Breastfeeding and Child Health in Uganda

Edward Bbaale

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Abstract

The study set out to estimate the effect of breastfeeding on child mortality and stunting. We used nationally representative Uganda Demographic and Health Survey (UDHS) of 2011 merged with the community section of the Uganda National Household Survey (UNHS) of 2012/13 to include community variables, such as distance to the health facility, that are potential instrumental variables. We used various techniques: ordinary least squares (OLS), Instrumental Variables (IV) approach and control function during the analysis. We found that breastfeeding reduced child mortality but was weakly associated with child stunting. Just as previous literature documents, the OLS estimate of the coefficient on breastfeeding was biased downwards compared to the IV and control function estimates. Health knowledge was important in influencing child mortality. Government efforts towards sensitizing citizens about the importance of breastfeeding should be strengthened. Additionally, government needs to prioritize dissemination of health knowledge to women of reproductive age who are no longer in school. Furthermore, school curricula should be improved to include communication of health knowledge to students during early education to mitigate poor child health outcomes for future generations.

Key words: Breastfeeding, child mortality, child stunting, Uganda

1. Introduction and study concern

Today, breastfeeding is the single most effective preventive intervention for improving the survival and health of children (WHO, 2000). The relationship between breastfeeding practices, early initiation of breastfeeding and exclusive breastfeeding, and the probability of childhood survival is well articulated. Early initiation of breastfeeding and exclusive breastfeeding for the first six months of life prevents neonatal and infant deaths largely by reducing the risk of infectious diseases (Lutter, 2010). The first breast milk, colostrum, is very rich in defensive ingredients, hence its ingestion in the first hour of life enhances neonatal health. Exclusive breastfeeding prevents the ingestion of contaminated liquids and foods that may cause neonatal infections (Lutter, 2010). According to a study conducted in Ghana by Edmond et al. (2006), the risk of neonatal mortality was four times higher in children given milk-based fluids or solids in addition to breast milk. In addition, late initiation of breastfeeding (after 1 day) was associated with a 2.4-fold risk of mortality. Furthermore, Jones et al. (2003) and Darmstadt et al. (2005) stress that 13% to 15% of under-five mortality in poor countries could be mitigated via 90% coverage of exclusive breastfeeding. Thus, breastfeeding is an important vehicle for attaining Sustainable Development Goal (SDG) 2 (zero hunger) and 3 (good health and well-being) by the year 2030.

The World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) designed several guidelines concerning breastfeeding practices that are believed to be associated with favourable child health outcomes. It is recommended by WHO and UNICEF that mothers initiate breastfeeding within the first hour of life; exclusively breastfeed for the first six months; breastfeed their infants on demand, that is, as often as the child wants, day and night; and avoid using bottles, teats or pacifiers. However, for the developing world as a whole, recent statistics show that compliance to breastfeeding practices is still far from the recommended levels. Only 39% of all infants 0–5 months of age in the developing world are exclusively breastfed, and less than 60% of 6–9-month-olds continue to breastfeed while also receiving solid, semi-solid or soft foods. Although global levels of continued breastfeeding are relatively high at 1 year old (76%), only half the infants are still breastfeeding at 2 years of age (50%) (UNICEF, 2010). In Uganda, only 6 in 10 Ugandan children under the age of 6 months are exclusively breastfed. Among children 4–5 months old, only 35% are exclusively breastfed. Under the age of 2 months, 84% of children were exclusively breastfed, while 9% received breast milk and plain water only, 4% received breast milk and other milk, and 2% received some complementary foods (UBOS and Macro International Inc. 2007).

There is little wonder then that recent statistics indicate vulnerability to poor child health outcomes, especially for sub-Saharan Africa. According to WHO (2005), more than 10 million children worldwide die each year before celebrating their 5th birthday, and of these 4 million die within their first few days of life. In sub-Saharan Africa one in every six children dies before their fifth birthday. A total of 99% of neonatal deaths take place in developing countries (Bhutta et al., 2005). In Uganda, the period 2000–2011 shows improvement in all components of early childhood mortality rates. Table 1 shows the under-five, infant, post-neonatal and neonatal mortality rates per 1,000 live births.

Table 1: Child mortality rates per 1,000 live births in Uganda (2000–2011)

	2000	2006	2011
Under-5 mortality	152	137	90
Infant mortality	88	76	54
Post-neonatal mortality	55	46	27
Neonatal mortality	33	29	27

Source: Uganda Bureau of Statistics (UBOS) and ICF International Inc. 2012

Under-five mortality declined from 152 deaths per 1,000 live births in the 2000/2001 to 137 in 2006 before declining further to 90 in 2011. The infant mortality declined from 88 deaths in 2000/2001 to 76 in 2006 before declining further to 54 deaths per 1,000 live births; post-neonatal mortality declined from 55 deaths in 2000/2001 to 46 in 2006 before declining further to 27 deaths per 1,000 live births in 2011. The change in neonatal mortality rate was not as pronounced: it declined from 33 deaths per 1,000 live births in 2000/2001 to 29 deaths per 1,000 live births in 2006, and declined only slightly to 27 deaths per 1,000 deaths in 2011. Despite the remarkable improvements, Uganda is still doing poorly compared to her neighbours. For example, Tanzania performed better than Uganda in all measures of child mortality. The neonatal, infant, child, and under-five mortality rates for Tanzania were 26, 51, 32, and 81 per 1,000 live births, slightly lower than that of Uganda (National Bureau of Statistics (NBS) [Tanzania] and ICF Macro. 2011.). Further, the situation was much better in Nepal than in Uganda and Tanzania; the infant, child, and under-five mortality rates were 46, 9, and 54 per 1,000 live births (Ministry of Health and Population (MOHP) [Nepal], New ERA, and ICF International Inc. 2012.).

