Breastfeeding in Developing Countries: Selection and Effects

Seline Spillmann*

Master's Thesis
University of Zurich
Department of Economics
Prof. Dr. Anne Brenøe
Supervisor: Dr. Claudio Schilter

August 26, 2022

*seline.spillmann@uzh.ch, 16-705-345

Abstract

Using data from the Demographic and Health Survey, I show that mothers from a lower socioeconomic status tend to breastfeed longer in developing countries. Accounting for this selection into breastfeeding, shorter breastfeeding durations are associated with a decrease in the probability of stunting. Longer durations of more than 24 months are associated with an increase in the probability of being underweight and wasted. There is considerable heterogeneity in results depending on the quality of the drinking water. Breastfeeding is associated with positive effects on health outcomes if the water comes from poor-quality sources. Furthermore, I provide evidence that part of these effects is mediated through the difference in diet between breastfed and weaned children. Finally, using family fixed effects leads to statistically insignificant results, which indicates that between-family estimates suffer from selection bias.

1 Introduction

According to the World Health Organization [WHO], 2021b, optimal breastfeeding is critical for child survival and healthy growth and development. The WHO and UNICEF recommend exclusive breastfeeding for the first 6 months of life, and continued breastfeeding with complementary foods until 24 months or beyond. The WHO and UNICEF are committed to increasing breastfeeding rates globally through policy changes and programs to support mothers. However, the promotion of 'breast is best' is also associated with monetary and emotional costs. Mothers who are unable to breastfeed experience negative emotions, such as guilt and stigma (Fallon et al., 2017). They are also likely to hide the use of formula if they fear judgement by others (Bresnahan et al., 2020). Breastfeeding is also time-consuming and may make it more difficult for mothers to return to their workplace. Due to these potential costs of breastfeeding, it is crucial to thoroughly examine the effects of breastfeeding on health.

This thesis examines two questions: What characterizes mothers who select into breastfeeding across developing countries? Accounting for this selection, what is the association between breastfeeding and the probability of being underweight, stunted, wasted or overweight? I show that mothers are less likely to breastfeed for more than 12 months if they have a higher socioeconomic status and if they are from urban areas. A lower child-size at birth and cesarean sections are also associated with shorter breastfeeding or no breastfeeding. Before accounting for these selection effects, shorter breastfeeding durations are associated with positive effects on health outcomes, while longer durations are associated with negative health outcomes. After accounting for these selection effects, many of these associations disappear and become statistically insignificant. However, shorter breastfeeding durations are still associated with a small reduction in the probability of stunted child-growth by 1.6 percentage points. Longer breastfeeding durations of more than 24 months are still associated with an increase in the probability of being underweight by 2.4 percentage points and an increase in the probability to be wasted of 1.3

percentage points. Longer breastfeeding is also associated with a decrease in the probability of being overweight by 1.5 percentage points. Furthermore, I provide evidence that part of these effects is mediated through the difference in diet between breastfed and weaned children. There is also heterogeneity in effects of breastfeeding depending on the source of drinking water. If the household does not have access to safe water, breastfeeding is associated with positive effects on weight and height. To analyze the remaining influence of unobserved heterogeneity, I follow the methodology of Evenhouse and Reilly (2005) and Colen and Ramey (2014) by using family fixed effects. The results show that between-family estimates still suffer from selection bias, even when controlling for many confounding variables. Finally, I show that exclusive breastfeeding compared to non-exclusive breastfeeding is only associated with a small increase in weight and height in children aged 0-3 months.

I use data from the Demographic and Health Survey (DHS) from 49 countries in Europe, Africa, the Eastern Mediterranean Region, the Americas and South East Asia. The surveys were conducted between 1991 and 2018. The dataset contains variables on women's demographic characteristics, full birth history, maternity history for all children born in the last five years, as well as household characteristics. As a first step, I analyze the characteristics of mothers who select into short breastfeeding durations and long breastfeeding durations using OLS regressions. I use a rich set of child-, mother- and household-specific variables which may be associated with the child's health as well as with the selection into breastfeeding. Then, I analyze the effects of the breastfeeding duration for children older than 24 months, taking into account the differential selection. I compare children who have never been breastfed to children who have been breastfed for different durations using OLS and logistic regression functions. Each of my final results also includes region-year fixed effects to control for time-variant regional differences. I also estimate the effects separately for each world region. To see whether there is heterogeneity in the effects depending on the safety of the drinking water source, I estimate the effects for three levels of water quality: poor, intermediate and high. Furthermore, to investigate the mediating effect of nutrition on health outcomes,

I compare children who are still being breastfed to weaned children for different age groups. I add information on the types of food the child consumed in the last 24 hours, to see whether the difference in the diet of breastfed and weaned children has an effect on health outcomes. To more accurately control for any remaining selection and omitted variable bias, I use family fixed effects to compare whether a difference in breastfeeding duration within siblings has an effect on health outcomes. The identifying assumption of this approach is that this method controls for any unobserved characteristics which are constant within families. Lastly, using the data on the types of foods consumed in the last 24 hours also allows me to analyze whether exclusive breastfeeding has any additional benefits to non-exclusive breastfeeding for children aged 0-6 months.

The results of this thesis have important implications for policy and future research. First, I provide evidence that observational data suffers from selection and omitted variable bias. Even after controlling for many confounding factors, there are associations which remain statistically significant and only disappear after adding family fixed effects. Second, my thesis provides evidence that the source of drinking water matters when analyzing the effect of breastfeeding. Breastfeeding is associated with more positive effects when the source of drinking water is unsafe. Policy makers should take this into account when deciding where to allocate their resources. Finally, I also show that compared to weaned children, children who are breastfed for more than 6 months tend to consume foods which are less beneficial to health outcomes. It is therefore important to ensure that breastmilk does not replace healthy and nutrient-rich foods in children older than 6 months.

My thesis contributes to the literature on breastfeeding in developing countries in several ways. Previous studies have found that in low- and middle-income countries, mothers from poorer households tend to breastfeed longer than mothers from richer households (Victora et al., 2016 Grummer-Strawn, 1996). My results are consistent with this research, but I extend the analysis by identifying more variables which are associated with the selection into breastfeeding, such as the water source and the size of the child at birth. I

also complement previous studies on the duration of breastfeeding in developing countries. Marriott et al., 2012 use data from the DHS from 14 countries to analyze child feeding indicators and their association to growth measures. They report a higher risk for being underweight for children who are continued to be breastfed at 12-15 months. Caulfield et al., 1996 also use data from the DHS from 19 countries to analyze the association between prolonged breastfeeding and malnutrition. They find that children older than 12 months who are still breastfed are lighter and shorter than children who are not breastfed anymore. My method to study the effects of breastfeeding differs from these previous studies. Instead of using the current breastfeeding status of children, my main analysis focuses on the reported duration of breastfeeding. Consistent with these two studies, I find that breastfeeding for more than 7-12 months is associated with a lower weight and height, but the risk for being underweight only increases at breastfeeding durations of more than 24 months. To control for remaining selection bias, I apply the method of Evenhouse and Reilly (2005) and Colen and Ramey (2014) and use within-family estimates. Similar to their results, all of the associations become statistically insignificant after applying family fixed effects. To my knowledge, no prior studies have used sibling comparison in developing countries to analyze the association between breastfeeding and child growth.

