## Introduction

Global trends of child malnutrition have decreased rapidly. Between 1990 and 2014, stunting and underweight prevalence rates for children under 5 years of age fell from 41.4% to 23.8% and 25% to 14.3%, respectively (WHO 2015). Yet Sub-Saharan Africa, progress has been slow in reduced child malnutrition. Between 1990-2014, stunting and wasting prevalence rates for children under 5 years of age have only fallen from 48.9%-35.7% and 30%-19.6%, respectively (WHO 2015). Even more alarming is that the number of stunted (44.8-57.2 million) and underweight (27.5-31.4 million) children has increased during those same time periods (WHO 2015). Apart from being related to increased risk of mortality (Black et al. 2010), children who suffer from malnutrition have negative long lasting health effects including developmental deficits, increased levels of hunger-related and chronic illnesses in adulthood, and adverse pregnancy outcomes for women (Peña and Bacallao 2002; Silva 2005).

The United States Agency for International Development (USAID) has accelerated its efforts to ending preventable child and maternal deaths (EPCMD). Specifically, USAID has invested $15 billion since 2009 to improve access to vaccinations, breastfeeding, diarrhea treatment, hand washing, and other basic interventions to improve health and especially nutrition (USAID 2015). The eradication of hunger by 2030 is a specific target of the new United Nations (UN) Sustainable Development Goal (SDGs) Target 2.2 which aims to “end all forms of malnutrition,

including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age (.)" (UN 2015). The Democratic Republic of the Congo (DRC) is one of the 24 priority countries that USAID has highlighted as making slow progress in achieving EPMCD. current estimates show that the DRC is one of five countries that accounts for over 50% of under-five malnutrition globally[1] [2] (UNICEF 2013a). Additionally about 43%, 9%, and 22% of Congolese children are stunted, wasted, or underweight, respectively (DHS). Thus, identifying the factors that limit Congolese children's nutrition is important in increasing their survival chances and later life health.

A large body of literature has shown a strong relationship between socioeconomic resources and health outcomes in developing countries. Specifically, analysts have stressed the specific importance of mothers' educational attainment for children's nutritional outcomes (Doan and Bisharat 1990; Gakidou, Cowling, Lozano, and Murray 2010). Educational attainment matters for children's nutritional outcomes for several reasons. Women, as children's primary care givers, shape children's health outcomes through the physical and non-physical education-related resources they bring into the household. Formal education provides women with specific knowledge (Baker et al. 2011), problem solving skills (Kravdal 2002), employment related credentials(Card 1999), and an increased sense of control over their lives (Bbaale and Buyinza 2012; Glick and Sahn 1998; Hoddinott and Haddad 1995). Therefore education allows women to increase their knowledge-base and socioeconomic benefits, which can then be used to

[1] India, DRC, China, Nigeria, and Pakistan.
[2] The DRC accounts for approximately 391,000 under-five child deaths or 6% share of global total in 2012.

influence children's overall nutritional outcomes and well-being (Basu and Stephenson 2005; Boyle et al 2006; Caldwell 1994; Pena, Wall, and Persson 2000). Additionally, more educated women are more likely to have better health behaviors than less educated women, which is key to influencing children's nutritional outcomes (Basu and Stephenson 2005; Block 2007).

Researchers have not only focused on women's educational attainment as a determinant of children's nutrition, but also on how reproductive behaviors and decisions are related to malnutrition (Barber 1999; Rahman 2015). Children's risk of poor nutrition increases if the pregnancy was unintended or mistimed (Rahman 2015, Santelli 2003). That is, women's psychological emotions toward a child that was born from an unwanted or mistimed pregnancy might diminish the positive effects education has on children's nutrition especially if these sentiments towards the child lead to conscious or unconscious neglect, poor feeding habits, limited parent-child bonding, and limited attention to the child's needs (Montgomery et al, 2009, Rahman 2015). Growing rates of mistimed or untimed pregnancies and high rates of an unmet need for modern contraceptive methods, coupled with high malnutrition prevalence rates in developing countries makes it very important to understand the link between these types of pregnancies and children's early life growth: in the DRC, 28% of women have an unmet need for family planning (DHS 2015). Therefore the aim of this study is to understand the relationship between maternal education, pregnancy intentions, and Congolese children's nutritional statuses.

