and zinc are known to have to have the greatest impacts on child mortality and morbidity (World Health Organization, 2019a). The World Health Organization (WHO) also estimated that of the approximated 2 billion people suffering from micronutrient deficiencies, mainly multiple micronutrient deficiencies, 85% live in resource-poor settings (Abu-Saad & Fraser, 2010; World Health Organization, 2000). Anemia and stunting are the most common nutritional ailments in malnourished children from LMICs and contribute significantly to mortality, morbidity, and poor development (Organization, 2015; United Nations Children's Fund., 2015). Malnourished children are also vulnerable to a range of many other health and developmental complications such as cognitive and motor developmental delays, increased risk for infections, and low intelligence quotient (IQ), which can all consequently affect their functionality as an adult (Pal et al., 2017). As an adult they may experience physical growth issues, poor performance at work and school, and fertility complications. According to WHO, more than one-third of all child deaths are related to malnutrition with undernutrition being one of the underlying causes of about half of all deaths (45%) in children under 5 (Kosec et al., 2015). This translates to 3.1 million children a year lost to malnutrition around the

world (Kosec et al., 2015). To make matters worse, country-level analyses by The United Nations Children Fund (UNICEF), WHO, and World Bank Group revealed that LMICs have a higher burden of undernutrition, specifically anemia and stunting, than high income countries (United Nations Children's Fund, 2015). Most of the deaths related to malnutrition in children occur in Sub-Saharan Africa and South Asia (Walson & Berkley, 2018). In 2018, 22% of the world's population of children under five, that is, 149 million children were chronically undernourished (United Nations). These high rates of malnutrition are especially true for India where undernutrition is a major public health dilemma and "human development challenge" as described in a study that found the prevalence of stunting in adolescents aged 10 to 17 to be 54% and poverty to be the main sociodemographic determinant of malnutrition in this population in West Bengal, a rural region of India. (Pal et al., 2017).

Child Malnutrition in India

In India, the under 5 population has the highest number of stunted children. There are 40.6 million children in India representing one-third of the world's under five stunted population (Ministry of Health and Family Welfare - India, 2005 - 2006; U. a. P. C. Ministry of Health and Family Welfare - India, 2019). This alarming statistic highlights the critical role of proper nutrition during a child's first few years of life, especially during the first 1,000 days, the period from conception to a child's 2nd birthday. The first 1,000 days in a child's life are critical for cognitive and physical development and is influenced by nutrition during this period, the mother's nutrition while pregnant, and child malnutrition. (Kattula et al., 2014). A multitude of factors: maternal undernutrition

and resultant low birth weight, socioeconomic disparities, lack in or access to health services, diseases, and poor access to and lack of affordability for highly nutritious foods put many children at risk for malnutrition (Black et al., 2013; Müller & Krawinkel, 2005a; Rahman, Howlader, Masud, & Rahman, 2016). In India, specifically, rural India, additional factors that contribute to child malnutrition include illiteracy, the country's large population size, and shortages in healthcare workers and health centers, which add to the challenge of healthcare provision (Maryse C. Kok et al., 2014; Pal et al., 2017). A systematic review of more than a hundred community health worker (CHW) studies in 2014 uncovered that Africa and Asia have total a shortage of 4.25 million healthcare workers (Maryse C. Kok et al., 2014).

Child Malnutrition in Bihar, India

Bihar, one of the poorest states in India, has some of the highest malnutrition rates in India with poor infant and young child feeding practices aggravating the issue. The most recent National Health Family Survey (2015 – 2016), a large-scale multi-round survey conducted throughout India identified high child malnutrition rates in Bihar with anemia being the highest. Among malnourished children under five, 48.3% of children under five were stunted, 20% were wasted, and 43.9% were underweight (Ministry of Health and Family Welfare - India, 2016). The survey also found that many children were anemic; 63.5% of children aged 6 to 59 months were anemic (Ministry of Health and Family Welfare - India, 2016). Similar malnutrition rates were seen in a cross-sectional baseline survey from a micronutrient powder program in West Champaran, Bihar to evaluate child feeding practices and malnutrition among children 6 to 18 months in Bihar.

The study found that 72% of children were anemic, 33% were stunted, 27% were wasted, and 42% were underweight. (Melissa Fox Young et al., 2016). Some of the factors found to be associated with anemia and stunting included gender, household hunger, and income. While breast-feeding rates were found to be high, the infant and young child feeding practices in Bihar were low. Only 39% reported initiating complementary feeding at 6 months characterizing the profound nature of the situation (Melissa Fox Young et al., 2016). As seen in both studies, the greatest burden of child malnutrition stemmed from anemia.

Anemia, a condition defined by low blood hemoglobin levels of less than < 11g/ld, affects 60% of children in LMICs and its nutritional determinants include deficiencies in iron, folate, zinc, vitamin A, and vitamin B12 (World Health Organization, 2015). While anemia can also be caused by infectious diseases, malaria, and genetic disorders like sickle cell, iron deficiency anemia (IDA) is the most prevalent form of anemia and can contribute to up to 75% of anemia cases depending on the country and region (Petry et al., 2016; Stevens et al., 2013; World Health Organization, 2015). In children, IDA has negative effects on the brain, immune system, and metabolism, which can negatively affect their mental, motor, social, and emotional development as well as their future academic performance (Bryan et al., 2004; Hassan et al., 2016; Oexle, Gnaiger, & Weiss, 1999). These adverse effects are estimated to be a leading cause in years to lost disability in children (Institute for Health Metrics and Evaluation, 2017). In Asia, IDA is associated with more than 20% of deaths in the first week of life underscoring the consequences of a diet insufficient in iron (Akombi et al., 2017). After 4 to 6 months of age, iron stores need to be supported by a balanced diet in

iron especially during the highest risk period of 1 to 2 years old (Alvarez-Uria, Naik, Midde, Yalla, & Pakam, 2014). Among all the micronutrient deficiencies, deficiencies in iron, and other essential micronutrients like vitamin A and zinc contribute significantly mortality and morbidity in children under five (World Health Organization, 2019b). A balanced diet in iron and other essential micronutrients to prevent anemia and other child malnutrition maladies requires an appropriate mix of nutritious foods in both quantity and quality. Nonetheless, achieving this type of diet is a challenge for families in resource-poor countries like Bihar where little is known or understood about adequate complementary feeding. The implementation of nutritional interventions that contribute towards improved infant and young child feeding practices in combination with the prevention and treatment of micronutrient deficiencies are vital methods for tackling child malnutrition in Bihar and worldwide.

Interventions for Child Malnutrition

A variety of child nutrition interventions exist with the most common being food fortification, supplementation, and behavioral interventions according to WHO's electronic library of evidence for nutrition actions (eLENA) (World Health Organization, 2017). Behavioral interventions are defined as strategies that change or alter accustomed personal practices and habits (World Health Organization, 2017). These interventions generally involve the promotion of infant and young child feeding (IYCF) practices and usually occur through nutrition education and counseling services. Exclusive breastfeeding promotion during the first 6 months of life and the introduction to complementary feeding coupled with continued breastfeeding after 6 months are the most

prominent behavioral interventions for preventing child malnutrition. As defined by WHO, complementary feeding is the transition period from exclusive breastfeeding to the introduction of family foods to the infant or child (World Health Organization, 2018a). Safe and adequate complementary feeding is necessary to meet the micronutrient requirements of a child after 6 months of exclusive breastfeeding when breast milk is no longer sufficient. Complementary feeding usually occurs between 6 to 24 months and is a very critical period since it is a time the child is most vulnerable to malnutrition (Das et al., 2016). Unfortunately, less than one-fourth of children 6 to 23 months in many countries meet the dietary diversity criteria and feed frequency for their age as outlined by WHO IYCF indicators (World Health Organization, 2018c). There are 8 IYCF indicators: exclusive breastfeeding under 6 months, early initiation of breastfeeding, continued breastfeeding at 1 year, introduction of solid, semi-solid, or soft foods, minimum dietary diversity, minimum meal frequency, minimum acceptable diet, and consumption of iron-rich or iron-fortified foods. The criteria is not met because many women and families such as those in Bihar, India do not practice the appropriate feeding practices or feed the child appropriate foods. In Bihar, fewer than 7 % of children receive the minimum acceptable diet, only approximately 21% of children receive iron rich and fortified foods, and less than 20% of all children receive the minimum dietary diversity (Alive and Thrive, 2016). Based on evidence from effectiveness interventions, appropriate complementary feeding practices add an additional 6% in the reduction of under-five mortality (Jones, Steketee, Black, Bhutta, & Morris, 2003). Interventions that make complementary foods more nutrient dense such as the fortification of

complementary foods or administration of vitamin-mineral supplements are therefore, fundamental.

According to the Copenhagen Consensus: Hunger and Malnutrition Challenge Paper, supplementation with vitamin A and zinc and fortification with iron and iodine have proven to be the most "cost effective global development efforts" (Sue Horton, 2008). Supplementation is the process of adding to the nutrient content of a child's diet with a concentrated source of a vitamin, mineral, or other nutrient in the form of a pill, tablet or liquid (Lindsay Allen, 2006). Food fortification comprises of the adding of micronutrients to staple food items or complementary foods to increase the nutrient content of these foods (World Health Organization, 2017). Food fortification interventions range from mass fortification (fortification of rice and cereals such as maize and wheat with iron, and fortification of salt with iodine) to fortification in a single residence to increase the nutrient content of staple household or community food items (UNICEF, 2018). Food fortification has proven to be a "very cost-effective public health intervention" because it can lead to a rapid increase in a population's micronutrient status at an affordable price (Lindsay Allen, 2006). Some studies have even shown that fortification with nutrients like iron present as more cost effective and produce better nutritional outcomes than supplementation (Baltussen, Knai, & Sharan, 2004; Thi Le, Brouwer, Burema, Nguyen, & Kok, 2006).

For example, a study that compared the efficacy of iron fortification to the efficacy of iron supplementation in anemic Vietnamese school children based on the improvement in anemia and iron status indicators (haemoglobin, serum ferritin (SF), and body level iron) found that indicator levels improved at a greater level for the fortification

group compared to the supplementation group. The fortification group received noodles fortified with 10.7 mg iron per 52 grams of noodles. After 6 months of feeding the children fortified instant noodles versus iron supplements, haemoglobin, SF, and body iron levels were 42%, 20%, and 31% of that in the iron supplementation group (Baltussen et al., 2004; Thi Le et al., 2006). In another study that estimated the health effects, costs, and cost effectiveness of fortification versus supplementation in 4 regions of Africa, Southeast Asia, and Europe, analyses were provided for six fortification and supplementation interventions. Both iron supplementation and fortification were examined at three different geographic coverage rates: 50%, 80%, and 95%. Costs were reported in international dollars and interventions were deemed cost-effective if they had a cost-effectiveness of less than three times GDP per capita. Fortification was seen to be less costly and cost effective even though the effects on population health were seen to be higher for supplementation (Baltussen et al., 2004). Fortification was found to be less costly than supplementation because it does not require a healthcare provider visit and the cost of supplementation per unit increases with increasing coverage. Baltussen et al pointed out that the cost-effectiveness of fortification is always lower than the cost-effectiveness of supplementation regardless of fortification coverage. While there are many benefits associated with nutritional interventions, the effectiveness of these interventions can be impacted by poor adherence to dosing regimens, low acceptability, lack of a skilled healthcare workforce, and poor distribution channels (Baltussen et al., 2004; World Health Organization, 2019a). Point-of-use fortification with micronutrient powders (MNPs), originally known as home fortification using micronutrient powders (MNPs) is a great alternative to the aforementioned interventions.

Fortification with Micronutrient Powders (MNPs) – A Child Nutrition Intervention

Point-of-use fortification with MNPs is the addition of micronutrient powders to energy-containing foods or complementary foods at the home residence or any place where food is consumed. The term 'home fortification', while still used, has been substituted with the term 'point-of-use fortification' because the previous term assumes that fortification only happens at the home residence when realistically fortification with MNPs is also carried out at schools, child centers, and refugee camps where food is fed to young children (World Health Organization, 2018d, 2019b). Micronutrients powders are vitamins or minerals in powder-form sprinkled on to ready-to-eat semi-solid foods for consumption at any point-of-use (Zlotkin et al., 2004).

The MNP formula can be as simple as a few micronutrients to a mix of many different nutrients, but they normally contain iron, vitamin A, and zinc. The powders are advantageous such that they add to the nutrient content of the food item without changing much of its taste, texture or appearance because they are they are coated in hydrogenated lipids (Zlotkin et al., 2004). This feature of MNPs increases its acceptability because the child will most likely not notice the addition of the powder to the food, and the risk of the child declining the fortified meal will be small. MNPs are also beneficial such that they add to a child's diet without changing their dietary habits or feeding routine, which is important for sustainability of the product (World Health Organization, 2019b). Moreover, they are more practical since they are economical, easier to use, transport, and

store (Nyhus Dhillon et al., 2017). In regard to nutritional health outcomes, scientific evidence, especially evidence from efficacy trials have shown that MNPs can reduce the risk of iron deficiency and anemia in infants and children 6 to 23 months. As a result of these outcomes, home fortification has become a main strategy in reducing anemia, micronutrient deficiencies, and improving IYCF practices in LMICs. For instance, a Cochrane systematic review of eight trials in LMICs with MNPs containing between 5 to15 nutrients and at least iron, vitamin A, and zinc have shown a reduction in iron deficiency by 51% and anemia by 31% in infants and children under the age of two compared to the infants and children given the standard practice (placebo/non-intervention group or those given iron supplements) (Suchdev et al., 2020). These results were independent of the MNP dose duration and anemic prevalence.

