North Asian International Research Journal of Business Economics & Management
ISSN: 2277-1018 Vol. 7, Issue-8 August-2023
IRJIF I.F. : 4.201
Index Copernicus Value: 56.02 Indian Citation Index Thomson Reuters ID: S-8304-2016
NAIRJC A Peer Reviewed Refereed International Journal
DOI: 10.6947/nairjcbem2023.10.8.3

THE EFFECTS OF BREASTFEEDING ON MATERNAL BODY MASS INDEX AND ANEMIA IN CAMEROON

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ABSTRACT

Background: *In Cameroon, breastfeeding has been linked with the health of both women and their children, but research that considers breastfeeding and women's weight change and anemia is limited. The aim of this paper is to investigate the effect of breastfeeding on maternal Body Mass Index (BMI) and anemia in Cameroon.*

Methods: *This study uses the women module of the 2018 Cameroon Demographic Health Survey (DHS) data with a sample size of 9733 women. For analytical purpose, his study employs the Two Stage Least Squares and the instrumental variable Ordered Probit. In order to account for the endogeneity of breastfeeding, the non-self-cluster for breastfeeding was used as an instrumental variable. The Conditional Mixed Process (CMP) regression model was used to test for the robustness of the results.*

Results: *The findings reveal that breastfeeding has a negative and significant effect on BMI. The findings further reveal that women who breastfeed are less likely to become anemic. The effect on BMI is statistically significant at 10% level while the effect on anemia is statistically insignificant.*

Conclusion: *Based on the results, the paper recommends that policies should focus on organising breastfeeding programs and reinforcing or implementing breastfeeding support programs in work places to encourage breastfeeding so that women can fully enjoy its effects in lowering BMI and anemia levels.*

KEYWORDS: *Breastfeeding, Conditional mixed process, Maternal health outcomes*

I. INTRODUCTION

The World Health Organization (WHO) defines exclusive breastfeeding (EBF) as the situation where a baby receives only breast milk from the mother or nurse for the first 6 months and no other solid or liquid except for drops or syrups from vitamins, minerals, supplements or medicines (1). In 2016, about 40% of babies worldwide were exclusively breastfed, and this number is expected to increase to 50% by 2025. EBF rates have risen over the past 20 years, but there is still a long way to go to reach the target coverage of 100% recommended by UNICEF (United Nations International Children's Emergency Fund) (2) . This is reflected in the current low prevalence of EBF in developing countries, especially in West and Central Africa, where child malnutrition is the highest in the world .(3,4). Although the WHO and UNICEF recommend that children initiate breastfeeding within the first hour of birth and be exclusively breastfed for the first 6 months of life(5), breastfeeding rates and especially exclusive breastfeeding practices continue to be suboptimal in many parts of Cameroon(6).

Breastfeeding is perceived to play a role in women's health. Besides knowing that her baby is well fed, a nursing mother receives many health benefits from breastfeeding because many mothers quickly identify the close bond with their infants as an important plus to breastfeeding. It is often a gratifying, emotionally-fulfilling extension of pregnancy. Effective breastfeeding is acknowledged to be a period of depletion, even among well-nourished women, as they lose weight during this time(7,8) . However, women with chronic energy deficiency have been observed to maintain their weight during partial breastfeeding which supports the notion that repletion is possible during more than just the non-pregnant, non-lactating interval. Indeed, there is experimental evidence of enhanced metabolic efficiency during lactation, such that energy intake need not necessarily be increased to pay for the energy cost of lactation (9–13).

It is worth noting that breastfeeding has been reported to confer a lower risk of breast and ovarian carcinoma (14), greater postpartum weight loss (15,16) and decreased blood pressure (16–20) compared with no breastfeeding. Similarly, a study on the association of breastfeeding and obesity carried out in Greek rural and urban regions also revealed that breastfeeding is associated with lower rates of overweight and obesity (19), as well as a study in Kingston Health Science Center in Canada (20). Lower rates of anemia were also revealed in breastfeeding mothers in Tanzania(21) and Sudan (22). However, some studies have revealed increasing anemia levels in breastfeeding mothers in some parts of Africa (23,24).