The patterns found in previous literature on the interaction between breastfeeding and nutrition can also be found in my analysis. Brenøe et al. (2022) find that Belarussian children who received more breastmilk in their first year of life consumed less liquids with fewer calories, which explains a large part of their weight gain. Rah et al. (2010) show that in children older than 6 months in Bangladesh, low food diversity is associated with lower height and is more common in children who are still breastfed. Similar results can also be found in my analysis: the positive associations between breastfeeding and health outcomes in children aged 0-12 months and the negative associations for children older than 12 months become weaker once I control for the types of foods consumed. Finally, my analysis is also consistent with the literature on the role of water sanitation. Butz et al. (1984), Keskin et al. (2017), and

VanDerslice et al. (1994) find that breastfeeding in environments with lower water sanitation is associated with fewer incidences of diarrhea and lower mortality in Malaysia, Bangladesh and the Philippines. I extend their analysis by analyzing data from numerous countries and looking at the effects on undernutrition.

2 Data and Variables

2.1 Data Source

The data used in this analysis comes from the Demographic and Health Surveys (DHS), which provide cross-sectional data. It contains data on population, health and nutrition based on in-person interviews. The data is representative at the national and regional level, due to its stratification sampling method. This means that each national sample has been divided into homogeneous groups of strata. Then, clusters within stratum are selected with a probability which is proportional to the population size. Finally, households are randomly selected within each cluster (Croft et al., 2020).

For this analysis, I use data from the women's questionnaire which interviews women aged 15-49 [1] (Croft et al. (2020)). The data contains variables on women's demographic characteristics, full birth history, maternity history for all children born in the last five years, as well as household characteristics. I restrict the data to phase II - VII of the DHS. Phase I is excluded, as many of the variables of interest are unavailable. 49 countries from Europe, Africa, the Eastern Mediterranean region, the Americas and South East Asia are included (see Appendix table A.1 for a list of countries). The division of countries into world region is based on the WHO division of countries. The selection of countries is based on the availability of data on children's health outcomes, maternity, feeding, and maternal and household characteristics. The data includes 646,146 children from 487,039 mothers, and covers the years 1991-2018.

[1] Some countries also interview women aged 12-14 or only interview women who have ever been married.

Only children below the age of 5 who are still alive and live with their mothers are included in the analysis.

2.2 Outcome Variables

The main health outcomes are variables indicating whether a child is underweight, stunted, wasted or overweight. These variables are based on z-scores, which can be interpreted as standard deviations from the median. A child is underweight if the weight-for-age z-score is below -2, stunted if the length-for-age z-score is below -2 and wasted if the weight-for-length z-score is below -2. According to the WHO, 2021c, wasting indicates a recent and severe weight-loss due to illness or if the child has not received enough food. Stunting indicates either chronic undernutrition, or that the child did not get enough nutrition in early life. Being underweight can reflect either wasting, stunting or both. Additionally, overweight is defined as having a weight-for-length z-score above 2.

The z-scores are based on the Child Growth Standard, which was released by the WHO (2006). As the z-scores of phase DHS II-IV were based on an older Growth Reference Curve, I updated the z-scores of phase II-IV using Stata code provided by the WHO (2019). Therefore, all z-scores used to compute the indicator variables are based on the same Child Growth Standard. As recommended by the WHO (2010), implausible scores were excluded. Implausible scores can arise due to measurement errors. They are defined as weight-for-age scores below -6 or above 5, length-for-age scores below -6 and above 6, and weight-for-length scores below -5 and above 5.

Figure 1 depicts the share of children above the age of 12 months who are wasted, stunted, underweight or overweight for each world region. The graph shows that there is a high prevalence of children who do not receive adequate nutrition. The share of underweight, wasted and stunted children is the lowest in Europe and the highest in South East Asia. Stunting is the most common form of undernutrition in all regions.

The share of stunted children is 14% in Europe, 42% in Africa, 27% in the

Figure 1: Share of children who are undernourished

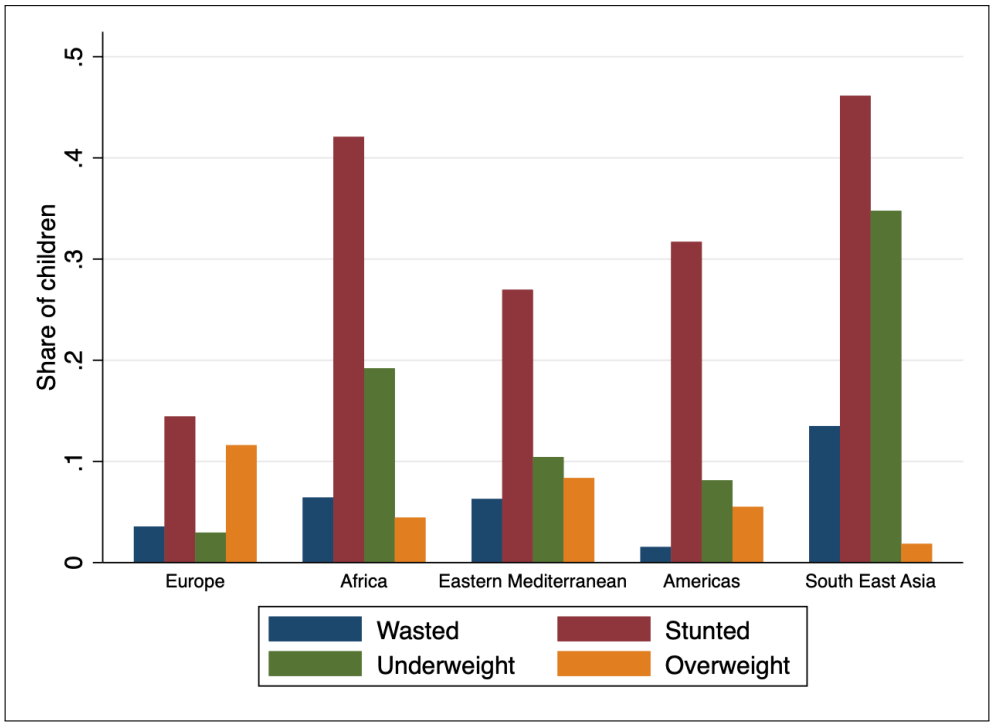


Figure includes children older than 12 months. Survey weights are applied, each country is weighted equally within each world region

Eastern Mediterranean region, 32% in the Americas and 46% in South East Asia. The share of underweight children is 3% in Europe, 19% in Africa, 10% in the Eastern Mediterranean region, 8% in the Americas and 35% in South East Asia. Wasting is the least common form of malnutrition, with a share of 4% in Europe, 6% in Africa, 6% in the Eastern Mediterranean region, 2% in the Americas and 14% in South East Asia. The share of overweight children is 12% in Europe, 4% in Africa, 8% in the Eastern Mediterranean region, 5% in the Americas and 2% in South East Asia.