Not only do MNPs have positive effect on iron deficiency, but MNPs have also been shown to reduce vitamin A deficiency. An effectiveness trial in a rural population in Kenya with high child malnutrition rates and poor healthcare access investigated if the scale up of MNP programs, namely, the marketing and distribution of Sprinkles MNPs through a community-based program would reduce iron and vitamin A deficiency. Improvements in mean hemoglobin concentrations, (0.9 g/dL increase versus 0.6 g/dL increase), vitamin A deficiency (7.5% reduction versus 2.5% reduction), and iron deficiency (19.3% reduction in ferritin iron versus 5.3% reduction in ferritin iron) were higher for the intervention group who were exposed to Sprinkles MNP sales and distribution versus the comparison group who were unexposed (Suchdev et al., 2012).

In regards to child growth, minimal evidence exists on the impact of multiple micronutrients (MMs) or MNPs on child growth. In a study that conducted meta-analyses

of randomized controlled trials to evaluate the effect of micronutrient interventions with iron, vitamin A, and zinc on child growth for children less than five years old, weighted mean effect sizes and 95% confidence intervals were calculated for weight, height, and weight-for-height z scores. In comparison to the MM interventions in children consisting of only one and two micronutrients, multiple micronutrient interventions (3 or more micronutrients) were seen to only have a little effect on growth in height (Ramakrishnan, Nguyen, & Martorell, 2008). Similar findings were seen in a systematic literature review that evaluated the effect of MNPs on women and children (Salam, MacPhail, Das, & Bhutta, 2013). Seventeen studies were reviewed that included MM interventions as supplements or fortified foods. Fortified foods were delivered as sprinkles added to food, fortified maize-meal or spread food, or fortified complementary foods. While reductions were seen in anemia prevalence by 34%, IDA by 57%, retinol deficiency by 21%, and hemoglobin levels improved, no significant reductions were seen in zinc deficiency, and no impact was seen on anthropometric measurements (stunting, wasting, underweight, height-for-age z-score, weight-for-height z-score, and weight-for-age z score) (Salam et al., 2013).

As demonstrated in the studies described above, MM interventions with MNPs do not have a substantial impact on child growth measures. But due to the positive results associated with MNPs in reducing deficiencies in micronutrients such as vitamin A and iron, many health recommendations and guidelines that impact health policies and clinical interventions have been formed. Since 2011, the World Health Organization has recommended point-of-use fortification of complementary foods with MNPs containing iron in children under five for populations where anemia prevalence is above 20% or

higher (World Health Organization, 2018d). MNPs consisting of not only iron but also vitamin A and zinc have also been recommended by WHO to meet a 100% of the suggested nutrient intake for children 6 to 23 months (Nyhus Dhillon et al., 2017). The popularity of MNPs has led to an expansion in the scale up of MNP programs globally to include programs that are more comprehensive in scope. A NutriDash survey in 159 countries revealed that the number of MNP intervention programs doubled from 36 programs in 22 countries to 59 programs in 50 countries between 2011 and 2014 (Nyhus Dhillon et al., 2017). At this time, 22 countries had planned to scale up nationally. Many of these programs have been evaluated through efficacy trials and although effectiveness trials are not as common, evidence has grown on the effectiveness of nutrition interventions and delivery strategies according to the Lancet Series on Maternal and Child Nutrition (Bhutta et al., 2013).

While the evidence on home fortification with MNPs is growing, minimal evidence exists on home fortification with MNPs in Bihar, India where child malnutrition affects the lives of many children daily. In order to combat this ongoing nutritional health dilemma in Bihar and settings like it, scaled up strategies to improve complementary feeding practices such as home fortification with MNPs through community-based programs need to be enacted. The main impediment in this type of scale up in LMICs is that the implementation process is usually presented with many complexities. For example, an evaluation by UNICEF found that only one-fifth of 15 million children targeted globally were reached through MNP strategies in 2014 (Nyhus Dhillon et al., 2017). Moreover, an MNP consultation series on program learning and experiences of MNP interventions found that the process of implementing MNP programs (planning,

development, and program improvement) is challenging and that there are gaps in knowledge with regard to MNP implementation (Nyhus et al., 2017), which affect the overall success of the programs. Two of the gaps identified were in how to manage the burden of increasing workload on frontline staff with MNP service delivery and how to provide effective supportive supervision with a high turnover in MNP staff. MNP staff, mainly frontline workers (FLWs) are integral to the implementation of MNP programs since they play a major role in service delivery and increasing the coverage of MNP programs. This is significant because increasing the coverage of nutrition interventions has been shown to reduce maternal and child undernutrition (Bhutta et al., 2013). According to the Lancet Series on Maternal and Child Nutrition, "innovative delivery strategies", specifically community-based delivery platforms comprised of communication and outreach activities, are efficacious in the scale up of nutrition programs and targeting hard to reach populations (*Executive Summary of The Lancet Maternal and Child Nutrition Series*, 2008). However, it is not always clear how to go about the scale up process for nutrition interventions since there are not any set guidelines to abide by (Pelletier et al., 2012). For these reasons, FLWs can be of big assistance in this arena. Additional research on using FLWs to deliver MNP programs is needed to fill in these gaps to improve the feasibility and effectiveness of MNP programs in Bihar and worldwide.

Role/ Significance of Frontline Health Workers in Delivering Nutrition Interventions

Frontline health workers are valuable assets to the healthcare system such that they directly provide health services to people in their community. They can be nurses, community health workers (CHWs), doctors, pharmacists, nurses, and midwives. FLWs have helped tremendously in expanding the reach of health services in remote and rural areas and strengthening healthcare systems. In many LMICs, particularly rural and remote areas where there is poor access to health and nutrition services as experienced in Bihar, FLWs serve as the first point of contact to healthcare services at both the community and local health facility level. In some cases, FLWs are the only point of contact for health and nutrition resources, counseling, and primary care services, which is why their performance can be so critical in delivering these services (Nguyen, Kim, Tran, Menon, & Frongillo, 2019).

A number of studies including studies on MNP program coverage in developing countries have found that frontline workers are essential for delivering nutrition interventions and reducing maternal and child health undernutrition (Ford et al., 2019; Maryse C. Kok et al., 2014). Many of these studies that will be described below provide evidence that it is beneficial to employ frontline workers in order to successfully deliver nutrition interventions at a scale and through community-based programs tuum(M. C. Kok et al., 2015; Kosec et al., 2015; Nguyen et al., 2019; Tumilowicz et al., 2019). This is especially true for community based nutritional programs that comprise of a behavior change component (Kosec et al., 2015). Since FLWs are community members themselves, they are generally aware of the IYCF practices exercised in their community and of the factors that influence these practices. Hence, they tend to be suitable drivers of

behavior change interventions, thereby increasing the coverage of nutrition programs (Kosec et al., 2015). Frontline workers' services are valuable since program beneficiaries are more likely to respond to behavior change interventions if members of their own community deliver them. While FLW performance can be enhanced by familiarity with health behaviors within their community, many LMICs have poor FLW performance (Rowe, de Savigny, Lanata, & Victora, 2005). Poor FLW performance can lead to poor service quality and provision, and affect the delivery of nutrition interventions (Nguyen et al., 2019).

Studies on FLW performance suggest that in order to improve FLW performance, it is integral that the factors that influence FLW performance are identified and acknowledged before planning, delivering, and monitoring interventions (Kosec et al., 2015). This is key for improving child nutrition outcomes such as micronutrient deficiencies and anemia. Fortunately, with the rise in interventions that employ FLWs such as home fortification with MNPs, studies have started focus more on factors that affect FLW service delivery in their analysis. For example, a conceptual framework developed from a systematic review of 140 studies on FLW programs in LMICs showed that FLW performance was a function of intervention design elements such as FLW training, supportive supervision, and incentives and end-user outcomes (mother's knowledge and service usage) (M. C. Kok et al., 2015). To illustrate further, FLW training, supportive supervision, and incentives seemed to strengthen FLW performance and receipt of services by improving FLW motivation, knowledge and service delivery. This framework influenced the development of a study that used survey data collected from 2010 to 2014 to examine how training, supervision and mass media affected FLW

service delivery in an effort to improve IYCF practices in Bangladesh and Vietnam. FLW performance was evaluated at the FLW-level (knowledge, motivation, and service delivery) and end-user level (mother's knowledge and service utilization). The intervention group which received specialized training, supervision, and mass media had higher service delivery scores compared to control group who was given standard training and supervision (Nguyen et al., 2019). Service delivery was measured through various indicators such as number of households visited, number of clients reached through IYCF services, and quality of IYCF counseling services. In Bangladesh, motivation scores and the number of households visited were higher for the intervention group compared to the control group whereas in Vietnam, the number of clients met through IYCF services at the health facility were also higher for the intervention group (Nguyen et al., 2019). At the end of the study, the service received and maternal knowledge improved.

As showcased by the FLW studies described above, supported and motivated FLWs perform best, and strong FLW performance is conducive to improving child nutrition interventions outcomes. For example, an evaluation of a MNP delivery trial in Ethiopia using a cross-sectional survey dataset of children 6 to 23 months discovered a positive relationship between increased frequency of contact with FLWs and continued MNP use. The success of the trial was attributed to the fact that caregivers were adequately supplied, had proper educational training on MNP side effects, and addressed all MNP and IYCF difficulties (Tumilowicz et al., 2019). A different study that analyzed household survey data of a scaled up IYCF - MNP program among children 6 to 23 months in Nepal concluded that FLW counseling may play a vital role in improving MNP

program coverage and adherence. As a finding, CHW and female community health volunteer (FCHV) counseling was independently associated with MNP coverage and repeat coverage (Locks et al., 2019). Counseling by FCHVs was specifically associated with maternal MNP knowledge and high intake (Locks et al., 2019).

Improvements in behaviors like IYCF feeding practices in children due to FLW service delivery have been researched as well. One study that aimed to assess the association between frontline worker nutritional counseling services and complementary feeding practices among infants 9 to 11 months old discovered that CHW advice given on age appropriate frequency of complementary feeding had a positive association with breastfeeding and the frequency and quantity of complementary feeding (Das et al., 2016).

Frontline Workers (FLWs) in India & Study Context

In India, the government along with support from organizations like CARE India have taken action to increase the capability of FLWs by providing them with the knowledge and skills needed for effectual scale up and delivery of nutritional interventions. FLWs are trained on how to properly counsel mothers and caregivers on maternal and child health nutrition. This effort to reduce child undernutrition are managed by two programs under the Ministry of Women and Child Development (MoWCD), the Integrated Child Development Services (ICDS), and the National Rural Health Mission (NRHM) (Kosec et al., 2015). Two types of FLWs have been assigned with the responsibility of delivering maternal and child nutritional interventions in India through these programs, Accredited Social Health Activists (ASHAs) and Anganwadi workers (AWWs).

The factors affecting the performance of ASHAs and AWWs are increasingly being examined through research studies with FLWs. One study conducted in South India assessed the time utilization and factors affecting the performance of ASHAs, AWWs, and auxiliary nurse-midwives (ANMs). Facilitators and barriers to FLW performance, specifically ASHA performance, were determined. The facilitators outlined were supportive supervision, community support, coordination from fellow workers, and ease of transportation. Weak supportive systems and increased work burden were two barriers to FLW performance (Singh et al., 2018).

Another study that investigated FLW performance was conducted in West Champaran, Bihar, through a cluster randomized community pilot to assess the feasibility and program effectiveness of home fortification of complementary foods with MNPs. The aim of the study was to find a suitable strategy to address child anemia and complementary feeding gaps in Bihar in children aged 6 to 18 months (Hoenig, 2019). While the main analysis focused on child nutritional outcomes, intervention uptake, and acceptability, and change in IYCF behaviors, a secondary analysis was performed with frontline workers to assess frontline worker experience and what influences them to effectively disseminate home fortification products and IYCF counseling. Data was collected on ASHAs, AWWs, and ANMs through two different surveys: a quantitative survey and qualitative survey. Twelve qualitative interviews were conducted with the frontline workers (4 AWWs, 4 ASHAs, and 4 ANMs) from four sub-health centers selected based on performance. Qualitative research findings of the intervention identified a few factors that influenced FLW's ability to deliver MNPs. Work environment was one factor where FLWs felt that were overworked and poorly paid,

which subsequently impacted their work-life balance. A second issue was that program beneficiaries had many misconceptions of MNPs, which made it difficult to advise on MNP usage. Lastly, the supply and distribution of MNPs was found to be extremely important in effective MNP delivery. A key finding overall was that all of these factors including FLWs' perception of MNP's benefits influenced the motivation of FLWs and their performance.

Significance of Study

As demonstrated by FLW performance studies globally and in India, FLWs must be capable, motivated, and equipped with the resources needed to adequately perform, deliver effective nutrition services, and ultimately make progress in significantly reducing child anemia and poor IYCF practices, especially in places like Bihar where child malnutrition occurs partly as a result poor FLW performance. More evidence on what behavior change strategies are essential in preventing poor FLW performance is needed to achieve these goals. Improving the design and implementation of evidence-based practice depends on successful behavior change interventions and can be achieved through implementation science. Implementation science involves the scientific study of methods "that promote the systematic uptake of research findings and other evidence-based practices into routine practice" to improve the quality and effectiveness of health services (Bauer, Damschroder, Hagedorn, Smith, & Kilbourne, 2015). One commonly used model in the field of implementation science is the Capability, Opportunity, Motivation, and Behavior or COM-B model. The COM-B system as shown in Figure 1 below is a framework used to understand what factors can influence behavior change.

Within this system, capability, opportunity, and motivation interact to impact behavior, and behavior can in turn impact the elements as well (Michie et al., 2011).