As a theoretical basis for the link between breastfeeding and maternal health, The self-efficacy theory posits that health behavior is chosen, performed and maintained as a function of one's expectations about the outcome (25). Self-efficacy has been shown repeatedly through correlations and causal associations to be predictive of health behaviors. This can be explained by the idea that, a woman's decision to breastfeed will depend on her expectations about the benefits of breastfeeding in the form of improved health outcomes (26).

Similarly, basic concepts of the human capital theory suggest that individuals develop their skills to enhance their career prospects and thereby generate income by investing in on-the-job training and healthcare. This requires the implementation of suitable policies in the areas of education, health, access to basic social facilities and social protection (27).

Sustainable development goal target 3.1 is aimed to reduce the global maternal mortality ratio to less than 70 per 100,000 live births (28). However, maternal mortality rate increased from 157.1 deaths per 100,000 live births in 2020 to 158.8 deaths per 100,000 live births in 2021 (29). Notwithstanding, the trajectory projects 140.9 deaths per 100,000 live births in 2030 which is double the SDG target of 70 per 100,000 live births.

From the literature reviewed, it can be observed that a handful of the existing studies have used descriptive and analytical methods and majority of these studies did not account for potential endogeneity that may affect maternal health and its covariates. Thus, econometric methods can be used in investigating this link which is addressed in this study. Despite the flooded literature associating breastfeeding with body mass index and anemia, those in Cameroon seem limited. The socio-economic context and cultural differences might alter or change the findings elsewhere. How does breastfeeding therefore affect postpartum maternal BMI and anemia? Therefore, this paper sought to evaluate the effect of breastfeeding on two maternal health outcomes (BMI and anemia) from a nationally representative survey data. However, the benefits of breastfeeding to a breastfeeding mother have not been ascertained using Cameroonian data as literature reveals in other countries. Thus, given the health benefits of breastfeeding to the mother it is important to investigate whether Cameroonian data support these maternal health benefits so that policy implications can be appropriately suggested in order to meet up with the SDG target for maternal mortality rate.

II. METHODS

Study design, setting, study population and eligibility criteria

Secondary data analysis of the 2018 Demographic and Health Survey (DHS) data was carried out. The 2018 DHS was a nationwide cross-sectional study carried out at household levels. A stratified two-stage cluster sampling was implemented. The 2018 DHS data set provides high quality data on child and maternal health, nutritional status of young children and women, childhood mortality levels and treatment of childhood illnesses amongst other aspects.

Our study population was made up of all women of childbearing age who reportedly had at least one child. This included a total of 9733 participants as was extracted from the whole 2018 DHS data.

Sampling: A stratified, two-stage cluster sampling was implemented. At the first level, 470 Enumeration Areas (EAs) or clusters were systematically drawn with a probability proportional to their size in households, from the list of EAs from the RGPH of 2005 and updated in 2014 during the cartographic work of the fourth Cameroon Household Survey (ECAM 4). A mapping and counting operation of households in the selected clusters was organized on a Tablet PC from December 13, 2017 to March 25, 2018 to draw up the updated list of households in each EA to serve as the basis for the second-degree draw. Then, at the second stage, a sample of 28 households per cluster with a systematic selection with equal probability was selected. In the selected households, all women aged 15-49 usually living there, or having spent the night preceding the interview, were eligible to be interviewed. In addition, in a subsample of one in two households of all sampled households, all men aged 15-64, as well as all women aged 50-64, were eligible to be investigated. (30)

Definition of some study variables

Body mass index (BMI): BMI is a simple index of weight-for-height that is commonly used to classify overweight and obesity in adults. It is defined as a person's weight in kilograms divided by the square of his height in meters (kg/m2) (31).

Anemia: Anemia was captured in the Cameroon DHS data in ordered categories (that is severe, moderate, mild and not anemic). According to the DHS program, severe anemia corresponds to a level of hemoglobin concentration of less than7.0g/dl, moderate anemia corresponds to a level of 7.0-9.9g/dl, mild anemia corresponds to a level of 10.0-11.9g/dl and levels above 12 are considered not anemic.(30)

Breastfeeding

Breastfeeding in this study corresponds to mothers who were currently breastfeeding at the time of the survey.

Statistical models, statistical analysis and justification

This work used the 2SLS (Two Stage Least Square) and IV (Instrumental Variable) ordered probit techniques to test the three hypotheses. The 2SLS technique was used to investigate the effect breastfeeding on BMI in concordant with the fact that BMI is continuous while the IV ordered probit regression technique was applied assess the effect of breastfeeding on anemia corresponding to the ordinal scale of measurement of anemia.

