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Full Length Research Paper

Maternal education and child nutritional status in the Democratic Republic of Congo

Jacques Be-Ofuriyua EMINA[1,2]*, Ngianga-Bakwin KANDALA[3], Joseph INUNGU[4] and Yazoume YE[5]

[1]Malawi Liverpool Welcome Trust Clinical Research Program, P. O Box 30096, Chichiri, Blantyre 3, Malawi.
[2]Liverpool School of Tropical Medicine, Pembroke Place, Liverpool L3 5QA, UK.
[3]Clinical Sciences Research Institute, Warwick Medical School, University of Warwick, Coventry, UK.
[4]Population Services International, Cotonou, Benin.
[5]ICF Macro, USA.

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Using data from the 2001 Democratic Republic of Congo (DRC)-Multiple Indicators Cluster Survey, this study examines association between maternal education and child nutritional status in the Democratic Republic of Congo. Analyses are based on chi-square tests and logit generalized estimating equations. The results showed that maternal education difference in child nutritional status depends on the nutritional status indicator used. Maternal education is associated with lower prevalence of simultaneous multiple-malnutrition. In contrast, the prevalence of single malnutrition indicators "stunting only" or "wasting only" is higher among children whose mother has secondary education or higher. However, depending on the indicator, the association disappears or appears only after controlling for the province of residence. Therefore, any study on the determinants of children nutritional status should be based on a clearly defined nutritional indicator. In addition, only national policies integrating education, access to food and use of health service are pivotal to improve child health and nutrition.

Key words: Nutritional status, under-five children, maternal education, Democratic Republic of Congo, socioeconomic factors, conflict affected area.

INTRODUCTION

The nutritional status of children influences their health status, which is a key determinant of human development. Malnutrition is associated with about 60% of under-five mortality in sub-Saharan Africa (UNICEF, 1998). Therefore, improvement of children nutritional status increases the chances of child survival and is considered as a precondition for their contribution to community as well as human development (UNICEF, 1998).

In parallel, it is well established that mothers' education has a positive effect on child health in developing countries (Caldwell, 1979); though findings from existing studies have shown mixed results. Indeed, depending on the unit of analysis, the socio-economic and the cultural context, some studies have shown significant maternal education difference in child nutritional status (Caldwell, 1979; Baraigi, 1980; Solon et al., 1985; Reed et al., 1996; Desai and Alva, 1998; Gwatkin et al., 2000a, b) while other studies did not (Pongou et al., 2006). Nevertheless, investing in women's education is widely advocated as a key intervention strategy for promoting child health.

The Democratic Republic of Congo (DRC) national reports show improvement in women education. The proportion of women with secondary or higher education increased from 16% in 1984 to 30% in 2001 and that of women without formal education decreased from 50 to 20% during the same period. At the same time, citizens of the DRC are among the poorest in the world though the country is considered to be the richest country in the world regarding natural resources. The Congolese have the second lowest nominal gross domestic product (GDP)

*Corresponding author. E-mail: jacques.emina@gmail.com.

per capita. The country has the worst human development index (HDI) and global peace index (GPI) in decades (Institute for Economics and Peace, 2011). Between 1980 and 2010, Congo's HDI declined by -0.4% annually from 0.267 to 0.239 today, which gives the country a rank of 168 out of 169 countries with comparable data (UNDP, 2010). Likewise, the DRC's GPI score deteriorated in 2010 and the country remains among the ten lowest-ranked nations in the 2011 GPI. The country is ranked 148th of 153 countries in 2011, compared with 140th of 149 nations in the 2010 GPI. Furthermore, the DRC has the higher global hunger index (GHI) worldwide that has increased from 24.7 in 1990 to 41.0 in 2010.

Does maternal education affect child nutritional status even in such hard living conditions? Yet, except for some descriptive survey reports (Zaïre, 1996; UNICEF and USAID, 2002; Congo, 2008), few systematic studies of factors that influence the prevalence of malnutrition among young children in the DRC were carried out (Kandala et al., 2011).

This study has twofold objectives. First, the study aims to assess the association between maternal education and children nutritional status in the DRC; also, the study will identify the factors that account for the difference. A good understanding of the pathways of maternal education difference in child nutritional status in a post conflict country like the DRC will inform the country's efforts in achieving the health-related Millennium Development Goals (MDGs).

MATERIALS AND METHODS

Data source

This study is based on secondary analysis of the children module of the 2001 DRC multiple indicators cluster survey (MICS2), a nationally representative investigation of children and women. The MICS is an international household survey initiative developed by UNICEF to assist countries in collecting and analyzing data in order to fill data gaps for monitoring the situation of children and women. The MICS was originally developed in response to the World Summit for Children to measure progress towards an internationally agreed set of mid-decade goals (Multiple indicator survey 6 (MICS), 2011). Data from MICS allow producing statistically sound and internationally comparable estimates of a range of indicators in the areas of health, education, child protection and HIV/AIDS.

The 2001 DRC MICS2 used a two stage method. At first stage, 206 clusters (enumeration areas) in rural areas and 94 in urban areas were selected with probability proportional to population size. At the second level, villages in rural areas and "quartiers" in urban areas were selected with probability proportional to population size. The selected villages and "quartiers" dwellings (compounds) units were selected randomly. All households, women (15 to 49 years) and children aged less than 5 years old within each dwellings unit were selected for interview.

In total, 7,438 occupied dwellings, 8,704 households, 12,818 women (15-49) and 10,364 children aged less than 5 years old were selected for interview. Although 100% of targeted dwellings were occupied, the DRC 2001 MICS2 analytical files include 8,141 households; 12,407 women (15 to 49) and 9,454 children aged less than 5 years old due to the non-response and inconsistencies in responses. With reference to anthropometric data, 1.7% of children do not have weight records and 2.1% do not have height records. Maternal education is missing for 98 children (1% of the sample). Therefore, our analyses are based on 9,748 children. This sample is from 365 enumeration areas among which are 206 rural areas, 28 districts and 128 municipalities ("territoires") out of the 143 in the DRC. Each major city including Kinshasa and province-capital are represented by 1 "quartier" at least.

The questionnaire includes 17 modules and the database encompasses 7 analytical files: 1) household file including information on housing, assets and amenities (module 1); 2) individual files encompassing household membership record, child (5 to 17 years old) education and child labour (module I to module IV); 3) women (15 to 49 years) file that stores reproductive health behavior, attitudes and knowledge (module VI to module X); 4) children file including child nutritional status, breastfeeding, morbidity and under-five mortality (module XII to XVII); 5) children living elsewhere (module V); 6) children immunization; and 7) community information. The questionnaire was in French, although interview was done in local languages. Fieldworkers were trained on the administration of the questionnaire in the local languages. This study is based on the children file including child health status, mother's and household's characteristics.

Details on sampling, questionnaires, fieldwork operations and evaluation of data quality are reported elsewhere (Congo, 2002; DRC-MICS, 2011).

Analytical framework

This study analyzes the association between maternal education and child health outcomes through three theoretical approaches (or hypotheses): socioeconomic status, women empowerment and autonomy, and health and reproductive behavior. We summarize below the main propositions of each of these theoretical model, how we operationalize them in the current study, and their respective importance in understanding the relationship between maternal education and child nutritional status in the DRC.