The statistics for Uganda, compared to those of other countries, reveal that the country still has a far to go, and hence the need for an accelerated set of interventions to reverse the situation if the MDG target is to be achieved. Early childhood interventions which include early breastfeeding within one hour and exclusive breastfeeding for the first six months are imperative in this area. Examining the role of breastfeeding practices in ensuring child survival is particularly relevant in developing countries like Uganda where under-five mortality is high and the importance of breastfeeding is little known. The health sector in the country is not particularly focused on improving public awareness of the importance of breastfeeding, partly because of lack of empirical evidence to support advocacy. The main objective of the study was to assess the protective effect of breastfeeding against the risk of child mortality and malnutrition. We sought to answer the following pertinent questions: Is the duration of breastfeeding associated with a lower child mortality risk? Does breastfeeding lead to childhood undernourishment? Answers to these questions should identify the key policy parameters that the government and public health initiatives need to target to boost the benefits from breastfeeding. To the best of our knowledge, this is the first study to address these questions for the case of Uganda, hence it represents a real value added.

2. Selected literature

Two major strands of literature exist on the relationship between breastfeeding and child health outcomes to mortality and to malnutrition. We first present literature relating breastfeeding to child mortality. There are various pathways through which breastfeeding enhances infant and child health. At the forefront of these arguments is the view that breast milk is a special form of "childhood immunization". Medical and public health authors contend that breast milk comprises glycans that fight against infections in the gastrointestinal tract (Morrow et al., 2005; Jayachandran and Kuziemko, 2009). The second pathway is breast milk acting as a substitute to the consumption of hazardous drinking water and contaminated foods by infants and children, especially in developing countries with unhygienic sanitary environments (Victoria et al., 1987; Habitcht et al., 1988; Jayachandran and Kuziemko, 2009; Lutter, 2010). These pathways find support in empirical works. Bahl et al. (2005) indicated that non-breastfed infants had a higher risk of dying than predominantly and partially breastfed infants. Molbak et al. (1994) argue that prolonged breastfeeding reduces child mortality and morbidity. Dadhich et al. (2009) reviewed a huge body of the literature and their main message justified the need for mainstreaming early and exclusive breastfeeding to improve child survival. Arifeen et al. (2001) conducted a study in Bangladesh in which they found over twofold risk of infant mortality for children who were not or partially breastfed compared to their counterparts who were exclusively breastfed. The authors further offer evidence that if exclusive breastfeeding was increased from 39% to 70%, infant mortality would reduce to 32% in a very short period of time. These findings corroborate those of Edmond et al. (2006) who conducted a study in rural Ghana.

The other strand of literature is on the relationship between breastfeeding and child nutritional status. Muchina et al. (2010) find a significant association between breastfeeding initiation and stunting, discontinuation of breastfeeding and underweight, and no association between breastfeeding practices and wasting. These findings seem to corroborate those of Onayade et al. (2004) which show that inappropriate breastfeeding practices and childhood malnutrition are significantly associated. A paper by Marquis et al. (1997) argues that the negative association between breastfeeding and linear growth reflect reverse causation. This paper was a response to the divergent evidence on the effect of breastfeeding after six months on linear growth. Other studies have found evidence of weight, mid-upper arm circumference, and height gains from increased breastfeeding duration after 6–12 months of age (Adair et al., 1993; Taren and Chen., 1993). Conversely, authors (Brakohiapa et al., 1988; Victora et al., 1992) document an increase in childhood malnutrition due to breastfeeding during the second year of life. According to Marquis et al. (1997), this unexpected association may reflect the fact that decisions to continue breastfeeding might occur as a direct response to a child's poor health. In this case, low nutrition status may be the cause rather than the consequence of prolonged breastfeeding. The effect of the reverse causality of breastfeeding and malnutrition found in Marquis et al. (1997) is corroborated by Simondon et al. (1998) who argue that mothers prolong breastfeeding of malnourished children and reduce the duration among well-nourished children.

In a nutshell, there seems to be a consensus in the literature that early initiation of breastfeeding within one hour and exclusive breastfeeding up to six months of life are pertinent public health initiatives to reduce child mortality, especially during the neonatal period. The literature shows that if early initiation and exclusive breastfeeding are made universal, many infants' lives would be saved. Despite the availability of evidence in different parts of the world concerning the protective effect of breastfeeding against childhood mortality and under-nutrition, public health initiatives in Uganda are yet to emphasize the importance of breastfeeding. This is probably because of lack of empirical regularity to add the right flavour to policy formulation and analysis in the country. The main thrust of our empirical analysis was to tackle the endogeneity of the breastfeeding variable in the child health outcome equations thereby providing more reliable empirical evidence that can support policy formulation and advocacy. To achieve this, we follow the works of Mwabu (2009) and employ the Two-stage Least Squares (2SLS) and the control function approach and then compare the estimates with ordinary least squares (OLS) estimates to establish whether a bias exists or not. Throughout our literature survey, we found no paper on Uganda addressing the relationship between breastfeeding and child health outcomes. Most of the papers written on Uganda (for example, Wamani et al. 2005) analysed the factors influencing breastfeeding practices; none examined the relationship between breastfeeding and child health outcomes. This is the first paper on this issue for Uganda and hence represents a real value added.