For the effect of breastfeeding on BMI, the following econometric model was used:

$$y_1 = B_0 + B_1(Breastfeeding) + X\beta + \varepsilon \qquad 1$$

Where, y_1 = BMI, X = Matrix of independent variables, B_1= The coefficient associated with breastfeeding, B_0= the intercept and β=a vector of coefficients associated with independent variables. Breastfeeding is potentially endogenous because if a woman is breastfeeding regularly, her health will be enhanced and breastfeeding is also encouraged and promoted for women who are healthy. And as such, bearing in mind that breastfeeding might enhance maternal health the perceptions towards breastfeeding practice are highly associated with health outcomes (32).

Non-self-cluster breastfeeding was used as a potential instrument for breastfeeding. This is because it makes the variable to be free from the many individual differences that causes it to be endogenous and excludes the individual woman in each cluster. This instrument must however be exogenous and relevant. An instrument is exogenous if it is not correlated with the structural error term. In which case $corr(Z_i, \mu_{i1}) = 0$. In our case here non-self-cluster breastfeeding must not correlate with the error term of our structural equation that captures maternal health as a function of breastfeeding and other covariates.

To address the endogeneity issue we derive the reduced form for breastfeeding equation which accommodates the instrument as follows:

$$BF_i = \alpha_0 + \alpha_1 IV_i + \alpha_2 X_i + \varepsilon_i \qquad 2$$

Where IV_i represents instrument (non-self-cluster breastfeeding) for the potential endogenous variable (breastfeeding) and X_i is a vector of exogenous variables that affect breastfeeding such as age, educational level, number of children ever born, marital status, place of residence. Breastfeeding is then predicted from 2 using the binary probit technique and predicted to obtain $\widehat{BF}_i$. The structural form in 3.1 above becomes:

$$y_1 = B_0 + B_1\widehat{BF}_i + X\beta + \varepsilon \qquad 3$$

To conveniently use the instrumental variable technique in the system in 3.3, we test for endogeneity using the Durbin and Wu-Hausman tests. If the tests statistics are significant, we conclude that there is endogeneity and the 2SLS technique is appropriate.(33). The Cragg-Donald Wald F statistics on weak identification is expected to be larger than the Stock-Yogo weak ID test critical values of 16.38(10% maximal IV size) (34).

While for the effect of breastfeeding on anemia the model is specified as follows:

$$y^* = X^T\beta + \varepsilon \qquad 4$$

Where y^* is the exact but unobserved dependent variable; X is the vector of independent variables including the predicted breastfeeding($\widehat{BF}_i$), and β is the vector of regression coefficients which we wish to estimate. Further suppose that while we cannot observe y^*, we instead can only observe the categories of response:

$$y = \begin{cases} 0 \; if \; y^* \le 0, \\ 1 \; if \; 0 < y^* \le \mu_1, \\ \quad . \\ \quad . \\ \quad . \\ N \; if \; \mu_{N-1} < y^*. \end{cases} \qquad 5$$

Then the instrumental variable ordered probit technique will use the observations on y which is a form of censored data on $y^*$to fit the parameter vector β.

The coefficients on explanatory variables of nonlinear models β (ordinary outcomes) like in our case do not measure the marginal effects of the variables in the model. Significant economic interpretations can only be made on the marginal effects of variables. thus;

$$\Pr(y_i = j) = \varphi[X_i\beta - K_{j-1}] - \varphi[X_i\beta - K_j] \qquad 6$$

Where K_j are threshold values (35)). The marginal effects are computed at each cut-off point and interpreted as probabilities.

This paper further used the conditional mixed process (CMP) regression model in investigating (and to check for robustness of results) the effect of breastfeeding on maternal health outcomes while considering the different measures of maternal health outcomes. The CMP was implemented by David Roodman (36)) and it allows the dependent variables (maternal health outcomes) to have different scales of measurement.