Socioeconomic status approach

This is the most dominant theme in the explanation of the association between maternal education and child health outcome, the socioeconomic status approach. This approach assumes that maternal education is a proxy for socioeconomic status at the individual and household levels (Cleland and Van Ginneken, 1988; Frost et al., 2005). In general, the most educated women come from high socioeconomic strata of the society. They tend to have better work opportunities and high incomes compared to non-educated women. Educated women are also more likely to marry husbands with high education level, belonging to high socio-economic class of the society (Cleland and Van Ginneken, 1988; Barrett and Brown, 1996). In addition, they tend to live in more economically developed areas such as urban areas with access to safe water, sanitation systems, and health facilities. In parallel, children from high socio-economic households with mothers working in formal sectors are well fed; less exposed to infectious diseases, and have access to health services (preventive and curative cares). Therefore, there is an inverse relationship between the mother's education and child under-nutrition (Frost et al., 2005; Mukuria et al., 2005).

Following the empirical and theoretical considerations and the availability of data in this study, we focus on household wealth index, place of residence (urban or rural) and the province of residence. The MICS wealth index is an attempt to measure the household socioeconomic status. Principal components analysis was performed by using information on the ownership of household

goods and amenities (assets) to assign weights to each household asset, and obtain wealth scores for each household in the sample. The assets used in these calculations were as follows: persons per sleeping room, type of floor, type of roof, type of wall, type of cooking fuel, electricity, radio, TV, mobile and non-mobile phone, refrigerator, watch, bicycle, motorcycle or scooter, car or truck, boat with a motor, source of drinking water, and type of sanitary facility. Each household was then weighted by the number of household members. Households were divided into five groups of equal size (wealth quintile), from the poorest quintile to the richest quintile, based on their wealth index scores from factor analysis. The MICS wealth index does not provide information on absolute poverty. Further information on the construction of the wealth index can be found in Filmer and Pritchett (2001) and Rutstein and Johnson (2004).

Women empowerment and autonomy approach

One of the conclusions that have received far more consensus among scholars of reproductive health behavior including child health status is the role played by women's empowerment and participation in decision-making including child nutrition as well as use of health services (Kravdal, 2004). Women empowerment and autonomy include: 1) opportunity for women to take part and be heard in discussions with parents, husbands, or in laws regarding use of preventive health services, child's nutrition, and treatment of sick children; and 2) access to economic market and women's rights regarding their sexual as well as reproductive behavior. These different dimensions of women's autonomy impact on child nutritional status through their participation in decision-making regarding reproduction behavior (birth interval, number of children), child feeding patterns, and use of health services. Unfortunately, the 2001 DRC MICS did not collect data on different aspects of women's empowerment and autonomy listed above. Therefore, we use the relationship to the head of household as proxy to capture women autonomy in our analyses. We assume that women who are head of household have autonomy and are decision-makers regarding their children diet and access to health facilities.

Health and reproductive behavior approach

Reproductive and health behavior provide another pathway through which women's education impact child health outcomes including child nutritional status. Forste (1998) found negative association between maternal age and child stunting in Bolivia. Likewise, short (preceding as well as subsequent) birth intervals are associated with a high risk of child stunting (Forste, 1998). In parallel, previous studies have shown that educated women have better nutritional status, give birth at low risk ages, have longer birth intervals and have lower fertility (Cleland and van Ginnekken, 1988; Mukuria et al., 2005). We measure health and reproductive behavior by three key variables: maternal age at child's birth, her number of under-five children and child possession of health card.

Following from the framework discussed and availability of data, we summarize the analytical framework for this study in Figure 1. The framework assumes that maternal education difference in child nutritional status is related to socioeconomic status measured in term of household wealth index, place of residence and region of residence; maternal autonomy and participation in decision-making, captured by the relationship to the head of household; and maternal health and reproductive behavior measured by the number of under-five children, maternal age at the index child birth and possession of health card. We measure child nutritional statu by two indicators: wasting and stunting.

Measurement

Outcome: Child nutritional status

Children's nutritional status is a reflection of their overall health. Nutritional status in young children is conventionally determined through measurement of height, weight, skin-fold thickness (or subcutaneous fat) and age. The most commonly used indices derived from these measurements are stunting (low height-for-age), wasting (low weight-for-height) and underweight (low weight-for-age).

In a well-nourished population, there is a standard distribution of height and weight for children under age five. In this study, under-nourishment in a population is gauged by comparing children to the WHO/CDC/NCHS reference, which is recommended for use by UNICEF and the World Health Organization. The 2001 DRC-MICS data provide the three nutritional status indicators (height-for-age, weight-for-height and weight-for-age) in standard deviation units (z-scores) from the median of this reference population.

Height-for-age is a measure of linear growth. Children whose height-for-age is more than two standard deviations below the median of the reference population are considered short for their age and are classified as moderately or severely stunted. Stunting is a reflection of chronic malnutrition as a result of failure to receive adequate nutrition over a long period and recurrent or chronic illness.

Weight-for-height is usually the result of a recent nutritional deficiency. Children whose weight-for-height is more than two standard deviations below the median of the reference population are classified as moderately or severely wasted, while those who fall more than three standard deviations below the median are severely wasted. The indicator may reveal significant seasonal shifts associated with changes in the availability of food or disease prevalence.

Finally, weight-for-age is a measure of both acute and chronic malnutrition. Children whose weight-for-age is more than two standard deviations below the median of the reference population are considered moderately or severely underweight while those whose weight for age is more than three standard deviations below the median are classified as severely underweight.

These indices reflect distinct biological processes, and their use is necessary for determining appropriate interventions. However, they are not mutually exclusive. Some children who are under-weight will also have wasting and/or be stunted; and some children who have wasting will also be stunted and/or underweight. For instance, using anthropometric data on 24,396 children in India, Nandy et al. (2005) found that 41.2% had multiple antropometric failures. This proportion represents 68.9% of undernourished children in India. Furthermore, children with multiple anthripometric failures are at greater risk of morbidity and are likely living in poorer households (Nandy et al., 2005).

Against this background, this study considers moderate and severe malnutrition, meaning that malnourished children include all children whose height-for-age or weight-for-height or weight-for-age is more than two standard deviations below the median of the reference population. Nutritional status is measured by three independent indicators: 1) stunting only; 2) wasting only; and (3) simultaneous multiple-malnutrition (stunting and wasting).

