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Factors Associated with Micronutrient Powder Acceptability among Women of Reproductive Age in El Alto, Bolivia

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Abstract

Factors Associated with Micronutrient Powder Acceptability among Women of Reproductive Age in El Alto, Bolivia

By Lara Kusnezov

Background: Women in Bolivia suffer from a high prevalence of micronutrient deficiency contributing to high rates of maternal and child mortality. Consequentially, micronutrient deficiency is among the top public health priorities in Bolivia. Because of this, the Bolivian Ministry of Health and Sports has partnered with Micronutrient Initiative to introduce micronutrient powders as a tool to improve maternal and child health. As a precursor to the development of a national nutrition program targeting the maternal population, this study aimed to assess the acceptability of micronutrient powder supplementation among women of reproductive age in El Alto, Bolivia.

Methods: Quantitative data were collected from surveys and included questions about demographic information, knowledge, practices, and attitudes of vitamins and micronutrient powder supplementation. Multivariable logistic regression was performed to investigate the contribution of the independent variables (vitamin knowledge, vitamin use, demographic factors, perceived barriers, and experience with Chispitas) to the acceptability of micronutrient powder supplements among women of reproductive age.

Results: A total of 70 women between 15 and 50 years old were included in the final sample. Women with the following factors were more likely to accept micronutrient powders: high levels of education (OR: 3.88 [95% CI, 1.58-9.55]), young age (OR: 1.73, [95% CI, 1.09-1.82]), and married or in a domestic partnership (OR: 2.19 [95% CI, 1.01-4.76]).

Conclusions: Improving maternal micronutrient status could greatly improve maternal and child health in Bolivia. Less educated, older, and single women are least likely to accept the use of micronutrient powders. Developing programs that target basic nutrition promotion through education systems and community-based organizations are essential to improving acceptability of micronutrient powders among women and ultimately, to improving micronutrient status in women and children in Bolivia.

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Global Burden of Micronutrient Deficiencies

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Globally, micronutrient deficiencies are among the top public health priorities, adversely impacting one-third of the world population [1, 2]. Deficiencies in iron, iodine, zinc, and vitamin A are among the most common micronutrient deficiencies, resulting in severe health consequences [3]. One of the most prevalent micronutrient deficiencies is iron deficiency [3]. Iron deficiency results in high rates of mortality and an estimated total loss of 35 million disability-adjusted life years (DALYs) [4]. Furthermore, studies have reported that iron deficiency affects approximately 500 million people globally, manifesting itself as tissue iron deficiency or anemia [5]. Another common micronutrient deficiency is iodine. Iodine deficiency affects approximately 1.9 billion people worldwide (reviewed in [6]). Deficiencies in iodine have been shown to lead to disabilities, and have been previously estimated to lead to a total loss of approximately 2.6 million DALYs (reviewed in [6]). In addition, deficiencies in zinc have been linked to high rates of stunting, immune incompetence, and suboptimal cognitive development in populations with inadequate zinc consumption (reviewed in [7, 8]). In low-income countries, the prevalence of zinc deficiency in the population has been estimated up to 30 percent (reviewed in [7]). Similar to the negative consequences associated with zinc deficiency, vitamin A deficiency is a known immune system suppressor, contributing 16 percent to the global burden of disease (reviewed in [9]). Consequentially, deficiencies in vitamin A can result in increased risk of mortality. Vitamin A deficiency is responsible

for up to 24 percent of deaths attributed to measles, diarrhea, and malaria (reviewed in [10]).

Economic Impact

There are major economic costs associated with micronutrient deficiencies which continue to perpetuate the poverty cycle [11-14]. Collectively, micronutrient deficiencies can cost up to 5 percent of the gross domestic product (GDP) [15]. Deficiencies in iron, iodine, and zinc are most commonly linked to economic repercussions [16]. For example, deficiencies in iron among children between 6 and 24 months can result in mental impairment (reviewed in [16]). Iron deficiency also has serious implications within the general population, leading to a GDP loss of up to 2 percent in most severe cases (reviewed in [16]). Similar to the consequences of iron deficiency, deficiencies in iodine during pregnancy have been linked to cognitive impairment in approximately 20 million infants per year (reviewed in [16]). Among those born with iodine deficiency, iodine-deficient individuals will achieve an IQ that is 10-15 points lower, on average, than those born with sufficient levels of iodine (reviewed in [16]). Furthermore, deficiency in iodine can result in a decrease in productivity, poor cognitive ability, limited cognitive capacity, and therefore an increase in economic burden [16, 17]. As a consequence of micronutrient deficiencies in pregnancy, infants born to these mothers are more likely to give birth to low birth weight or premature babies that are at a high risk for suboptimal cognitive and physical development [18]. Thus, micronutrient deficiencies in the mother, lead to deficiencies in the child, which impact their growth and hinder productivity and school performance [10]. In addition, lower productivity and education have been linked to childbearing earlier in life as compared to their counterparts [10]. Therefore, the poor

nutrition status in the mother carries over to the next generation, fueling the existence of the poverty cycle [10]. These factors are not only responsible for hindering productivity and growth on a personal level, but also impact economic growth at a community and country level, having the highest negative impacts in low-income countries [10].

Burden in Women

Studies have shown that women and children have significantly worse health and nutrition status than men [14, 19]. Women and children often suffer more from undernutrition and micronutrient deficiencies than men, due to their metabolic needs and increased growth requirements resulting from insufficient dietary intake [20]. Moreover, micronutrient deficiencies in iron, iodine, zinc, and vitamin A have widespread impacts in women, worldwide [1]. For example, iron-related anemia impacts approximately 500 million women of reproductive age globally, and approximately 40 percent of women in low-income countries (reviewed in [16]). Vitamin A deficiency currently impacts an estimated 19 million women (reviewed in [6]). Deficiencies in these essential micronutrients during pregnancy can have severe implications in the health of the fetus [16]. For example, iron deficiency is responsible for approximately 60,000 deaths of women in pregnancy and childbirth each year (reviewed in [16]). In addition, pregnant women suffering from severe anemia lead to an estimated 13 percent of the maternal disease burden (reviewed in [16]). Iodine deficiency during pregnancy can have severe consequences on fetal development, leading to mental impairment [6]. In severe cases, iodine deficiency can result in cretinism [6]. Furthermore, in areas with high rates of iodine deficiency, there was an average IQ deficit of approximately 13 IQ points in children born to iodine deficient mothers (reviewed in [6]). Moreover, approximately 38

million infants worldwide are born iodine deficient, resulting in approximately 18 million infants with cognitive impairment [21]. Studies have shown that zinc deficiency during pregnancy can result in preterm delivery, maternal morbidity, and growth restriction in the fetus [6]. Conversely, the use of zinc supplementation in pregnancy can reduce preterm delivery up to 14 percent (reviewed in [6]). In addition to zinc deficiency, approximately 15 percent of women have subclinical vitamin A deficiency in pregnancy, globally (reviewed in [6]). More specifically, an estimated 8 percent of pregnant women are deficient in vitamin A, and as a consequence, suffer from night blindness (reviewed in [6]).