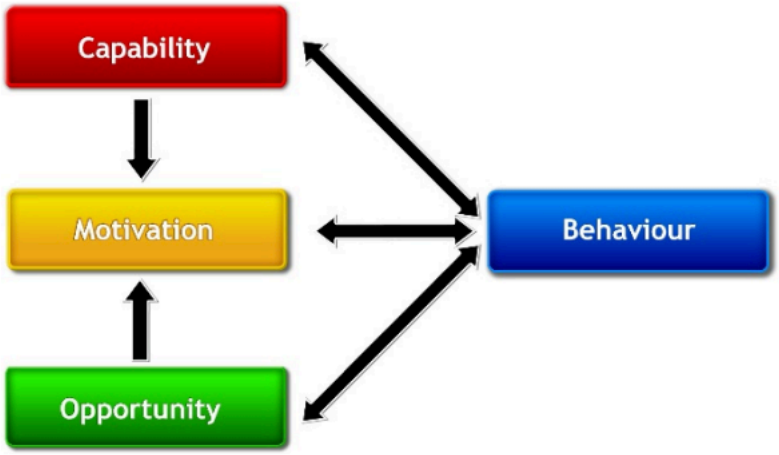


Figure 1: The COM-B System, a conceptual framework for understanding what impacts behavior (Michie et al., 2011)

Studies have used the COM-B model as a framework for determining factors that influence behavior. For example, a sexual health study in England used the COM-B model to understand the barriers and facilitators to chlamydia testing for young people and primary care practitioners. Facilitators and barriers were analyzed using thematic analysis and then mapped onto the COM-B model components. Using 411 papers, barriers and facilitators were identified at the patient (e.g. knowledge), provider (time constraints), and service level (practice nurses). The factors were then categorized into subcomponents of the model. The subcomponents identified included: physical capability (practice nurse involvement), psychological capability (lack of knowledge), reflection motivation (beliefs regarding perceived risk), automatic motivation (embarrassment and shame), physical opportunity (time constraints), and social opportunity (e.g. stigma)

(Michie et al., 2011). As this sexual study demonstrated, using this model to predict what factors are central in improving poor FLW performance will generate and contribute to the evidence needed to close the gaps in MNP program implementation and clearly define FLW performance indicators. Having this additional evidence can help make advancements towards the issue of there being limited evidence on what FLW service delivery behaviors are substantial for producing effective home fortification programs with MNPs and IYCF counseling through FLW delivery in poorly resourced areas such as Bihar.

Since Bihar has a significant healthcare worker shortage, poor FLW performance, high child malnutrition rates, and the nutritional health impacts of home fortification strategies have not been thoroughly explored there, developing a study that examines this issue with Bihar as the study setting would be valuable. Hence, a study needs to be conducted that investigates if FLW capability, FLW opportunity, and FLW motivation has influence on the delivery of MNP home fortification programs in Bihar. The aim of this study will be to assess what influences FLWs to disseminate MNPs and IYCF counseling. This assessment will be done using the findings from the quantitative FLW survey conducted through the cluster randomized community pilot study on the feasibility and program effectiveness of home fortification of complementary foods with MNPs in Bihar (Larson et al., 2017). Findings from this study can be used to support other MNP home fortification programs that are exposed to the same conditions and are implemented in similar settings like Bihar.

Chapter 3: Methods

Study Purpose and Setting

The study took place in West Champaran, Bihar. West Champaran is one of the eight key focus districts for CARE's Integrated Family Health Initiative (IFHI). IFHI was launched in 2011 and uses a core set of interventions of family health services such as family planning, immunization, and nutrition to increase the universal coverage and quality of these interventions, and improve the overall health and survival of women, newborns, and children during the 1st 1000 days of a child's life (CARE, 2020).

The study highlighted the importance of FLWs in improving child nutrition. It was a cross-sectional cluster randomized community pilot designed to examine the implementation feasibility and effectiveness of enhanced IYCF counseling and MNP use in young children ages 6 to 18 months (Larson et al., 2017). The MNPs which were labeled as Jeevan Jyoti consisted of micronutrient powder sachets composed of 8 micronutrients: iron, zinc, folic acid, vitamin A, vitamin C, vitamin B12, iodine, and amino acid maltodextrin. A detailed list of the micronutrients and their compositions can be seen in figure A below. The aim of the study was to address anemia and complementary feeding gaps through the IFHI program in Bihar in partnership with the Indian government.

Figure A: Ingredients in the Micronutrient Powders (MNPs)/Jeevan Jyoti

Home Fortification Product/ MNP Ingredients	**Amount**
Iron (Ferrous Fumarate)	*12.5 mg*
Zinc (Zinc Gluconate)	*5 mg*
Folic Acid	*0.160 mg*
Vitamin-A (Vit-A Acetate)	*0.30mg*
Vitamin-C (Ascorbic Acid)	*30 mg*
Vitamin-B12	*0.9 mcg*
Iodine	*90 mcg*
Maltodextrin	*Base*

Study Population, Sampling, Training, and Intervention Procedures

The study consisted of two interventions: enhanced IYCF counseling and MNP distribution to eligible households. Eligible households were households with children of ages 6 to 18 months from randomly selected Health Sub-Centers (HSCs) from four blocks of West Champaran, Bihar. This group was chosen as the target study population since this age group is the most vulnerable to iron deficiency and anemia and benefits the most from this type of intervention. The intervention was delivered by frontline workers to two different study arms: an intervention group (group that received the intervention – MNP distribution + IYCF counseling) and control group (IYCF counseling only). 70 Health Sub-Centers were randomized into these two study arms with 35 HSCs in each arm. Before the intervention was delivered to the target group, FLWs were trained on

IYCF counseling and MNP and educational material distribution through HSC meetings. For both arms, FLWs were trained to visit all children in the study population at least once per month to counsel them on child feeding practices. Special instructions were given to visit and counsel households with children 6 to 9 months more frequently to ensure these child-feeding practices were properly established from early on. In the intervention arm, FLWs were instructed to deliver a maximum dose of 240 MNP sachets to mothers or caregivers in households with eligible children over two 6-month periods totaling to 12 months overall. A maximum dose of 120 sachets were to be delivered in the first 6 to 11 months and another 120 sachets to be delivered in the last 12 to 18 months. FLWs in this arm were also trained on the proper use of MNPs, so that they could best advise mothers or caretakers on its use at home. One sachet per child per day was used for proper MNP usage demonstrations.

Study Ethics - Approval, Confidentiality, and Consent

The Institutional Review Boards at 3rd Futures Group, Delhi, India, St John's Medical College & Hospital Institutional Ethics Committee, Bangalore, India, and Emory University in Atlanta, Georgia has approved this study for continuing review (Larson et al., 2017). The cluster-randomized study was also registered as a clinical trial with the US National Institute of Health.

All surveys were kept confidential and private and were only reviewed by the immediate research team except for a de-identified batch that was used for quality control checks. Community and individual consent was obtained from participants prior to the study. Community consent was obtained verbally from chiefs of all the randomly selected

HSCs before obtaining individual consent from study participants through written consent.

Research Instrument and Data Collection

Data was collected for both the target population (eligible households with children 6 to 18 months) and secondary population (FLWs) of interest through two surveys:

1) Household survey
2) FLW survey

Household Survey

*Note - this survey will not be used in the current data analysis

A separate study using a household survey was done to evaluate the impact of the intervention on the children's IYCF behaviors, MNP uptake and acceptability, and child development, anemia, and child growth.

FLW Survey

To evaluate the frontline worker experience and examine what factors influence FLWs to disseminate IYCF counseling and MNP distribution, a survey was conducted with 280 FLWs in the intervention arm and 280 FLWs in the control arm totaling to 560 FLWs. To break it down further, 8 FLWs were randomly selected per HSC (4 ASHAs and 4 AWWs) for 70 SCs. Data was collected at baseline (month 0), midline (month 4), and endline (month 9). Eight topics were covered in the FLW survey: basic background information, IYCF training, interaction with HHs on IYCF, IYCF knowledge,

intervention related questions, MNP distribution and community interaction, opinions, and motivation, and payment. The survey was powered to detect a 20% difference in knowledge and practices (ex # of household visits). Surveys were conducted by teams of four trained field research staff and data quality was monitored by onsite supervisors for each team.

To ensure privacy and confidentiality of all collected data, data was stored securely in password-protected computers with restricted access. Only the immediate research team reviewed the surveys. Surveys were checked for completion and accuracy before and after being entered into the database and a SAS dataset was created for all baseline, midline, and endline surveys.

Data Analysis

While data was collected at baseline, midline, and endline, data analysis for this study only focused on the endline frontline worker survey in the intervention communities. All data from the endline frontline worker dataset was cleaned and statistical analysis was carried out on the variables fundamental for answering the research question using statistical analysis software, SAS 9.4. The COM-B model was used to guide the analysis and define all variables used in the analysis.

Variables were created for or assigned to each level of the COM-B model to represent the outcome and predictors of interest. The behavior component (B) of the model was defined by the following outcome of interest: *number of households visited in the past month to talk about MNPs (Jeevan Jyoti)*. It is important to note that when frontline workers visited households to talk about MNPs, this implies that they not only

distributed the MNP sachets, but counseled families on them as well. It is also important to note that the outcome being assessed only represents one aspect of FLW performance for the purposes of informing future evaluations on effective IYCF counseling and MNP distribution. The outcome is not an indication of effective IYCF counseling and MNP distribution on its own. Table 1A below shows all the outcome indicators that can be used for measuring IYCF counseling and MNP distribution. To accurately measure effective IYCF counseling and MNP distribution by FLWs, it is best for all indicators to be evaluated simultaneously. In other words, to best measure effective IYCF counseling, the two indicators under IYCF counseling in table 1A should be evaluated together and to best measure effective MNP distribution, the three indicators under MNP distribution in table 1A should be evaluated together in future studies.

Table 1A: Outcome indicators for IYCF counseling and MNP Distribution by FLWs

<table>
<tr><th>IYCF Counseling</th><th>MNP Distribution</th></tr>
<tr><td>Number of households visited to discuss or distribute MNPs in the past week</td><td>Number of households visited to discuss or distribute MNPs in the past week</td></tr>
<tr><td>*Number of households visited to talk about MNPs in the past month</td><td>*Number of households visited to talk about MNPs in the past month</td></tr>
<tr><td rowspan="2">How much time is spent talking to a given mother/family member about feeding practices on a regular basis
a) 30 minutes or less
b) 31 minutes or more</td><td>How often a given mother /caregiver that has a 6-17 month old child is visited to distribute MNPs (Jeevan Jyoti)
a) At least once a month
b) Less than once a month</td></tr>
<tr><td>Minutes spent counseling an individual/caregiver on MNPs (Jeevan Jyoti)
a) 30 minutes or less
b) 31 minutes or more</td></tr>
</table>

* For the purposes of this study, this is the only outcome being assessed.

In regards to the predictors of interest for the study, variables were carefully chosen or recoded to accurately characterize the capability, opportunity, and motivation components of the model. The three model components used to define the predictors of interest were FLW capability, FLW opportunity, and FLW motivation.

FLW capability was defined as FLWs possessing the proper knowledge, skills, and training to distribute MNPs and counsel on them. The variables used to characterize FLW capability are shown in descriptive tables 2a and 2b. For the purposes of this study, FLW capability was split into 2 categories: knowledge and training. Three scores were created to measure knowledge and training: a score for IYCF knowledge, a score for MNP (Jeevan Jyoti) specific knowledge on its benefits and use, and a score for the range of topics covered during MNP (Jeevan Jyoti) training. Column 1 in table 2a displays the variables used to create the score for IYCF knowledge. Column 2 in table 2a displays the variables used to create the score for MNP (Jeevan Jyoti) specific knowledge, and column 2 in table 2b displays the topics used to create the score for the range of topics covered during MNP (Jeevan Jyoti) training.

The scores were created based on whether or not the FLWs answered the knowledge and training related questions correctly or incorrectly. The answer options in the survey were coded by numbers. For example, 'yes' was coded as 1 and 'no' was coded as 2. The right answers were recoded as 'correct' and wrong answers were recoded as 'incorrect'. For example, if Variable A equaled to 1, the new variable for Variable A was coded as 'correct', and if Variable A equaled to 2, the new variable for Variable A was coded as 'incorrect'. After recoding correctly identified answers as 'correct' and all

other wrong answers as ‘incorrect’, scores were assigned with new variables names. For each score created, all ‘correct’ variables were coded as 1 and all ‘incorrect’ variables were coded as 0. All newly labeled variables with their newly assigned scores were added up to get a maximum score for a range of scores obtained. Using two of the IYCF knowledge variables as an example, if VariableAnew equaled "correct", then it was relabeled as ‘X’ for breastfeeding and coded as 1 and if VariableAnew equaled "incorrect" then it was also relabeled as ‘X’ for breastfeeding but coded as 0. All the new variables with their new labels coded as 0 or 1 were added together to create the IYCF knowledge score.

FLW opportunity was defined as FLWs being properly equipped with the resources to and having the access to distribute MNPs and counsel on them. The variables used to characterize FLW opportunity are shown in descriptive table 3. FLW motivation was defined as FLWs having the determination and incentive to distribute MNPs and counsel on them. The variables used to characterize FLW motivation are shown in descriptive table 4. The next step in data analysis was performing exploratory and descriptive analyses to understand the distribution of data and examine bivariate relationships between the predictors of interest (FLW capability, FLW opportunity, and FLW motivation) and outcome of interest (number of households visited in the past month to talk about MNPs (Jeevan Jyoti)). Frequency tables were examined for categorical variables and summary statistics; namely, the mean, median, and standard deviation were examined for continuous variables such as FLW age. Only variables that had enough variation, that is, greater than 5% in each level were included in the bivariate analysis.