A Conditional mixed process modeling (CMP) is a conceptual process for modeling (sometimes seemingly unrelated regressions -SUR processes) simultaneous stochastic relations (linear regressions in this case) where the error processes are possibly linked and where there may or may not be relationships between the dependent variables in those stochastic relationships. The CMP (conditional mixed process) model differs from the multivariate regression model in the sense that it takes account of prior information concerning the absence of certain explanatory variables from certain equations of the model. Such exclusions are highly realistic in many economic situations. For a CMP (37), let:

$$y = f^t(\theta^t, \epsilon)$$

$$\theta^t = s^t(X, \beta^t) \quad , {}^{\epsilon}/_{X} \sim iid.P(\gamma) \qquad 7$$

Where f^t and s^t are models for the interplay between the independent variable and error for the structural part respectively, and γ is a parameterization of the error distribution P for a family of general regression indexed by $t \in T$. It is proposed that a link function g exists between error processes in the model of the family in 7. Thus, we write:

$$y_{ti} = \sum_{j=1}^{k_i} X_{tij}\beta_{ij} + \varepsilon_{ti}, \quad i = 1, 2,3; j = 1, 2,3,4,5, \ldots \qquad 8$$

The CMP jointly estimates the independent variables β_{ij} with linkages among their error process ε_{ti}.

Where, y_{ti} = Maternal health outcomes (BMI and anemia) X_{tij} = Independent variables of the study (predicted breastfeeding and control variables) β_{ij} = The coefficient associated with independent variables at each maternal health outcome. ε_{ti}= The i^{th} value of the random error component associated with i^{th}equation of the model.

In determining the effect of breastfeeding on maternal health, the CMP model is appropriate because the maternal health outcomes (BMI and anemia) are measured differently. BMI is continuous while anemia is ordinal.

III. RESULTS

Weighted descriptive statistics of the characteristics of the study population

Table 1 hosts the weighted descriptive statistics of all the variables used in the study. The descriptive statistics reveal that with respect to breastfeeding, 48.6% of the women were breastfeeding while 51.4% of the women were not breastfeeding mothers. The average mean for breastfeeding at the individual level (0.486) is greater than that at the community level when the individual mother is excluded (0.473). As for the body mass indices of the women considered, descriptive statistics show that the average their body mass index was 24.65kg/m2. On average, 0.46% of the mothers had severe anemia, 9.66% had moderate anemia, 11.3% had mild anemia and a greater majority of 78.6% were not anemic.

Table 1: **Weighted descriptive statistics of the characteristics of the study population**

Variables	Modalities	Obs	Mean	Std. Dev	Min	Max
Breastfeeding	1=yes and 0 =otherwise	9,733	0.485976	0.499829	0	1
	Non-self-cluster breastfeeding	9,732	0.4725892	0.1802912	0	1
BMI	BMI	9,733	24.64754	5.053428	14.35	54.37
Anemia	Severe anemia	9,733	0.0046321	0.0679053	0	1
	Moderate anemia	9,733	0.0965694	0.2953857	0	1
	Mild anemia	9,733	0.1130783	0.3167047	0	1
	Not anemic	9,733	0.7857202	0.4103428	0	1
Maternal education (ME)	Higher education	9,733	0.043342	0.203636	0	1
	Secondary education	9,733	0.331981	0.470948	0	1
	Primary education	9,733	0.326707	0.469033	0	1
	No education	9,733	0.29797	0.45739	0	1
Marital status	Married (1=yes and 0 =otherwise)	9,733	0.826368	0.378812	0	1
Place of residence	Urban(1=yes and 0 =otherwise)	9,733	0.401403	0.490208	0	1
Maternal age	[15-24]	9,733	0.282453	0.450216	0	1
	[25-34]	9,733	0.50005	0.500026	0	1
	[35-49]	9,733	0.217497	0.412565	0	1
Spouse's level of education	No education	9,733	0.417916	0.493241	0	1
	Primary education	9,733	0.280881	0.449453	0	1
	Secondary education	9,733	0.249001	0.432457	0	1
	Higher education	9,733	0.052202	0.222445	0	1
Husband's age	Continuous	9,733	35.45247	13.41704	15	95
Husband's occupation	Working	9,733	0.814869	0.388423	0	1
	Not working	9,733	0.185131	0.388423	0	1
Number of children ever born	Continuous	9,733	4.266659	2.523711	1	16
Protected source of drinking water	1=yes and 0 =otherwise	9,733	0.626517	0.483754	0	1
Wealth index	Richest	9,733	0.131067	0.337491	0	1
	Richer	9,733	0.181296	0.385283	0	1
	Middle	9,733	0.21584	0.411425	0	1
	Poorer	9,733	0.242594	0.428674	0	1
	Poorest	9,733	0.229203	0.420342	0	1
Religion	Christian	9,733	0.642341	0.479336	0	1
	Muslim	9,733	0.317037	0.465346	0	1
	Others	9,733	0.040622	0.197422	0	1