Micronutrient Powder Supplementation

Development and History

In an effort to combat micronutrient deficiencies and improve overall health status in vulnerable populations, micronutrient powders (MNP) were developed as a cost-effective and sustainable solution [22]. Micronutrient powder supplements contain essential vitamins and minerals, such as vitamin A, vitamin C, zinc, iron, and folic acid, provided in single-dose sachets [23]. These sachets can be combined with food or beverage for easy consumption [23]. In order to increase acceptability, the powder is tasteless, odorless, and colorless [23]. Most programs which distribute MNP target children under-five years [23]. However, recent programs have expanded the target group to include pregnant and lactating women as well as other vulnerable groups, such as refugee populations in emergency settings [24].

Efficacy and Effectiveness

Micronutrient powders have been shown to be an effective method for improving nutritional status in developing countries [25]. Effectiveness trials of MNP conducted in Southeast Asia and sub-Saharan Africa in children under age six showed decreased rates of anemia, however had limited implications on growth [20]. In addition, a systematic review of effectiveness trials of MNP suggests that MNP have been found significant reductions in anemia prevalence in children under six by 34 percent and iron-deficiency anemia by 57 percent [20]. Hemoglobin levels and retinol deficiency saw significant improvement as well [20]. Nonetheless, results of MNP on anthropometric outcomes did not show any significant trends [20]. Yet, improvements in maternal nutritional status from micronutrient supplements have been directly linked to improved nutritional status in their child [20, 26].

Use in Maternal Populations

Since maternal health status has direct implications in the health status of her child, utilization of MNP have been explored to improve both maternal and child health [27]. There is limited evidence on the impact of MNP in maternal populations. Although MNP have been used in populations over six years of age, effectiveness of MNP has not been thoroughly investigated [20]. Systematic reviews of MNP effectiveness trials in women and children were unable to identify any previous studies in women [20]. In recent years, there has been advocacy for the use of MNP in place of other micronutrient supplementation. A meta-analysis of micronutrient supplementation in pregnant women in developing countries found evidence to support the replacement of folic acid supplements by multiple micronutrient powders (reviewed in [28]). In addition, the

World Health Organization, the World Food Program, and UNICEF have recommended the provision of multiple micronutrient supplements to pregnant and lactating women in emergency settings, to help sustain the higher micronutrient needs of women in these stages and for the prevention and control of micronutrient deficiencies [29]. However, these recommendations have not been extended to non-emergency settings.

Acceptability and Adherence among Women

Previous studies have reported high acceptability and adherence rates to micronutrient supplementation among pregnant and lactating women [13,28, 30-33]. Factors that have been found to impact the use of MNP include dietary preferences, experience with adverse symptoms related to MNP consumption, and perceived importance of MNP [32, 34]. For example, in Mexico, the Oportunidades program, which aims to improve maternal and child health, found that dietary preferences influenced their preferred method of MNP preparation [32]. Pregnant and lactating women reported the highest rates of acceptance for MNP when mixed with milk [32]. In addition, MNP preparation differed by region of residence [32]. Some women had negative perceptions of the MNP, as a result of experiencing unpleasant physiological symptoms [32]. Women reported adverse side effects immediately following the first few times of consumption, including vomiting, diarrhea, and other gastrointestinal illness resulting in weight loss [32]. As a result, women either suspended or stopped the use of MNP [32]. Conversely, pregnant and lactating women reported having positive perceptions of the MNP, believing that the supplement was going to improve the nutrition of their child, increase the likelihood of a healthy birth weight, and increase the quality and production of breast milk [32]. In another study, in Pakistan, MNP were also widely accepted in pregnant women from both

urban and rural areas [34]. Approximately 75 percent of the MNP sachets were consumed during the current pregnancy [34]. Similar to the Oportunidades study, some women reported adverse symptoms including vomiting and gastrointestinal illness [34]. Reasons given for reduced consumption included forgetfulness (8.6%) and vomiting (5.6%) [34]. In conclusion, micronutrient powders are generally accepted by pregnant women, however personal perceptions of health benefits and experience with side effects impact the acceptance rates [30, 32].

Although previous studies have investigated the acceptability of micronutrient supplements among women, there is limited research into the acceptability and adherence of micronutrient powders. However, findings on acceptability and adherence to multiple micronutrient supplements may help inform the success of MNP in similar populations. Factors associated with micronutrient supplement use include method of presentation, information provided about the micronutrient supplement, level of understanding of the purpose of micronutrient supplements, and ease of access to supplements [31]. For example, in Bangladesh, pregnant and lactating women reported high acceptability of the micronutrient supplements [31]. In addition, pregnant and lactating women consumed 95 percent of the recommended number of micronutrient supplements in the two week study period [31]. Supplements were deemed most acceptable when they were presented as a special food product rather than a medication [31]. Overall, the supplement was highly accepted by pregnant and lactating women at the study site and during the home trial period [31]. Focus group discussions reported high household acceptance rates and the preference for household delivery of supplements rather than picking them up from a

designated site [31]. Similar to other studies, pregnant and lactating women did not report high levels of sharing the supplements with other family members [31, 32]**.**

In addition, studies in China and Mali have identified factors that support higher rates of acceptability and adherence of micronutrient supplements among women such as government-supported maternal and child health programs, follow-up programs, consistent supply of micronutrient supplements, and frequent communication with health care workers [30, 33]. A study in rural Western China, found a high mean adherence to multiple micronutrient supplements (93%) in women [33]. Recently, China has launched an initiative to focus on antenatal care, as part of the maternal and child healthcare program [33]. Rates of adherence may be much higher in this study than reported in previous studies for several reasons [33]. First, there was an intensive follow-up program for pregnant women [33]. Also, the research staff operated under the supervision of healthcare workers and the healthcare providers received subsidies for their participation [33]. Lastly, women received a constant supply of micronutrient supplements, including free refills delivered directly to their households, and were provided consistent and frequent contact with health workers. [33]. High rates of acceptability and adherence to multiple micronutrient supplements were also found in pregnant women in Mali [30]. Similar to the study in Western China, highest rates of adherence and acceptability were consistent with guaranteed access to supplementation, counseling, and information [30]. The study also found that women had positive perceptions of the health benefits provided to themselves as well as to their newborns from the multiple micronutrient supplements [30].