3. Theoretical framework and estimation strategy

The theoretical foundations of our analysis were based on a standard economic model of the household in which utility is maximized subject to the health production, time, and income constraints. We use a modified version of the model first proposed by Rosenzweig and Schultz (1983). The model forms the basis of the analysis of health production and demand in the contemporary literature (see, for example, Mwabu, 2009). Within this framework, a mother demands some level of child health together with other commodities, food consumption, and non-food consumption. The utility function takes the following shape:

$$U = U(ch, fc, bf) \tag{1}$$

Where ch, fc, and bf refer to health status of the child, food and non-food consumption, and breastfeeding which is a health-related good or behaviour that yields utility to the mother and also affects the health of the child. Just as in the standard microeconomics, a mother is faced with a constrained utility maximization. There are various constraints to the utility maximization behaviour of a mother: health production constraint, time constraint, and the budget constraint. The health production function relates child health to health inputs. The health inputs may include breastfeeding, market purchased inputs (antenatal care services and other medical requirements), time of the mother devoted to health production, education of the mother, education of the spouse, and the genetic healthiness of the child.

$$ch = ch(bf, z, t_m, m_e, f_e, \alpha) \tag{2}$$

Where bf, z, t_m, m_e, f_e and α refer to the breastfeeding initiation or duration, purchased market inputs such as medical care services, time of the mother devoted to producing child health, education of the mother, education of the husband, and the unobservable genetic healthiness or endowment of the child which is not under the direct control of the parents. Breastfeeding is essentially a bundle of health inputs into child health. The health effect of breast milk alone is hard to identify. For example, breastfeeding creates body contact between a mother and the baby which is thought to regulate the body temperature of the baby, thus preventing the baby from being sickly.

The utility maximization behaviour of the mother is also constrained by time. Breastfeeding is a highly time-intensive activity, as the mother is required to breastfeed on demand, or as often as the baby desires. Breastfeeding time may conflict with the time a mother requires for other child care activities, household chores, farm production, and working outside the home for a wage. The time constraint is thus;

$$\mu_t = h_t + l_t + bf_t \tag{3}$$

Where h_t, l_t, and bf_t refer to time allocated for work, leisure, and to breastfeeding. In this context, leisure may refer to all the unpaid household activities performed by a mother.

The mother also faces a budget constraint that separates attainable from unattainable combinations of goods and services. The total household budget comprises the wage earnings of the mother and her husband, and an exogenous amount of money or assets owned by the household (non-labour income). The household spends money on the breastfeeding inputs, such as porridge, required by the mother, food consumption, and non-food consumption.

$$w_t h_t + \omega = B = P_{bf} bf + P_{fc} fc + P_z z \tag{4}$$

Where $w_t h_t, \omega, B, P_{bf} bf, P_{fc} fc$, and $P_z z$ refer to the wage income of the mother and her husband, non-labour income, total budget; household spending on breastfeeding inputs, spending on food and non-food consumption; and purchased market inputs such as medical care services.

Since child health is embedded in a household's utility function, the household finds the utility maximizing quantities of child health and other goods that enter the utility function. The process of finding the optimal quantities involves two steps. First, the household purchases the market goods in accordance with the optimality conditions for all goods. Second, since the optimal level of child health cannot be purchased from the market, the household minimizes the cost of inputs used to produce that specific level of child health, where breastfeeding is one of these inputs. Performing the above processes on (1), (2), (3), and (4) yields the reduced form household demand functions for our commodities of interest:

$$D_{bf} = D_{bf}(P_{bf}, P_{fc}, P_z, B, m_e, f_e, \alpha)$$
$$D_{fc} = D_{fc}(P_{bf}, P_{fc}, P_z, B, m_e, f_e, \alpha) \quad (5)$$
$$D_z = D_z(P_{bf}, P_{fc}, P_z, B, m_e, f_e, \alpha)$$

The reduced-form demand function for child health may be written in a similar way with an extension to include the physical environment and the social environment . The physical environment may include air and water quality, occupational exposure, availability of health and other infrastructure. Yet the social environment may include ethnic and religious affiliations or beliefs and social support.

$$ch = ch(P_{bf}, P_{fc}, P_z, B, m_e, f_e, p_e, s_e, \alpha) \quad (6)$$

Rosenzweig and Schultz (1983) suggest a hybrid health production function that allows estimating the impact of breastfeeding to changes in child health status. Thus Equation 6 can be rewritten as:

$$ch = ch(bf, P_{bf}, P_{fc}, P_z, B, m_e, f_e, p_e, s_e, \alpha) \quad (7)$$

As a preliminary step during the analysis, we estimated Equation 7 using simple OLS to understand the effects of breastfeeding on child health. However, the proposition that breastfeeding (bf) is endogenous in the health outcome equation (mortality or nutritional status) seems plausible. The decision to initiate breastfeeding and its duration is made by each individual mother. In addition, the health status of the child may influence the decision of whether to terminate or continue breastfeeding, which would lead to a correlation between the explanatory variables and the error term. For example a mother may decide to prolong breastfeeding of a child with poor health, making poor health a cause rather than an effect of breastfeeding. Thus, if the parameters in Equation 7 are estimated by OLS will be biased and inconsistent. Consequently, in estimating this equation, the endogeneity of and the unobservability of should be considered. Following Mwabu (2009), we used the control function approach to deal with the estimation inconsistency arising from the correlation of the endogenous regressors with the unobservables captured by the error term. The control function approach is also known as the two-stage residual inclusion (2SRI). Practically, we first ran the first-stage regression with the endogenous variable (breastfeeding) on the left-hand side with the exogenous variables, including the instrument, on the right-hand side, and then we predicted residuals. In the second stage, we ran a regression with child health outcome on the left-hand side and the exogenous variables, endogenous variable, residual and the interaction between the residual and the endogenous variable on the right-hand side. The control function form that we shall estimate is given as:

$$ch_j = \alpha_1 bf_j + w\alpha_2 + \alpha_3 v_j + \alpha_4 (bf_j \times v_j) + \varepsilon_j \quad (8)$$