To investigate the association between the variables representing each predictor of interest with the outcome, a bivariate analysis was conducted using Poisson regression. Poisson regression is a type of regression that seeks to determine the relationship between a predictor of interest and a response variable that comprises of 'count data' or data that is countable. In this study, the outcome, *number of households visited in the past month to talk about MNPs (Jeevan Jyoti)* is the countable response variable, and Poisson regression was conducted to determine which predictor variables had a statistically significant effect (p-value less than or equal to 0.05) on the outcome variable. After carrying out bivariate analyses of each predictor variable with the outcome variable, all statistically significant predictor variables were identified. Once identified, these variables were selected to be included in the multivariate model that would seek to answer the research question and determine if FLW capability, FLW opportunity, and FLW motivation influences FLWs ability to visit households and talk about MNPs.

Statistical modeling for the multivariate model was also conducted using Poisson regression since the outcome variable consists of 'count data'. Poisson regression was used to model the relationship between the main predictors of interest, namely, FLW capability, FLW opportunity, and FLW motivation and the outcome behavior, namely, the number of households visited by FLWs in the past month to talk about MNPs (Jeevan Jyoti). Before running the model, the following assumptions for Poisson regression were tested for: the response variable consists of count data, the observations are independent, the distribution of counts follow a Poisson distribution, and the mean and variance of the model are equal. If any assumption was not met, it was adjusted for in the model by using a general Poisson mixed model for overdispersed count data instead of the standard

Poisson regression model. The following potential confounders were adjusted for in the model, frontline worker category and Health Sub-Centers since the type of frontline worker (whether the FLW was an Anganwadi worker or Accredited Social Health Activist) and HSC from which they were randomly selected for the study could confound the relationship between FLW capability, FLW opportunity, and FLW motivation, and their ability to deliver MNP services. Findings from the multivariate model, specifically, the Poisson regression coefficients or estimates and the associated p-values were analyzed to determine which predictors representing FLW capability, FLW opportunity, and FLW motivation influenced the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month. The value of each regression coefficient was exponentiated as e ^ (Poisson regression coefficient) to get the percentage change in counts for the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month. For continuous variables included in the model, the effect a one unit increase or decrease in that variable on the percentage change in counts of the number of households visited was investigated. In regards to categorical variables, the percentage change in counts of one group or level of that variable compared a reference group (ref) or another level of that variable was investigated.

Limitations & Delimitations

Not all assumptions for the multivariate Poisson regression model were met. The mean and variance of the model was not equal, a condition known as overdispersion. Overdispersion is a condition whereby the data appears more dispersed than expected under the reference model. To adjust for overdispersion, a general Poisson mixed model for overdispersed count data was run instead of the standard Poisson regression model.

The standard Poisson regression model was fit with random intercepts by maximum likelihood.

Alternative Approaches for Data Analysis

Another approach to data examining bivariate relationships between FLW capability (knowledge and training), FLW opportunity, and FLW motivation and the number of households visited to talk about MNPs was using One - Way Analysis of Variance (ANOVA). ANOVA was used to test for significant differences between the mean number of households visited for two different groups or varying levels of the categorical variables representing FLW capability, FLW opportunity, and FLW motivation.

For the three FLW knowledge scores measuring IYCF knowledge, MNP (Jeevan Jyoti) knowledge, and knowledge on the topics covered during MNP training, correlation analysis was used to statistically test if there was a linear relationship between the score and the number the number of households visited to talk about MNPs. Scatterplots were initially used to examine the linear relationship between the score variables and outcome variable.

These approaches were done in order to further explore the relationships between FLW capability (knowledge and training), FLW opportunity, and FLW motivation and the number of households visited to talk about MNPs. However, since the number of households visited to talk about MNPs is "count data' and is not continuous data, which is best for ANOVA and correlation analyses, the findings from these alternatives will just be briefly mentioned for informational purposes, so that the main study findings are not implicated.

Chapter 4: Results

Characteristics of FLWs in MNP intervention Health Sub-centers in Bihar, India

Table 1 describes the basic sociodemographic characteristics of FLWs in MNP intervention communities. Of the 280 FLWs, 53.6% were AWWs and 46.4% were ASHAs. The average FLW age was 36 years. A majority of FLWs were married (94.3%) and had children (97.9%). The education level of a FLW was defined by their ability to read or write. Most FLWs had 10 to 12 years of experience reading or writing (68.6%), 26.1% had less than 10 years of reading or writing experience, and only 5.4% had graduate level or more reading and writing experience. Hinduism was a dominant religion among the FLWs with 88.6% practicing Hinduism and 11.4% practicing Islam. A high percentage of FLWs were living and working in the same village (86.4%) and for many it was there only profession (97.9%). Many of them, around 90%, had been working as a FLW for more than 6 years and only 6.4% had been in the field 5 years or less. The most popular reason for becoming a FLW was being able to help people and work with children (72.9%). Income generation was the second most popular reason for becoming a FLW worker with 49.3% agreeing to that reason. Some FLWs reported choosing to be in the field because they had nothing else to do or were bored (7.9%). At work, FLWs were very interactive with their colleagues and 99.6% said that they interacted with and discussed work related matters with other FLWs on a regular basis. IYCF counseling comprised a large part of their workload and 99.6% of them counseled children on eating and drinking. The average time spent counseling a mother or caregiver on feeding practices was 30 minutes or less for a majority of the FLWs (91.8%) and 31 minutes or more for the remaining 8.2%. As for the location where counseling take

places, the most frequent location for counseling children on eating and drinking was the child's home (96.8%), followed by the AWC (44.1%), and at Village and Health Nutrition Days /Routine Immunization (VHSND/RI) days (31.9%).

In relation to FLW work regarding the delivery of and counseling on MNPs, the primary method through which FLWs were informed on micronutrient powders were through sub-center trainings (98.6%). FLWs attended an average of 10 HSC meetings. Other methods through which FLWs were informed on MNPs were through receiving information from another FLW (5.8%), through community meetings or demonstrations (2.6%), and through brochures or pamphlets (1.8%). The primary method through which FLWs distributed MNPs to community members was during home visits (89.3%). Only a small percentage FLWs distributed MNPs at AWCs (9.1%), and even a smaller percentage distributed during VHSNDs, routine immunization or other places (1.6%). If FLWs faced any issues or needed more information on the MNP program, most went to an ANM (55.6%) for help. However, most FLWs did not experience any problems related to the MNP program (87.7%).

Table 1: Sociodemographic characteristics of FLWs in MNP intervention HSCs in Bihar, India

Characteristics	N (%) or Mean [SD]	Characteristics	N (%) or Mean [SD]
Frontline worker type		Methods through which frontline workers were informed on micronutrient powders	
Aanganwadi worker	150 (53.6%)	At sub-center trainings	273 (98.6%)
Accredited Social Health Activist	130 (46.4%)	Through another frontline worker	16 (5.8%)
Frontline worker religion		Through community meeting/ demonstration	7 (2.6%)
Hindu	248 (88.6%)	Through brochure/pamphlet	5 (1.8%)
Muslim	32 (11.4%)	How often MNPs are distributed to community members	
Frontline worker age	36.3 [6.4]	During home visits	225 (89.3%)
Frontline worker martial status		When visiting the AWC	23 (9.1%)
Married	264 (94.3%)	At VHSND/routine immunization	2 (0.8%)
Unmarried	16 (5.74%)	Other	2 (0.8%)
Frontline worker has children		Average time spent counseling a given mother/family member about feeding practices	
Yes	274 (97.9%)	30 mins or less	223 (91.8%)
No	6 (2.14%)	31 mins or more	20 (8.2%)
Frontline worker can read or write		The person you got to if you need more help or information on the program	
Less than 10 years	73 (26.1%)	No one	4 (1.6%)
10 to 12 years	192 (68.6%)	ANM	140 (55.6%)
Graduate or more	15 (5.4%)	Lady supervisor	6 (2.4%)
Time working as a frontline worker		Other	29 (11.5%)
> 10 years	134 (47.9%)	Don't know	5 (2.1%)
6 to 9 years	128 (45.7%)	Experienced any problems related to Jeevan Jyoti program	
< = 5 years	18 (6.4%)	Yes	31 (12.3%)
Interact with/discuss work related matters with other frontline workers often		No	221 (87.7%)
Yes	279 (99.6%)	Problems experienced related to Jeevan Jyoti program	
No	1 (0.4%)	Child side effects	7 (22.6%)
Live and work in the same village		Insufficient supplies	1 (3.3%)
Yes	242 (86.4%)	High work burden	4 (12.9%)
No	38 (13.6%)	Complaints from community	23 (74.2%)
Have profession other than frontline worker		Other	2 (6.5%)
Yes	6 (2.1%)		
No	274 (97.9%)		
Reasons for becoming a frontline worker			
Income generation	134 (49.3%)		
Like helping people/working with children	204 (72.9%)		
Had nothing else to do with time/bored	22 (7.9%)		
Counsels children on eating and drinking (IYCF) as part of work		Number of HSC meetings attended in the last year	10.2 [1.9]
Yes	279 (99.6%)		
No	1 (0.4%)		
Locations where children are counseled on eating and drinking (IYCF)			
At home	270 (96.8%)		
AWC	123 (44.1%)		
VHSND/RI days	89 (31.9%)		

Note: Sample size included 280 frontline workers within the intervention group

Characteristics of FLW Capability

The variables describing FLW capability are outlined in tables 2a and 2b. The maximum score that FLWs could attain for IYCF knowledge was 18, and mean IYCF knowledge score attained was 12.68 with 6 being the lowest score attained. The maximum score that FLWs could attain for knowledge on MNP (Jeevan Jyoti) benefits and use was 23 and the mean MNP (Jeevan Jyoti) knowledge score attained was 18.53 with 14 being the lowest score attained. The maximum score that FLWs could attain for the range of topics covered in their MNP (Jeevan Jyoti) training was 12 and the mean score attained was 6.63 with 2 being the lowest score attained. FLWs reported that the following topics on the benefits and use of MNPs were most covered in the training: MNPs improve children's physical and mental development (88.4%), 1 packet of MNPs should be added to 1 meal of the child per day (87.3%), and one side effect of MNPs is that the child may have black or darkened stools (65.2%).

Table 2a: Frontline worker capability: IYCF and MNP knowledge

Characteristics	N (%) Mean [Min, Max]	Characteristics	N (%) Mean [Min, Max]
IYCF Knowledge		**MNP (Jeevan Jyoti) Knowledge**	
IYCF Knowledge Score	12.68 [6,18]	Jeevan Jyoti Knowledge Score	18.53 [14, 23]
Breastfeeding Initiation		Ever heard of Jeevan Jyoti	
Correct	273 (97.5%)	Yes	277 (98.9%)
Incorrect	7 (2.5%)	No	3 (1.1%)
Duration of exclusive breastfeeding		Jeevan Jyoti beneficiaries	
Correct	280 (100%)	Correct	258 (92.1%)
Timing of initiation of complementary feeding		Incorrect	22 (7.9%)
		Jeevan Jyoti: benefits	
Correct	144 (51.4%)	Improves physical/mental development	233 (83.2%)
Incorrect	136 (48.6%)	Improves appetite	68 (24.3%)
Duration of non-exclusive breastfeeding		Improves immunity	147 (52.5%)
Correct	207 (73.9%)	Prevents anemia in child	149 (53.2%)
Incorrect	73 (6.1%)	Child becomes more active and playful	91 (32.5%)
Handwashing		Jeevan Jyoti: daily dose	
Handwashing before eating	215 (76.8%)	Correct	218 (77.9%)
Handwashing after using the toilet	193 (68.9%)	Incorrect	62 (22.1%)
Handwashing before feeding a child	260 (92.9%)	Jeevan Jyoti: # of boxes/6 months	
Handwashing after cleaning a child who has defecated	128 (45.7%)	Correct	165 (58.9%)
		Incorrect	115 (41.1%)
Complementary feeding: frequency		Jeevan Jyoti: side effects	
4 months	275 (98.2%)	Child may have loose stools	161 (57.5%)
6 – 8 months	219 (78.2%)	Child ma have black/darkened stools	186 (66.4%)
9 – 11 months	150 (53.6%)	Child may have constipation	20 (7.1%)
12 -23 months	81 (28.9%)	Jeevan Jyoti: foods to mix with	
Complementary feeding: quantity		Correct	260 (92.9%)
4 months	273 (97.5%)	Incorrect	20 (7.1%)
6 – 8 months	131 (46.8%)	Jeevan Jyoti: foods should not be mixed with	
9 – 11 months	124 (44.3%)		
12 – 23 months	50 (17.9%)	Very hot foods	144 (51.4%)
Complementary feeding: consistency		Liquids such as milk and water	255 (91.1%)
Semi-solid - Yes	276 (98.6%)	Tea	163 (58.2%)
		Jeevan Jyoti: food consistency	
		Solid (e.g., roti)	259 (92.5%)
		Semi-solid (e.g., porridge)	263 (93.9%)
		Watery (e.g., milk or thin soup)	267 (95.4%)
		Jeevan Jyoti: temperature of foods	
		Correct	266 (95%)
		Incorrect	14 (5%)