## Methods

*Sample*

This analysis uses data from the 2014 EDS-RDC II. The objective of the EDS-RDC II was to provide data on fertility and family planning behavior, child mortality, maternal and child health services, and knowledge of HIV/AIDS. In addition, the EDS-RDC II collects anthropometric measures (height and weight) for children under age 5 and women aged 15-49. The EDS-RDC II was conducted between August 2013 and February 2014 and is representative at the national level, for urban and rural residences, and for eleven provinces (Kinshasa, Bas-Congo, Bandundu, Équateur, Orientale, Nord-Kivu, Sud-Kivu, Maniema, Katanga, Kasaï Orientale, and Kasaï Occidental) and the 26 new provinces. The 2014 EDS-RDC II has complete interviews from 18,171 households, 18,827 women aged 15-49 years, and 8,656 men aged 14-59 years. This analysis limited the sample to EDS-RDC II lastborn singleton children 0-59 months of age who had complete anthropometric measurements and whose mothers were married non-visiting residents of the interviewed household. The final sample size was 4,080 children.

*Dependent Variable*

Height-for-age, weight-for-height, and weight-for-age z-score indexes from the EDS-RDC II, are used as proxies of children's nutritional status. Height-for-age is used to measure "stunting", which describes growth retardation among children (being very short for their age) and typically results from chronic nutritional deprivation coupled with repeated infections. Weight-for-height is used to measure "wasting", an anthropometric measure that taps into children's body mass in relation to length and is a measure of children's current nutritional outcomes. Finally, weight-for-age is used to measure both chronic and acute malnutrition or being "underweight". All children who were two

standard deviations below the reference height-for-age, weight-for-height, or weight-for-age populations were defined as being stunted, wasted, or underweight, respectively.

*Independent Variables*

The primary independent variables are women's educational attainment and pregnancy intendedness. Mother's level of educational attainment was measured as a 5 category variable: no formal education (0 years), incomplete primary (>0-5 years), complete primary (6 years), incomplete secondary (>6-11 years), and complete secondary school or higher (12 plus years). Mothers in the EDS-RDC II were asked to recall their feelings at the time of conception for each birth in the last 5 years. Specifically they were asked whether the pregnancy had been planned (wanted at that specific time), mistimed (wanted later), or unwanted (not wanted at any time).

Maternal characteristics included were age, household wealth, body mass index (BMI), height, age at time of birth, and autonomy. Maternal age was measured as ≤19, 20-24, 25-29, 30-34, 35-39, 40-44, or 45-49 years. Maternal household wealth was separated into 5 quintiles: poorest, poorer, middle, richer and richest. Maternal BMI was measured as thin (<18.5kg/m2), normal (18.5-24.99 kg/m2), and overweight/obese (≥25.0 kg/m2). Age at birth to the index child was coded as ≤17, 18-24, 25-34, 35-39, or ≥40 years.

Women's autonomy was measured based on questions about women's household decision-making abilities. Specifically, the questions on women's household decision making abilities were: "Who usually makes the final decision on your health care, the purchase of major household goods, visits to family or friends, and your earnings?" I recoded women's responses to these 4 different questions into three categories: the woman made the sole decision, the woman made the decision jointly with the

husband/partner, or the husband/partner made the sole decision. Next, each of the women's autonomy responses was used to create an autonomy index measure. The autonomy index ranged from 0-4 and corresponded to the number of decisions in which a woman participated alone or jointly with her husband. A high score on the autonomy index indicated a higher level of household autonomy.