Furthermore, a meta-analysis of micronutrient supplementation in pregnant women in low-income countries identified high rates of acceptability and adherence to micronutrient supplementation (reviewed in [28]). The findings demonstrate high rates of adherence among pregnant women, in particular, with steady access to supplements and with the support of trained counseling staff for the use of the supplements (reviewed in [28, 30]). Adherence rates of multiple-micronutrient supplements were reported from 69 percent to 98 percent among women, where adherence was indicated through observation of pill consumption or by pill count (reviewed in [28]). Moreover, efficacy trials showed that pregnant women have an estimated 20 percent higher adherence when they received the supplements and were directly observed as compared to when they were distributed on a monthly basis (reviewed in [28]).

There is minimal investigation of acceptability and adherence of MNP among women. However, there have been several studies to assess acceptability and adherence of micronutrient supplements in maternal populations (reviewed in [28]). Since there are minimal differences between MNP and micronutrient supplements, identified factors that influence the use of micronutrient supplements in maternal populations may also inform further investigation into acceptability of MNP. Factors associated with increasing acceptability and adherence include ease of access to supplements, consistency of supply, frequency of contact with healthcare workers, and follow-up programs [30, 33]. Conversely, factors that have been found to decrease acceptability and adherence include experience with adverse events and negative perceptions of using supplements [32, 34]. Other factors that have been identified to impact acceptability and adherence include dietary preferences, perceived importance of supplements, understanding the purpose of

use, the dissemination of culturally appropriate information, and method of introduction of supplements to the population (reviewed in [28],[32]). Since research on MNP acceptability is sparse, there are many factors that have not yet been thoroughly investigated. Factors that are of particular interest include socio-demographic factors, such as education level, income level, and marital status. In addition, previous use of vitamins and knowledge of supplements are also of interest, because they may have a direct impact on the use of MNP and may help describe mechanisms of MNP acceptability. Furthermore, perceived barriers and motivators to acceptability have not yet been explored, but may also be important to consider, since they may elucidate key factors that hinder or promote the use of MNP and therefore influence acceptability and adherence.

Micronutrient deficiencies in Bolivia (Study site)

Epidemiology

Despite recent improvements in overall health and nutrition status of the population in Bolivia, the focus of this study, mothers and children continue to suffer from a high prevalence of micronutrient deficiencies [35]. Poor maternal nutrition status has resulted in an average of 13,000 children born with mental impairment, each year [36]. More specifically, iron deficiency and anemia are among the most severe public health threats in Bolivia, affecting approximately 30 percent of women of reproductive age and 60 percent of children under-five [36]. An estimated 80 percent of Bolivian children under 2 years old suffer from anemia (reviewed in [37]). Furthermore, severe anemia is responsible for an estimated 120 deaths per year [36]. As a consequence, Bolivia suffers from high rates of under-five mortality most commonly as a result of diarrheal disease

and pneumonia, the second highest within the Latin America and Caribbean region [36]. In addition to iron deficiency, vitamin A deficiency is also of concern. However, vitamin A deficiency is not as prominent of a threat in El Alto as iron deficiency, since the highest prevalence occurs in rural populations [36].

Micronutrient Powder Supplementation "Chispitas" in Bolivia

Introduction of Chispitas in Bolivia

In order to improve the micronutrient status of children in Bolivia, a collaboration between the Micronutrient Initiative (MI), Bolivian Ministry of Health and Sports, and the Pan American Health Organization (PAHO), led to the widespread distribution of micronutrient powder supplements, known as Chispitas [38]. Chispitas were provided by the Bolivian government's universal healthcare program for women and children, Seguro Universal Materno Infantil (SUMI) to children between 6 and 24 months (reviewed in [37]). Chispitas were a replacement for ferrous sulfate syrup which was not widely accepted due to unpleasant taste [37]. In 2006, the recommended annual dose of Chispitas, or 60 sachets per year, was distributed to a total of 100,000 children nationwide (reviewed in [37]). Using SUMI as the primary delivery organization, MI provided 6 million sachets for distribution that same year (reviewed in [37]). In order to launch a sustainable program in Bolivia, MI helped establish a reliable supply chain for Chispitas, created educational campaigns to promote the use of Chispitas, and worked with the Bolivian government to help attain product sustainability [37]. The convergence of Chispitas to the SUMI program and its national distribution was the first effort by the Bolivian government to scale-up free distribution of fortified foods and supplements [37].

To assess the success of the program, Asociación de Instituciones de Promoción y Educación (AIPE) conducted a process evaluation in 2008 (reviewed in [37]). AIPE found that the most important reason for poor acceptability and non-compliance was due to ineffective counseling to caregivers (reviewed in [37]). In addition, the 2008 AIPE evaluation determined that healthcare personnel were the primary source of information on Chispitas (reviewed in [37]). More specifically, approximately 50 percent of caregivers reported uncertainty about Chispitas, with regards preparation, taste, and effectiveness (reviewed in [37]). An additional study was conducted by a third party, TICs Communications (TICs), contracted by MI in 2010 (reviewed in [37]). The results of the TICs study concluded that urban caregivers (50%) were less likely to understand the purpose and use of Chispitas when compared to rural caregivers (61%) (reviewed in [37]). In addition to the findings from AIPE and TICs, a primary concern for the sustainability of the program was attributed to high staff turnover, which made it difficult to maintain consistent counseling services [37].

Mechanism and Efficacy

The use of Chispitas in the pediatric population has been shown to be an effective method in reducing micronutrient deficiencies [38]. Chispitas are single-dose sachets with similar composition to other MNP, containing 12.5 mg of ferrous fumarate, 30 mg of vitamin C, 200 μg of vitamin A, 5 μg zinc gluconate, and 160 μg of folic acid [37]. Chispitas are distributed in packages, containing 30 sachets each [39]. The recommended dosage of Chispitas is 60 sachets per year [39]. Chispitas are easily prepared by mixing with a semi-solid food, such as porridge [39]. Chispitas do not alter the taste, texture, or color of the food [39]. A prospective cohort study of micronutrient supplementation in children ages

0 to 6 years, in Bolivia, showed a significant decrease of anemia prevalence from 35 percent to 9 percent after only 2 months of treatment [38].

Use in the Maternal Population

Based on the success of Chispitas in improving nutrition status in the pediatric population, use of Chispitas in the maternal population should be considered. Until now, the use of multivitamins in women has not been well documented. However, due to the high prevalence of iron-deficient anemia among women in Bolivia, pregnant and lactating women receive iron folic acid supplements [40]. In addition, in 2012, MI along with the Bolivian Ministry of Health and Sports provided micronutrient supplements, nutrition education, and nutrition counseling, to an estimated 18,000 women and children (reviewed in [40]). This was one of the first efforts to target the use of micronutrient supplements in women in Bolivia. Nonetheless, the use of MNP has not yet been evaluated among women. The use of MNP and supplements have been explored in other countries, reporting relatively high acceptability (68-95%) and adherence rates (69-95%) [28,30,31,41]. Although large-scale programs have not yet been implemented, there is evidence to support the efficacy of micronutrient powder use in children and implications in women from previous studies conducted outside of Bolivia.