Note: Sample size included 280 frontline workers within the intervention group

Table 2b: FLW Capability: MNP training and MNP knowledge training score

Characteristics	N (%) Mean [Min, Max]	Characteristics	N (%) Mean [Min, Max]
Received training on topics related to maternal and/or child health		Frontline workers whose training covered the following topics	
Yes	143 (51.1%)	Improves physical and mental development	236 (88.4%)
No/not sure	137 (48.9%)	Add 1 packet to 1 meal of the child's day	233 (87.3%)
Number of sessions that covered nutrition and child feeding related content in the past year		Child may have black/darkened stools	174 (65.2%)
Covered in 1 – 6 sessions	34 (12.4%)	Do not add to liquid foods	156 (58.4%)
Covered in 6 – 8 sessions	42 (15.3%)	Child may have loose stools	156 (58.4%)
Covered in 8 to all 12	197 (71.6%)	Do not add to hot foods or foods being cooked	154 (57.68%)
Training on child feeding (understandability)		Prevents anemia in child	153 (57.3%)
Found the training related to child-feeding easy to understand	250 (90.9%)	Improves immunity	152 (56.9%)
Understood most of the child-feeding training but did not understand some topics	25 (9.1%)	Feed within an hour after mixing into food	122 (45.7%)
How FLWs perceived the training on Jeevan Jyoti		Child becomes more active and playful	111 (41.6%)
Understood everything in the training	243 (91%)	Improves appetite	61 (22.9%)
Did not understand everything in the training	24 (9%)	Discussed type of age-appropriate complementary foods (diversity, quantity, and consistency)	45 (16.9%)
		Child may have constipation	18 (6.7%)
		Topic Training Score	6.63 [2,12]

Note: Sample size included 280 frontline workers within the intervention group

Characteristics of FLW Opportunity

The variables describing FLW opportunity are outlined in table 3 along with the associated summary statistics. Overall, the FLWs were well-equipped with the resources they needed to visit households and distribute an counsel on MNPs. 90% of FLWs received a pamphlet that contained information on child feeding, about 81% received a resource for frequently asked questions on the MNPs, 91% received MNPs to distribute to the households, about 87% received adequate supplies of MNPs when asked about the past 3 months, and about 68% were supplied with MNPs at the time they were asked. In

terms of MNP supply and restocking, only about 38% of FLWs received MNPs as frequently as once a month. While 60% of FLWs never ran out of MNPs, only about 50% of FLWs said there stock was replenished right away. About 6% of FLWs reported that it took longer than a month to have their stock replenished while about 16% stated they were replenished within 2 to 4 weeks. The majority of FLW did not experience problems with the MNP program (87.7%) and of those FLWs that did experience problems, only about 3% experienced insufficient supply.

Table 3: FLWs opportunity to effectively deliver home fortification, MNP services in Bihar, India

Characteristics	N (%)	Characteristics	N (%)
Live and work in the same village		Ever run out of Jeevan Jyoti	
Yes	242 (86.4%)	Yes	98 (38.9%)
No	38 (13.6%)	No	151 (60%)
Other profession besides FLW		Received adequate supplies of Jeevan	
Yes	6 (2.1%)	Jyoti in the past three months to	
No	274 (97.9%)	distribute to households	
Has a home visit planner		Yes	218 (86.5%)
Yes	255 (91.4%)	No	34 (13.5%)
No	24 (8.6%)	How often Jeevan Jyoti stock is	
Received a pamphlet that contains		replenished after its finished	
information on child feeding		In a week (immediately)	125 (50.6%)
Yes	252 (90%)	In a few weeks (2 to 4 weeks)	40 (16.2%)
No	28 (10%)	Greater than a month	16 (6.5%)
Received a resource from training for		Can't say/Don't Know	66 (26.7%)
frequently asked questions from the		Currently have a supply of Jeevan Jyoti	
community about Jeevan Jyoti		Yes	172 (68.3%)
Yes	216 (80.9%)	No	80 (31.8%)
No	51 (19.1%)	Who do you go to if you need more	
Received Jeevan Jyoti to distribute to		information or help on this program	
households in your community		ANM	140 (55.6%)
Yes	252 (91%)	Other FLW	29 (11.5%)
No	25 (9%)	Experienced any problems related to	
Frequency of receiving Jeevan Jyoti		Jeevan Jyoti program*	
At least once a month	96 (38.1%)	Yes	31 (12.3%)
Less frequently than once a month	150 (61.7%)	No	221 (87.7%)
		(Problems Experienced - insufficient	
		supply	
		Yes	1 (3.2%)
		No	30 (96.8%)

Note: Sample size included 280 frontline workers within the intervention group.
*This variable does not represent FLW opportunity but the variable - insufficient supplies does. The variable is listed here to help interpret what percentage of FLWs that experienced problems also experienced insufficient supplies.

Characteristics of FLW Motivation

The variables describing FLW motivation are outlined in table 4 along with the associated summary statistics. Overall, the FLWs were very motivated to deliver MNP services to households even though most FLWs did not get paid properly. The most reported reasons for becoming a FLW worker were wanting to help people or work with children (72.9%) and income generation (49.3%). With specific regards to IYCF and MNP counseling, all the FLWs agreed that counseling was an important role in frontline work and that it was important to provide counseling to mothers of young children in the community. The majority of FLWs (97%) agreed that counseling families on appropriate child feeding practices helped build respect for them in the community. FLWs expressed a similar outlook about the MNP program overall and about 95% of FLWs agreed that the program improved their status in the community. Almost all FLWs (99.6%) recognized the significance of MNPs in child nutrition and agreed that it was important to provide MNPs to young children in the community. Almost all FLWs (98.8%) had a desire to continue distributing MNPs even after the program ended. With respect to payment, about 72% of FLWs did not receive the full amount of their payment when paid and about 97% of FLWs experienced irregularities with receiving payment. Most FLWs either never received their payments on time or only received it on time sometimes.

Table 4: Motivating factors for effective delivery of home fortification, MNP services by FLWs in Bihar, India

Motivating Factors	N (%)	Motivating Factors	N (%)
Reasons for becoming a FLW worker		It is important to provide Jeevan Jyoti to young children in the community	
Income generation	138 (49.3%)	Agree	251 (99.6%)
Like helping people/working with children	204 (72.9%)	Don't know/no opinion	1 (0.4%)
Had nothing else to do with time/bored	22 (7.9%)	Jeevan Jyoti program has increased workload	
Experienced any problems related to the Jeevan Jyoti program		Agree	132 (52.4%)
Yes	31 (12.3%)	Disagree	120 (47.6%)
No	221 (87.7%)	Jeevan Jyoti improved his/her status in the community	
Problems experienced as a FLW		Agree	239 (94.8%)
Child side effects	7 (22.6%)	Disagree	3 (1.2%)
Insufficient supplies	1 (3.2%)	Don't know/ no opinion	10 (4%)
High work burden	4 (12.9%)	Desire to continue to distribute Jeevan Jyoti in the future for the community	
Complaints from community	23 (74.2%)	Agree	249 (98.8%)
Other	2 (6.5%)	Disagree	3 (1.9%)
Counseling considered an important role as a FLW		Full amount of payment received when paid	
Agree	100%	Yes	57 (20.4%)
Important to provide counseling on child feeding to mothers of young children in the community		No	201 (71.8%)
Agree	100%	Don't remember	22 (7.9 %)
Counseling families on how to feed their child helps increase respect for me in the community and builds trust		Regularity of receiving payments	
Agree	262 (97%)	Always on time/ Mostly on time	3 (1.1%)
Disagree	2 (0.7%)	Sometimes on time/Never on time/ Variable	261 (96.7%)
Don't know/ no opinion/ not applicable	6 (2.2%)	Don't/Can't Say/Others (specify)	6 (2.2%)

Note: Sample size included 280 frontline workers within the intervention group

Outcome of Interest

According to table 5 below, the mean number of households visited by FLWs to talk about MNPs in the past month was 12.22. In other words, FLWs visited an average of 12 households for the past month they were surveyed about. The highest number of households visited was 60 and the least number of households visited was 0.

Table 5: Summary statistics on variables measuring MNP delivery and IYCF Counseling

Outcome variables for MNP delivery and IYCF Counseling			
	N (Mean +/- SD or Percent %)	Minimum	Maximum
Variables			
Number of households visited to discuss or distribute MNPs in the past week	195 (5.63 + 0.40)	0	30
*Number of households visited to talk about MNPs in the past month	235 (12.22 + 0.62)	0	61
How much time is spent talking to a given mother/family member about feeding practices on a regular basis			
a) 30 minutes or less	248 (88.89%)		
b) 31 minutes or more	32 (11.11%)		
Minutes spent counseling an individual/caregiver on MNPs/Jeevan Jyoti			
a) 30 minutes or less	229 (90.87%)		
b) 31 minutes or more	20 (7.94%)		
How often will you visit a given mother /care giver that has a 6-17 month old child to distribute Jeevan Jyoti?			
a) At least once a month	226 (89.68%)		
b) Less than once a month	24 (9.52%)		

*For the purposes of this study, this is the only outcome being assessed

Overall, all three predictors of interest (FLW capability, FLW opportunity, and FLW motivation) were shown to have an effect on the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month.

Bivariate Associations between FLW Capability, FLW Opportunity, FLW Motivation and the delivery of MNP Services

Significant bivariate associations were seen between some of the variables representing FLW capability, FLW opportunity, and FLW motivation and the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month. Select variables from all 3 categories of the COM-B model (capability, opportunity, and motivation) were significantly associated with the number of households visited.

For FLW capability, the following variables were seen to have a significant effect on the outcome: MNP (Jeevan Jyoti) knowledge score, whether or not a FLW received training on topics related to maternal and/or child health, the number of sessions that covered nutrition and child feeding related content in the past year, understandability of training on child feeding, and how FLWs perceived the training on Jeevan Jyoti. While the MNP (Jeevan Jyoti) knowledge score was significant ($p=0.046$), the percent increase in the number of households visited was very small (2%), so this variable will not be interpreted for the bivariate findings, but still be included in the multivariate model. The number of households visited to talk about MNPs in the past month was 12% higher for FLWs that received training on topics related to maternal and/or child health compared to FLWs that did not ($p=0.0039$). The number of households visited to talk about MNPs in

the past month was 28% higher for FLWs whose training on child feeding and nutrition related content was covered 6 to 8 sessions versus FLWs whose training was covered in only 1 to 6 sessions ($p<0.0001$). The number of households visited to talk about MNPs in the past month was 24% higher for FLWs whose training on child feeding and nutrition related content was covered 8 to all 12 sessions versus FLWs whose training was covered in only 1 to 6 sessions ($p<0.0001$). The number of households visited to talk about MNPs in the past month was 29% higher for FLWs that found the training on child feeding easy to understand compared to FLWs that did not understand some of the topics on child feeding ($p=0.0005$). The number of households visited to talk about MNPs in the past month was 25% higher for FLWs that understood everything in the training on MNPs versus FLWs that did not understand everything in the training on MNPs ($p=0.002$).

Table 6: Association between factors assessing frontline worker's (FLW) knowledge and training to deliver and counsel on MNPs (Jeevan Jyoti) and the number of households visited in the past month to talk about MNPs

FLWs capability (training and knowledge) to deliver and counsel on MNPs: Bivariate Analysis		
	Poisson regression coefficient (% change)	**P-value**
Variables		
Infant and Young Child Feeding Knowledge Score	-0.01527 (-2%)	0.1005
MNP (Jeevan Jyoti) Knowledge Score	0.02104 (2%)	0.0456*
Training on MNP (Jeevan Jyoti)Topics Score	0.01658 (2%)	0.0864
Received training on topics related to maternal and/or child health in past year a) Yes No/ not sure (ref)	0.1096 (12%)	0.0039*
Number of sessions that covered child nutrition and child feeding related content in the past year		
a) Covered in 1 to 6 sessions (ref)		
b) Covered in 6 to 8 sessions	0.2434 (28%)	< 0.0001*
c) Covered in 8 to all 12 sessions	0.2174 (24%)	<0.0001*
Training on child feeding (understandability) a) I found the training related to child-feeding easy to understand **b)** I understood most of the child-feeding training, but there were some topics I did not understand (ref)	0.2580 (29%)	0.0005*
How FLWs perceived the training on Jeevan Jyoti a) Understood everything in the training **b)** Did not understand everything in the training (ref)	0.2247 (25%)	0.0020*

*p<=0.05, ref = reference group

For FLW opportunity, the following variables were seen to have a significant effect on the outcome: whether or not FLWs received a pamphlet that contained information on child feeding, the frequency of receiving MNPs, whether or not FLWs received adequate supplies of MNPs in the past 3 months, how often MNPs were replenished after it was finished, and having a current supply of MNPs. The number of households visited to talk about MNPs in the past month was 28% higher for FLWs that received a pamphlet with information on child feeding compared to those that did not receive a pamphlet on child feeding ($p=0.004$). The number of households visited to talk about MNPs in the past month was 24% higher for FLWs that that received a supply MNPs at least once a month compared to FLWs that received MNPs less frequently ($p =<0.0001$). The number of households visited to talk about MNPs in the past month was 17% higher for FLWs that received adequate supplies of MNPs in the past 3 months to distribute versus FLWs that did not receive adequate supplies in the past 3 months ($p = 0.0109$). FLWs that did not have their MNP stock replenished for more than month visited 22% fewer number of households to talk about MNPs in the past month than FLWs that had their stock replenished immediately or within a week ($p=0.006$). The number of households visited to talk about MNPs in the past month was 31% higher for FLWs that had a current supply of MNPs compared to FLWs that did have a current supply of MNPs ($p<0.0001$).