Children's characteristics included age, sex, birth order, birth size, previous birth interval, and breastfeeding status. Children's age was measured as 0-11, 12-23, 24-35, or 36-59 months. Birth order was coded as 1st, 2nd, 3rd, 4th, and ≥5th. Birth size was coded as small, average, and large. Preceding birth interval was categorized ≤23 months, 24-35, 36-47, or greater than 48 months. Current breastfeeding status was coded as a dichotomous variable.

*Statistical Methods*

This analysis used descriptive statistics and multivariate logistic regressions to test the relationships between education, pregnancy wantedness, and Congolese children's nutritional outcomes. In all the analyses, the significance level was $p<.05$ (two-tailed). All statistical analyses were conducted using STATA 14 and took into account sample weighting related to the complex design of the EDS-RDC II. All coefficients are expressed as odds ratios.

## RESULTS

*Descriptive Statistics*

Table 1 presents weighted descriptive statistics for all the measures used in the multivariate analyses for the analytic sample of Congolese children. Close to 30%, 8%, and 24% of Congolese children were stunted, wasted, or underweight, respectively. The

majority of children's mothers were formally educated. Specifically, one in five women was not formally educated. About 1/3 of children's mothers did not finish primary school while close to 10% did complete primary school. Over 37% of children's mothers attended secondary school. About 22% of children's mothers reported that the pregnancy was mistimed and 6.5% said the pregnancy was unwanted. Less than 5% of births were to mothers under 18 years of age: most mothers were 25-34 years of age at birth. About 11% of mothers were thin. Most children (41%) were a $5^{th}$ order birth or higher.

About 10% of children were smaller than average at birth. Almost 67% of children were breastfeeding at the time of the survey.

*Multivariate Logistic Regressions*

Table 2 presented the multivariate regression models showing the relationship between women's education, pregnancy wantedness, and Congolese children's nutritional status. The results show that pregnancy intendedness is not associated with children's odds of being stunted, wasted or undernourished. Yet the results show that maternal education is associated with children's nutritional status. Specifically, compared to children whose mothers had no formal education, children whose mothers had some secondary school or completed secondary school had 33% and51% lower odds of being stunted, respectively.

Maternal age at birth was associated with children's nutritional outcomes. Compared to children whose mothers who were less than 18 years of age when they gave birth, children whose mothers were 18-24, 25-34, or ≥40 were 69%, 88%, and 88%, less likely to be wasted, respectively. Children whose mothers had a normal BMI had 33% lower odds of being underweight compared to children whose mothers were thin. Children whose mothers were overweight/obese had 61% lower odds of being wasted and

57% lower odds of being underweight compared to children whose mothers were thin. Each centimeter increase in maternal age lowered children's risk of stunting or wasting by 5% and 4%, respectively. Interestingly, maternal age was negatively associated with nutritional status. That is, increases in maternal age were linked with higher odds children being wasted at every age category. Children residing in households in the highest wealth quintile had 56% lower odds of being underweight.

Children over 12-23, 24-35, or 36-59 months had 4, 5, and 7 times greater odds of being stunted compared to children 0-11 months of age. Children who were a $5^{th}$ order birth or higher had 1.5 times greater odds of being stunted compared to children who were a first order birth. Compared to children whose mothers said they were small at birth, children who were average size at birth had 25% lower odds of being stunted and 35% lower odds of being underweight. Additionally children who were large at birth had 47% lower odds of being stunted and 54% lower odds of being underweight. Birth interval was associated with children's nutritional outcomes. Specifically relative to children whose preceding birth interval was less than 24 months, children whose preceding birth interval was 36-47 months or ≥48 months had 32% and 35% lower odds of being stunted, respectively. Children whose birth interval was greater than or equal to 48 months had 64% lower odds of being wasted compared to children whose birth interval was under 24 months. Children whose birth interval were 24-35, 36-47, and ≥48 months had 32%, 44%, and 47% lower odds of being underweight compared to children whose birth interval was ≤23 months, respectively. Female children had 19%, 35%, and 24% lower odds of being stunted, wasted, or underweight, respectively, compared to male children.