Where

ch = child health outcome (mortality or stunting)

bf = endogenous regressor (breastfeeding)

w = vector of exogenous variables

v = residual of an endogenous input

$bf \times v$ = interaction of the residual with the endogenous input

The control function variables in Equation 8 are v_j and $bf_j \times v_j$. v serves as a control for unobservable variables that are correlated with bf, thus allowing these endogenous inputs to be treated as if they were exogenous covariates during estimation. $bf \times v$, the interaction term, serves as the control for the effects of neglected non-linear interactions of unobservable variables with child health inputs. Using the insights from Mwabu (2009), we noted the following concerning the control function terms in Equation 8. If α_3 and α_4 are statistically insignificant, the parameters of the child health outcome equation can be consistently estimated with OLS. This means that endogeneity and heterogeneity problems cannot be practically identified despite a plausible theoretical basis for their existence. If it is only α_4 that is statistically insignificant, then the only control function variable in the child health outcome equation is the predicted residuals of the endogenous inputs. In this case the structural parameters can be consistently estimated using 2SLS also known as the two-stage predictor substitution (2SPS). Empirically, we run the first stage regression with the endogenous variable on the left-hand side and the exogenous variables including the instruments on the right-hand side. The second stage entails running a regression with child health outcome on the left-hand side and then replaces the endogenous variable on the right-hand side with the predicted values of the endogenous variable. This approach not only addresses the concern of endogeneity, but also, because the instruments are uncorrelated with the error term, it removes biases in the estimator due to unobserved heterogeneity.

4. Data and measurement of variables

The data were obtained from the Uganda Demographic and Health Survey (UDHS) 2011 (Uganda Bureau of Statistics (UBOS) and ICF International Inc. 2012). The 2011 UDHS is a nationally representative survey of about 7,878 women aged 15–49 years (reproductive age). The UDHS 2011 was merged with the community section of the Uganda National Household Survey (UNHS) 2012/13 (Uganda Bureau of Statistics (UBOS). 2014) to get additional exogenous variables, such as distance to the public health facility from the Local Council I Centre that we used as instruments during our regressions. The analytic sample comprises mothers who gave birth in the five years preceding the survey. The unit of analysis was a child under five years of age. However, during the analysis, we created 2 cohorts of children: those younger than 3 years of age (<36 months) and then those younger than 5 years (≤59 months). This helped analyse a younger and older sample to check the recall bias effect.

The UDHS provides information on the demographic characteristics of the country. It contains information on household size, age and sex distribution, region, location, religious affiliation, occupation of household members, the number of children ever born by a woman, child mortality, marital status, and educational attainment of women and men. It also contains information on breastfeeding: early initiation, exclusive, and duration. Data were also collected to help calculate three indices—weight-for-age, height-for-age, and weight-for-height—all of which take age and sex into consideration. Weight measurements were taken using a lightweight electronic SECA scale designed and manufactured with guidance from UNICEF. The scale allowed for the weighing of very young children through an automatic mother–child adjustment that eliminated the mother's weight while she was standing on the scale with her baby. Height measurements were carried out using a measuring board produced by Shorr Productions. Children younger than 24 months were measured lying down (recumbent length) on the board, while standing height was measured for older children.

Variables

Table 2 shows the descriptive statistics (mean and standard deviation), and the definition of the variables used during the analysis. None of the variables considered had a standard deviation of zero, suggesting that all our variables qualified to be included in our regressions. Our computations from the UDHS 2011 revealed that the under-5 mortality rate was, on average, approximately 10%, meaning that almost 100 children out of 1,000 live births die before celebrating their 5th birthday. This result was not significantly different from the figure reported in the Uganda Demographic and Health Survey Report 2011 where the under-5 mortality rate is at 90 per a 1,000 live births, significantly lower than 137 per 1,000 live births of 2006 (Uganda Bureau of Statistics (UBOS) and ICF International Inc. 2012). In addition, our calculations from the UDHS 2011 show that the infant mortality rate, children dying before celebrating the 1st birthday, is approximately 9% meaning that almost 90 children out of a 1,000 live births die before celebrating their first birthday. Our computations (from Uganda Demographic and Health Survey Report 2011) also show that 32% of children were stunted (low height-for-age); this is an improvement compared to the UDHS of 2006 where the share of children that were stunted was reported at 39%. Considering the distribution of children by sex, our sample had an equal share of males and females; the difference is negligible.

Table 2: Variables

Variable name	N	Mean	Standard deviation	Variable definition
Child mortality rate	7,217	0.0984	0.1634	Died before 60 months
Infant mortality rate	1,541	0.0884	0.1693	Died before 12 months
Share of children stunted	1,944	0.3174	0.4667	Stunted:1; otherwise: 0
Child sex	7,217	0.4987	0.5000	Male: 1; Female: 0
Child age in months	7,217	29.061	17.321	Age in months
Mother's age	7,217	28.914	6.783	Age in years
Mother's education	7,217	5.196	3.9191	Years
Father's education	6,765	6.882	4.297	Years
Knowledge of oral rehydration	7,188	0.9077	0.2897	Know: 1; Do not: 0
Breastfeeding duration	5,474	7.783	6.149	In months
Exclusive breastfeeding	7,217	0.3940	0.4887	Yes: 1; No: 0
Ever breastfed children	7,217	0.8104	0.5898	Ever breastfed: 1; No: 0
Piped water	7,066	0.1929	0.395	Yes: 1; No: 0
Time to water source	7,687	43.419	48.224	Minutes
Distance to the public health facility	5,310	4.422	7.287	Kilometres
Distance to the private health facility	3,632	5.074	10.931	Kilometres
Religion	7,217	0.1493	0.3564	Unorganized: 1; other: 0
Currently working	7,209	0.7467	0.4349	Mother working: 1; other: 0