Three reasons support the use of these indicators. First, the common indicators (stunting, wasted and underweight) overlap: some children who are stunted will also be wasted and/or be underweight; some children who are underweight will also be wasted and/or be stunted; and some children who are wasted will also be stunted and/or underweight (Svedberg, 2000; Nandy et al., 2005). Second, wasting and stunting represent different processes of malnutrition and are associated with different risk factors (Ricci and Becker, 1996; Van de Poel et al. 2008; Ramli et al., 2009). Lastly, children who are simultaneously stunted and wasted are

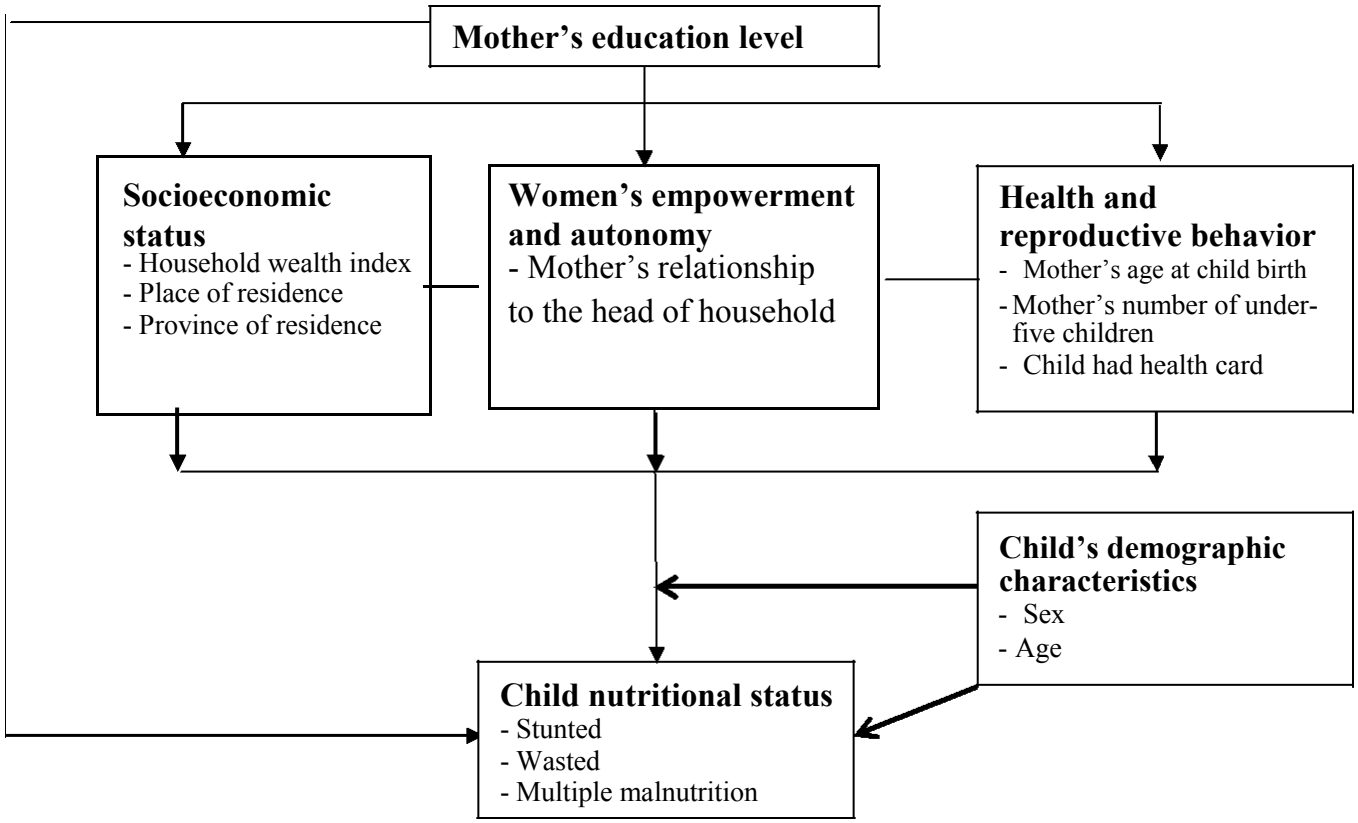

Figure 1. Maternal education and child nutritional status, analytical framework (adapted from UNICEF, 2008).

likely to suffer from diarrhea and acute respiratory infection (Nandy et al., 2005).

Therefore, we will assess whether association between maternal education and child nutritional status is selective depending on the considered child nutritional status indicator:

Predictor - maternal education: maternal education is defined as the highest level of schooling attended, but not necessarily completed. This variable has three categories: no education, primary, secondary education or higher.

Control factors: four categories of control variables are used according to our analytical framework and available information in the dataset. Some of these variables may be the causal pathway between maternal education level and the dependent variable of child nutritional status; other may be confounding variables:

i. Socioeconomic characteristics encompass four following indicators: place of residence, province of residence and household wealth index;

ii. Health and reproductive behavior is measured by three indicators: the possession of health card (proxy of attending preventive health service such as immunization), maternal age at child birth; and mother's number of children aged less than 5 years. We used this last variable as proxy of birth interval not available in our dataset. High number of under-five children from the same mother assumes short birth interval although this could be biased by infant and/or under-five mortality.

iii. Mother's empowerment and autonomy is captured by her relationship to the head of household.

iv. Child demographic characteristics are measured by child sex and age.

Statistical analyses

To assess the impact of maternal education on child nutritional status, we use descriptive methods (frequency distribution), chi-square and multivariate analysis based on the logit generalized estimating equation (LGEE) with exchangeable correlation covariance matrix using STATA 10.

Described by Liang and Zeger (1986), GEE extend the generalized linear model to allow for correlated observations that may exist on a given subject (children). It is characterized by the marginal expectation (average response for observations sharing the same covariates) as a function of covariates. We assume the marginal regression model:

$$G(E[Y_{IJ} / X_{IJ}]) = X_{IJ}^{'}\beta,$$

Where *xij* is a p times 1 vector of covariates, β consists of the p regression parameters of interest, g(.) is the link function, and *Yij* denotes the *j*th outcome (for j=1,.,J) for the *i*th subject (for i=1,.,N). We choose the logit link function to include: g(a)=log(a/(1-a)) [logit link for binary data].

Assuming no missing data, the J x J covariance matrix for Y is modelled as:

$$V_I = \varphi A_I^{1/2} R(\alpha) A_I^{1/2}$$

Where φ is a glm dispersion parameter, A is a diagonal matrix of

variance functions, and $R(\alpha)$ is the working correlation matrix of Y (exchangeable correlation covariance matrix).

The LGEE estimates the same model as the standard logistic regression, appropriate when the dependent variable is dichotomous. Unlike in logistic regression, LGEE allows for dependence within clusters. The appeal of GEE models is that it gives consistent estimates of the parameters and consistent estimates of the standard errors can be obtained using a robust "sandwich" estimator even if the "working" correlation matrix is incorrectly specified. If the "working" correlation matrix is correctly specified, GEE models will give more efficient estimates of the parameters. GEE models measure population-averaged effects as opposed to cluster-specific effects (Ziegler, 1998).

The analysis is performed in three steps regardless of the method (chi-square or LGEE). First, we assess the crude association between maternal education and each indicator of child malnutrition (Table 2). Secondly, we performed analysis using the theoretical model presented in the analytical framework (Table 3). We ran a separate model for each set of explanatory variables to identify mediating and/or moderating factors among the selected control variables. Lastly, we included all variables from each model in the final model to capture the maternal net difference in child nutritional status.