## DISCUSSION

Studies have shown that women's education is positively related to children's nutritional status, yet few studies have analyzed the effects of socioeconomic status and reproductive behaviors on children's nutritional outcomes in SSA. This analysis used a nationally representative sample of Congolese children to investigate the relationships between women's educational attainment, pregnancy intendedness, and children's odds of being nutritionally deficient.

The first key finding in this analysis echoes much research on education and health: women's education is related to children's nutritional outcomes, as measured by stunting and wasting. Specifically, secondary school education was associated with children's risk of being stunted or wasted. This outcome reconfirms results from other studies that women's education is related to child health outcomes only at the higher levels of educational attainment (Ainsworth-Darnell and Downey 1998; Harttgen, Klasen, and Vollmer 2013; Willey, Cameron, Norris, Pettifor, and Griffiths 2009). The completion of secondary school provides women more access to specific resources and skills that allow them to improve their children's well-being compared to less educated women. The second key finding shows that pregnancy intendedness is not associated with increased likelihoods of stunting, wasting, and underweight among Congolese children. Therefore children's malnutrition is not affected by a mother's attitudes and behaviors about having an unwanted child.

To understand how education and pregnancy intentions were associated with children's nutritional outcomes, I analyzed the mediating effects of women's socioeconomic status, reproductive behaviors, health status, women's autonomy, and children's health characteristics. Socioeconomic status partially explained the

relationship between education, pregnancy intendedness, and underweight. Specifically, children from high wealth households had lower odds of being underweight compared to children from low wealth households. This finding is consistent with those found in other studies on household socioeconomic status and children's nutrition in SSA (Uthman 2008; Van de Poel, O'Donnell, and Van Doorslaer 2007). Maternal age at birth was associated with lower odds of children being wasted or underweight. This finding is not unexpected, because studies have shown that women who give birth before 18 years of age have higher odds infant mortality and poor nutritional outcomes (Lartey 2008). Children whose mothers were normal or overweight/obese had lower risks of being wasted or underweight. This finding highlights a protective effect of BMI for children.

The child characteristics were also strongly associated with malnourishment. Consistent with other studies, child age is strongly associated with the risk of stunting and being underweight (Pongou, Ezzati, Salomon 2006). Specifically, these results suggest that children 12-59 months have a high risk of being stunted or underweight compared to children 0-11 months. Yet the risk of being stunted, wasted, or underweight was lessened for children whose preceding birth interval was over 23 months. This finding is consistent with studies showing higher risk of mortality and morbidity for closely spaced pregnancies. As expected, birth size at birth was associated with lower risk of malnutrition.

| **Table 1: Demographic, Social and Health Characteristics of Mothers & Children in the DRC N=4, 080** | |
|---|---|
| | **%** |
| Stunted | 29.8 |
| Wasted | 8.1 |
| Underweight | 24.2 |
| Women's education level | |
| *No formal education* [1] | 19.5 |
| *Incomplete primary* | 33.1 |
| *Completed primary* | 10.1 |
| *Incomplete secondary* | 28.3 |
| *Completed secondary and more* | 9.0 |
| Conception intendedness | |
| *Wanted then* | 70.6 |
| *Wanted later* | 22.9 |
| *Unwanted* | 6.5 |
| Age at birth | |
| *≤17* [1] | 4.3 |
| *18-24* | 23.4 |
| *25-34* | 49.7 |
| *35-39* | 13.9 |
| *40+* | 8.7 |
| Mother's BMI | |
| *Thin* [1] | 11.7 |
| *Normal* | 71.8 |
| *Overweight/Obese* | 16.5 |
| Mother's height in cm | 156.93 (mean) |
| Mother's age (years) | 29.6 (mean) |
| Autonomy | |
| Household wealth index | |
| *Lowest* [1] | 21.0 |
| *Second* | 24.2 |
| *Middle* | 20.4 |
| *Fourth* | 19.0 |
| *Highest* | 15.5 |
| Child's age (months) | 19.02 (mean) |
| Birth order | |
| *1* | 14.3 |
| *2* | 15.2 |
| *3* | 14.6 |
| *4* | 14.1 |
| *5+* | 41.8 |
| Child's birth size | |
| *Small* [1] | 10.4 |
| *Average* | 39.3 |
| *Big* | 50.3 |
| Currently breastfeeding | 67.2 |
| Preceding Birth Interval | |
| *≤23 months* | 21.0 |
| *24-35 months* | 48.0 |
| *36-47 months* | 16.9 |