Source: Author's own computations from DHS 2011 merged with the community section of UNHS 2011

On average, children in the UDHS 2011 were aged 29 months while the average age of their mothers was 29 years. We sought to include the sex of the child to ascertain whether there is any special preference towards a certain sex. The age of the mother was included to control for either biological factors, such as decreased birth weight with rising maternal age at delivery, or experience with child care, which increases with age (Kovsted et al., 2003). The years of education of the father were higher than the years of education of the mother (seven versus five years). Education of the father was included to control for the effect of permanent income on child health outcome. This variable is deemed a better proxy for income because household income is likely to be endogenous to household health decisions, making father's education an instrumental variable to income. This is in line with previous studies such as Kovsted et al. (2003) and also in line with the theoretical model suggested by Rosenzweig and Schultz (1983) where income is one of the factors influencing child health.

Health knowledge seems to be high amongst women in Uganda. On average, 91% of the women had knowledge of oral rehydration (computation based on Uganda Demographic and Health Survey Report 2011. In the DHS, mothers were asked whether they had knowledge of oral rehydration, a cure for diarrhoea. Health knowledge as a regressor in the child health model has been included by previous studies (see, for example, as Kovsted et al., 2003). However, health knowledge is endogenous in the child health model as it is potentially correlated with the unobservables. Consequently, we needed to use an instrument; following Kovsted et al. (2003), we used religion. This is based on the premise that belonging to unorganized religion (including traditionalists and others), compared to organized religions (Catholics, Protestants and Muslims), is less likely to increase a person's health knowledge. It is plausible to conjecture that traditionalists do not believe in modern medicine as a way of treating sickness and as such are opposed to seeking modern health knowledge. However, organized religions have their own hospitals and medical personnel and can also disseminate modern health knowledge to their congregations in the places of worship. As expected, religion had a significant influence on the knowledge of oral rehydration even after controlling for parental education.

The average number of months before a child is weaned is eight. Moreover, 39% of the women practised exclusive breastfeeding and 81% of children ever breastfed. However, breastfeeding variables are potentially endogenous. Consequently, we sought to instrument breastfeeding variables by the distance to the public health facility from the Local Council I Centre. The distance to the public health facility was, on average, 4.4 km from Local Council I Centre; the distance to the private health facility was 5 kilometres from the same centre. The proximity to the health facility is expected to enhance the possibility that a particular mother breastfeeds her child and does so as required by the principles of WHO. This is because mothers who have easy access to the health facility are more likely to learn from their peers and health workers about the importance of breastfeeding and how best and how long it should be implemented.

We also sought to include variables that capture the mechanisms through which breastfeeding influences child health outcomes. The quality of the source of drinking water is an important issue in this regard; we therefore included a variable that captures households with piped water. On average, the data revealed that only 19% of the households had piped water. It is argued in the literature that breastfeeding avoids the ingestion of contaminated water and foods and this is particularly important in communities with poor sanitation facilities typical of developing countries like Uganda (Jayachandran and Kuziemko, 2009). Following Jayachandran and Kuziemko (2009), we included piped water in both the child mortality and stunting models as a control variable. Another channel is a child being in contact with the mother ("kangaroo contact") which is argued to regulate the baby's body temperature, preventing sickly conditions of the baby. To capture this unobserved effect, we included whether the mother was working and the age of the mother as control variables. Our data show that on average, 75% of the mothers were working.

5. Results and discussion

The main thrust of our empirical analysis was to tackle the endogeneity of the breastfeeding variable in the child health outcome equations. Table 3 shows the first-stage regressions; OLS for the duration of breastfeeding in months, linear probability model for the ever breastfed children and knowledge of oral rehydration of mothers. From the first-stage regressions we generated the residuals and fitted values that we used in the respective second-stage regressions. Distance to the health facility reduces the duration of breastfeeding and the probability that a child is ever breastfed. This is based on the premise that the nearness to the health facility makes it easier for mothers to visit the facility and hence be more likely to learn from peers about the importance of breastfeeding. In addition, a mother living close to the health facility takes relatively little time moving to and from the facility and hence reserves more time which could be devoted to breastfeeding. Belonging to an unorganized religion (like the traditionalists) as opposed organized religions (Catholic, Protestant and Muslim) is less likely to increase a person's health knowledge. We conjecture that traditionalists are opposed to the modern way of treating diseases and hence are less likely to seek modern health knowledge. However, organized religions have hospitals and hence value modern medicine and are more likely to avail health knowledge to their congregations through sermons in the places of worship. This is consistent with the findings of Kovsted et al. (2009). Mother's education, especially at post-secondary level, reduces breastfeeding duration and the probability of ever breastfeeding, but increases the probability of having knowledge of oral rehydration.