Table 7: Association between factors assessing frontline worker's (FLW) opportunity to deliver and counsel on MNPs (Jeevan Jyoti) and the number of households visited in the past month to talk about MNP

Opportunity for FLWs to deliver and counsel on MNPs: Bivariate Analysis		
	Poisson regression coefficient (percent change)	**P-value**
Variables		
Live and work in the same village (ref = No) a) Yes	-0.1005 (-10%)	0.0601
Has a home visit planner (ref = No) a) Yes	-0.01803 (2%)	0.7909
Received a pamphlet that contains information on child feeding? (ref =No) a) Yes	0.2507 (28%)	0.0437*
Received a resource from training for frequently asked questions from the community about Jeevan Jyoti (ref = No) a) Yes	0.06036 (7%)	0.2207
Received Jeevan Jyoti to distribute to households in your community (ref = No) a) Yes	NA	NA
Frequency of receiving Jeevan Jyoti (ref = Less frequently than once a month) a) At least once a month	0.2170 (24%)	<.0001*
Ever Run Out of Jeevan Jyoti (ref = No) a) Yes	0.03564 (4%)	0.3584
Received adequate supplies of Jeevan Jyoti in past three months to distribute to households (ref = No) a) Yes	0.1546 (17%)	0.0109*
How often Jeevan Jyoti stock is replenished after its finished (ref = In a week - immediately)		
a) In a few weeks (2 to 4 weeks)	-0.09869 (-9%)	0.0689
b) Greater than a month	-0.2478 (-22%)	0.0059*
c) Can't Say/ Don't Know	0.01200 (1%)	0.7861
Currently have a supply of Jeevan Jyoti (ref =no) a) Yes	0.2725	<.0001*

*p<=0.05, ref = reference group

For FLW motivation, the following variables were seen to have a significant effect on the outcome: reasons for becoming a FLW (income generation, like helping people or working with children, and had nothing else do with time or bored), whether or not FLWs experienced any problems related to the Jeevan Jyoti program, problems experienced as a FLW (complaints from the community), whether or not a FLW experienced increased workload due to the MNP program, whether or not FLWs had improved status in the community due to the MNP program, and whether or not FLWs received their full amount of payment when paid. FLWs that became a FLW for income generation visited 10% fewer number of households to talk about MNPs in the past month compared to FLWs that did not become a FLW for income generation ($p=0.007$). The number of households visited to talk about MNPs in the past month was 54% higher for FLWs that became a FLW because they like helping people or working with children compared to FLWs that did not become a FLW due to this reason ($p <0.0001$). FLWs that became a FLW because they had nothing else to do or due to boredom visited 19% fewer number of households talk about MNPs in the past month compared to FLWs that did not become FLW due to those reasons ($p=0.005$). FLWs that experienced any problems related to the MNP program visited 18% fewer number of households to talk about MNPs in the past month compared to FLWs that did not experience any problems with the program ($p=0.002$).

FLWs that reported receiving complaints from the community as a problem they experienced with the program visited 26% fewer number of households compared to FLWs that did not report complaints from the community as a problem with the program ($p = 0.03$). FLWs that agreed to have experienced increased workload due to the MNP

program visited 25% fewer number of households talk about MNPs in the past month compared to FLWs that did not experience an increased workload ($p<0.0001$). The number of households visited to talk about MNPs in the past month was 51% higher for FLWs that believed that the program improved his or her status in the community compared to FLWs that did not believe their status increased in the community due to the program ($p<0.0001$). FLWs that did not receive the full amount of payment when paid visited 9% fewer number of households talk about MNPs in the past month compared to FLWs that did receive the full amount of payment when paid ($p= 0.03$). FLWs that did not remember receiving the full amount of payment when paid visited 38% fewer number of households talk about MNPs in the past month compared to FLWs that did receive the full amount of payment when paid ($p<0.0001$).

Table 8: Association between factors assessing frontline worker's (FLW) motivation to deliver and counsel on MNPs (Jeevan Jyoti) and the number of households visited in the past month to talk about MNPs

Motivation for FLWs to deliver and counsel on MNPs: Bivariate Analysis		
	Poisson regression coefficient (% change)	**P-value**
Variables		
Reasons for becoming a FLW Worker (ref = No)		
a) Income Generation (Yes/No)	-0.1025 (-10%)	0.0068*
b) Like helping people/ working with children (Yes/No)	0.4303 (54%)	<.0001*
c) Had nothing else to do with time/bored (Yes/No)	-0.2105 (-19%)	0.0054*
Experienced any Problems related to the Jeevan Jyoti Program (ref = No) a) Yes	-0.1992 (-18%)	0.0019*
Problems experienced as a FLW (ref = No)		
a) Child Side Effects (Yes/No)	0.2218 (25%)	0.1388
b) High Work Burden (Yes/No)	0.1656 (18%)	0.3109
c) Complaints from community (Yes/No)	-0.3033 (-26%)	0.0328*
d) Other (Yes/No)	0.3041 (36%)	0.1459
Jeevan Jyoti program has increased workload a) Agree **b)** Disagree (ref)	-0.2846 (-25%)	<.0001*
Jeevan Jyoti improved his/her status in the community a) Agree **b)** Disagree/Don't know/no opinion (ref)	0.4099 (51%)	<.0001*
Full amount of payment received when paid		
a) Yes (ref)		
b) No	-0.09668 (-9%)	0.0284*
c) Don't Remember	-0.4732 (-38%)	<.0001*

*p<=0.05, ref = reference group

All significant variables defining FLW capability, FLW opportunity, and FLW motivation identified from the bivariate analyses and were considered to be included multivariate model. While all of these variables did have a significant effect on the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month, one of these variables was not included in the final multivariate model. For the variable representing FLW motivation, whether or not the FLW experienced any problems related to the Jeevan Jyoti program, only 31 FLWs, that is, 12.3% of the FLWs delivering the intervention, had experienced problems with the program. This was not enough variation to have a meaningful impact on the outcome when included in the final model, so it was not included. In the end, 13 variables made it into the final multivariate Poisson regression model including frontline worker category (whether the FLW was an ASHA or AWW) and health sub-center, which were adjusted for as a potential confounders. The findings from the Poisson regression multivariate model can be seen in table 9 below.

Final Multivariate Associations between FLW Capability, FLW Opportunity, FLW Motivation and the delivery of MNP Services

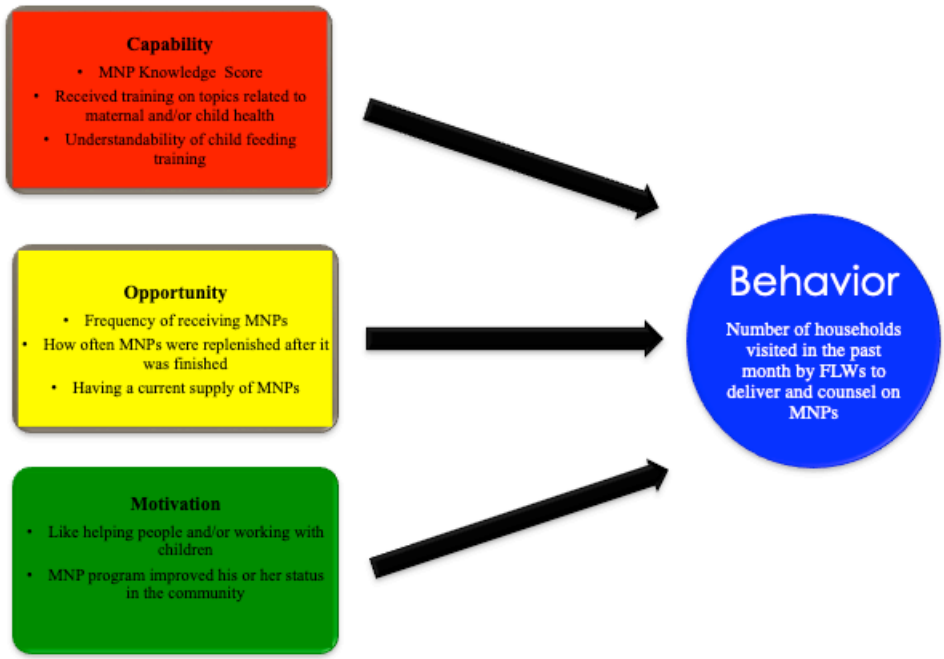
Table 9: Association between factors assessing frontline worker's (FLW) capability, opportunity, and motivation to deliver and counsel on MNPs (Jeevan Jyoti) and the number of households visited in the past month to talk about MNPs (Jeevan Jyoti)

Final Multivariate Poisson Regression Model					
Variables	Poisson Regression Coefficient (% Change)	P-Value	Variables	Poisson Regression Coefficient (% Change)	P-Value
FLW Capability			**FLW Motivation**		
MNP (Jeevan Jyoti) Knowledge Score	0.03663 (4%)	0.0100*	Reasons for becoming a FLW worker		
			Income generation		
Received training on topics related to maternal and/or child health in past year			Yes	-0.03777 (-4%)	0.4411
			No (ref)		
Yes	0.1561 (17%)	0.0028*	Like helping people/working with children		
No/not sure (ref)					
Number of sessions that covered nutrition and child feeding related content in the past year			Yes	0.3326 (39%)	<0.0001*
			No (ref)		
			Had nothing else to do with time/bored		
Covered in 8 to all 12 sessions	0.07501 (8%)	0.1919	Other		
Covered in 6 - 8 sessions	-0.07674 (-7%)	0.2707	Yes	0.006808 (1%)	0.9449
Covered in 1- 6 sessions (ref)			No (ref)		
Training on child feeding (understandability)			Jeevan Jyoti program has increased workload		
Found the training related to child-feeding easy to understand	0.2277 (26%)	0.0164*	Agree	-0.09206 (-9%)	0.0656
Understood most of the child-feeding training but did not understand some topics (ref)			Disagree (ref)		
			Jeevan Jyoti improved his/her status in the community		
How FLWs perceived the training on Jeevan Jyoti			Agree	0.2603 (30%)	0.0458*
			Disagree/ Don't know/ no opinion (ref)		
Understood everything in the training	-0.07215(-7%)	0.4425	Full amount of payment received when paid		
Did not understand everything in the training (ref)			No	-0.06393 (-6%)	0.2719
			Don't remember	-0.1434 (-13%)	0.2101
			Yes (ref)		
FLW Opportunity					
Frequency of receiving Jeevan Jyoti			FLW Category		
At least once a month	0.3190 (38%)	<0.0001*	ASHA	-0.1480 (-14%)	0.0038
Less frequently than once a month (ref)			AWW(ref)		
Received adequate supplies of Jeevan Jyoti in the past three months to distribute to households					
Yes	0.1102 (12%)	0.1301			
No (ref)					
How often Jeevan Jyoti stock is replenished after its finished					
Can't say/Don't Know	0.2705 (31%)	0.0005*			
Greater than a month	-0.3607 (-30%)	0.0008*			
In a few weeks - 2 to 4 weeks	-0.02118 (-2%)	0.7715			
In a week – immediately (ref)					
Currently have a supply of Jeevan Jyoti					
Yes	0.1463 (16%)	0.0108*			
No					

*p<= 0.05, ref = reference group. Model is adjusted for FLW category and health sub-center.

Among the variables representing FLW capability, FLW opportunity, and FLW motivation that were included in the final multivariate Poisson regression model, the variables shown to be significant predictors for the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month while adjusting for the type of frontline worker (working as AWW versus ASHA) and the health sub-center from which the FLWs were randomly selected are shown in figure B below.

Figure B: Factors representing FLW Capability, FLW Opportunity, and FLW Motivation that influence FLW Behavior (the number of households visited in the past month to distribute and counsel on MNPs)



(This figure was created by the author of this thesis and is the author's original work)

In summary, three variables defining FLW capability, three variables defining FLW opportunity, and two variables defining FLW motivation were significant in the final multivariate model with p-values less than or equal to an alpha significance level of 0.05. Frontline worker category, a potential confounder, was also shown to be significant in the model.

FLW Capability

The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month increased by 4% for every one-point increase in a FLW's MNP (Jeevan Jyoti) knowledge score holding all other variables in the model constant. The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 17% higher for FLWs that received training on topics related to maternal and/or child health in the past year compared to those that did not receive training on topics related to maternal and/or child health in the past year holding all other variables in the model constant. The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 26% higher for FLWs that found the training on child feeding easy to understand compared to FLWs that did not find all topics on child feeding easy to understand holding all other variables in the model constant.

FLW Opportunity

The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 38% higher for FLWs that received MNPs more frequently or at least once a

month compared to FLWs that received MNPs less frequently or less than once a month holding all other variables in the model constant. FLWs that did not have their MNP (Jeevan Jyoti) stock replenished until greater than a month visited 30% fewer households than FLWs that had their stock replenished immediately or within a week holding all other variables in the model constant. The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 16% higher for FLWs that had a current supply of MNPs compared to FLWs that did not have a current supply of MNPs holding all other variables in the model constant.

FLW Motivation

The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 39% higher for FLWs that reported they became a FLW because they like helping people or working with children compared to FLWs did not report wanting to help people and liking to work with children as a reason for becoming a FLW holding all other variables in the model constant. The number of households visited to talk about MNPs (Jeevan Jyoti) in the past month was 30% higher for FLWs that agreed working in the Jeevan Jyoti program improved their status in the community compared to FLWs that did not agree or were not sure if working in the Jeevan Jyoti program improved their status in the community holding all other variables in the model constant.

FLW Category

FLWs that worked as an ASHA visited 14% less households to talk about MNPs (Jeevan Jyoti) in the past month compared to FLWs that worked as an AWWs holding all other variables in the model constant.

The following variables representing FLW capability, FLW opportunity, and FLW motivation were not shown to be significant predictors of the number of households visited to talk about MNPs (Jeevan Jyoti) in the past month: The number of sessions that FLWs attended that covered child nutrition and child feeding related content in the past year (6 to 8 sessions, $p = 0.27$; 8 to all 12 sessions, $p = 0.19$), how FLWs perceived the training on Jeevan Jyoti ($p = 0.44$), whether or not FLWs received adequate supplies of Jeevan Jyoti in past three months to distribute to households ($p = 0.13$), whether or not the Jeevan Jyoti program increased a FLW's workload ($p = 0.07$), and whether or not the full amount of payment was received by a FLW when paid (No, $p = 0.27$; Don't Remember, $p = 0.21$; reasons for becoming a FLW (Income generation, $p = 0.44$; Having nothing else to do/boredom, $p = 0.94$).