| | |
|---|---|
| *>=48 months* | 14.1 |
| Female child | 49.8 |
| Urban | 29.8 |
| **Source: 2014 EDS-RDCII**<br>**[1] reference category** | |

**Table 2: Multivariate regression analyses testing the relationship between Maternal and Child Characteristics and odds of being stunted, wasted, or underweight in the Democratic Republic of the Congo**

| | Stunted | Wasted | Underweight |
|---|---|---|---|
| Women's educational attainment | | | |
| *Incomplete primary* | 0.93 | 1.46* | 1.15 |
| | 0.75 - 1.17 | 1.04 - 2.06 | 0.90 - 1.46 |
| *Completed primary* | 0.97 | 1.04 | 1.15 |
| | 0.67 - 1.41 | 0.56 - 1.91 | 0.78 - 1.68 |
| *Incomplete secondary* | 0.67** | 0.96 | 1.00 |
| | 0.50 - 0.90 | 0.53 - 1.75 | 0.73 - 1.36 |
| *Completed secondary and more* | 0.49** | 0.93 | 0.84 |
| | 0.30 - 0.80 | 0.43 - 2.01 | 0.52 - 1.36 |
| Pregnancy Intendedness | | | |
| *Wanted later* | 0.81 | 1.15 | 1.07 |
| | 0.62 - 1.05 | 0.77 - 1.72 | 0.78 - 1.45 |
| *Unwanted* | 1.03 | 0.79 | 1.54 |
| | 0.68 - 1.58 | 0.42 - 1.49 | 0.89 - 2.65 |
| Age at birth | | | |
| *18-24* | 0.88 | 0.31** | 0.65 |
| | 0.42 - 1.84 | 0.13 - 0.71 | 0.31 - 1.34 |
| *25-34* | 0.82 | 0.12*** | 0.46+ |
| | 0.33 - 2.02 | 0.03 - 0.41 | 0.18 - 1.16 |
| *35-39* | 0.69 | 0.16* | 0.77 |
| | 0.23 - 2.07 | 0.03 - 0.95 | 0.26 - 2.32 |
| *40+* | 0.55 | 0.12* | 0.47 |
| | 0.14 - 2.10 | 0.02 - 0.90 | 0.12 - 1.82 |
| BMI | | | |
| Normal | 0.93 | 0.61+ | 0.66* |
| | 0.69 - 1.25 | 0.36 - 1.02 | 0.48 - 0.92 |
| *Overweight/Obese* | 0.81 | 0.39* | 0.43*** |
| | 0.51 - 1.27 | 0.16 - 0.94 | 0.27 - 0.69 |
| Mother's height in cm | 0.95*** | 1.00 | 0.96*** |
| | 0.93 - 0.96 | 0.98 - 1.02 | 0.94 - 0.98 |
| Mother's age (years) | | | |
| *20-24* | 1.50 | 1.98 | 1.33 |
| | 0.73 - 3.12 | 0.86 - 4.57 | 0.65 - 2.70 |
| *25-29* | 1.03 | 4.02* | 1.30 |
| | 0.43 - 2.48 | 1.34 - 12.05 | 0.54 - 3.12 |
| *30-34* | 0.92 | 9.32*** | 1.94 |
| | 0.35 - 2.44 | 2.51 - 34.68 | 0.70 - 5.32 |
| *35-39* | 1.10 | 5.24+ | 1.36 |
| | 0.37 - 3.23 | 0.88 - 31.34 | 0.40 - 4.65 |
| *40-44* | 1.40 | 11.99* | 1.71 |
| | 0.37 - 5.33 | 1.76 - 81.82 | 0.37 - 7.94 |
| *45-49* | 1.22 | 10.29* | 2.67 |
| | 0.24 - 6.16 | 1.27 - 83.10 | 0.44 - 16.06 |
| Autonomy | 1.00 | 1.06 | 0.98 |
| | 0.94 - 1.08 | 0.94 - 1.20 | 0.90 - 1.06 |
| Household wealth | | | |
| *Poorer* | 0.86 | 0.87 | 0.90 |
| | 0.64 - 1.15 | 0.55 - 1.39 | 0.66 - 1.23 |
| *Middle* | 0.85 | 1.12 | 0.99 |
| | 0.62 - 1.17 | 0.70 - 1.78 | 0.75 - 1.32 |
| *Richer* | 1.09 | 0.90 | 1.04 |
| | 0.67 - 1.78 | 0.51 - 1.58 | 0.55 - 1.97 |
| *Richest* | 0.67 | 0.50 | 0.44** |