Gaps in Knowledge and Need

Before implementing a national program to distribute Chispitas to women, there is a need to investigate several key indicators including current levels of vitamin use, barriers and motivators to vitamin use, and overall acceptability of micronutrient powder supplements in the maternal population. Current levels of vitamin use among women in Bolivia are not well documented. Previous studies assessing barriers to compliance and acceptability

of Chispitas among caregivers in Bolivia, found that unreliable nutrition counseling services, high staff turnover, and urbanity impacted the understanding and use of Chispitas [37]. However, studies assessing use of Chispitas in Bolivian women has not yet been explored. Therefore, there is a need for further studies evaluating micronutrient powder acceptability and adherence within the maternal population in Bolivia.

Study Goals and Aims

The primary objective of this study was to investigate the acceptability of micronutrient powder supplementation among women of reproductive age in El Alto, Bolivia from May to August, 2013. Specific study aims of this project included:

I. Assess the impact of vitamin use on the acceptability of micronutrient powder supplementation among women of reproductive age in El Alto, Bolivia through surveys.

II. Evaluate the impact of knowledge of vitamins on the acceptability of micronutrient powder supplementation among women of reproductive age in El Alto, Bolivia, through surveys.

III. Assess the impact of demographic factors on vitamin use among women of reproductive age in El Alto, through surveys.

Significance

Since micronutrient deficiencies are among the most important public health priorities in Bolivia, this study is an effort to better understand the deficits in maternal, and thus, child health and potential barriers and motivators to utilization of micronutrient powder among women of reproductive age [42]. Furthermore, this study aims to determine the

knowledge, attitudes, practices, and demographic factors that are associated with MNP acceptability, provide insight for the development of national nutrition interventions, and serve as a precursor to further investigation on MNP acceptability in other maternal populations in Bolivia. Little is known about acceptability of MNP in the maternal population in Bolivia. This study aims to better understand the factors that impact MNP acceptability among women of reproductive age in El Alto, Bolivia. Moreover, we hope to identify factors at a community and at an individual level that are associated with increased acceptability of MNP. This study attempts to address gaps in knowledge and understanding of current vitamin use and MNP acceptability in Bolivia. The focus of the study to determine factors that impact MNP acceptability will provide general information about mechanisms of MNP acceptability in the maternal population in El Alto, which will be used to improve the efforts to decrease the burden of micronutrient deficiencies in women and children. As a result, this study will also provide important information to aid in the development of a nutrition program to control and reduce micronutrient deficiencies in the population.

In addition, we want to identify the most influential factors impacting MNP acceptability to inform the design and implementation of a national nutrition program to distribute MNP and to improve the nutrition status of women and children, in particular, within the most vulnerable groups. Evaluating the acceptability of MNP will enable the assessment of remaining barriers to utilization and determine an appropriate plan of delivery of micronutrient supplements to the maternal population in Bolivia by Bolivia's Micronutrient Initiative and the Ministry of Health and Sports. In addition, this study will

help assess the feasibility of designing a national micronutrient program to deliver MNP to women in Bolivia.

This study will also provide the foundation for further investigation to MNP supplementation in other populations throughout Bolivia. The focus of the study to determine factors that impact MNP acceptability will provide additional information to current evidence about MNP acceptability in maternal populations. Since there is minimal research on the vitamin use and MNP acceptability in the maternal population in Bolivia, this study will be one of the first studies of its kind to be carried out in this area. As a result, this study can be used as a precursor for a larger study on MNP acceptability and adherence in other maternal populations in Bolivia, which will ultimately, help inform the development of nutrition programs for women in Bolivia.

MANUSCRIPT

Abstract:

Background: Women in Bolivia suffer from a high prevalence of micronutrient deficiency contributing to high rates of maternal and child mortality. Consequentially, micronutrient deficiency is among the top public health priorities in Bolivia. Because of this, the Bolivian Ministry of Health and Sports has partnered with Micronutrient Initiative to introduce micronutrient powders as a tool to improve maternal and child health. As a precursor to the development of a national nutrition program targeting the maternal population, this study aimed to assess the acceptability of micronutrient powder supplementation among women of reproductive age in El Alto, Bolivia.

Methods: Quantitative data were collected from surveys and included questions about demographic information, knowledge, practices, and attitudes of vitamins and micronutrient powder supplementation. Multivariable logistic regression was performed to investigate the contribution of the independent variables (vitamin knowledge, vitamin use, demographic factors, perceived barriers, and experience with Chispitas) to the acceptability of micronutrient powder supplements among women of reproductive age.

Results: A total of 70 women between 15 and 50 years old were included in the final sample. Women with the following factors were more likely to accept micronutrient powders: high levels of education (OR: 3.88 [95% CI, 1.58-9.55]), young age (OR: 1.73, [95% CI, 1.09-1.82]), and married or in a domestic partnership (OR: 2.19 [95% CI, 1.01-4.76]).

Conclusions: Improving maternal micronutrient status could greatly improve maternal and child health in Bolivia. Less educated, older, and single women are least likely to accept the use of micronutrient powders. Developing programs that target basic nutrition promotion through education systems and community-based organizations are essential to improving acceptability of micronutrient powders among women and ultimately, to improving micronutrient status in women and children in Bolivia.

Introduction:

Globally, undernutrition is a leading risk to health resulting in high rates of mortality, micronutrient deficiencies, and severe economic consequences [1]. Malnutrition results in over 3.5 million deaths in children under age five and affects approximately two billion people worldwide (reviewed in [1]). Micronutrient deficiencies affect one-third of the global population (reviewed in [44]). In particular, deficiencies in zinc, iron, and iodine are among the most prevalent [3]. For example, zinc deficiency accounts for 10 percent of diarrheal disease globally and approximately 800,000 deaths per year (reviewed in [45, 46]). Micronutrient deficiencies also lead to severe economic repercussions, thus fueling the existence of a poverty cycle [11-13]. Children who are malnourished will earn less than 20 percent on average as adults than children who are not malnourished (reviewed in [11]). Micronutrient deficiencies in iron, iodine, and zinc can contribute 2-3 percent of a loss of gross domestic product (GDP) per country (reviewed in [12]).