Alternative Approaches: Analysis of Variance (ANOVA) and Correlation Analysis

ANOVA

For FLW capability - training, there were no significant differences in the mean number of household visited to talk about MNPs for the different levels of the variables, so these variables will not be interpreted (Appendix A – Table 1).

For FLW opportunity, the following variables: frequency of receiving MNPs and

whether or not FLWs had a current supply of MNPs showed significance. The mean number of households visited to talk about MNPs was greater than and significantly different ($p = 0.03$) for FLWs that received MNPs at least once a month (13.85) compared to FLWs that received MNPs less than once a month (12.10). The mean number of households visited to talk about MNPs was greater than and significantly different ($p = 0.02$) for FLWs that had a current supply of MNPs (13.15) compared to FLWs that did not have a current supply of MNPs (10.01) (Appendix A - Table 2).

For FLW motivation, the following variables: increased workload due to the MNP program and liking to help people or work with children as a reason for becoming a FLW showed significance. The mean number of households visited to talk about MNPs was less than and significantly different ($p = 0.005$) for FLWs that experienced increased workload (10.57) compared to FLWs that did not experience increased workload (14.05). The mean number of households visited to talk about MNPs was greater than and significantly different ($p = 0.0007$) for FLWs that became a FLW because they liked helping people or working with children (13.50) compared to FLWs that did not become a FLW for those reasons (8.78) (Appendix A – Table 3).

Correlation Analysis

The scatterplot showed no linear relationship between any of the knowledge scores and the number of households visited to talk about MNPs. Additionally, no significant relationships were seen between any of the knowledge scores (IYCF knowledge, $p = 0.55$; MNP (Jeevan Jyoti) Knowledge, $p = 0.47$; knowledge of the topics

covered in MNP training, $p = 0.53$) and the number of households visited to talk about MNPs. The results will therefore, not be interpreted (Appendix A – Table 5).

Chapter 5: Discussion & Conclusion

Summary of key findings

Using the COM-B model as an underlying framework proved to be a valuable method for evaluating what factors were central in influencing FLWs to deliver home fortification services with MNPs in Bihar, India to children aged 6 to 18 months. All three components of the COM-B model: capability, opportunity, and motivation had an influence on FLW's behavior, specifically FLW's ability to deliver MNPs to households and counsel families about its use and benefits.

For variables measuring if FLWs were capable or had the proper training, knowledge, and skills for delivering the MNPs to households, the following factors played a significant role in the number of households visited: knowledge on the MNP product, whether or not FLWs received training on topics related to maternal and/or child health, and understandability of the training on child feeding. Since the average FLW knowledge score on MNP use and benefits was about 81%, it is reasonable that increased knowledge on the MNP product's use and benefits led to an increased number of households visited to talk about MNPs in the past month even though the increase was very small, only 4%. Since there was a 17% increase in the number of households visited for FLWs who received training on maternal and child health related topics and a 26% increase in the number of households visited for FLWs who found the training on child feeding easy to understand (26%), it is not clear why knowledge on IYCF measured by the IYCF knowledge score did not end up being a significant variable through bivariate analyses. However, since the implemented program deals specifically with delivering MNPs, it is more reasonable for the score measuring MNP knowledge to have more

significance than the knowledge on IYCF. Likewise, even though the number of sessions attended by FLWs that covered child nutrition and child feeding related content in the past year and understandability of the MNP training were significant variables in the bivariate associations with the number of households visited to talk about MNPs in the past month, they did not end up being significant predictors representing FLW capability in the multivariate Poisson regression model when adjusting for other important factors. This is especially surprising for FLW's understandability of the MNP training because whether or not FLWs understood at least some or all of the training on Jeevan Jyoti is conceptually an important factor for how they might have performed and delivered MNP services. On the contrary, perhaps the difference between FLWs understanding all the training versus some of the training was not a big enough difference to be able to have a critical impact on the number of households visited to talk about Jeevan Jyoti in the past month. Similarly, it could be that the difference in the number of sessions attended by FLWs that covered child nutrition and child feeding related content in the past year (6 to 8 sessions versus 1 to 6 sessions, and 8 to all 12 sessions versus 1 to 6 sessions) was also not a large enough difference to have a substantial impact. With all that being said, these results demonstrate that FLW knowledge and training are integral factors for FLW performance in the MNP program. This is also true for many programs using community health workers such as FLWs as a delivery channel.

In a policy brief by the World Health Organization that explores factors that act as incentives and disincentives for community health workers (CHWs), community involvement in CHW training was listed as an incentive for CHW performance and the success of the CHW program (World Health Organization, 2007). The brief also

mentioned that training should be located close to the CHW's working context. The FLWs in this study were trained at the HSCs in the community they were to deliver services and attended an average of 10 HSC trainings. Training within this context might have made the service delivery process easier for them since they were already familiar with the community they served. In another paper by the Basic Support for Institutionalizing Child Survival Project (BASICS 2), they examine how CHW incentives and disincentives influence motivation, retention, and sustainability of child and nutrition programs. The authors highlighted that training is important if CHWs are to do their work effectively (Karabi Bhattacharyya., 2001). To support their statement, the authors mentioned a study about the role of community health volunteers (CHVs) in treating Acute Respiratory Infection (ARI) in a Nepalese community as an example. Increased training allowed CHVs to correctly identify fast breathing as a symptom of ARI and this new ability to help in treatment increased their motivation (Curtale, Siwakoti, Lagrosa, LaRaja, & Guerra, 1995). As emphasized by these papers, FLW capability measured by training and knowledge is critical for influencing FLW performance. Given that the MNP knowledge score was high (about 81%), it is evident why the FLWs who responded better to the IYCF-related training were capable enough to deliver MNPs to households and counsel on them.

FLW capability was also proven to be important for FLW performance in the evaluation of a MNP delivery trial conducted with children 6 to 23 months in Ethiopia. A positive association was found between continued MNP use and the frequency of contact with FLWs, and this positive association was a result of the caregivers receiving adequate training on MNP side effects (Tumilowicz et al., 2019). Behavior change interventions

were also shown to increase capability factors like knowledge and skills in the evaluation of a survey for an integrated MNP and IYCF pilot conducted in Amuria district, Uganda targeting children 12 to 23 months. The study purpose was to evaluate predictors of MNP coverage and recent MNP uptake. Knowledge of correct MNP preparation was positively associated with MNP coverage (Ford et al., 2019). As displayed, adequate training and knowledge can increase the skillset of FLWs.

To ensure child nutrition programs in Indian states through ICDS and NRHM make a substantial impact, properly training FLWs with the skills they need is crucial. For example, a desk review of literature from 2000 to 2012 on evidence based programs through ICDS and NRHM found that the training and mentoring of program personnel was a " system-strengthening feature" for inputs that improved child nutrition such as appropriate complementary feeding practices (Rasmi Avula, 2013). Hence, FLW capability can positively influence FLW performance. In the case of this study, FLW performance due to increased capability was shown to have a positive effect on the number of households visited to talk about MNPs.

Amongst the variables measuring if FLWs had the opportunity or were equipped with the proper resources and had the proper access to deliver MNP services to households, the frequency with which FLWs received MNPs, how often it was replenished, and having a current supply of MNPs all showed to be important predictors for the number of households visited to talk about MNPs in the past month. The number of households visited to talk about MNPs was higher for FLWs who received MNPs more frequently than those FLWs who received MNPs less frequently (38% higher) and for FLWs that had a current supply of MNPs (16% higher) compared to FLWs that did

not. Moreover, the number of households visited to talk about MNPs was lower (39% lower) for FLWs for which it took greater than a month for their stock to be replenished compared to FLWs for which it took only 1 week for their stock to be replenished. While the receipt of a pamphlet that contained information on child feeding ended up being a significant factor on the number of households visited through bivariate analysis, it did not end up being a significant factor in the final multivariate model. This may be due to the possibility that resources particularly designed for the MNP program are more important for service delivery than resources that are not MNP product-specific and just target the general topic of child feeding. Overall, these findings measuring FLW opportunity suggest that the supply and distribution of MNPs are important factors for FLW performance in the Jeevan Jyoti program.

Supply was also considered an important factor in the previously described study on the MNP delivery trial in Ethiopia that identified a positive relationship between increased frequency of contact with FLWs and continued MNP use. Having FLWs that were adequately supplied facilitated the positive relationship (Tumilowicz et al., 2019). Similar findings were also seen in the qualitative study with this MNP (Jeevan Jyoti) program in Bihar. In an effort find out what factors influence the ability of FLWs to deliver MNP services, the qualitative interviews revealed that the supply and distribution of MNPs was a main factor (Hoenig, 2019). Although the supply of MNPs was not reported as an issue, there were issues with the distribution of MNPs. ASHAs that were interviewed stated that they experienced increased workload in the MNP distribution process. One ASHA reported that it was challenging to carry the MNP powder and a common challenge reported was that it was difficult to visit all the households in one day.

As evident in this qualitative study, it is important to ensure that FLWs are properly supplied with the resources they need to distribute and deliver MNPs to households, so that they do not experience increased workload. About half (52.4%) of the FLWs in the MNP (Jeevan Jyoti) program reported to have experienced increased workload in the FLW survey, but it is not clear if this is mainly due to supply and distribution. A different study performed with the monitoring data collected for this MNP (Jeevan Jyoti) program revealed matched findings. The study aimed to use the MNP monitoring data to evaluate program performance and inform subsequent program activities. At the start of the study (baseline), 72% and 53% of households reported receiving and using MNPs and this decreased to 40% and 43% at midline. One bottleneck was a lack of MNPs partly due to infrequent distribution of MNPs by FLWs (Mehta et al., 2019).

Providing FLWs with the resources and support they need to get their work done is necessary as it can possibly affect their motivation to deliver MNPs. For example, in a study that investigated the ways in which and how training, supportive supervision, and mass media affected FLW's delivery of nutrition services in Bangladesh and Vietnam, FLW delivery was shown to improve due to these intervention elements (Nguyen et al., 2019). The intervention group, which received IYCF training, job aids, and regular supportive supervision had higher service delivery scores than the non-intervention group that just received standard training and supervision. One indicator of service delivery was the number of households visited to deliver IYCF services. The number of households visited was higher for the intervention group compared to the non-intervention group in Bangladesh. Motivation scores were also higher for the intervention group in Bangladesh highlighting the relationship between FLW resourcefulness and FLW's motivation.

In regards to the variables measuring FLW motivation to deliver MNP (Jeevan Jyoti) program services, the desire to help people or working with children and experiencing an improved status in the community due to the program were both significant factors for the number of households visited to talk about MNPs in the past month. The number of households visited to talk about MNPs in the past month was higher for FLWs that reported that they became a FLW because they liked helping people or working with children (39% higher) and for FLWs that agreed that their status in the community improved due to working in the program (30% higher). The desire to make an impact and promote healthy change in the community was also listed as a motivating factor for CHWs in the BASICS 2 paper that examined how CHW incentives and disincentives influence motivation, retention, and sustainability of child and nutrition programs in developing countries. Accomplishment, community recognition, respect, community status, and personal growth and development were a few of the non-monetary incentives that motivated CHWs (Karabi Bhattacharyya, 2001). Comparable findings were also seen in the aforementioned qualitative study on what factors influenced FLWs to implement the MNP program to children and their families in Bihar. The feeling of fulfillment through work and the desire to make a difference in the community were facilitators of FLW delivery (Hoenig, 2019).

Non-cash incentives were also facilitators of FLW performance in a cluster randomized control trial also conducted in Bihar. The study team evaluated the impact of team-based goals and incentives (TBGI) on FLW performance and health behaviors related to maternal, reproductive, newborn, and child health and nutrition. Teams of FLWs were created and teams that met greater than 70% of their quarter –year goals and

coverage targets were awarded. Two types of non-cash incentives were used to motivate the FLW teams: a certificate of recognition from the highest administrative officer in the district and household kitchen items like utensils, stoves, and storage containers. The TBGI intervention resulted in the following outcomes: increases in the frequency of antenatal visits and receipt iron-folic acid tablets, improved attitudes towards FLW teamwork and coordination, and improved FLW-beneficiary interactions in relation to IYCF and iron-folic acid counseling (Carmichael et al., 2019).

As corroborated by this study, FLWs are more motivated and work well as a team when they are determined. About 95% of the FLWs surveyed in the MNP (Jeevan Jyoti) program agreed to have improved status in the community and this was positively associated with an increased number of household visited to talk about MNPs. Motivations such as increased community status, certificates, and household items, which FLWs might need, especially in resource poor settings like Bihar, propelled the FLWs to work harder. This hard work translated into stronger FLW performance and better MCH outcomes, which is needed for the successful scaling up of home fortification programs. While non-monetary motivations had a significant effect on the delivery of MNP services in this study, this was not the case for monetary-related motivations or motivations that were not purposeful such as income generation and becoming a FLW because of boredom.

Despite the fact that income generation and having nothing else to do or boredom were reported as popular reasons for becoming a FLW and significant variables for the number of households visited in the past month to talk about MNPs in bivariate associations, they were not significant variables in the final multivariate Poisson

regression model. FLWs who joined for financial reasons may have been demotivated due to the inconsistent and limited pay in the program. In a similar manner, whether or not a FLW received the full amount of payment when paid also did not end up being a significant variable in the final model, but was significant in the bivariate association with the number of households visited to talk about MNPs. A reason for this outcome could also be due to the possibility that any incentive not money-related was not motivating enough for FLWs to perform well and deliver MNPs to households. Although monetary incentives were not motivating for FLWs in this nutrition program possibly due to the pay structure, monetary incentives proved to be motivating for FLWs in other health and nutrition programs in India.