To assess the different theoretical approaches presented in the analytical framework section: socioeconomic status hypothesis; health and reproductive behavior, and mother's empowerment and autonomy hypotheses, we control for control variables through stratification or analysis by strata and multivariate logit generalized estimating equation (LGEE). If the initial difference disappears after control for one variable, we say that this variable is the factor that account for the difference. In this case, maternal education is a covariate which itself does not have influence on child nutritional status. In contrast, if any variable does not inhibit the initial difference, we say that maternal education is itself a factor of child nutritional status in the DRC.

According to the framework, the statistical analysis was performed by five LGEE- models. The first model assesses the bivariate association between maternal education and child nutritional status (unadjusted model). Model 2 presents the association between maternal education and child nutritional status after controlling for mother's health and reproductive behavior indicators. Models 3 and 4 evaluate the association between maternal education and child nutritional status after including respectively socioeconomic characteristics and the relationship between the mother and the head of household. The last model includes maternal education and all control variables.

RESULTS

Maternal education differences in health behaviour and socioeconomic characteristics

Table 1 reports maternal education difference in selected background variables through the sample descriptive statistics. With reference to the predictor, stratification of children by maternal education has reversal U form: 27% have non-educated mother whereas 31% have a mother who has attended at least secondary school.

The sample distribution by child's demographic characteristics seems to be similar across maternal education categories except the slight overrepresentation of male children among the most educated mothers. The distribution of children by age shows reversed U pattern. Majority of children belong to the groups 6 to 11 months and 12 to 23 months representing about 20% respectively, regardless of the mother's education.

By contrast, there is maternal education difference in health and reproductive behavior as well as socioeconomic characteristics and the relationship to the head of household. Overall, children whose mothers have attended at least secondary school are more likely to: 1) have health card (67%) compared to other children (less than 50%); 2) live in urban areas (70% compared to less than 30% for other children), particularly in Kinshasa, the country capital-city. The lower proportion of children whose mother has at least secondary education is observed in Maniema (1%), Nord-Kivu and Sud-Kivu (3%); and 3) live in wealthier households. More than half of children with a most educated mother stay in the richest household compared to 3% for children whose mother never attended school. Further, most of the non-educated mothers are spouse of head of household, whereas proportion of others including daughter is much higher among the most educated mothers. The analysis of the sample distribution assumes that maternal education differences impact on child nutritional status.

Maternal education and child nutritional status in the DRC: Mixed results

Maternal education and child nutritional status: Descriptive results

Table 2 displays the distribution of nutritional status among children aged less than five years in the DRC by maternal education. About fifty-two percent of children under five are malnourished (stunted and/or wasted). Most of the malnourished children (59%), about thirty percent of the sample, are suffering from simultaneous malnutrition problems. These children are simultaneously stunted and wasted. Children suffering from stunting only represent 16% of the sample whereas five percent of the sample suffered from wasting only (Figure 2).

The analysis of children nutritional status by maternal education presents mixed results (Table 2). Maternal education is negatively associated with the prevalence of simultaneous multiple-malnutrition.

Proportion of children suffering from simultaneous multiple-malnutrition decreases from 39.5% for children whose mother never attended school to 20.4% for those whose mother has attended at least secondary school. Maternal education could be considered as a factor of child health promotion if one considers the prevalence of simultaneous multiple-malnutrition.

However, opposite results are observed considering single malnutrition indicators. Indeed, there is no signify-cant association between maternal education and the prevalence of stunting among children under the age of 5 years in the DRC. Further, unexpectedly there is positive association between maternal education and the

Table 1. Percentage of under five children by mother's education level according to the intermediate factors.

Control variable	Maternal education			Total	
	None	Primary	Secondary and +	Percent	Number
Child demographic characteristics					
Child' sex					
Male	48.3	49.4	51.7	49.8	4,855
Female	51.7	50.6	48.4	50.2	4,893
Child' age					
< 6 months	11.5	12.2	12.1	12.0	1,165
6-11 months	10.7	12.4	10.3	11.3	1,099
12-23 months	21.5	22.3	22.6	22.2	2,161
24-35 months	20.0	18.7	18.6	19.0	1,855
36-47 months	17.5	16.8	19.4	17.8	1,739
48-59 months	18.8	17.6	17.0	17.7	1,728
Health and reproductive behavior					
Mother age at child birth					
<20	11.1	14.0	9.5	11.8	1,150
20-34	62.0	67.1	75.9	68.4	6,672
35and+	26.9	18.9	14.6	19.8	1,926
Number of under-five children					
1	37.4	35.3	36.9	36.4	3,546
2	49.7	52.5	47.2	50.1	4,880
3	12.9	12.2	15.9	13.6	1,322
Had health card					
No	62.7	54.8	32.7	50.0	4,877
Yes	37.3	45.2	67.3	50.0	4,871
Socioeconomic factors					
Place of residence					
Urban	11.0	25.5	69.6	35.4	3,446
Rural	89.0	74.5	30.4	64.7	6,302
Province					
Kinshasa	2.7	5.8	34.4	13.9	1,352
Bas-Congo	3.4	5.8	6.3	5.3	515
Bandundu	10.6	12.5	12.4	11.9	1,162
Equateur	17.6	12.2	4.8	11.4	1,107
Orientale	11.3	12.4	5.6	10.0	974
Nord-Kivu	12.9	7.0	2.7	7.3	708
Sud-Kivu	11.5	4.9	3.0	6.1	593
Maniema	3.9	2.9	1.0	2.6	253
Katanga	14.1	11.3	8.8	11.3	1,100
Kasai oriental	5.9	12.0	13.8	10.9	1,058
Kasai occidental	6.1	13.4	7.3	9.5	926
Household wealth index					
Poorest	30.2	22.6	7.8	20.0	1,953
Poor	26.3	22.8	9.2	19.5	1,903
Middle	24.6	22.8	11.0	19.6	1,911

Table 1. Contd.

Rich	15.8	21.3	19.7	19.3	1,877
Richest	3.2	10.5	52.3	21.6	2,104
Mother's empowerment and autonomy					
Relationship to head of household					
Head of household	4.8	4.1	5.2	4.7	453
Spouse	82.8	78.6	72.9	78.0	7,601
Other	12.5	17.2	21.9	17.4	1,694
Total (%)	100.0	100.0	100.0	100.0	9,748
Total (N)	2,680	4,015	3,053	9,748	

Source: 2001 –DRC MICS.

Table 2. Maternal education and child nutritional status in DRC, 2001.

Maternal education	Stunted only			Wasted only			Simultaneous multiple malnutrition			Total No.
	Percent	Chi-square	P-value	Percent	Chi-square	P-value	Percent	Chi-square	P-value	
None	16.3			4.7			39.5			2,680
Primary	16.4	2.622	0.269	4.7	15.30	0.000	32.7	257.78	0.000	4,015
Secondary and +	15.0			6.6			20.4			3,053
Total	15.9			5.3			30.7			9,748

Source: 2001; DRC-MICS.