Consequentially, deficiencies in essential micronutrients such as iron and zinc, in pregnant women, can lead to substantial mental and physical deficits, and increased rates of micronutrient deficiencies in children. For example, iron deficiency affects approximately 47 percent of pregnant women worldwide [47]. Furthermore, iron deficiency can have severe heath implications in the fetus, resulting in impaired intellectual ability and an increased risk of child mortality [48]. Another example is zinc deficiency. Zinc deficiency in pregnancy can inhibit healthy development of the fetus and lead to stunting [1]. Studies have demonstrated that maternal micronutrient status plays an important role in the micronutrient status of the infant [49]. Micronutrient deficiencies among breastfeeding women can result in a substantial decrease in the concentration of

essential nutrients in breast milk, thus decreasing the transfer of these nutrients to the infant [50]. In order to impact infant health, it is essential to target improvement in maternal health.

Since micronutrient deficiencies in mothers have been linked to negative birth outcomes, the maternal population has been targeted for the use of micronutrient supplements as a tool to improve both maternal and child health [30, 49]. Micronutrient powder supplementation (MNP) sachets, such as Sprinkles, have been shown to be an effective method for improving nutritional status in developing countries [25]. Micronutrient powders offer a long-term, affordable, and easy method of delivering adequate daily nutrients to children and adults [25, 51]. However, the need for utilization of MNP spans beyond the target population of children 6 to 24 months and has become recognized as an important supplement for pregnant and breastfeeding women to decrease infant mortality [30].

In order to improve the micronutrient status in both maternal and pediatric populations, adherence to micronutrient supplements in the maternal population must be accomplished. Previous studies have shown a high adherence to micronutrient supplementation among pregnant and lactating women in developing countries given consistent access to counseling or contact with trained health care workers and a reliable supply of supplements [13, 30]. For example, higher acceptability rates have been reported among Malian women for micronutrient supplementation as compared to an iron and folic acid supplement [30]. Several studies have also shown high adherence rates to prenatal supplementation from mothers in community based supplementation programs

[22]. Furthermore, these findings are consistent with sustained support from healthcare workers [25].

To improve micronutrient status in the maternal and pediatric populations in Bolivia (study site), it is important to first understand fundamental underlying causes, such as poverty. Poverty is a vehicle for nutritional deficits and mortality, which are highly prevalent in Bolivia [19-24]. Bolivia is among the poorest countries in South America, with over 50 percent of the population living below the national poverty line [52]. The average income among those living in extreme poverty is 25 percent less than the cost of basic food needs [52]. The average food consumption is 28 percent less than the recommended daily caloric intake of 2100 calories and the average income is 34 percent less than the cost of basic food needs [52]. Low socioeconomic status is associated with maternal and child anemia [53].

High prevalence of micronutrient deficiencies in the maternal and child population in Bolivia has prompted the introduction of MNP to young children. Each year 115,000 maternal deaths are attributed to iron-deficiency anemia during pregnancy [46]. Low iron concentrations in breast milk have been linked to the development of anemia in the infant [53]. Approximately 27.2 percent of children under age five suffer from stunting and 50 percent of children under age five suffer from anemia [35, 54]. Bolivia's altitude-adjusted pre-school-age anemia prevalence (61.3%) is higher than the average anemia prevalence for the Latin America & Caribbean region (39.5%) [13]. In an effort to address these disparities, in 2002, a prospective cohort study of introduction of Chispitas, a micronutrient powder supplement, in children ages 0 to 6 years, in Bolivia showed a significant decrease of anemia prevalence from 35 percent to 9 percent after only 2

months of treatment [38]. The success of this study provided an affordable method to reduce anemia and other micronutrient deficiencies in the pediatric population. These findings support the potential of a Chispitas program targeting women of maternal age in an effort to improve maternal and child nutritional status. These findings also provide evidence for MNP use in the maternal population.

Micronutrient deficiency is among the top public health priorities in Bolivia [42]. Despite recent improvements in overall health and nutrition status of the population, maternal and child mortality remains high [43]. Bolivian mothers have a high prevalence of micronutrient deficiency, with the highest deficiencies occurring post-pregnancy [35]. Anemia prevalence is 71 percent among children of moderately anemic mothers compared to 57 percent among children of mothers without anemia [13]. In an effort to reduce these high rates of micronutrient deficiencies, micronutrient powder supplementation has been introduced to the pediatric population, but has not yet been introduced to the maternal population [38]. There is a need to assess the acceptability of micronutrient powder supplementation in the maternal population in Bolivia.

To address these needs, the goal of the study was to assess the impact of vitamin use on the acceptability of MNP among women of reproductive age in El Alto, Bolivia. The study included a sample from two hospitals surveyed about knowledge of vitamins and acceptability of MNP. Women who achieved higher levels of education and were in a committed relationship were more likely to accept taking MNP. This study is an effort to better understand the deficits in maternal, and thus, child health and potential barriers to utilization of MNP among women of reproductive age.

Methods:

Project Site and Study Population

There were two study sites: Hospital Corea and Hospital Los Andes in El Alto, Bolivia. Participants were sampled from an urban area with high population density and a predominantly indigenous Amerindian (Aymara), Roman Catholic population [55]. Based on our sample size calculations, we estimated that 198 women total would be an adequate sample size to detect a statistically significant difference in acceptability of micronutrient powder supplementation between women who had or had not previously used vitamins (based on 80 % power, 0.05 alpha level) [56, 57]. Due to limited resources and time constraints, a total of 70 women were surveyed. Prior to the start of the study, the Institutional Review Board at Emory University approved the protocol (IRB00056127).

Recruitment, Enrollment, and Informed Consent

Participants were recruited from two hospitals in El Alto: Hospital Corea and Hospital Los Andes to participate in 70 surveys and 7 pilot interviews. Women were approached at random from waiting areas within and surrounding the hospital sites and were provided detailed information about the study. Women of reproductive age, between the ages of 15 and 50 years old, who were outpatients, were eligible to participate in the study. Fluency in Spanish was the only exclusion criteria. Eligible women who wanted to participate were immediately enrolled. Women were considered enrolled after they were informed about the study and agreed to participate. Women who did not choose to participate were not considered enrolled. Informed consent was a pre-requisite to study participation. Participants were given an information sheet about the study and were orally consented

immediately after enrollment. Participants were told that participation was not mandatory and that they were allowed to stop the interview at any point. Consent status was documented directly on the survey.

Qualitative Pilot Interview

A qualitative interview of 7 women was conducted prior to the quantitative survey in order to inform the development of questions that were culturally sensitive to nuances in interpretation. Qualitative interviews consisted of 28 open-ended questions. Interview questions probed about basic demographic information, knowledge, familiarity, utilization, and attitudes of vitamins and micronutrient supplements. Interviews were approximately between 15 to 30 minutes.