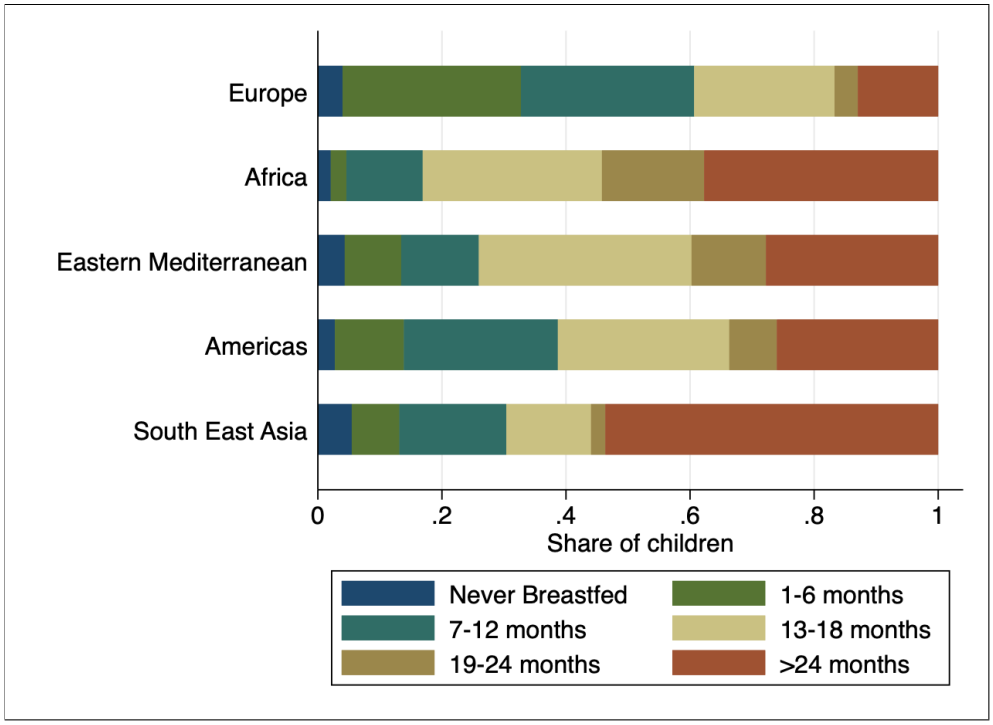
2.3 Independent Variables

The main independent variable is the duration of breastfeeding. Mothers are asked about the duration of breastfeeding for each child under the age of 5 years. To analyze which mothers choose to breastfeed longer, I create a dummy variable which takes on the value 1 if the child was breastfed for more than 12 months and 0 otherwise. I chose this threshold based on the indicator "Continued breastfeeding at 12-24 months" set by the WHO, 2021a. However, I extend the indicator beyond 24 months as they recommend breastfeeding until 24 months or longer. To analyze the selection into shorter breastfeeding durations, I also create a dummy variable which equals 1 if the mother breastfed for less than a year, and 0 if she did not breastfeed the child at all.

To analyze the effects of breastfeeding on child growth measures, I divide the breastfeeding duration into multiple categorical variables, as the duration of breastfeeding could have a non-linear effect on health outcomes. For children older than 24 months, the following 6 categories were constructed: no breastfeeding, breastfeeding 1-6 months, breastfeeding 7-12 months, breastfeeding 13-18 months, breastfeeding 19-24 months and breastfeeding for more than 24 months. These categories are not constructed for children younger than 24 months, since this could bias the estimation. First, a large share children below the age of 24 months are still being breastfed and therefore one cannot observe the final duration of breastfeeding. Second, children under 24 months who are weaned are more likely to be breastfed for a shorter duration than weaned children who are older than 24 months. Children who are still being breastfed and are older than 24 months fall into the 'breastfeeding for more than 24 months' category, and will therefore not bias the estimation. In DHS phase VII, mothers were no longer asked about the duration of breastfeeding and instead were asked if they are currently still breastfeeding their child and if they ever breastfed their child. Therefore, the duration of breastfeeding is missing for phase VII.

Figure 2 shows the share of children above the age of 24 months who were breastfed for a certain duration for each world region. The share of never-

Figure 2: Breastfeeding durations in each world region



Notes: Figure includes children older than 24 months. Survey weights are applied, each country is weighted equally within each world region.

breastfed children is below 6% in all regions. In Europe, children tend to be breastfed for shorter durations compared to other regions. Only 39% of European children are breastfed for longer than 12 months, as opposed to 83% in Africa, 74% in Eastern Mediterranean, 61% in the Americas and 70% in South East Asia. 54% of all mothers breastfeed for more than 24 months in South East Asia, which is the highest share among all regions for this category.

In addition to the duration of breastfeeding, I also construct a variable indicating the current breastfeeding status for all children. This variable equals 1 if the child is currently breastfed and 0 otherwise.

To analyze the role of complementary foods on health outcomes, I use the 24 hours feeding recall, where mothers are asked about the foods given to their child in the last 24 hours. The question is only asked about the youngest child under the age of 36 months. I divide the types of foods into

the following categories: water, milk, baby-formula, dairy, meat, grains, fruit and vegetables, juice and legumes. The food variables are only constructed for DHS phases IV-VII. Earlier rounds are excluded as they ask about fewer food categories than later rounds.

Finally, the variables on the breastfeeding status and the food categories are combined to create a variable indicating exclusive breastfeeding for children below the age of 7 months. A child is coded as being exclusively breastfed if no foods or liquids are reported and the child is still being breastfed. If the child received any food or liquid, or is not being breastfed, it is coded as not exclusively breastfed. If the food recall has missing values for some food categories, the exclusive breastfeeding variable is set to missing. This measure of exclusive breastfeeding is not perfect, as it only considers food given in the last 24 hours. It is very likely that some children who are coded as exclusively breastfed had been given food more than 24 hours before the interview, and therefore this measure overestimates the share of exclusively breastfed children. It is also possible that some mothers do not recall whether they had given a specific food-group to their child.

2.4 Control Variables

A rich set of control variables for mother-, child- and household-specific characteristics is used in this analysis. The following child characteristics are included: child age in months, age in months squared, gender, a dummy variable indicating whether the child was part of a multiple birth, the birth order (only, first, middle or last child), a dummy variable indicating whether there was a preceding birth less than 25 months before the child was born, birth size as reported by the mother (very large, larger than average, average, smaller than average and very small), place of delivery (home, public sector, private sector and other), whether the child was born via cesarean section, how many vaccines the child has received in total (as reported by a health card or the mother) and whether the pregnancy was intended, intended later or not at all.