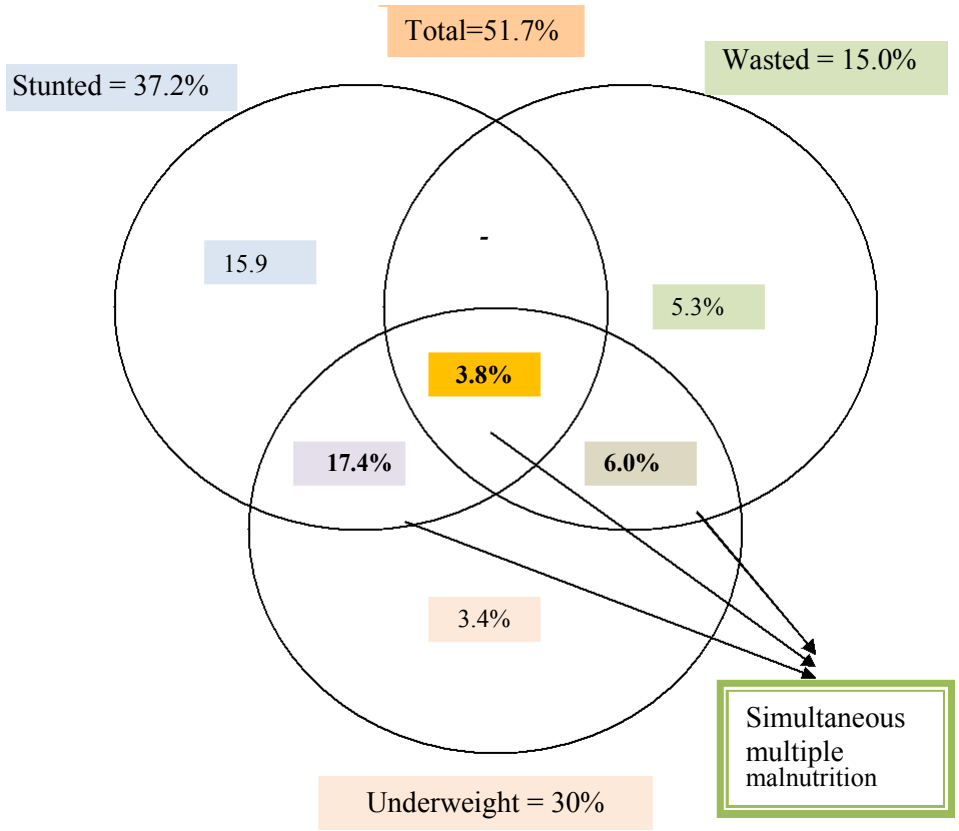

Figure 2. Child malnutrition in the Democratic Republic of Congo by indicator.

likelihood of being wasted only. Compared to children whose mothers have no education or have attended only primary school, children of the most educated mothers experienced a high risk of being wasted only: 6.6% of the children whose mothers have secondary education or higher were wasted only, about 40% more than children whose mothers have no education or attended only primary school (4.7%). Therefore, considering single malnutrition indicators (only stunted and only wasted), maternal education is not associated with the promotion of child health.

What could explain these mixed results regarding the relationships between maternal education and child nutritional status in the DRC? For each nutritional status indicator, we will use multivariate LGEE to assess different hypotheses presented in the analytical framework and to evaluate the validity of findings from bivariate analysis reported in Table 2. There are five LGEE models for each outcome (Tables 3 to 5). The first model assesses the association between maternal education and child nutritional status. The second model includes maternal education, child characteristics and maternal health/reproductive behavior indicators. The third model incorporates socioeconomic characteristics in addition to maternal education, whereas mother relationship to the head of household, proxy of mother autonomy, is introduced in the fourth model. The last model encompasses all variables included in previous models (Models 1 to 4).

Maternal education and child stunting in the DRC

Table 3 shows the risk of stunting (odds ratio) and the corresponding p-values among children aged less than five years in the DRC using five LGEE models as described. The relationship between maternal education and the prevalence of stunting in the DRC is not significant at bivariate level.

However, the likelihood of being stunted becomes positively associated with maternal education after controlling for socioeconomic variables, particularly the province of residence (Models 3 and 5, Table 3). Indeed, the likelihood of experiencing stunting for an under-five child is about 19% lower [odds-ratio=0.81; 95% Confidence Interval (CI) = 0.68 to 0.97] among children whose mothers did not attend school compared to children whose mothers have secondary education or higher. Likewise, children whose mothers have primary education have about 13% lower [odds-ratio=0.878; 95%; 95% CI=0.754 to 1.021] compared to those whose mothers have secondary education, though the difference is not statistically significant at 5%.

Therefore, the province of residence could be considered as the confounding factor of the association between maternal education and child stunting in the DRC. This could be due to variation of maternal education difference in child stunting pattern by province (Figure 3).

In 4 provinces out of 11, there is positive association between the risk of being stunted only and maternal education. Reversed U pattern (∩) association is observed in three provinces where higher risk of child stunting is observed among children born to non-educated women and those whose mothers are most educated. The opposite situation (U pattern) is observed in three other provinces meaning that the lowest prevalence is observed among children whose mothers are most educated or non-educated. The expected negative association between maternal education and stunting is only observed in Maniema.

The analysis of other factors included in the models shows that child's age and the province of residence are the most important factor associated with stunting prevalence in the DRC. The likelihood of being stunting is positively associated with child's age. With reference to the province of residence, the lowest prevalence of stunting is observed in Kinshasa, the capital-city, whereas the highest is observed in provinces under war during the survey (Equateur, Orientale, Nord-Kivu, Sud-Kivu and Maniema). The risk for a child living in these provinces to experience stunting is double of a child living in Kinshasa.

Maternal education and child wasting

Children of the most educated women are more likely to experience wasting than their counterparts in the DRC. However, the association between maternal education and wasting is not significant after accounting for socioeconomic characteristics in models 3 and 5 (Table 4).

Like for stunting, child's age and his/her province of residence are the only variables significantly associated with the risk for a child to experience wasting. By contrast to child's pattern of stunting prevalence, wasting prevalence among under-five children in the DRC decreases with child's age. Likewise, whereas children living in Kinshasa are less likely to suffer from stunting, they are more likely to experience wasting compared to their counterpart living in other provinces.

Maternal education and simultaneous multiple malnutrition

A child is considered as suffering from simultaneous multiple-malnutrition if he/she is simultaneously stunting and wasting. Risks (odds-ratio) of experiencing simultaneous multiple malnutrition and p-values are presented in Table 5.

Simultaneous multiple-malnutrition is negatively associated with maternal education regardless of regression

Table 3. Factors associated with child stunting in DRC, 2001: Odds ratio from LGEE.