Table 3: First stage regressions for breastfeeding and health knowledge of oral rehydration

Variables	Breast-feeding duration in months (children ≤59 months)	Breast-feeding duration in months (children <36 months)	Ever breastfed Children ≤59 months	Ever breastfed Children <36 months	Knowledge of oral rehydration, children ≤59 months	Knowledge of oral rehydration, children <36 months
Religion	0.00134	0.00185	-0.0182	-0.0154	-0.0459***	-0.0444**
	(0.0502)	(0.0667)	(0.0229)	(0.0282)	(0.0136)	(0.0179)
Distance to the health facility	-0.0371***	0.0171	-0.0207***	-0.0174**	0.00650*	0.00640
	(0.0141)	(0.0184)	(0.00648)	(0.00789)	(0.00386)	(0.00501)
Child sex	0.0665*	0.0575	0.0123	0.0242	0.0128	0.0298**
	(0.0375)	(0.0497)	(0.0170)	(0.0208)	(0.0101)	(0.0132)
Mother's education:						
Primary	-0.0759	-0.0928	-0.0139	-0.0269	-0.00160	0.0149
	(0.0640)	(0.0915)	(0.0281)	(0.0359)	(0.0167)	(0.0229)
Secondary	-0.256***	-0.268**	-0.0631*	-0.0694	0.0591***	0.0735***
	(0.0775)	(0.107)	(0.0343)	(0.0429)	(0.0205)	(0.0273)
Post-secondary	-0.319***	-0.253*	-0.166***	-0.136**	0.0762**	0.0972**
	(0.113)	(0.150)	(0.0507)	(0.0636)	(0.0303)	(0.0405)
Child age (months)	0.306***	0.455***	-0.185***	-0.203***	0.00762	0.00839
	(0.0314)	(0.0449)	(0.00930)	(0.0117)	(0.00553)	(0.00744)
Mother's age	0.458***	0.474***	-0.235***	-0.155***	0.0367	0.0672**
	(0.0869)	(0.113)	(0.0394)	(0.0475)	(0.0235)	(0.0301)
Constant	-0.711**	-1.114***	2.004***	1.790***	0.713***	0.589***
	(0.312)	(0.409)	(0.138)	(0.167)	(0.0824)	(0.106)
Joint F (p-value) test for Ho: coefficients on instruments = 0	6.94	3.94	10.16	4.84	41.45	33.51
	(0.0000)	(0.000)	(.0000)	(0.0280)	(.0000)	(.0000)
Partial R-squared on excluded instruments	0.0125	0.0113	0.0048	0.0034	0.0055	0.0077
Observations	2,193	1,175	2,905	1,771	2,895	1,765
R-squared	0.107	0.147	0.152	0.165	0.021	0.025

Validity of the instruments

Mwabu (2009) presents the three econometrically accepted properties of a valid instrument. The first concerns the relevancy. An instrument is relevant if its effect on the endogenous regressor is statistically different from zero. The second concerns the strength; an instrument is deemed strong if the magnitude of its effect is big. The third concerns the exogeneity; an instrument is exogenous if it is not correlated with the unobservable captured in the error term. The first-stage F statistic and the partial R-square prove the validity and relevance of instruments in the case of a single endogenous variable (Mwabu, 2009). The p-value and the magnitude of the first-stage F statistic on excluded instruments in Table 3 suggest that the instruments (distance to the public health facility and religion for breastfeeding and knowledge of oral rehydration for this study are valid. The partial R-square shows the predictive power or strength of the instruments in each of the reduced-form equations. Instruments are irrelevant if their joint effect on an endogenous explanatory variable is zero. Instruments are relevant but weak if their joint effect is statistically significant but at a low F statistic that is typically less than 10 (Mwabu, 2009).

The first-stage F statistic on excluded instruments (Table 3) varies from about 5 to 42 (p-value = 0.000). The F statistic on religion as an instrument is sufficiently large (34 to 42) suggesting that it is a strong and relevant instrument for both the entire sample (children ≤59 months) and for the subsample (children <36 months). However, the F statistic on the distance to the public health facility as an instrument for breastfeeding duration is approximately 7 (p-value = 0.000) implying that it is weak but relevant. In addition, the F statistic on the distance to the public health facility as an instrument for ever breastfed children is 10 (p-value = 0.000) implying that it is strong and relevant for the entire sample of children (≤59 months). However, the F statistic on the distance to the public health facility as an instrument for ever breastfed children is approximately 5 (p-value = 0.000) implying that it is weak, but relevant for the subsample of children (<36 months).

Breastfeeding, health knowledge, child mortality and stunting under different specifications

Tables 4, 5, 6 and 7 show the effect of breastfeeding duration, ever breastfeed and knowledge of oral rehydration on child mortality and stunting under different specifications: OLS, control function approach, and 2SLS. The regressions are carried out on different child age cohorts: those younger than 36 months and those younger than 60 months. The choice to run a regression separately for younger children is to avoid the fact that breastfeeding, stunting or mortality information may suffer from a recall bias. Columns 1 and 2 of Tables 4, 5, 6 and 7 present the OLS regressions of the effect of endogenous variables on child mortality and stunting and as such the results are biased. Columns 3, 4, 5 ad 6 of the same tables present the results from the control function approach. In columns 3 and 4 we introduce predicted residuals in the regressions together with the endogenous variable to control for the correlations of child mortality and stunting with the unobservable. In columns 5 and 6 we further introduce the interaction terms between the predicted residuals and endogenous variables to control for heterogeneity of child mortality and stunting.