Table 1: Summary Statistics of Control Variables

a) Child Variables		b) Mother and Household Variables	
Child's age in months	28.28	Mother's age in years	28.95
Child is female	0.49	Children older than 5 years	1.59
Multiple Birth	0.02	Births in last 5 years	1.42
Birth Order		Children who have died	0.29
- Only Child	0.18	Age of mother at 1st birth	20.08
- First Child	0.08	Mother currently pregnant	0.09
- Middle Child	0.18	Mother's weight for height % of median	124.98
- Last Child	0.56	Mother's height for age % of median	96.07
Preceding birth <25 months	0.16	Number of Antenatal Visits	4.77
Birth Size		Mother's highest Education	
- Very large	0.09	- No Eudcation	0.26
- Larger than average	0.23	- Primary	0.33
- Average	0.51	- Secondary	0.32
- Smaller than average	0.12	- Higher	0.08
- Very small	0.05	Mother's Occupation	
Place of Delivery		- Not working	0.46
- Home	0.35	- Low-skilled	0.28
- Public Sector	0.54	- Medium-skilled	0.22
- Private Sector	0.08	- High-skilled	0.05
- Other	0.02	Mother's Marital Status	
Cesarean section	0.09	- Single	0.06
Total number of vaccines	5.82	- Living with Husband/Partner	0.86
Whether pregnancy was intended		- Widowed/Divorced/Separated	0.08
- Yes	0.72	Type of Place of Residence	
- Later	0.17	- Urban	0.35
- No more children	0.11	- Rural	0.65
		Wealth Index	
		- 1	0.22
		- 2	0.22
		- 3	0.21
		- 4	0.19
		- 5	0.17
		Source of Drinking Water	
		- Piped Water	0.43
		- Well Water	0.32
		- Surface Water	0.17
		- Rain Water	0.01
		- Tanker Truck	0.02
		- Bottled Water	0.04
		- Other	0.01
Observations	645,486	Observations	486,586

Survey weights applied
All countries are weighted equally

Panel a) in table 1 provides summary statistics for all child characteristics used in the analysis. For the mother, the following variables are used: age, age squared, number of births in the last 5 years, number of children older than 5 years, number of children who have died, age of the mother at her first birth, a dummy variable indicating whether the mother is currently pregnant, weight-for-height, height-for-age, number of antenatal visits, highest education (no education, primary, secondary or higher) 4 occupational categories (no occupation, low-skilled, medium-skilled and high-skilled) and marital status (single, married/living with partner, widowed/divorced/separated). The number of antenatal visits is only available for the most recent pregnancy, therefore I assign the same number of antenatal visits to all children of the same mother. The 4 occupational categories are constructed using 9 occupation categories provided by the DHS. I aggregate the occupations into skill-levels, based on the International Standard Classification of Occupations (International Labour Organization, n.d.).

For the household, I include the following variables: whether it is located in an urban or rural area, the region within the country, the source of drinking water and the wealth index (index from 1 to 5). The source of drinking water is based on country-specific categories, which I aggregate into major categories to make it consistent across countries. These categories are: piped water, well water, surface water, rain water, water from tanker trucks, bottled water and water from other sources. The wealth index is based on observable household assets and groups households into wealth quintiles. The DHS calculates the index within each survey using principal component analysis. Because income is difficult to measure in developing countries, the wealth index is a more reliable measure of a household's economic status (Rutstein and Johnson, 2004). Due to a high number of missing values, I use multiple imputation to calculate missing values for the wealth index. To follow the approach of the original calculation of the wealth index, the index is imputed within each survey (i.e. for each country and survey round). Furthermore, I use variables which were used in the original calculation of the wealth index and are available in the women's questionnaire: whether the region is urban or rural, whether the

household has electricity, a radio, a television, a bicycle, a motorcycle, a car, the number of household members, the water source, the type of toilet facility, whether the household shares a toilet with another household, the material used for the floors, walls and roof. 43,451 observations contain imputed values for the wealth index, which corresponds to around 6.7% of all observations. As the water source is part of the wealth index, the coefficient of the water source on breastfeeding and health outcomes will be partly absorbed by the wealth index coefficient. Panel b) in table 1 provides summary statistics for mother and household variables.

3 Methods

The goal of this thesis is to analyze two questions. First, what characterizes mothers who breastfeed longer? Second, what is the association between child growth measures and breastfeeding? In a first step, I examine the correlation between mother's socio-demographic characteristics and breastfeeding using the following OLS regression model:

$$BF_{cmhrt} = \alpha_0 + \delta P'_m + \zeta Q'_c + \eta S'_h + \Pi_{rt} + u_{cmhrt} \tag{1}$$

BF_{cmhrt} denotes the breastfeeding variable for child c, mother m, household h, region r and year t. P is a vector of mother demographic characteristics. Q is a vector of child demographic characteristics. S is a vector of household characteristics. Π_{rt} denotes region-year fixed effects, which control for time-variant region characteristics. Such characteristics could be the culture of the region or access to health facilities. u_{cmhrt} is the error term. I first use a dummy variable which takes on the value 1 if the child was breastfed for more than 12 months and 0 otherwise as the outcome variable. Then, to analyze shorter breastfeeding durations, I use a variable indicating 1 if the child was breastfed for less than 12 months and 0 if it was not breastfed at all. By regressing these two breastfeeding variables on a wide set of control variables, I analyze which factors have a statistically significant association with longer

and shorter breastfeeding. I estimate equation 1 for children older than 12 months.

In a second step, the association between child growth measures and the breastfeeding duration are analyzed, by taking into account the selection into breastfeeding. The following equation is analyzed using OLS and logistic regression function:

$$Y_{cmhrt} = \alpha_0 + \beta_1 BF_{cmhrt} + \delta P'_m + \zeta Q'_c + \eta S'_h + \Pi_{rt} + u_{cmhrt} \tag{2}$$

Y_{cmhrt} is the child's health outcome. In my main specifications, the health outcomes are variables indicating whether a child is underweight, stunted, wasted or overweight. BF_{cmhrt} is a categorical variable indicating the duration of breastfeeding. Therefore, β_1 captures the association between the duration of breastfeeding and the health outcome. Control variables for the child, mother and household are gradually added to the estimation to investigate how these factors change the association between breastfeeding and child health outcomes. Equation 2 is estimated for children older than 24 months and BF_{cmhrt} can take on the 6 duration categories described in section 2.3.