Predictor	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z
Maternal education										
None	1.098	0.221	1.108	0.208	0.809	0.017	1.071	0.372	0.801	0.017
Primary	1.106	0.140	1.150	0.052	0.873	0.075	1.091	0.201	0.893	0.153
Secondary and Higher	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Child characteristics										
Child' sex										
Male			1.111	0.064					1.110	0.069
Female			Ref	Ref					Ref	Ref
Child' age										
< 6 months			Ref	Ref					Ref	Ref
6-11 months			1.474	0.042					1.459	0.049
12-23 months			2.818	0.000					2.797	0.000
24-35 months			5.278	0.000					5.326	0.000
36-47 months			6.762	0.000					6.767	0.000
48-59 months			7.574	0.000					7.579	0.000
Health behavior factors										
Mother age at birth										
< 20			Ref	Ref					Ref	Ref
20-34			0.927	0.398					0.920	0.361
35 and high			0.861	0.153					0.839	0.103
Number of under 5 children										
1			Ref	Ref					Ref	Ref
2			0.943	0.367					0.917	0.198
3 and +			0.999	0.993					0.952	0.621
Had health card										
No			0.989	0.854					0.935	0.301
Yes			Ref	Ref					Ref	Ref
Socio-economic factors										
Place of residence										
Urban					0.916	0.316			0.924	0.391
Rural					Ref	Ref			Ref	Ref
Province of residence										
Kinshasa					Ref	Ref			Ref	Ref
Bas-Congo					1.582	0.006			1.613	0.005
Bandundu					1.506	0.006			1.439	0.020
Equateur					2 .078	0.000			2.059	0.000
Orientale					2.296	0.000			2.252	0.000
Nord-Kivu					2.205	0.000			2.102	0.000
Sud-Kivu					2.271	0.000			2.277	0.000
Maniema					2.355	0.000			2.404	0.000
Katanga					1.596	0.002			1.590	0.002
Kasai-Oriental					1.763	0.000			1.733	0.000
Kasai-Occidental					1.512	0.008			1.541	0.007

Table 3. Contd.

Household wealth index						
Poorest	Ref	Ref			Ref	Ref
Poor	1.039	0.681			1.001	0.991
Middle	1.062	0.514			1.040	0.686
Rich	1.307	0.006			1.283	0.016
Richest	0.987	0.923			0.905	0.484
Mother's autonomy						
Relationship to head of household						
Head of household			Ref	Ref	Ref	Ref
Spouse			1.123	0.417	1.200	0.224
Other			0.851	0.307	1.044	0.797

Source: 2001 DRC – MICS; Model 1: bivariate, Model 2: Child characteristics, health and reproductive behavior, Model 3: socioeconomic status; Model 4: mother's autonomy, Model 5: global.

models. Children born to non-educated women experience higher risk of simultaneous multiple malnutrition even after controlling for control variables (Models 2 to 5). However, the magnitude of maternal education difference in child simultaneous multiple-malnutrition decreases when socioeconomic factors are included in the model (Models 3 and 5). Compared to children born to mothers with secondary education, those born to non-educated mothers have 2.6 times the risk of simultaneous multiple-malnutrition in bivariate model. This ratio decreased to 1.8 times after controlling for socioeconomic factors (Models 3 and 5). Likewise, children born to mothers with primary education have 1.9 times the risk of simultaneous multiple-malnutrition observed among children whose mothers have secondary education in bivariate model, whereas this risk decreased to 1.5 after controlling for socioeconomic factors.

These findings support the socioeconomic hypothesis assuming that part of maternal education in child simultaneous multiple-malnutrition is due to the association between women education and their socioeconomic status (place of residence, province and wealth index) in one hand; and on the other hand, the association between children health status and women socioeconomic status. In fact, in the DRC, 70% of children whose mothers have a secondary education live in urban areas, and 52% in the richest households. These proportions are respectively 11 and 3% for children whose mothers are not educated. In parallel, children living in urban areas particularly in Kinshasa and in the richest households are less exposed to poor health outcomes including malnutrition (Table 6).

With reference to control variables, the analysis of Models 2 to 5 shows that child's characteristics (sex and age) and all socioeconomic variables (place of residence, province and household wealth index) and the relationship to the head of household are significantly associated with the risk of simultaneous multiple- malnutrition.

DISCUSSION

This study examined maternal education difference in child nutritional status in the DRC. The study relies on the 2001 DRC multiple indicators cluster survey (MICS2). The independent variable, the educational attainment, has three categories: none, primary and secondary or higher. Considering the outcome, the study used refined indicators of child's nutritional status (only stunted, only wasted and simultaneous multiple malnutrition).

To identify factors driving maternal education difference in child nutritional status, tested three hypotheses separately and simultaneously (combined): health and reproductive behavior, socioeconomic status and women autonomy models.

Statistical analyses included LGEE that is relevant to the nature of variables mostly categorical and the nature of data sets (hierarchical structure: children are nested in households and households are nested in communities). The LGEE method has the ability to produce estimates of regression coefficients and standard errors that are efficient and robust by accommodating clustering or correlation in data (Ziegler, 1998). This is because the data used contain more than one child per woman: about 64% of the children have a mother who has two under-five children or more. In a selected household, all eligible women (15 to 49 years) were interviewed and health data were collected for their children aged less than 5 years old. In light of findings from various analyses, four keyresults could be discussed:

i. Anthropometric measures (height-for-age, weight-for-age and weight-for-height) are not mutually exclusive. They overlap.

ii. Maternal education differences in child nutritional status depend on the nutritional status indicator used.

iii. Socioeconomic factors influence the maternal education difference in child nutritional status although

Table 4. Factors associated with child wasting in DRC, 2001: Odds ratio from LGEE.

Predictor	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z
Maternal education										
None	0.700	0.000	0.685	0.002	1.002	0.911	0.704	0.003	0.988	0.938
Primary	0.693	0.000	0.655	0.000	0.871	0.244	0.695	0.001	0.833	0.143
Secondary and higher	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Child characteristics										
Child' sex										
Male			0.994	0.746					1.011	0.909
Female			Ref	Ref					Ref	Ref
Child' age										
< 6 months			Ref	Ref					Ref	Ref
6-11 months			1.239	0.130					1.250	0.113
12-23 months			0.603	0.000					0.604	0.000
24-35 months			0.401	0.000					0.394	0.000
36-47 months			0.176	0.000					0.174	0.000
48-59 months			0.238	0.000					0.235	0.000
Health behavior factors										
Mother age at birth										
< 20			Ref	Ref					Ref	Ref
20-34			0.943	0.758					0.898	0.489
35 and high			1.135	0.433					1.059	0.758
Number of under 5 children										
1			Ref	Ref					Ref	Ref
2			0.997	0.994					0.995	0.962
3 and +			0.906	0.570					0.900	0.545
Had health card										
No			0.957	0.773					0.992	0.943
Yes			Ref	Ref					Ref	Ref
Socio-economic factors										
Place of residence										
Urban					1.128	0.384			1.137	0.388
Rural					Ref	Ref			Ref	Ref
Province of residence										
Kinshasa					Ref	Ref			Ref	Ref
Bas-Congo					0.465	0.005			0.441	0.003
Bandundu					0.869	0.472			0.897	0.607
Equateur					0.853	0.478			0.880	0.570
Orientale					0.515	0.004			0.523	0.005
Nord-Kivu					0.255	0.000			0.263	0.000
Sud-Kivu					0.406	0.001			0.404	0.001
Maniema					0.372	0.023			0.366	0.016
Katanga					0.553	0.006			0.541	0.005
Kasai-Oriental					0.717	0.103			0.707	0.094
Kasai-Occidental					0.836	0.414			0.816	0.360

Table 4. Contd.