| | | | |
|---|---|---|---|
| | 0.39 - 1.16 | 0.21 - 1.18 | 0.24 - 0.81 |
| Child's Age | | | |
| *12-23* | 4.41*** | 1.47 | 4.70*** |
| | 3.10 - 6.28 | 0.85 - 2.52 | 3.48 - 6.36 |
| *24-35* | 5.44*** | 0.95 | 5.95*** |
| | 3.26 - 9.08 | 0.35 - 2.60 | 3.96 - 8.93 |
| *36-59* | 7.61*** | 0.90 | 6.11*** |
| | 4.70 - 12.29 | 0.31 - 2.62 | 3.59 - 10.40 |
| Birth order | | | |
| *2* | 0.96 | 0.92 | 0.78 |
| | 0.62 - 1.49 | 0.50 - 1.68 | 0.51 - 1.19 |
| *3* | 1.24 | 0.85 | 0.85 |
| | 0.77 - 2.00 | 0.33 - 2.18 | 0.52 - 1.40 |
| *4* | 1.39 | 1.17 | 1.04 |
| | 0.79 - 2.47 | 0.51 - 2.69 | 0.52 - 2.09 |
| *5+* | 1.57+ | 0.64 | 0.77 |
| | 0.93 - 2.65 | 0.26 - 1.57 | 0.41 - 1.46 |
| Birth size | | | |
| *Average* | 0.75+ | 1.03 | 0.65** |
| | 0.53 - 1.05 | 0.65 - 1.63 | 0.48 - 0.89 |
| *Big* | 0.53*** | 0.73 | 0.46*** |
| | 0.37 - 0.75 | 0.46 - 1.16 | 0.32 - 0.66 |
| Currently breastfeeding | 1.02 | 0.98 | 1.27 |
| | 0.74 - 1.41 | 0.48 - 1.98 | 0.90 - 1.79 |
| Birth interval | | | |
| *24-35 months* | 0.93 | 0.71 | 0.68* |
| | 0.71 - 1.22 | 0.46 - 1.08 | 0.50 - 0.92 |
| *36-47 months* | 0.68* | 0.67 | 0.56** |
| | 0.47 - 0.98 | 0.36 - 1.27 | 0.38 - 0.83 |
| *≥ 48 months* | 0.65* | 0.36*** | 0.53** |
| | 0.42 - 1.00 | 0.21 - 0.64 | 0.35 - 0.80 |
| Female | 0.81* | 0.65* | 0.76* |
| | 0.66 - 0.99 | 0.46 - 0.92 | 0.61 - 0.95 |
| Urban | 0.73+ | 1.03 | 0.78 |
| | 0.51 - 1.06 | 0.63 - 1.70 | 0.49 - 1.22 |
| Constant | 1,366.93*** | 0.48 | 315.37*** |
| | 90.98 - 20,537.32 | 0.01 - 18.03 | 24.88 - 3,996.78 |
| Observations | 4,080 | 4,080 | 4,080 |

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

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