Quantitative Survey

Quantitative data were collected from surveys. Surveys consisted of 32 open-ended and close-ended questions. Survey questions included basic demographic information, knowledge, practices, and attitudes of vitamins and micronutrient supplementation. The approximate duration of the survey was 10 minutes.

Data Collection and Management

Pilot interviews and surveys were conducted at the recruitment site and were led by a female moderator in Spanish to facilitate comfortable and open discussion. No incentives were provided. To ensure confidentiality, no personal identifiers were collected. After data were collected, data were double-entered into a data template in EpiInfo (version 3.5.4; CDC, Atlanta, Georgia, USA). Copies of the data were compared for consistency using the Compare feature. Any differences in data records were reconciled. In order to

ensure consistency in data, five percent of each dataset were crosschecked against the initial dataset to confirm successful entry. All data was password-protected and was solely available to the research group.

Variable Classification

Variables were defined prior to the analysis. Education level was defined as incomplete secondary education or less and complete secondary education or higher. Pregnancy status was classified as currently pregnant or not pregnant. Marital status was dichotomized to describe committed relationships, married or living with a domestic partner and single or widowed. In order to describe location of residence, urbanity was defined as urban or rural. Previous vitamin use was described as having previously taken any vitamins or have never taken vitamins. To characterize perceived barriers, individual factors such as cost, limited knowledge, and inconvenient schedule, were considered having perceived any barriers or difficulties in taking vitamins, compared with no perceived difficulties or barriers. Current vitamin use was defined as currently taking any vitamins and not currently taking any vitamins. Knowledge of vitamins was gauged based on any knowledge of sources, benefits, or use of vitamins and no knowledge of vitamins. To evaluate the use of MNP, use of Chispitas was defined as have used or currently using Chispitas in the household and have never used Chispitas in the household.

Statistical Analysis

Prior to performing the analysis, data were imported and cleaned in SAS software (version 9.2; SAS Institute, Cary, North Carolina, USA). Main characteristics were first investigated through univariate analyses using chi-square tests for categorical variables

and *t*-tests for continuous variables. Then, bivariate logistic regression analysis was performed to identify variables significantly associated with the acceptability of micronutrient powder supplements. Variables that were found to be least significant were eliminated one-by-one from model consideration until all variables remaining in the model were significant or justified by previous literature, biological or behavioral mechanisms. Following the bivariate logistic regression, multivariable logistic regression was performed to investigate the contribution of the independent variables (vitamin knowledge, vitamin use, demographic factors, perceived barriers, and experience with Chispitas) to the acceptability of Chispitas among women of reproductive age. Hierarchical backwards elimination was performed to eliminate non-significant terms from the model [58]. Multicollinearity was evaluated by variance decomposition proportions (VDPs) and condition indices (CIs) using a SAS macro program, COLLIN. Variables with a VDP greater than 0.5 or with a CI greater than 30 were eliminated from the model. Interaction was assessed using the likelihood ratio test (LRT). Interaction terms that were not significant were eliminated from the model. Since the results of the LRT were not statistically significant, the final models did not contain any interaction terms. Confounding was assessed using the 10 percent change in the odds ratio in the exposure variable within the full model. The fit of the final multivariate models were assessed using Hosmer-Lemeshow goodness-of-fit test and the area under the Receiver Operating Characteristic (ROC) curve [59]. Missing values accounted for 2.9% of total cases that were included in the logistic regression analysis. These values were treated as missing during the analysis. A p-value<0.05 was considered statistically significant.

Results:

To describe the distribution of demographic characteristics of women in Hospital Corea and Hospital Los Andes in El Alto, Bolivia, we measured several demographic variables including age, education level, pregnancy status, marital status, number of children, and urbanity (Table 1). The mean age of the participants was 28.5 years (SD 8.8), ranging from 15 to 50 years. Furthermore, women were more likely to have education levels of incomplete secondary school; women were less likely to be pregnant; women were more likely to be married or living with a domestic partner and have 1 or 2 children; and women were more likely to live in an urban area (Table 1).

To evaluate if previous vitamin use increases the acceptability of taking MNP among women of reproductive age, we measured previous vitamin use as the main exposure and five independent variables—pregnancy status, marital status, education level, perceived barriers, and current vitamin use (Table 2). We found that women who were married or living with a domestic partner were more than twice as likely to accept taking vitamins than women who were not married. In addition, women with higher education levels were more likely to accept taking MNP than compared to women with lower education levels. There was no significant association between previous vitamin use, pregnancy status, perceived barriers, current vitamin use and the acceptability of MNP. In conclusion, women who were married or lived with a domestic partner and had achieved higher levels of education were more likely to accept taking MNP than women who were not married and had achieved lower levels of education.

To evaluate if knowledge of vitamins increases the acceptability of taking MNP among women of reproductive age, we investigated associations between the primary exposure,

knowledge of vitamins, and several independent variables including education level, marital status, and use of Chispitas (Table 3). There was a significant association between education level, marital status, and the acceptability of MNP. Women with higher levels of education were more likely to accept taking MNP. Furthermore, women who were married or in domestic partnerships were twice as likely to accept taking MNP than unmarried women. There was no significant association between knowledge of vitamins, use of Chispitas, and the acceptability of MNP. In conclusion, women who achieved higher levels of education and were in committed relationships were more likely to accept taking MNP.

To assess the impact of demographic factors on vitamin use among women of reproductive age, we measured several variables including education level, age, and marital status (data not shown). The findings were consistent with the results of the previous multivariate logistic regression analysis—age and marital status were significantly associated with vitamin use (data not shown). We found that older women were less likely to use vitamins than younger women (data not shown). In addition, women who were married or in domestic partnerships were twice as likely to use vitamins as women who were not married (data not shown). Education level was not significantly associated with vitamin use. In conclusion, younger women who were married or living with a domestic partner were more likely to use vitamins than older women who were not married.

Discussion:

This study assessed the impact of determinants on the acceptability of micronutrient powder supplementation and vitamin use among women of reproductive age in El Alto, Bolivia. Among women of reproductive age, those who had achieved a higher level of education were four times more likely to accept taking MNP compared to women with lower education levels. Results also indicated that younger women had a higher chance of using vitamins than older women. In addition, being married or living with a domestic partner significantly increased the acceptability of MNP.