To assess whether exclusive breastfeeding is associated with child health, the following OLS regression model is estimated for children younger than 7 months:

$$\begin{aligned} Y_{cmhrt} = \alpha_0 + \gamma_1 BFstill_{cmhrt} + \gamma_2 BFstill_{cmhrt} \times older_{cmhrt} \\ + \gamma_3 BFexclusive_{cmhrt} + \gamma_4 BFexclusive_{cmhrt} \times older_{cmhrt} \\ + \delta P'_m + \zeta Q'_c + \eta S'_h + \Pi_{rt} + u_{cmhrt} \end{aligned} \tag{3}$$

Where $BFstill_{cmhrt}$ is a dummy variable indicating whether the child is still being breastfed, both exclusively and non-exclusively. $BFexclusive_{cmhrt}$ is a dummy variable indicating whether the child is being exclusively breastfed. $older_{cmhrt}$ is a dummy variable indicating whether the child is 4-6 months old or not. γ_1 captures the difference in health outcomes between children who are still being breastfed and children who are not being breastfed. γ_2 captures the additional effect of being breastfed for more than 3 months. γ_3 captures

the effect of being exclusively breastfed, additionally to being breastfed non-exclusively. γ_4 captures the additional effect of being exclusively breastfed for more than 3 months. As in Equations 1 and 2, control variables for child, mother and household characteristics are added as well as region-year fixed effects.

The main concern when studying the association between breastfeeding and children's health outcomes is selection bias. The choice about the duration of breastfeeding is not random, but mothers actively choose if and how long to breastfeed their child. This choice may be influenced by variables specific to the mother, the child and the household. To reduce this selection bias, I control for a rich set of variables which may be correlated with both the duration of breastfeeding and the health outcomes. To control for the amount of time and resources a mother might invest in her child, I include the following variables: birth order of the child, an indicator for a multiple birth, preceding birth interval, whether the pregnancy was intended, the number of births in the last 5 years, the number of children older than 5 years, the number of children who have died, the mother's age at her first birth, the pregnancy status of the mother, occupation, marital status, highest education and wealth index. These factors may also influence the duration of breastfeeding and should therefore be included in the regression.

To control for the in-utero environment and premature births, I control for the size of the child at birth and whether the child was born via cesarean section. Since I do not have data on the mother's behavior during her pregnancy, such as nutrition or smoking habits, these variables try to capture such effects. Unfortunately, the size at birth is based on the mother's subjective recall of the child's size, as many children were not weighted at birth. Furthermore, data on whether the child was born prematurely is not available. Therefore, the subjective size at birth also serves as a proxy for the weight and whether the child was born prematurely.

As a measure of the mother's access and willingness to visit health care facilities, I control for the place of delivery, the number of vaccines the child has received and the number of antenatal visits during the pregnancy. The

number of antenatal visits is only available for the most recent pregnancy of the mother. It is therefore not an accurate measure of antenatal care for children who are not born last. One concern is that mothers change their behavior depending on how many pregnancies they had before. Since I control for birth order and the total number of pregnancies she has had, this should adjust for such behavioral changes.

To control for the mother's health, I add the mother's weight-for-height and height-for-age scores in terms of percentage of the median (based on the WHO reference standard). This does not capture her full health, but indicates whether she is wasted or stunted.

To take into account water sanitation, I control for the source of drinking water. The water source may play an active role in the choice to breastfeed, as clean water is important when feeding children infant formula.

I also use fixed effects to account for time-variant unobserved geographical differences. Such time-variant unobserved characteristics may be culture, access to health care facilities and health policies. I show results using country-year fixed effects, and region-year fixed effects. My preferred specification includes region-year fixed effects, as there may be differences in unobserved characteristics even within countries.

In all of the regressions, I account for the sample design by using sample weights and information on strata and clusters, as recommended by the DHS[2]. The sample weights account for the under- or oversampling of certain respondents, as well as the response rate. Without using sample weights, the results are biased towards the associations found in the over-sampled population (Croft et al., 2020). Certain sub-populations are purposefully over-sampled to get more accurate results for these groups. There are also sub-populations which are more likely to respond to the surveys, such as households in rural areas and poorer households (ICF International, 2012). To get the correct standard errors in regressions, the information on strata and clusters should be used to account for the sampling method (Croft et al., 2020). In my main results, I adjust the sample weights such that they sum up to 1 for each coun-

[2]To account for the sample design, I use the command svy on Stata 16.1

try. This means that each country has the same weight when estimating the results. As a robustness check, I also estimate my main regressions without using sample weights and using population-size adjusted sample weight. When using population-size adjusted weights, the estimations are driven by larger countries such as India or Nigeria.

While I control for many variables in my regressions, there could still be potential threats to the validity of the results. One issue could be that there still is omitted variable bias. Even though I control for many variables which could potentially affect the duration of breastfeeding and health outcomes, there could still be unobserved differences between the children and mothers. Another issue is reverse causality, where the health outcomes of the children could determine the duration of breastfeeding.

To examine whether there is omitted variable bias and selection bias, I follow the method of Evenhouse and Reilly (2005) and Colen and Ramey (2014) and estimate a family fixed-effect model. The following estimation will be used:

$$\Delta Y_h = \alpha_0 + \beta_1 \Delta BF_h + \delta \Delta age_m + \Lambda_c + \zeta \Delta Q_c' + \Delta u_h \tag{4}$$

ΔY_h is the difference in health outcomes between siblings who are older than 24 months. ΔBF_h is the difference in the breastfeeding duration category between siblings. Δage_m is the difference of the age at birth of the mother between siblings. $\Delta Q_c'$ is a vector of child controls. Λ_c denotes country-year-of-birth fixed effects. This is to control for time-varying factors at the country level which may affect siblings differently. Any control variables used in equation 2 which are constant within families drop out of the equation. The identification strategy is based on comparing siblings who have the same mother. Any unobserved characteristics which are constant within family will therefore not affect the estimation. To analyze selection bias, I first estimate equation 4 without using family fixed-effects but including all mother and household-specific control variables as well as region-year fixed effects, and then compare it to the estimation using family-fixed effects. However, this method

is not able to investigate whether there is any reverse causality. If siblings have different health outcomes that are caused by unobserved variables, and the mother reacts to these health outcomes by adjusting the breastfeeding duration, this would not be captured. Furthermore, this method also cannot control for within-family factors that change over time. For example, the mother's health, marital status or household wealth may have changed over time, therefore the decision to breastfeed may have been based on different circumstances for each sibling in the family. Therefore, this method cannot fully control for selection bias but it can give some insight whether there is any selection bias.

4 Results

4.1 Selection into breastfeeding

As a first step, I analyze the characteristics of mothers who breastfeed for longer and shorter durations. Table 2 shows the regressions of a dummy variable indicating continued breastfeeding of more than 12 months on mother-, child- and household-specific characteristics for children older than 12 months. The reference group are children who were not breastfed or were breastfed for less than 12 months. The first regression only includes the most important mother-specific variables. This is to get a clearer picture of the mother-specific variables that are associated with continued breastfeeding. I also use country-year fixed effects in this first regression, as some of the variables may not vary much within regions. In a second regression, I include all mother-, child- and household-specific characteristics as well as region-year fixed effects.