Table 4: Breastfeeding duration, health knowledge and child mortality

Variables	OLS (children ≤59 months)	OLS (children <36 months)	Control function (children ≤59 months)	Control function (children <36 months)	2SLS (children ≤59 months)	2SLS (children <36 months)
Breast-feeding feeding duration in months	-0.00689***	-0.00843**	0.0202	0.138		
	(0.00250)	(0.00376)	(0.0667)	(0.201)		
Knowledge of oral rehydration	-0.02262***	-0.02142*	-0.622**	-1.171***		
	(0.007631)	(0.01102)	(0.302)	(0.419)		
Fitted values for breastfeeding duration in months					0.0979	-0.143*
					(0.0611)	(0.0801)
Constant	-0.139***	-0.106**	-0.518**	-0.729*	0.0411	0.0360
	(0.0353)	(0.0506)	(0.251)	(0.390)	(0.143)	(0.188)
Observations	5,063	2,698	2,186	1,172	2,905	1,771

Breastfeeding duration in Table 4 is strongly statistically significant (at 1% level) for the OLS regression model and is marginally statistically (at 10% level) for the 2SLS regression model in reducing child mortality in Uganda. However, the coefficient on breastfeeding duration for the 2SLS (0.143) is 17 times bigger than the OLS coefficient (0.00843). The importance of breastfeeding duration in reducing child mortality finds support in the previous literature (Molbak et al., 1994). The results in Table 5 reveal that a child who has ever been breastfed has reduced child mortality throughout the different specifications. The coefficients on ever breastfed children for the control function (0.216–0.437) are 5–8 times bigger than the OLS estimates (0.04–0.05). In addition, the coefficient on ever breastfed children for the instrumental variable approach (0.257) is also 5 times bigger than the OLS estimate. The coefficient on ever breastfed children is larger for the cohort of children younger than 36 months than for the entire sample of children (≤59 months). This might imply that the effect of breastfeeding in reducing mortality is more important amongst younger children. These findings are supported by those in previous literature (Arifeen et al., 2001; Bahl et al., 2005; Ip et al., 2007). In Tables 6 and 7 of the child stunting equations, breastfeeding duration and ever breastfed children variables are only marginally significant only for the OLS models. This suggests a weak association between breastfeeding and child stunting.

Health knowledge is negatively associated with child mortality in all specifications in Tables 4 and 5. The coefficient on the knowledge of oral rehydration from the control function regressions in both Tables 4 and 5 are large compared to the OLS estimates. However, its effect is not statistically different from zero for the child stunting equations in Tables 6 and 7. We therefore find that health knowledge, measured by the knowledge of oral rehydration, is a key determinant of child mortality in Uganda. Our findings find support from a paper by Kovsted et al. (2003).

The estimated coefficients on child sex differ across specifications (Tables 4 and 5). The OLS estimate (column 1) is positive and statistically significant at 10% level, while the control function approach for children younger than 36 months is negative and statistically significant at 10% level. This suggests that being a male child is associated with a lower risk of mortality than their female counterparts. However, the coefficient is not statistically different from zero for the instrumental variable (IV) approach in both Tables 6 and 7. This result is supported in previous literature that revealed gender discrimination by parents in India against girls and documented the notion of "missing girls" (Jayachandran and Kuziemko, 2009). On the contrary, being a male child is positively associated with child stunting and the estimates are similar across specifications in terms of sign and level of significance perhaps due to the exogeneity of the sex variable (Tables 6 and 7). Being a male child increases the probability of stunting by 0.1–0.16 percentage points for the OLS, instrumental variable (IV) approach and control function approach. Whereas the coefficients on the child's sex are slightly larger for the instrumental variable (IV) approach and control function approach than in the OLS, the difference is not as significant as in the earlier cases encountered. This experience finds support in Mwabu (2009) who documented that the coefficients on the sex of the child were similar for OLS and IV estimates in the study of the determinants of child birth weight in Kenya.

Table 5: Ever breastfed, health knowledge and child mortality

Variables	OLS (children <59 months)	OLS (children <36 months)	Control function (children <59 months)	Control function (children <36 months)	2SLS (children ≤59 months)	2SLS (children <36 months)
Ever breastfed	-0.0411***	-0.0503***	-0.216**	-0.364**		
	(0.00420)	(0.00586)	(0.109)	(0.170)		
Knowledge of oral rehydration	-0.02225***	-.02151**	-0.585**	-0.938***		
	(0.006657)	(0.008711)	(0.277)	(0.359)		
Fitted values for ever breastfed children					0.176	-0.257*
					(0.110)	(0.144)
Constant	-0.0747**	-0.0531	-0.934***	-1.377***	-0.381	-0.581*
	(0.0314)	(0.0408)	(0.328)	(0.434)	(0.256)	(0.337)
Observations	6,748	4,125	2,895	1,765	2,905	1,771

The coefficients on residuals for breastfeeding duration and ever breastfed children (Tables 4 and 5) are statistically significant, indicating that breastfeeding is endogenous in the child mortality equation. Consequently, the inclusion of the residual terms in the child mortality equation is prudent for attaining consistent estimates. In addition, we controlled for the heterogeneity in the child mortality and stunting models by adding the interactions of the residuals with endogenous variables. The interactions of breastfeeding and health knowledge variables with their residuals are clear sources of heterogeneity in the child mortality. This might imply that mothers who breastfeed their children are more likely to be associated with other modern health practices such as childhood immunization, issues that contribute to survival of children to their 5th birthday. Furthermore, mothers with health knowledge are more likely to visit a health facility for check-ups of their children and are more likely to undertake other health enhancing practices such as administering the right medication doze as prescribed by a medical doctor.