In one study also conducted in Bihar, India, researchers examined what factors predicted effective FLW service delivery and use of services by households. Four services were evaluated: immunization information services, food supplements, pregnancy care information and general nutrition information. Monetary incentives given to AWWs for immunization services were statistically significant with household receipt of immunization services (Kosec et al., 2015). Immunization incentives given to AWWs were also significantly associated with a high odds of households receiving general nutrition information. Finally, incentives given to ASHAs for institutional delivery was marginally associated with an increased odds of receiving pregnancy care information. The BASICS 2 paper described above also listed financial incentives as a monetary motivating factor for CWHs like FLWs. Future paid employment and material incentives were also listed under monetary motivating factors for CHWs in developing countries.

With all that being said, FLWs can be motivated for many different reasons whether those reasons are due to no incentives, personal fulfillment or cash/non- cash incentives. These motivating factors can influence the delivery of health and nutrition services and possibly the receipt of services by beneficiaries (M. C. Kok et al., 2015).

In regards to FLW performance for ASHAs in comparison to FLW performance for AWWs, ASHAs visited fewer households (14% less) than AWWs. This may be due to the fact that AWWs are salaried government employees that receive more incentives to motivate them to work harder as compared to ASHAs that are volunteers and are usually only awarded based on performance. Barriers to ASHA performance were examined in a study that assessed the time utilization and factors affecting the performance of ASHAs, AWWs, and auxiliary nurse-midwives (ANMs) in South India. Barriers to FLW performance, particularly for ASHAs included weak supportive systems and increased work burden (Singh et al., 2018). Increased workload may have played a part in ASHAs visiting fewer households since 52.4% of FLWs experienced increased workload due to the program. For this reason, it is necessary to make sure FLWs have a strong support system.

In summary, the findings from this MNP program study reveal that FLWs that were capable, motivated, and well resourced performed better and visited more households to deliver MNP services. Having the proper knowledge and training on the MNP program and maternal and child health topics, in addition to easily understanding the training on child feeding, enhanced FLW capability. Having an improved status in the community and a desire to want to help people and work with children are factors that motivated FLWs to perform better. Finally, being well resourced with Jeevan Jyoti

sachets through adequate supply and demand chains were factors that also influenced FLWs to perform better in the program. Most importantly, since more households were visited to talk about MNPs due to these influential factors, it could be that more services were being delivered to families as a result, which could possibly lead to better infant and young child feeding practices in these homes such as improved complementary feeding with Jeevan Jyoti.

Considering these findings in addition to the fact that Bihar suffers from poor child feeding practices and high child malnutrition rates, and also considering that not many children globally receive MNP services, it is critical that the barriers to the scaling up of MNP programs such as the delivery of MNPs by FLWs are broken down, so that more children can be reached through MNP programs (Ministry of Health and Family Welfare - India, 2016; Nyhus Dhillon et al., 2017). The provision of FLWs that are capable, well resourced, and motivated in programs that address child malnutrition could help to resolve the nutritional dilemmas and improve anemia and child development outcomes in Bihar and other settings like it.

Strengths and Limitations

Strengths

While the outcome of interest measured in this study is not a comprehensive indicator for effective MNP service delivery, this study's findings helped to provide more evidence on what factors could influence FLWs to effectively deliver home fortification MNP programs, which was lacking and had many gaps. Another strength of this program is that the COM-B model provided a solid guiding framework for characterizing the factors that might influence frontline worker performance and their ability to effectively

deliver home fortification MNP services. Lastly, potential confounding was addressed in the study by adjusting for the category to which a FLW belonged (ASHA versus AWW) and the health sub-center from which they were randomly selected. This helped to prevent biased results that may have implicated the study finings.

Limitations

The first limitation of this study is the survey instrument used. The endline survey was the only survey instrument used to analyze the data reported by FLWs, and not the baseline and midline surveys. This limited the scope of the findings and did not allow for the full story to be told from baseline to endline of how FLW capability, FLW opportunity, and FLW motivation influence the number of households visited to deliver and counsel on MNPs. A second limitation was that some of the data contained missing values since some of the FLWs did not answer all the questions, which might have affected some of the analyses performed. A third limitation of this study is that there were some missing values in the data for the outcome variable, the number of households visited by FLWs to distribute and counsel on MNPs. Some FLWs might have not answered this question on the survey. This could have potentially biased the results and future work should address this issue.

Future Recommendations

While this study does provide useful information for how FLW capability, FLW opportunity, and FLW motivation could influence the number of households visited to distribute and counsel on MNPs, this information is not extensive enough provide

substantial evidence for the effectiveness of home fortification MNP programs in Bihar, India or other LMICs like India. Future studies should look at more outcomes to accurately measure effective service delivery of MNPs. As shown in table 1A, a future study should take the next steps in examining how FLW capability, FLW opportunity, and FLW motivation influence not only the number of households visited to talk about MNPs in the past month, but also evaluate the combined effect on the number of households visited in the past week to discuss or distribute MNPs, the effect on the minutes spent counseling on MNPs, and the effect on how often a mother or caregiver is visited to distribute MNPs.

Additional studies should also be done on or existing studies should expand on the role of FLWs in delivering home fortification MNP services to other communities in Bihar, India that suffer greatly from child malnutrition. Doing do will help to close the evidence gap on barriers and facilitators to MNP service delivery in poor Indian states. The studies should further explore the association between FLW capability, FLW opportunity, and FLW motivation and other outcomes not mentioned in this study such as IYCF and child development indicators that can accurately measure effective delivery of home fortification services using MNPs. Furthermore, this study can also be replicated with data from the baseline and midline survey to be more comprehensive and discover if FLW capability, FLW opportunity, and FLW motivation also influenced the number of households visited to distribute and counsel on MNPs at those start points and midpoints of the study. It would also be beneficial to research more thoroughly into how strongly the factors from the COM-B model influence effective service delivery and the

effectiveness of MNP programs, and if capability, opportunity, and motivation interact with one another to influence effective service delivery of MNPs.

Moreover, future studies should explore how the relationship between FLW capability, FLW Opportunity, and FLW capability differs among ASHAs and AWWs since this study revealed that AWWs performed better. Finally, since the outcome variable had missing some missing data values on the number of households visited to deliver MNP services, future work should examine the characteristics of FLWs with and without missing data to see if any potential bias was introduced into the study.

Conclusion

All together, FLW capability, FLW opportunity, and FLW motivation were all shown to be significant predictors for factors that that influence FLWs to deliver home fortification MNP services, specifically the Jeevan Jyoti program, to children aged 6 to 18 months in Bihar, India. Even though the percent change in households visited to talk about MNPs in the past month were all less than 40% for the variables defining FLW capability, FLW opportunity, and FLW motivation in the final multivariate model, the change was still meaningful compared to no change at all signifying the central importance of these three main predictors in frontline worker performance. Skilled FLWs with proper knowledge on MNP's use and benefits, proper training on MNPs, and FLWs that have a better understanding of training on child feeding all performed better than FLWs that did not. Well-equipped FLWs with a regular supply of Jeevan Jyoti that was replenished regularly or within less than a month performed better than FLWs that did not. Finally, FLWs that were motivated by wanting to help people or work with children

or FLWs that were motivated by potentially having their status increased in the community due to the MNP program performed better than FLWs that did not. As demonstrated, the capability, motivation, and resourcefulness of FLWs affected their performance and ability to deliver home fortification services with micronutrient powders to children aged 6 to 18 months in West Champaran, Bihar.

Future MNP interventions and programs should aim to specifically enhance capability, opportunity, and motivation before implementing them and monitor these factors throughout the duration of the programs. In order for this study to be more comprehensive moving forward, more outcomes measuring the effectiveness home fortification MNP programs should be added to the analysis and more research should be done on the factors that were found to be significant in impacting service delivery to validate the strength of their impact. The study should also be reproduced in other regions in Bihar and in other states similar to Bihar with poor child malnutrition outcomes and poor FLW performance. This will expand the scope of the findings, support the strength of the findings, and help to provide a more in-depth understanding of how strongly the factors representing FLW capability, FLW opportunity, and FLW motivation play a role and how exactly they play a role in effective delivery of home fortification programs that use MNPs.

Appendix A: Tables

Analysis of Variance Tables (ANOVA) Reference Tables

Table 1: Association between factors assessing frontline worker's (FLW) knowledge and training to deliver and counsel on MNPs (Jeevan Jyoti) and the mean number of households visited in the past month to talk about MNPs

Variables	Mean (p-value)
Received training on topics related to maternal and/or child health	
Yes	12.85 (0.29)
No/not sure	11.51
Number of sessions that covered nutrition and child feeding related content in the past year	
Covered in 1 – 6 sessions	10.81 (0.70)
Covered in 6 – 8 sessions	13.34
Covered in 8 to all 12	12.07
Training on child feeding (understandability)	
Found the training related to child-feeding	12.33(0.20)
easy to understand	
Understood most of the child-feeding training but did not understand some topics	9.52
How FLWs perceived the training on Jeevan Jyoti	
Understood everything in the training	9.80 (0.25)
Did not understand everything in the training	7.66

*p<=0.05

Table 2: Association between factors assessing frontline worker's (FLW) opportunity to deliver and counsel on MNPs (Jeevan Jyoti) and the mean number of Households visited in the past month to talk about MNPs

Variables	Mean (p-value)	Variables	Mean (p-value)
Live and work in the same village		Ever run out of Jeevan Jyoti	
Yes	12.05 (0.49)	Yes	12.54 (0.69)
No	13.32	No	12.10
Has a home visit planner		Received adequate supplies of Jeevan	
Yes	12.20 (0.92)	Jyoti in the past three months to	
No	12.42	distribute to households	
Received a pamphlet that contains		Yes	12.44 (0.35)
information on child feeding		No	10.66
Yes	12.30 (0.46)	How often Jeevan Jyoti stock is	
No	9.57	replenished after its finished	
Received a resource from training for		In a week (immediately)	12.54 (0.69)
frequently asked questions from the		In a few weeks (2 to 4 weeks)	11.36
community about Jeevan Jyoti	12.43 (0.66)	Greater than a month	9.79
Yes	11.70	Can't say/Don't Know	12.69
No	13.85 (0.05)	Currently have a supply of Jeevan Jyoti	
Received Jeevan Jyoti to distribute to		Yes	13.15 (0.02)*
households in your community		No	10.01
Yes	NA	Who do you go to if you need more	
No		information or help on this program	
Frequency of receiving Jeevan Jyoti		ANM	
At least once a month	13.85 (0.05)*	Yes	13.17 (0.08)
Less frequently than once a month	11.15	No	10.98
		Other FLW	
		Yes	13.91 (0.37)
		No	12.03
		CARE Staff Member	
		Yes	12.33 (0.82)
		No	12.05

*p<=0.05

Table 3: Association between factors assessing frontline worker's motivation to deliver and counsel on MNPs (Jeevan Jyoti) and the mean number of households visited in the past month to talk about MNPs

Variables	Mean (p-value)	Variables	Mean (p-value)
Reasons for becoming a FLW worker		Jeevan Jyoti program has increased workload	
Income generation		Agree	10.57 (0.005)*
Yes	11.56 (0.32)	Disagree	14.05
No	12.81	Jeevan Jyoti improved his/her status in the community	
Like helping people/working with children		Agree	12.43 (0.14)
Yes	13.50 (0.0007)*	Disagree/Don't know/ no opinion	8.25
No	8.78	Full amount of payment received when paid	
Had nothing else to do with time/bored		Yes	13.44 (0.18)
Other		No	12.20
Yes	10.05 (0.31)	Don't remember	8.38
No	12.41		
Experienced any problems related to the Jeevan Jyoti program			
Yes	10.22 (0.25)		
No	12.48		
Problems experienced as a FLW			
Child side effects			
Yes	12.20 (0.35)		
No	9.77		
High work burden			
Yes	11.75 (0.53)		
No	9.96		
Complaints from community			
Yes	9.48 (0.16)		
No	12.83		
Other			
Yes	13.50 (0.36)		
No	9.90		

*p<=0.05

Correlation Analysis Reference Tables

Table 4: Summary statistics (mean, median, minimum, maximum) for IYCF Score, MNP (Jeevan Jyoti) Knowledge Score, and MNP Topic Training Score

Summary Statistics for IYCF Knowledge, MNP Knowledge, and MNP Training Topic Scores				
Variables	**Minimum**	**Maximum**	**Mean**	**Median**
IYCF Knowledge Score	6.00	18.00	12.68	13.00
MNP (Jeevan Jyoti) Knowledge	14.00	23.00	18.53	18.50
MNP (Jeevan Jyoti) Training Topic Score	2.00	12.00	6.63	7.00

Table 5: Correlation Analysis Table for IYCF Score, MNP (Jeevan Jyoti) Knowledge Score, and MNP Topic Training Score

Association Between Knowledge Scores (IYCF Knowledge, MNP Knowledge, and Knowledge on MNP Training Topics) and the Number of Households Visited in the Past Month to Talk About MNPs			
Variables	**N of Observations**	**r**	**P - Value**
IYCF Knowledge Score	235	-0.04	0.55
MNP (Jeevan Jyoti) Knowledge Score	225	0.05	0.47
MNP (Jeevan Jyoti) Training Topic Score	231	0.04	0.53

r = correlation coefficient and ranges from -1 to 1. The sign of r represents the direction of the relationship (a positive r value means that as the independent variables (x) increases, the dependent variable (y) tends while a negative value for r means that as x increases, y tends to decrease. An r closer to +1 or -1 indicates a strong linear relationship and an r close to 0 indicates a weak linear relationship

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