Column (1) in table 2 shows the regression of continued breastfeeding on the most important mother-specific variables. Education has a statistically significant association with continued breastfeeding. Mothers with a higher education are the least likely to breastfeed beyond 12 months, followed by mothers with a secondary education. A primary education is not associated with a change in the probability for continued breastfeeding compared to moth-

Table 2: Selection into continued breastfeeding

	(1) Continued Breastfeeding		(2) Continued Breastfeeding	
Mother Characteristics				
Mother's age			−0.001	(0.002)
Mother's age squared			−0.000	(0.000)
Highest education, omitted: No education				
-Primary	0.001	(0.003)	0.001	(0.003)
-Secondary	−0.042***	(0.005)	−0.030***	(0.005)
-Higher	−0.105***	(0.011)	−0.078***	(0.012)
Occupation, omitted: Not working				
-Low-skilled	0.005	(0.004)	−0.006	(0.005)
-Medium-skilled	−0.003	(0.005)	−0.013**	(0.005)
-High-skilled	0.004	(0.014)	−0.005	(0.014)
Marital status, omitted: Single				
-Living with partner/husband	0.032***	(0.010)	0.044***	(0.010)
-Widowed/Divorced/Separated	0.017	(0.011)	0.017	(0.011)
Mother's weight for height percent of median	−0.000	(0.000)	−0.000	(0.000)
Mother's height for age percent of median	−0.001***	(0.000)	−0.002***	(0.000)
Rural region	0.037***	(0.005)	0.026***	(0.006)
Wealth Index	−0.019***	(0.002)	−0.018***	(0.002)
Drinking Water, omitted: piped water				
-Well water	0.007	(0.006)	0.007	(0.006)
-Surface water	0.007	(0.006)	0.007	(0.006)
-Rain water	0.027**	(0.012)	0.033***	(0.012)
-Tanker truck	−0.019	(0.022)	−0.009	(0.022)
-Bottled water	−0.062***	(0.013)	−0.040***	(0.013)
-Other	0.028**	(0.012)	0.027**	(0.011)
Children older than 5 years			0.007***	(0.002)
Births in last 5 years			−0.035***	(0.005)
Children who have died			0.001	(0.002)
Age of mother at 1st birth			0.001	(0.001)
Mother currently pregnant			−0.044***	(0.005)
Number of Antenatal Visits			−0.000	(0.001)
Child Characteristics				
Child's age in months			−0.005***	(0.001)
Child's age squared			0.000***	(0.000)
Child gender: female			0.004	(0.003)
Birth order, omitted: only child				
-First Child			−0.084***	(0.010)
-Middle Child			−0.036***	(0.009)
-Last Child			0.032***	(0.008)
Preceding birth <25 months			−0.015***	(0.004)
Multiple Birth			−0.012	(0.012)
Cesarean section			−0.030***	(0.007)
Size at birth, omitted: Average				
-Very large			−0.006	(0.005)
-Larger than average			−0.002	(0.004)
-Smaller than average			−0.012**	(0.005)
-Very small			−0.032***	(0.006)
Place of delivery, omitted: Home				
-Public Sector			−0.014***	(0.004)
-Private Sector			−0.056***	(0.005)
-Other			−0.012	(0.013)
Was pregnancy intended? omitted: Yes				
-Later			−0.005	(0.004)
-No more			−0.001	(0.006)
Total number of vaccines			0.004***	(0.001)
Constant	0.748***	(0.053)	0.801***	(0.066)
Country x Year FE	*Yes*		*No*	
Region x Year FE	*No*		*Yes*	
Observations	313257		313257	
R^2	0.161		0.200	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights were applied, all countries were weighted equally.

ers without an education. None of the occupation categories are statistically significantly associated with continued breastfeeding. Mothers who live with a husband or partner tend to breastfeed longer than single mothers. Mothers in rural areas are also more likely to breastfeed longer. A higher wealth index and being taller is associated with a decrease in the probability to breastfeed longer. The source of drinking water also has a statistically significant association with continued breastfeeding. Mothers who use rainwater are the most likely to continue breastfeeding beyond 12 months. Mothers who use bottled water are the least likely to continue breastfeeding. Overall, the regression shows that mothers with a higher socioeconomic status are less likely to breastfeed for more than 12 months.

Column (2) of table 2 shows the full regression including all mother-, child- and household-specific characteristics and region-year fixed effects. A higher education, a higher wealth index and being taller is still associated with a decrease in the probability for continued breastfeeding in the full regression. Living with a husband or partner and living in a rural area is still associated with an increase in the probability. However, occupation is now also statistically significantly associated with continued breastfeeding compared to column (1). Mothers who have an occupation are less likely to continue breastfeeding beyond 12 months, although this reduction in continued breastfeeding is only statistically significant for medium-skilled occupations. The association for the source of drinking water has not changed substantially compared to column (1).

The full regression also shows additional factors that are associated with continued breastfeeding. Having more children under the age of 5 and being pregnant is associated with a decrease in the probability to breastfeed longer, but having more children above the age of 5 is associated with an increase.

A number of child-specific factors also have a statistically significant association with continued breastfeeding. The coefficients indicating the birth order are statistically significant. Compared to only children, first born children and middle children are less likely to be breastfed for more than 12 months. Last born children are more likely to be breastfed longer. If the preceding birth was

less than 25 months before the child was born or if the child was born via cesarean section, the child is less likely to be breastfed longer. The child's size at birth also has a statistically significant association with continued breastfeeding. Children who were very small at birth are the least likely to be breastfed for more than 12 months. Since very small children could have been born prematurely or had a worse in-utero environment, this provides some evidence that such children are also less likely to be breastfed longer. Children who were smaller than average are also less likely to be breastfed for more than 12 months compared to average-sized children. Children who were born in the public or private sector are less likely to be breastfed longer compared to children who were born at home. Children who received more vaccines are more likely to be breastfed longer. The analysis shows that child-specific factors are also associated with the mother's decision to breastfeed longer. It is therefore important to control for such factors.

Appendix Tables A.2 - A.6 show the same analysis separately for each world region. The selection into continued breastfeeding is generally consistent across regions, although the statistical significance of the factors varies. In Europe, education is more strongly associated with breastfeeding compared to other regions. Having any education is associated with a decrease in continued breastfeeding. Europe is the only region where surface water is associated with a decrease in the probability to breastfeed for more than 12 months. A child being part of a multiple birth is also associated with a large decrease in the probability. In Africa, in addition to women living with a husband or partner, women who are widowed, divorced or separated are also more likely to continue breastfeeding. Using surface and rain water is also associated with an increase in the probability. Being party of a multiple birth is associated with a decrease in the probability for continued breastfeeding. In the Eastern Mediterranean region, having an occupation is more relevant for continued breastfeeding than the education. Having a low-skilled occupation is associated with an increase compared to having no occupation, and having a medium-skilled or high-skilled occupation is associated with a decrease. Unintended pregnancies are also associated with a decrease in continued breastfeeding.