Our findings indicated higher acceptability of micronutrient powder supplementation in women with higher levels of education. Education is a well-established marker of social inequities in health [14, 60]. Its effect on acceptability may be due to higher socioeconomic status, increased autonomy, and healthier behaviors of individuals with higher education compared to those with lower education [14, 60-62]. In low-income countries, a direct relationship between wealth and education level has been well documented [14]. Moreover, girls from impoverished backgrounds are less likely to achieve primary education or higher [14, 63]. Women who achieve higher education are more likely to have a partner who has also achieved higher education (reviewed in [61]). As a consequence, attainment of higher education has been associated with increased household socioeconomic status, thus increasing the available resources to support healthier behaviors including sufficient dietary intake and access to medical care [19, 61]. In addition to socioeconomic status, studies have shown that well-educated women increase their social autonomy (reviewed in [61]). Women with higher social status and education have better health and nutrition indicators [14, 26]. Furthermore, maternal

social status has also been shown to directly impact the nutritional status of her child [14]. Women who are educated have increased awareness and concern for health for themselves and for their children [63]. Similarly, women with higher social status have better nutritional status, are better cared for by their families, and provide better medical care for their children [19]. Further yet, education has been linked to more optimistic attitudes towards health behavior, increasing receptivity to innovative prevention and treatment methods [61]. Educated women are more likely to accept modern medicine, such as MNP (reviewed in [61]). Studies have reported that demographic factors such as level of education are associated with higher rates of acceptability and use of micronutrient supplements among maternal populations [64-66]. Similar to previous studies, the association between education level and micronutrient acceptability among women is supported by our findings.

The findings of our study showed that younger women were more likely to take vitamins than older women. These findings may describe the societal shift towards increased education in Bolivia, indicating that younger women may have more opportunities to achieve higher levels of education than previous generations [67]. Higher education level is linked to better nutritional awareness and improved overall nutritional status in both women and in children, as previously mentioned [19, 63]. The impact that advanced education has on health and nutrition awareness may contribute to the increased likelihood of vitamin use. In addition, social status is also a marker for education level [14,61, 62]. In recent years, younger women have achieved better status within the community, which may have contributed to increased educational opportunities, that were absent in previous generations [68]. Furthermore, there has been an increased focus

on nutrition in Bolivia in recent years. As a result, there have been nutrition campaigns primarily targeting children [37, 39]. Since these programs have only been established in the past few years, women who are younger may benefit from the presence of these programs at a younger age than older women. That is to say that girls and young women who have been around these campaigns, can better prepare and improve awareness for their future. However, older women who did not have the benefit of these campaigns when they were younger may not be able to utilize this information for their childcare, since they may no longer be bearing children. The presence of nutrition programs may also explain why younger women have an increased awareness of healthcare and have directly benefited from health education programs and nutrition campaigns launched in Bolivia in recent years [69-71]. This result is also consistent with previous studies, which have identified age as a major demographic variable associated with maternal vitamin use [64,66, 72]. Conversely, in developed countries, studies have reported an inverse relationship between vitamin use and age [65, 73]. However, there can be great disparities between high-income and low-income countries implying that results in high-income countries may not be generalized to countries outside this context [74]. Nonetheless, our results are in agreement with the identified relation between age and maternal vitamin use in developing countries [64,66, 72].

The results of our study also found a significant association between marital status and acceptability of micronutrient powder supplementation. These results represent the positive impact that social support networks can have on an individual's health status. Furthermore, gender inequities may impact the delivery of health services in the study population [68]. Partners may be more educated and therefore have better knowledge or

overall nutritional awareness [75]. In addition, partners may be the primary decision maker for healthcare and exert an influence over these decisions, which may be a contributing factor to this observed association [61, 62]. Furthermore, in recent years, there has been an effort to increase paternal involvement in health and nutrition in Bolivia [76]. The participation of fathers in these health and nutrition programs, increases their overall health awareness and therefore may contribute to increased familial health awareness, in particular of their partners [76]. Therefore, women may directly benefit from health promotion in the paternal population, and increased health awareness, leading to an increase in acceptability of MNP. The positive association of marital status has been highlighted in many studies exploring the impact of social support systems on vitamin use and micronutrient supplement acceptability in women of reproductive age, which is consistent with our findings [65, 73].

Strengths and Limitations

There were a number of strengths in our study. For example, this study emphasized the importance of understanding the current level of knowledge about nutrition among women in El Alto. In order to improve the health of these women, health promotion and behavioral interventions may be necessary. In particular, this study highlighted the importance of identifying appropriate avenues for further evaluation of nutrition knowledge, development of sustainable community-based health education programs, and dissemination of culturally-specific health educational tools. Partnerships with physicians, nutritionists, and healthcare systems may be integral for the success of nutrition programs, since the opinions of medical professionals are greatly valued within the community. This study also underscored the importance and need to target younger

adults in order to improve overall nutrition of future generations. Furthermore, the findings of this study could be applicable for improving health outcomes in women and children in other regions or countries that have similar social, economic, and cultural distributions.

There were also some limitations to our sample. Due to limited resources, we sampled women from only two hospitals. Because of this, there is a risk of selection bias (reviewed in [77]). Our sample may have included women who were able to access the hospitals, may have more knowledge or overall awareness of health, or may suffer from diseases of long duration, requiring frequent visits to the hospital [77]. Thus, our sample may have excluded women who were geographically inaccessible or differed in level of health awareness. Additionally, non-response bias may also be of concern (reviewed in [77]). Women who volunteered to participate in the study may have different characteristics than women who did not volunteer to participate. Additionally, we were only able to interview women who understood and spoke Spanish. El Alto has a highly dense indigenous population, where Aymara and Quechua are commonly spoken languages [13]. Our study instruments were not available in those languages, potentially excluding individuals that could compose a more representative sample of the overall population in El Alto. Moreover, the study population was a cohort of indigenous women who lived in harsh conditions including high altitude, extreme cold, and extreme poverty. Thus, the findings of this study may not be generalized to other populations, unless under similar conditions.

Conclusions

This study aimed to evaluate factors associated with the acceptability of MNP among women of reproductive age in El Alto, Bolivia. The factors identified in this study suggest that education level, age, and marital status are important contributors to acceptability of MNP. Since higher education was found to be a protective factor of acceptability, it may be important to consider designing nutrition campaigns in school settings, starting with primary school, in particular due to the overwhelming number of women who did not complete secondary school. Since education depends on infrastructure, it may be more difficult to increase education levels for girls. However, by targeting primary and secondary school, regardless of the level of completion, children will receive health education. In addition, we determined that younger women were more likely to use vitamins. In order to increase acceptability among older women, it may be important to create nutrition promotion materials that are available in indigenous languages, as well as infographics, to increase basic understanding of key nutrition ideas.

Lastly, single women were less likely to accept MNP. For these women, it may be ideal to develop community based interventions through schools, community centers, or social groups, since they may lack the additional social support present in marriage or domestic partnerships. Furthermore, this study identified the most vulnerable groups of women who are less likely to accept MNP, such as less educated, older, and single women. This study also indirectly illuminated the more basic need of the population to launch general nutrition education or health promotion campaign to provide basic nutritional knowledge in Bolivia.