Population weight=82101.1498

Tables 2, 3 and 4 host the results pertaining to the effect of breastfeeding on maternal health outcomes (BMI, and anemia). The first part presents the results separating the maternal health outcomes while the second part presents the results using the conditional mixed process (CMP) estimation technique to check for the robustness of the results.

To estimate the effect of breastfeeding on maternal health outcomes, the potential endogenous variable (breastfeeding) was tested for endogeneity using the Durbin and Wu-Hausman tests. The test results for Durbin and Wu-Hausman statistics presented in table 2 are statistically significant, showing that there is an endogeneity problem and the instrumental variable estimates are reliable for inference. Thus, we proceed with the instrumental variable technique using non-self-cluster breastfeeding as the instrument for breastfeeding. The non-self-cluster breastfeeding is a potential instrumental variable for breastfeeding with respect to an individual mother because it excludes that individual mother from the sample in order to measure the effect of breastfeeding practices of other individuals in the sample on the breastfeeding practice of this individual mother.

The results in column 1 of table 2 present correlates of breastfeeding from the reduced form equation. There is a strong correlation between breastfeeding and non-self-cluster breastfeeding. The non-self-cluster breastfeeding increases the likelihood for a woman to breastfeed by 0.558 standard scores. The relationship is statistically significant at a 1% level. Likewise maternal age has a positive and significant effect on the breastfeeding decision of a woman. We also find that education plays a role in determining the breastfeeding decisions of women. However, all the regression coefficients of female education dummies are statistically insignificant. Being married increases the probability to breastfeeding by 0.126 points compared to when a woman is not married. This coefficient is statistically significant at 1% level. The wealth index of women appears to be an important determinant of breastfeeding with the richer and poorer wealth classes having negative coefficients and statically significant at 1% level. Also, urban residency has a negative and significant effect on breastfeeding implying that women who are based in urban areas will face a reduction in the probability to breastfeed by 0.048 standard scores compared to women based in rural areas.

Table 2: The effect of breastfeeding on BMI using 2SLS

	(1) Reduced Form Estimates	(2) BMI
VARIABLES	Breastfeeding	(2SLS)
Breastfeeding		-1.147 *
		(0. .6774)
Mat age[15-24]	0.218***	-2.732***
	(0.0194)	(0.2334)
Mat age[25-34]	0.107***	-1.404***
	(0 .0167)	(0.1663)
Mat age [35-49]	Reference category	Reference category
ME higher	-0.019	2.112***
	(0 .0403)	(0.3618)
ME secondary	-0.001	1.992***
	(0.0210)	(0.1880)
ME primary	-0.002	1.964***
	(0.0182)	(0.1629)
ME no education	Reference category	Reference category
Married	0.126***	0.502***
	(0.0179)	(0.1864)
Not married	Reference category	Reference category
Wealth index richest	-0.110***	5.522***
	(0.0321)	(0.3092)
Wealth index richer	-0.0774***	3.372***

	(0.0263)	(0.2479)
Wealth index middle	0.005	2.327***
	(0. 0226)	(0. 2014)
Wealth index poorer	-0.054***	1.385 ***
	(0. 0204)	(0. 1882)
Wealth index poorst	Reference category	Reference category
Non-self-cluster breastfeeding (nscbf)	0.558***	
	(0.0423)	
Urban residence	-0.048***	-0.180
	(0.0178)	(0.1664)
Rural residence	Reference category	Reference category
Constant	0.068*	22.399***
	(0.0350)	(0. 3452)
Observations	9,732	9,732
F test of excluded instruments	173.75 [1, 9719;0.0000]	
Sanderson-Windmeijer multivariate F test	173.75 [1, 9719;0.0000]	
Under identification test (Anderson canon. Corr. LM Statistics): Chi2[df;P-val]		168.53 [0.0000]
Weak identification test: Cragg-Donald F-stat [10%maximal IVrelative bais]		173.75 [16.38]
Sargan statistics		0.0000
Durbin chi2[p-value]		13.0311 (p = 0.0003)]
Wu-Hausman F-stat [df; p-value]		13.0286 (1,9718; p = 0.0003)
Endogeneity test of endogenous regressors: Chi2[p-val]		3.057[0.0804]

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The 2SLS model estimates are globally significant at 1% level. The Cragg-Donald F-statistics (173.75) is greater than the Stock-Yogo at 10% (16.38), the F-test of excluded instruments is significant at 1%, and the Sargan statistics is insignificant indicating that the instrument for breastfeeding (non-self-cluster breastfeeding) is an appropriate instrument.