The Eastern Mediterranean Region is the world region with the strongest association between the source of drinking water and continued breastfeeding. Mothers who use surface water or rain water are most likely to breastfeed longer. Mothers who use well water are also more likely to breastfeed longer compared to mothers who use piped water. As in Europe and Africa, children born as part of a multiple birth are also less likely to be breastfed in the Eastern Mediterranean region. In the Americas, occupation is also more relevant compared to other regions. Mothers who have a high-skilled occupation are the least likely to continue breastfeeding, followed by mothers with a low-skilled or medium-skilled occupation. Mothers without an occupation are the most likely to continue breastfeeding. The marital status is not associated with a change in the probability to breastfeed for more than 12 months. In South-East Asia, the selection into continued breastfeeding differs slightly from the other world regions. Compared to women with no education, women with a primary or secondary school education level are not less likely to breastfeed for more than 12 months. Only women with a higher education are associated with a decrease in the probability. South East Asia is the only region where living with a partner or husband, or being widowed, separated or divorced is associated with a decrease in continued breastfeeding. Mothers who did not want any more children at the time of the pregnancy are less likely to continue breastfeeding. Furthermore, the water source does not have a statistically significant association with continued breastfeeding in South East Asia. The preceding birth interval and whether the child was born via cesarean section is also not associated with continued breastfeeding. This difference in the selection into breastfeeding in South East Asia could be due to the fact that the majority of children are breastfed for more than 24 months in this world region. This is not the case in other world regions.

Overall, women with higher socioeconomic status tend to breastfeed for a shorter duration in all regions. This is in line with previous studies from developing countries (Victora et al., 2016, Grummer-Strawn, 1996). Controlling for these characteristics when estimating the association between breastfeeding and health outcomes is important to reduce selection bias. Without controlling

for such factors, the estimates for longer durations would likely have a negative bias since children from poorer households are expected to be breastfed longer.

To further analyze shorter breastfeeding durations, I compare children who have not been breastfed to children who were breastfed for less than 12 months. Table 3 shows the regression of shorter breastfeeding durations on child-, mother- and household-specific variables for children older than 12 months. The reference group is children who were not breastfed. The socioeconomic status of the mother does not play a big role in the probability to breastfeed, as the education and wealth index are not associated with breastfeeding. However, mothers who currently have an occupation are more likely to have breastfed. As all the children included in the regression have been weaned, the mothers may not have had an occupation at the time of breastfeeding. But it indicates that mothers who have a high-skilled occupation selected more into breastfeeding at the time. Mothers who are currently pregnant or who live in a rural area are also more likely to have breastfed. Mothers who weigh more or who have had children who died are less likely to have breastfed. The water source is also associated with breastfeeding: compared to piped water access, using surface water, rain water or bottled water is associated with an increase in the probability to breastfeed. Some child-specific factors are also associated with breastfeeding. Middle and last children are more likely to be breastfed than only children. Being part of a multiple birth, being born via cesarean section or unintended pregnancies are also associated with a lower probability to be breastfed. Children who were very small or smaller than average are also less likely to be breastfed. Finally, being born in the public sector compared to being born at home is also associated with a lower probability.

If we look at each world region separately, one can see that education also plays a role in the selection into breastfeeding. In Europe, having any education is associated with a lower probability of breastfeeding. Conversely, in Africa, the Eastern Mediterranean region and South East Asia, having an education is associated with a higher probability of breastfeeding.

The analysis on the selection into breastfeeding shows that when comparing no breastfeeding to shorter durations across all world regions, the socioe-

Table 3: Selection into short breastfeeding durations

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	−0.003	(0.003)
Mother's age squared	0.000	(0.000)
Highest education, omitted: No education		
-Primary	−0.002	(0.006)
-Secondary	0.005	(0.007)
-Higher	0.004	(0.011)
Occupation, omitted: Not working		
-Low-skilled	0.014**	(0.006)
-Medium-skilled	0.013**	(0.006)
-High-skilled	0.024**	(0.010)
Marital status, omitted: Single		
-Living with partner/husband	−0.002	(0.014)
-Widowed/Divorced/Separated	−0.015	(0.015)
Mother's weight for height percent of median	−0.000**	(0.000)
Mother's height for age percent of median	−0.001	(0.001)
Rural region	0.014**	(0.006)
Wealth Index	−0.000	(0.002)
Drinking Water, omitted: piped water		
-Well water	−0.005	(0.008)
-Surface water	0.019**	(0.009)
-Rain water	0.026**	(0.013)
-Tanker truck	0.003	(0.016)
-Bottled water	0.021***	(0.008)
-Other	0.005	(0.019)
Children older than 5 years	−0.001	(0.003)
Births in last 5 years	0.005	(0.004)
Children who have died	−0.017***	(0.004)
Age of mother at 1st birth	−0.001	(0.001)
Mother currently pregnant	0.028***	(0.005)
Number of Antenatal Visits	0.001	(0.001)
Child Characteristics		
Child's age in months	−0.002*	(0.001)
Child's age squared	0.000	(0.000)
Child gender: female	0.002	(0.004)
Birth order, omitted: only child		
-First Child	0.016	(0.010)
-Middle Child	0.038***	(0.011)
-Last Child	0.033***	(0.009)
Preceding birth <25 months	0.008	(0.006)
Multiple Birth	−0.057***	(0.019)
Cesarean section	−0.018**	(0.007)
Size at birth, omitted: Average		
-Very large	−0.011	(0.008)
-Larger than average	−0.003	(0.005)
-Smaller than average	−0.023***	(0.006)
-Very small	−0.072***	(0.013)
Place of delivery, omitted: Home		
-Public Sector	−0.015***	(0.006)
-Private Sector	−0.005	(0.008)
-Other	−0.006	(0.028)
Was pregnancy intended? omitted: Yes		
-Later	−0.001	(0.005)
-No more	−0.021***	(0.008)
Total number of vaccines	−0.000	(0.001)
Constant	1.084***	(0.081)
Region x Year FE	*Yes*	
Observations	75951	
R^2	0.084	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

conomic status does not play an important role. While having an occupation is associated with an increase in the probability to breastfeed, both education and wealth index are not. Children-specific variables play a more important role in the selection into breastfeeding within this sub-sample. Factors such as being very small, being part of a multiple birth or being born via cesarean section are associated with a decrease in the probability to be breastfed. The source of drinking water also plays a role in the choice to breastfeed. However, when comparing no breastfeeding or shorter breastfeeding durations to longer breastfeeding durations, a higher socio-economic status is associated with a decrease in the probability for long breastfeeding. A higher education, a higher wealth index and having an occupation outside of the house are associated with a lower probability for continued breastfeeding. The source of drinking water also plays a role in long breastfeeding durations.