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TABLES

Table 1. Characteristics of women in Hospital Corea and Hospital Los Andes in El Alto, Bolivia (N=70, valid N=69)

Characteristics	Total, n (%) (n=69)
Age	
15-28 years	39 (56.5)
29-50 years	30 (43.5)
Mean (SD)	28.5 (8.8)
Education	
Less than secondary school	46 (66.7)
Completed secondary school and above	23 (33.3)
Pregnancy status	
Pregnant	15 (21.7)
Not pregnant	54 (78.3)
Marital Status	
Married/ Domestic Partner	53 (76.8)
Single/ Divorced	16 (23.2)
No. of children[i]	
None	7 (11.9)
1 to 2	38 (64.4)
3+	14 (23.7)
Urbanity	
Urban	66 (95.7)
Rural	3 (4.3)

[i]Excludes 10 responses indicated as 'missing'; n=59.

Table 2. Previous vitamin use and micronutrient powder acceptability among women of reproductive age in El Alto, Bolivia by multivariate logistic regression model (N = 70, valid N = 68)

Characteristics	OR[a]	95% CI[b]	*P* value[†]
Previous vitamin use			
No[c]	1.0	NA	NA
Yes	1.57	0.43-5.67	0.493
Education level			
Incomplete secondary school or less[c]	1.0	NA	NA
Complete secondary school or higher	4.83	1.65-14.16	0.004[i]
Pregnancy Status			
Not pregnant[c]	1.0	NA	NA
Pregnant	0.21	0.04-1.22	0.083
Marital status			
Not married[c]	1.0	NA	NA
Married/Domestic Partner	2.43	1.11-6.25	0.028[i]
Perceived barriers			
No[c]	1.0	NA	NA
Yes	2.63	0.43-13.56	0.313
Current vitamin use			
Not currently using vitamins[c]	1.0	NA	NA
Currently using vitamins	0.37	0.07-1.83	0.222
Model's fit statistics:	Hosmer & Lemeshow goodness of fit test, p= 0.986 Area under the ROC curve=0.840		

[†]p<0.05 is statistically significant

[a]OR: Odds Ratio

[b]CI: Confidence Interval

[c]Reference Group

Table 3. Knowledge of vitamins and micronutrient powder acceptability among women of reproductive age in El Alto, Bolivia by multivariate logistic regression model (N = 70, valid N = 68)

Characteristics	OR[a]	95% CI[b]	*P* value[†]
Knowledge of vitamins			
No[c]	1.0	NA	NA
Yes	1.04	0.15-7.32	0.968
Education level			
Incomplete secondary school or less[c]	1.0	NA	NA
Complete secondary school or higher	3.88	1.58-9.55	0.003[i]
Marital status			
Not married[c]	1.0	NA	NA
Married/Domestic Partner	2.19	1.01-4.76	0.048[i]
Use of Chispitas			
Has never used Chispitas[c]	1.0	NA	NA
Has used/use Chispitas	2.87	0.87-9.48	0.085
Model's fit statistics:	Hosmer & Lemeshow goodness of fit test, p= 0.890 Area under the ROC curve=0.805		

[†]p<0.05 is statistically significant

[a]OR: Odds Ratio

[b]CI: Confidence Interval

[c]Reference Group

PUBLIC HEALTH IMPLICATIONS AND FUTURE DIRECTIONS

Little is known about the acceptability of micronutrient powders in the maternal population in Bolivia. This study aimed to address this gap by assessing knowledge and use of vitamins, barriers and motivators to vitamin use, and demographic factors on acceptability of micronutrient powders in El Alto, Bolivia. Furthermore, this study has important implications for the development of micronutrient supplementation programs for women.

- First, this study highlighted the importance of education and presence of community-based social networks on health awareness.
- This study provides insight to the current needs of Bolivia's more vulnerable populations, which can be used to inform the development of a national program to improve maternal and child health in Bolivia. Inevitably, this study may contribute to reducing preventable maternal and child deaths and to improving maternal and child health in neighboring countries in Latin America.
- In addition, perceived barriers such as money and lack of knowledge are likely associated with decreased acceptability in women in El Alto. Although each of these specific barriers was not thoroughly investigated, any intervention to increase acceptability of micronutrient powders and vitamin use should first assess these barriers.
- Finally, these results are precursors to better understanding the current level of knowledge, utilization, and acceptability of vitamins among women in Bolivia as well as preliminary steps to achieving successful delivery and adherence to micronutrient supplements in women in El Alto.

Our study evaluated the association between previous vitamin use and the acceptability of micronutrient powders, which may be used as a precursor to a proximal study on adherence to micronutrient powder supplementation. This study also illuminated key gaps in knowledge of vitamins among women in Bolivia, which give heed to further investigation.

- Potential areas for future research include adherence to micronutrient powder supplements and health education programs targeting nutrition in women and children in Bolivia. A similar acceptability study is also of interest, to achieve a larger sample size and to include women who exclusively speak indigenous languages, such as Aymara and Quechua, since they compose a large portion of the community.
- This was a small-scale study with sufficient support to identify important gaps in knowledge for further investigation. Before launching large-scale programs, there is a need for further evaluation of acceptability among women as well as an assessment of adherence in order to determine the most appropriate method of vitamin delivery to the maternal population in Bolivia.

APPENDIX

Appendix 1. Emory University Institutional Review Board Amendment Approval Letter

TO: Juan Leon
Principal Investigator
Global Health

DATE: May 1, 2013

RE: **Notification of Amendment Approval**
AM1_IRB00056127
IRB00056127
Effect of Nutrition, Immunity, and Vaccines on Pediatric Enteric Infections

Thank you for submitting an amendment request. The Emory IRB reviewed and approved this amendment under the expedited review process on **5/1/2013**. This amendment includes the following:

Personnel Change only: Lara Kusnezov, Lisa Mac, as other Emory study staff; and Ccoya Sejas as Non-Emory study staff.

Important note: If this study is NIH-supported, you may need to obtain NIH prior approval for the change(s) contained in this amendment before implementation. Please review the NIH policy directives found at the following links and contact your NIH Program Officer, NIH Grants Management Officer, or the Emory Office of Sponsored Programs if you have questions.

Policy on changes in active awards: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-12-129.html

Policy on delayed onset awards: http://grants.nih.gov/grants/guide/notice-files/NOT-OD-12-130.html

In future correspondence with the IRB about this study, please include the IRB file ID, the name of the Principal Investigator and the study title. Thank you.

Sincerely,

Donna Thomas
Administrative Assistant

This letter has been digitally signed

CC	Fabiszewski	Anna	Global Health
	Rebolledo Esteinou	Paulina	RTP
	Suchdev	Parminder	GEN PED EGLESTON

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