Column 2 presents the model estimating the effect of breastfeeding on BMI. The regression results show breastfeeding has a negative effect on BMI. Precisely, when a woman is breastfeeding, her BMI will reduce by 1.147kg/m2 compared to when a woman is not breastfeeding. This result is statistically significant at a 10% level, implying that as a woman breastfeeds, her BMI reduces which is in line with the apriori expectations.

Results in column 2 also reveal that the body mass index of women is negatively influenced by age and urban residence. Specifically, for women of the age group 15-24 years, their BMI will fall by 2.732kg/m2 compared to women of the age group 34-49 years statistically significant at a 1% level. Also, for women aged between 25-34 years, their body mass indices will decrease by 1.404kg/m2 compared to older women statistically significant at

1%level. While urban residence insignificantly reduces the BMI of women by 0.180 kg/m2 compared to rural residency. The educational level of a woman has a positive and significant effect on BMI. Likewise, being a married woman has a positive and significant effect on BMI as well the wealth index of a woman.

The effect of breastfeeding on anemia

Table 3 presents the effect of breastfeeding on anemia using the IV-ordered probit technique. Column 1 presents reduced form estimates for breastfeeding while columns 2, 3 and 4 present results on IV ordered probit for cut-off points 1,2 and 3 respectively. Column 1 results show that the instrument of breastfeeding (non-self-cluster breastfeeding) is positively associated with breastfeeding.

Table 3: The Effect of Breastfeeding on Anemia Using IV Ordered Probit

VARIABLES	Reduced form estimates	Cut-off point 1 Severe-moderate	Cut-off point 2 Moderate-mild	Cut-off point 3 Mild-not anemic
Breastfeeding hat		0.001 (0.00121)	0.021 (0.01707)	0.016 (0.01291)
Married	0.132*** (0.0476)	0.002* (0.00099)	0.027* (0.01602)	0.022 (0.01366)
Not married	Reference category	Reference category	Reference category	Reference category
Wealth index richest	-0.086*** (0.0257)	-0.002 *** (0.00058)	-0.033 *** (0.00887)	-0.027*** (0.00793)
Wealth index richer	-0.054** (0.0223)	-0.001** (.00055)	-0.02** (0.00826)	-0.016** (0.00682)
Wealth index middle	-0.041** (0.0186)	-0.002 *** (0.0005)	-0.032*** (0.00664)	-0.026*** (0.00565)
Wealth index poorer	-0.041*** (0.0169)	-0.002*** (0.00046)	-0.029*** (0.00612)	0.024 *** (0.00517)
Wealth index poorest	Reference category	Reference category	Reference category	Reference category
Urban residence	0.0063 (0.01441)	-0.0004 (0.00043)	-0.006 (0.00608)	-0.004 (0.00462)
Rural residence	Reference category	Reference category	Reference category	Reference category
Spouse's educ no	0.005 (0.03012)	0.0004 (0.00082)	0.006 (0.01153)	0.005 (0.00863)
Spouse's educ pri	0.002 (0.02749)	-0.0004 (0.0008)	-0.006 (0.01063)	-0.005 (0.00821)
Spouse's educ sec	0.0152 (0.02612)	0.0002 (0.00072)	0.003 (0.0105)	0.002 (0.00786)
Non-self-cluster breastfeeding	0.592*** (0.03371)			
Spouse's educ higher	Reference category	Reference category	Reference category	Reference category
Working husband	0.021 (0.0438)	-0.0028 (0.0013)	-0.036* (0.0202)	-0.025* (0.0131)
Non-working husband	Reference category	Reference category	Reference category	Reference category