Table 6: Breastfeeding duration, health knowledge and child stunting

Variables	OLS (children ≤59 months)	OLS (children <36 months)	Control function (children ≤59 months)	Control function (children <36 months)	2SLS (children ≤59 months)	2SLS (children <36 months)
Breastfeeding feeding duration in months	-0.0281*	-0.0289	0.306	1.104		
	(0.0151)	(0.0204)	(0.404)	(1.141)		
Knowledge of oral rehydration	-0.00378	-0.00967	0.664	0.0321		
	(0.044639)	(0.05818)	(2.101)	(2.834)		
Child sex (=1 if male)	0.101***	0.150***	0.0931*	0.0977	0.113***	0.149***
	(0.0253)	(0.0333)	(0.0518)	(0.0983)	(0.0438)	(0.0546)
Child age in months	0.0777***	0.224***	-0.0396	-0.315	-0.0156	0.0616
	(0.0219)	(0.0321)	(0.129)	(0.521)	(0.109)	(0.135)
Mother's age	-0.227***	-0.126*	-0.499**	-0.793	-0.393**	-0.246
	(0.0595)	(0.0755)	(0.211)	(0.559)	(0.180)	(0.222)
Constant	0.778***	0.0998	1.076	1.951	1.497*	1.323
	(0.206)	(0.267)	(1.718)	(2.552)	(0.815)	(1.007)
Observations	1,335	748	551	323	744	484

Table 7: Ever breastfed, health knowledge and child stunting

Variables	OLS (children ≤59 months)	OLS (children ≤36 months)	Control function (children ≤59 months)	Control function (children <36 months)	2SLS (children ≤59 months)	2SLS (children <36 months)
Ever breastfed	-0.0431*	0.0404	0.512	0.518		
	(0.0244)	(0.0324)	(0.627)	(0.920)		
Knowledge of oral rehydration	-0.005069	-0.01898	-0.303	-1.031		
	(0.03808)	(0.04663)	(1.887)	(2.373)		
Child sex (= 1 if Male)	0.0943***	0.118***	0.125***	0.160***	0.124***	0.157***
	(0.0214)	(0.0262)	(0.0377)	(0.0612)	(0.0368)	(0.0458)
Child age in months	0.0873***	0.136***	0.156	0.225	0.143	0.178
	(0.0128)	(0.0171)	(0.117)	(0.189)	(0.116)	(0.143)
Mother's age	-0.173***	-0.0791	-0.147	-0.0598	-0.174	-0.0848
	(0.0498)	(0.0594)	(0.171)	(0.179)	(0.166)	(0.203)
					(0.865)	(1.079)
Constant	0.606***	0.207	0.299	0.491	0.427	0.533
	(0.178)	(0.214)	(1.982)	(2.499)	(1.482)	(1.856)
Observations	1,821	1,171	742	483	744	484

Limitations: truncation/censoring of breastfeeding duration

While the analysis of the effects of breastfeeding on child health at different ages reduces the measurement errors due to poor recall of the duration of breastfeeding, it introduces a new a problem: truncation (or censuring) of breastfeeding duration. For example, in the analytic sample of children aged three months, the breastfeeding duration variable has a value of three months even though the children in the sample were breastfed for a much longer time. That is, higher values of breastfeeding duration are censored. This is known as right censoring where we do not know from the data when breastfeeding duration ended. Whereas, the instrument for breastfeeding is valid, it would not decisively deal with the problem. For example, since a three-month-old child is the same child as the five-year-old child in the future period, breastfeeding duration can have contradictory effects on the health of the same child. This can happen if truncation of breastfeeding introduces non-randomness in the estimation sample by, for example, systematically excluding younger or older children from the estimation samples. Unlike what is reported in the literature, in this paper the explanatory variable rather than the outcome variable is censored or truncated. This form of truncation is prone to sample selection problems encountered in the literature and can lead to substantial downward bias in the parameter estimates.

6. Conclusion

The study set out to estimate the effect of breastfeeding on child mortality and stunting. We used nationally representative UDHS data of 2011 merged with the community section of the Uganda National Household Survey 2012/13 to include community variables such as distance to the health facility that are non-existent in the UDHS. We used various techniques: OLS, instrumental variable approach and control function techniques during the analysis. Breastfeeding and health knowledge reduced child mortality and a weak association between breastfeeding and child stunting was observed. Ever breastfed children had reduced child mortality of 0.2–0.4 percentage points across the different specifications. In addition, having health knowledge reduces child mortality by 0.6–2 percentage points across all specifications. The coefficients of the instrumental variable approach and control function approach are many times larger than the OLS estimates. Just as previous literature documents, the OLS estimate of the coefficient on breastfeeding and health knowledge is biased downwards compared to the instrumental variable and control function estimates. The bias emerges from the correlation of breastfeeding with unobserved healthiness of the child. A particular child may be breastfed longer than others due to poor health making poor health the cause rather than the effect of breastfeeding. It is this unobservability of child health that is the source of endogeneity in the child mortality model.

However, the estimated reduction in child mortality might not fully be attributed to breastfeeding and health knowledge alone. Breastfeeding mothers and those with health knowledge are more likely to be connected to other good health practices such as full childhood immunization that are important in reducing child mortality. However, due to data limitations, it is rather difficult to capture all these effects meaning that the interpretation of these findings needs to be done with caution. Nonetheless, breastfeeding and health knowledge are important inputs in the child health production function which should be prioritized by policy makers. Government needs to design a mechanism in which health knowledge is disseminated to women of reproductive age who are no longer in school. In addition, school curricula should be improved to include dissemination of health knowledge to students early in their education years such that even those who leave school early may benefit to help mitigate child mortality for future generations. Deliberate government effort to encourage breastfeeding such as embracing/rejuvenating the Baby Friendly Hospital Initiative, will go a long way in improving child health outcomes.

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