Household wealth index						
Poorest	Ref	Ref			Ref	Ref
Poor	0.965	0.628			0.999	0.995
Middle	0.926	0.792			0.972	0.862
Rich	0.940	0.354			1.216	0.267
Richest	1.155	0.948			1.100	0.659
Mother's autonomy						
Relationship to head of household						
Head of household			Ref	Ref	Ref	Ref
Spouse			0.954	0.805	0.833	0.404
Other			1.013	0.999	0.738	0.221

Source: 2001 RDC-MICS; Model 1: bivariate, Model 2: health and reproductive behavior, Model 3: socioeconomic status; Model 4: mother's autonomy, Model 5: global.

the nature and the direction of this influence depend on the nutritional status indicator.

iv. Child's age and the province of residence are key determinants of the child's nutritional status.

Stunting, wasting and underweight overlap

Though stunting and wasting have different biological patterns, most children experiencing stunting are also suffering from wasting, and vice-versa. Furthermore, though underweight, the indicator for MDG1 is a combination of wasting and/or stunting, some children are underweight without being wasted or stunted. These findings are consistent with other studies in developing countries (Nandy et al., 2005; Nandy and Miranda, 2008; Lutter et al., 2011). This suggests that the MDG target should be children with simultaneous multiple malnutrition for two reasons. First, underweight as an indicator clearly misses numbers of undernourished children. Secondly, children with simultaneous multiple-malnutrition are more likely to have health problems including diarrhea (Nandy et al., 2005; Nandy and Miranda, 2008; Lutter et al., 2011).

Variation of maternal education differences in child nutritional status

The choice of malnutrition indicator affects the conclusion about the relationship between maternal education and child nutritional status. There is negative association between maternal education and child nutritional status if one considers non-refined indicators (stunted, wasted and underweight) and simultaneous multiple-malnutrition. Similar results were found in India (Nandy et al., 2005) where the prevalence of simultaneous malnutrition is high among children living in low socioeconomic status households. Indeed, the most educated women live in higher socioeconomic households or good environments, and are able to break logistical and geographical barriers to healthcare utilization.

Surprisingly, children whose mothers have secondary education or higher are more likely exposed to single malnutrition indicators (only stunted or only wasted). Reed et al. (1996) have reported unexpected negative association between maternal education and child nutritional status in 41 rural communities of Benin. The fact that majority of children of less educated mothers (none or primary) suffer from simultaneous multiple malnutrition could explain this finding.

Maternal education and child nutritional status: role of socioeconomic factors

Overall, none of the control variables explain fully maternal education difference in child nutritional status. Similar results were found in Bolivia (Frost et al., 2005). It is possible that there are other pathways through which maternal education affects children's nutritional status. Information on maternal diet knowledge, attitude and beliefs, unavailable in the MICS data, may contribute to the understanding of the relationship between maternal education and child nutritional status in the DRC.

However, socioeconomic factors influence the maternal education difference in child nutritional status although the nature and the direction of this influence depend on the nutritional status indicator. For instance, there is no maternal education difference in child nutritional status among certain socio-economic strata among which the conflict affected Eastern provinces and/or intermediate living standards household. Bairagi (1980), Solon et al. (1985) and Reed et al. (1996) have reported the variation of the association between maternal education and child weight across the socio-environments. Bairagi (1980) and

Table 5. Factors associated with multiple malnutrition in DRC, 2001: Odds ratio from LGEE.

Predictor	Model 1		Model 2		Model 3		Model 4		Model 5	
	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z	OR	P>Z
Maternal education										
None	2.550	0.000	2.543	0.000	1.858	0.000	2.548	0.000	1.893	0.000
Primary	1.900	0.000	1.919	0.000	1.473	0.000	1.906	0.000	1.507	0.000
Secondary and higher	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref	Ref
Child demographic characteristics										
Child' sex										
Male			1.280	0.000					1.283	0.000
Female			Ref	Ref					Ref	Ref
Child' age										
< 6 months			Ref	Ref					Ref	Ref
6-11 months			5.233	0.000					5.289	0.000
12-23 months			9.949	0.000					10.309	0.000
24-35 months			8.282	0.000					8.470	0.000
36-47 months			9.594	0.000					9.895	0.000
48-59 months			9.939	0.000					10.380	0.000
Health behavior factors										
Mother age at birth										
< 20			Ref	Ref					Ref	Ref
20-34			0.963	0.445					0.956	0.473
35 and high			1.038	0.867					1.049	0.693
Number of under 5 children										
1			Ref	Ref					Ref	Ref
2			1.096	0.093					1.099	0.088
3 and +			1.012	0.909					1.042	0.816
Had health card										
No			1.149	0.010					1.073	0.236
Yes			Ref	Ref					Ref	Ref
Socio-economic factors										
Place of residence										
Urban					0.804	0.005			0.805	0.012
Rural					Ref	Ref			Ref	Ref
Province of residence										
Kinshasa					Ref	Ref			Ref	Ref
Bas-Congo					1.448	0.007			1.463	0.006
Bandundu					1.091	0.521			1.117	0.408
Equateur					0.865	0.222			0.855	0.219
Orientale					0.696	0.011			0.653	0.004
Nord-Kivu					0.948	0.808			0.940	0.816
Sud-Kivu					1.132	0.337			1.166	0.211
Maniema					1.137	0.395			1.152	0.343
Katanga					1.151	0.251			1.152	0.230
Kasai-Oriental					0.981	0.877			0.974	0.945
Kasai-Occidental					1.141	0.310			1.176	0.182

Table 5. Contd.

Household wealth index					
Poorest	Ref	Ref		Ref	Ref
Poor	0.986	0.850		0.974	0.762
Middle	0.905	0.223		0.917	0.289
Rich	0.775	0.004		0.773	0.005
Richest	0.595	0.000		0.574	0.000
Mother's autonomy					
Relationship to head of household					
Head of Household			Ref	Ref	Ref
Spouse			0.753	0.829	0.092
Other			0.732	0.947	0.647

Source: 2001 DRC – MICS; Model 1: bivariate, Model 2: Child characteristics, health and reproductive behavior, Model 3: socioeconomic status; Model 4: mother's autonomy, Model 5: global.