Protected water	0.001*	0.009*	0.007*
	(0.0004)	(0.00501)	(0.00387)
Unprotected water	Reference category	Reference category	Reference category
Pseudo	0.0043	0.0043	0.0043
Prob>chi2	0.0000	0.0000	0.0000
Observations	9732	9732	9732

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The model estimating the effect of breastfeeding on maternal health as measured by a decreasing order of severity in anemia level (increasing order of good health) is presented on table 3. The results show that on average, the probability that women who breastfeed will move from severe to moderate anemia level increases insignificantly by 0.001 standard scores as compared to women who do not breastfeed. Also, when a woman is breastfeeding, the probability for her to move from moderate to mild anemia level and from mild to non-anemic increases insignificantly by 0.021units and 0.016 units, respectively. Overall, the results reveal that breastfeeding increases the probability of good health as measured by anemia.

The variable married in relation to anemia shows that being married increases the probability for a woman to move from severe to moderate, moderate to mild and mild to non-anemic anemia levels by 0.002, 0.027 and 0.22 standard scores respectively, compared to when a woman is not married. By implication, being married increases the chances of a woman having low anemia levels compared to women who are not married, thus affecting her health positively. This result is statistically significant at cut-off points 1(severe-moderate) and 2(moderate-mild).

Taking in to consideration the wealth index of women in associated with anemia levels the results show that wealthy women are less likely to move from high anemia levels to lower levels. The coefficients for the dummies of wealth index are all negative and statistically significant. The coefficient of urban residency is negative for cut-off points 1, 2 and 3 indicating that being an urban residence reduces the probability of moving from higher anemia levels to lower ones. Women whose husbands have no education and secondary education are likely to be less anemic compared with women with husbands having higher education. On the other hand, women whose husbands have primary education are less likely to move from higher anemia levels to lower levels (good health) as well as women with working husbands. The results further reveal that when women drink from protected water sources their probability of moving from severe to moderate, moderate to mild and from mild to non-anemic anemia levels will increase by 0.001, 0.009 and 0.007 points respectively. Hence when women drink from protected water sources, they are liable to have improved health outcomes as compared to those who drink from unprotected sources.

For a robustness check of the results presented in table 3, the estimated CMP technique is also a combination of two techniques in columns 1 and 2. Column 1 indicates results on the effect of breastfeeding on BMI using the OLS technique and column 2 presents results on the effects of breastfeeding on anemia using the Ordered Probit technique of analysis.

Table 4: Estimating of the effect of breastfeeding on maternal health outcomes using the CMP technique.

	1		2	
VARIABLES	BMI OLS		Anemia	
		Severe-moderate	Moderate-mild	Mild-not-anemic
Breastfeeding	-0.105	-0.00004	-0.0005	-0.0004
	(0.1299)	(0.000323)	(0.0048)	(0.0034)
Mat age [15-24]	-2.984***			
	(0 .1857)			
Mat age [25-34]	-1.401***			
	(0.1669)			
Mat age [35-49]	Reference			
ME higher	2.322***			
	(0.3582)			
ME secondary	2.211***			
	(0 .1959)			
ME primary	1.787***			
	(0.1785)			
ME no education	Reference			
Married	0.089	0.002***	0.031*	0.023*
	(0.1640)	(0.0014)	(0.01857)	(0.0139)
Not married	Reference	Reference	Reference	Reference
Wealth index richest	4.723***	-0.003***	-0.041***	-0.030***
	(0.3052)	(0.0009)	(0.0106)	(0.0077)
Wealth index richer	3.398***	-0.002**	-0.024***	-0.018***
	(0.2583)	(0.0007)	(0.0088)	(0.0066)
Wealth index middle	2.259***	-0.003***	-0.037***	-0.027***
	(0.2179)	(0.0007)	(0.00575)	(0.0056)
Wealth index poorer	1.359***	-0.002***	-0.033***	-0.025***
	(0.2008)	(0.0006)	(0.0069)	(0.0052)
Wealth index poorest	Reference	Reference	Reference	Reference
Urban residence	0.0892	-0.0005	-0.006	-0.005
	(0.1640)	(0.0004)	(0.00611)	(0.0046)
Rural residence	Reference	Reference	Reference	Reference
Spouse's educ no		0.005	0.007	0.005***
		(0.0008)	(0.0114)	(0.0085)
Spouse's educ pri		0.0004	-0.006	0.004
		(0.0008)	(0.00109)	(0.0081)
Spouse's educ sec		0.0003	0.004	0.003
		(0.0008)	(0.0174)	(0.0078)
Spouse's educ higher		Reference	Reference	Reference
Working husband		-0.002**	-0.032*	-0.024*
		(0.0013)	(0.0174)	(0.0130)
Non-working husband		Reference	Reference	Reference
Protected water		0.0006	0.009	0.006*
		(0.0004)	(0.0051)	(0.0038)
Unprotected water		Reference	Reference	Reference
Constant	22.399***			
	(0. 2616)			
Observations	9,733	9,733	9,733	9,733

LR chi2(33)	1279.24	1279.24	1279.24	1279.24
Prob>chi2	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

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The results for the robustness check indicate that breastfeeding has a decreasing effect on BMI which is in line with the 2SLS results presented above. For the effect of breastfeeding on anemia, the results are surprisingly contradictory as they reveal that breastfeeding reduces the probability for a woman to move from a higher level of anemia to a lower level since the coefficient of breastfeeding at all cut-off points is negative indicating a lower probability to move from higher anemia levels to good health.

IV. DISCUSSION

The results on the positive effect of breastfeeding on BMI are in line with the findings of Blincoe and Krismanita *et al.* (38,39)who found that breastfeeding is associated with a decreased risk of being overweight on the mother's part because it can increase the calorie expenditure of the mother. Other studies that corroborate with these findings that breastfeeding reduces BMI are the studies of Bartick *et al.* (40), Zubaran and Foresti (41), Binns, Lee and Low (16) whose findings revealed that breastfeeding lowers the risk of obesity. In line with this study is a study carried out on the association of breastfeeding and obesity in Greek rural and urban regions whose findings revealed that breastfeeding is associated with lower rates of overweight and obesity. This is also in line with the findings of Rosenbaum *et al.* (19,42) also found that breastfeeding reduces the prevalence of obesity and overweight in lactating mothers. This is probably because the period of breastfeeding is considered as a period where women burn fats in the production of breast milk. Also, the rates of weight loss are different for each postpartum mother depending on their life style, metabolism, personal health, genetic factors and above all whether or not they are breastfeeding.

It can be noted that breastfeeding (as revealed by this study and most empirical findings) is considered a natural way of helping lactating mothers lose their baby weight. Research shows that exclusively breastfeeding mothers tend to burn on average 500 additional calories daily. This may help breastfeeding mothers lose around 0.45kg per week giving a total of 1.8kg per month(43).

The likelihood for breastfeeding to reduce anemia level as revealed by this study corroborates the findings of Huang *et al.* (44) whose study in china revealed that breastfeeding is associated with lower postpartum blood loss. In the same vein, the results of this study support the results obtained in Tanzania by Tairo and Munyogwa (21) that anemia is common with insufficient breastfeeding.

The findings on anemia are however contrary to the results obtained by Abdelbagi *et al.* (22) in Eastern Sudan who found that anemia was high in lactating mothers. In the same line, Yidana *et al.* (23) also revealed in Ghana that anemia increases with breastfeeding. The findings of this study with respect to anemia also contradict the findings of Clinton *et al.* (24)whose findings revealed in Uganda that anemia increases with breastfeeding as the prevalence of anemia was high in breastfeeding mothers.

The results on BMI and anemia as revealed by this study are in line with the concepts of human capital theory, the self-efficacy theory and the health production theory wherein breastfeeding is considered as an activity geared towards good health.

V. CONCLUSION

The results of this analysis indicate that breastfeeding has a negative and significant effect BMI. The findings also revealed that women who breastfeed have a greater probability to leave from high levels of anemia to good health. It is concluded that breastfeeding has a positive and significant effect on BMI and it increases the likelihood of a woman to become less anemic. It is therefore recommended that policies should be put in place to encourage breastfeeding in order for women to enjoy its full advantage in enhancing the health of women (especially its ability to reduce BMI) and reducing maternal mortality rate to the SDGs target. Breastfeeding support programs should also be implemented/ reinforced in work places and mass media so as to encourage lactating women to intensify breastfeeding practices and to continue breastfeeding when they return from maternity leave. This will permit them to enjoy reductions in BMI especially for women suffering from obesity and overweight and to reduce their chances of suffering from anemia.

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