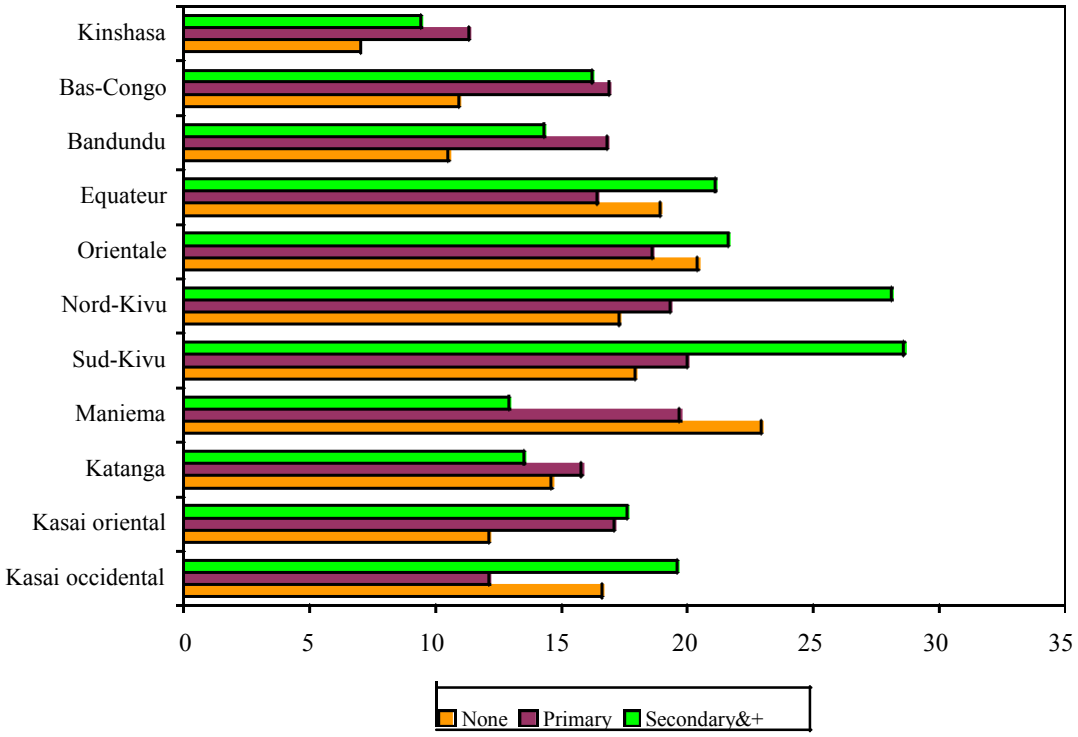

Figure 3. Proportion of stunted children by maternal education according to the province of residence in DRC, 2001.

Solon et al. (1985) have found that maternal education is associated with lower prevalence of malnutrition among under-five children in richest household whereas the relationship between maternal education and child malnutrition was not significant among the poorest. Solon et al. (1996) have observed that the relationship between maternal education and child nutritional status was flat and non-significant in the lowest socio-environment, positive and significant in intermediate conditions, and weakly positive under the best socio-environment conditions.

Three factors could explain the selectivity of maternal education differences in child' nutritional status in the DRC:

1) The most educated women living in households with higher socio-economic living standard may have left the

Table 6. Proportion of under-five children with multiple-malnutrition and those without malnutrition by mother education according to socioeconomic factors in DRC, 2001.

Socioeconomic characteristics	Multiple malnutrition			No malnutrition			% whose mother has secondary education or higher	Total No.
	%	Chi-square	P-value	%	Chi-square	P-value		
Place of residence								
Urban	21.3		0.000	58.1		0.000	61.7	3446
Rural	35.9	220.613		42.6	214.954		14.7	6302
Province								
Kinshasa	18.3			63.7			77.7	1352
Bas-Congo	35.7			45.1			37.3	515
Bandundu	34.7			44.6			32.4	1162
Equateur	32.5			43.3			13.3	1107
Orientale	26.5	162.005	0.000	50.0	188.536	0.000	17.6	974
Nord-Kivu	34.2			44.5			11.6	708
Sud-Kivu	36.8			39.8			15.4	593
Maniema	38.7			38.3			12.3	253
Katanga	34.1			46.8			24.3	1100
Kasai-Oriental	27.2			50.6			39.8	1058
Kasai-Occidental	34.6			44.6			24.2	926
Household Wealth Index								
Poorest	36.1			42.7			12.1	1953
Poor	37.5			42.1			14.8	1903
Middle	34.1	234.205	0.000	45.0	241.558	0.000	17.6	1911
Rich	28.8			46.5			32.1	1877
Richest	18.3			62.8			75.9	2104
Total	30.7			48.1			31.3	9748

Source: 2001 RDC-MICS;

conflict province (Nord-Kivu, Sud-Kivu and Maniema).

2) It is possible that educated mothers fail to realize the full advantage of their education if they live in conflict affected areas and/or if they live among lower education clusters. This observation is consistent with the fact that the health facilities and economic devastations brought by conflict will affect anyone living in these provinces regardless of education level as suggested by Pongou et al. (2006a) as: “In rural areas, the absence of such community factors exposes children born to educated and low-educated mothers to similar community poverty (for example, lack of health care facilities or potable water, seasonal shortages of food, unhygienic environment, etc.)” (Pongou et al., 2006: 654).

3) Education may have a positive effect on the richer and poorer segments of the population through the variety of available choices. In the context of scarce resources or of abundance,

maternal education could make a difference by empowering mothers (decision on type of nutrition and/or use of preventive medicine). These findings corroborate those observed in Cameroon (Pongou, Salomon, and Ezzati, 2006) where the advantage associated with maternal education increased during the 1990s crises particularly in urban areas. In fact, urban infrastructure increases the availability of food and health care, and provides potential for improved environmental conditions; and then allows the more educated mothers to have higher access to alternative choices. This may explain why differential trends in malnutrition among children of different maternal educational groups are explained by socioeconomic factors.

Nevertheless, our results with respect to the conflict, Eastern provinces are probably influenced by many confounding factors related to conflicts such as the lack of food, economic hardship, and lack of health care.

Child' age and province of residence as keys determinants of child' nutritional status

Considering other factors, findings show that child's age and province of residence are the only variables significantly associated with child's nutritional status regardless of the indicator. This supports age and spatial variations of child malnutrition in the DRC found by Kandala et al. (2011).

This study presents two methodological limitations. First, we used data from the 2001 DRC-MICS which do not include information on nutritional knowledge, attitude and perception that could contribute to the understanding of the relationship between maternal education and child nutritional status. Women's education improves maternal health knowledge including that about child nutrition and hygiene. Education facilitates mother's learning about causation, prevention, recognition, and treatment of disease (Frost et al., 2005). In addition to basic health knowledge, education is also a factor of acculturation by breaking away from tradition and increasing acceptance of ideas and practices associated with modern medicine (Cleland and Van Ginneken, 1988). Thus, children of educated women live in more hygienic environment, have higher prevalence of immunization than their counterparts, receive appropriate care in case of disease, and therefore have better nutritional status than others. Unfortunately, the 2001 DRC MICS did not collect data on maternal knowledge and attitude toward child health and use of health facility.

Secondly, the variable maternal education includes only three categories (none, primary and secondary or higher) that do not allow classifying women according to number of years completed in the considered level. Nevertheless, these limitations could not deny the quality of this study including empirical, theoretical and methodological contributions.

Conclusion

Children malnutrition is a major public health in the DRC. This study has twofold views in understanding child malnutrition in the DRC. From the methodological point of view, the paper has showed that the choice of malnutrition indicator affects the conclusion about the role of maternal education on the target for reducing hunger related to MDG1. Theoretically, findings confirmed socio-economic approach through the province of residence as control factor in analyzing the association between maternal education and child nutritional status. Therefore, 1) any study on the determinants of children nutritional status should be based on a clearly defined nutritional indicator; and 2) efforts to achieve the MDG-1 and 4 targets of reducing hunger and child mortality rates by two-thirds between 1990 and 2015 and post conflict reconstruction should be holistic and comprehensive. Parallel investments in programmes to addressing the basic human needs of food, poverty eradication, universal primary as well as secondary education, accessibility to safe drinking water and healthcare service, and women's empowerment can accelerate the achievement of the MDG-4.

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