4.2 Effects of Breastfeeding Duration

4.2.1 Regression Results

In this section, I will describe the regression results of the effects of the breastfeeding duration on the probability of being underweight, stunted, wasted and overweight. For each outcome, I will analyze OLS regression results where each country is weighted equally, followed by discussing robustness checks using population-size adjusted sample weights, using no sample weights and using a logistic regression function. Finally, I analyze the results separately for each region. In each regression, children who were never breastfed are the reference group.

Underweight The first outcome of interest is the probability of being underweight. Table 4 shows the OLS regression results of the probability to be underweight on different breastfeeding duration categories for children older than 24 months. Column (1) shows the results without any control variables, using only country-year fixed effects. Without any control variables, breastfeeding for less than 6 months compared to no breastfeeding is associated

Table 4: Association between the probability to be underweight and breastfeeding duration

	(1) Underweight	(2) Underweight	(3) Underweight	(4) Underweight	(5) Underweight
Breastfed 1-6 months	-0.012*	-0.005	-0.003	-0.001	0.001
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Breastfed 7-12 months	0.008	0.011	0.006	0.005	0.007
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Breastfed 13-18 months	0.004	0.007	0.002	0.000	0.001
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Breastfed 19-24 months	0.025***	0.024***	0.014*	0.011	0.006
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Breastfed >24 months	0.048***	0.045***	0.030***	0.026***	0.024***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.126	0.147	0.171	0.172	0.190

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

with a decrease in the probability to be underweight by 1.2 percentage points which is statistically significant at the 10% level. Breastfeeding for 7-12 and 13-18 months have coefficients that are close to zero and are statistically insignificant. Breastfeeding for 19-24 months is associated with an increase in the probability to be underweight by 2.5 percentage points, which is statistically significant at the 1% level. Breastfeeding for more than 24 months is associated with an even larger increase in the risk to be underweight by 4.8 percentage points, which is statistically significant at the 1% level. I gradually add variables which control for child-, mother- and household-specific variables as well as region-year fixed effects. Column (5) shows the results for the preferred regression using all control variables. Once I control for the full set of control variables and fixed effects, breastfeeding durations between 1-24 months are associated with a small increase in the probability of being underweight between 0.1 and 0.7 percentage points, but none of the coefficients are statistically significant anymore. However, breastfeeding for more than 24

months is associated with an increase in the probability to be underweight by 2.4 percentage points. This coefficient is statistically significant at the 1% level. By adding control variables, most coefficients move closer to zero and become statistically insignificant. Only breastfeeding for more than 24 months is still associated with a negative effect on children's weight.

Appendix table A.12 shows the regression results on weight-for-age z-scores. After including all control variables and fixed effects, all coefficients for durations longer than 7 months are negative and statistically significant. Even though durations between 7-24 months are not associated with a change in the probability to be underweight, they are still associated with a decrease in weight-for-age.

To check the robustness of the results, I also estimate the equations using a logistic regression function. I also estimate OLS regressions using population-size adjusted sample weights and using no sample weights at all. Table A.13 shows the results of the probability to be underweight using logistic regressions. The results are mostly in line with the OLS regressions, however, one notable difference is that breastfeeding for 1-6 months is now associated with a decrease in the probability to be underweight, although it is not statistically significant.

The OLS regression results using population-size adjusted sample weights are very close to the main results (see appendix table A.14). Appendix table A.15 shows the OLS regression results without using any sample weights and without adjusting for strata and clusters. The coefficients for durations between 1-24 months are now negative, but they are mostly statistically insignificant and close to zero. The only coefficient with a substantial change is the breastfeeding duration 7-12 months. It is now associated with small decrease in the probability to be underweight which is statistically significant. Breastfeeding for more than 24 months is still associated with an increase in the probability to be underweight. As the results without weights may be biased towards over-sampled sub-populations, this provides some evidence that in certain sub-populations, breastfeeding for 7-12 has a positive association with weight.

Appendix table A.16 shows the results separately for each world region.

With the exception of Europe, the results are mostly consistent across world regions. In Europe, all breastfeeding duration categories are associated with an increase in the probability for being underweight. However, this is mostly driven by one country in the sample [3], therefore it may not be representative for the whole region. In Africa and the Eastern Mediterranean region, all coefficients are close to zero and statistically insignificant. In the Americas and South East Asia, breastfeeding for more than 24 months is associated with an increase in the probability to be underweight which is statistically significant.

Stunting Table 5 shows the OLS regression results of the probability of stunting on breastfeeding duration categories. The regression compares never-breastfed children and breastfed children above the age of 24 months.

Column (1) shows the results using only country-year fixed effects but no other control variables. Breastfeeding for 1-6 months is associated with a decrease in the probability of stunting by 3.9 percentage points, which is statistically significant at the 1% level. Breastfeeding for 7-12 is associated with an increase in the probability of stunting by 1.2 percentage points, but it is statistically insignificant. Breastfeeding for 13-18 months is associated with an increase in the probability by 2.1 percentage points, which is statistically significant at the 10% level. Breastfeeding for 19-24 months is associated with an increase in the probability by 6.2 percentage points, which is statistically significant at the 1% level. Breastfeeding for more than 24 months is associated with an increase in the probability by 6.5 percentage points and is also statistically significant at the 1% level. I gradually add control variables in Columns (2)-(5). Column (5) shows the regression including all control variables and region-year fixed effects. Once all control variables and fixed effects are added, all coefficients become small and statistically insignificant. Breastfeeding durations below 18 months show negative coefficients between 0.5 and 1.6 percentage points, whereas breastfeeding durations above 18 months show positive effects of around 1 percentage point.

[3] Moldova

Table 5: Association between the probability of stunting and breastfeeding duration

	(1) Stunted	(2) Stunted	(3) Stunted	(4) Stunted	(5) Stunted
Breastfed 1-6 months	-0.039***	-0.029**	-0.022*	-0.019	-0.016
	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)
Breastfed 7-12 months	0.012	0.007	-0.001	-0.004	-0.005
	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
Breastfed 13-18 months	0.021*	0.016	0.004	-0.001	-0.007
	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)
Breastfed 19-24 months	0.062***	0.050***	0.028**	0.022*	0.012
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
Breastfed >24 months	0.065***	0.058***	0.029**	0.020*	0.013
	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.101	0.137	0.186	0.190	0.206

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Even though there are no statistically significant associations between the probability of being stunted once all control variables are added, some breastfeeding durations have statistically significant associations with length-for-age z-scores. Table A.17 shows the OLS results on z-scores including all control variables. Breastfeeding durations of more than 13 months are associated with a decrease in length-for-age which is statistically significant.

Using a logistic regression function, breastfeeding for 1-6 months is now associated with a decrease in the risk of being stunted, which is statistically significant at the 10% level (see Appendix Table A.18). When using population-size adjusted sample weights, the coefficient for breastfeeding for more than 24 months shows a statistically significant increase in the probability to be stunted (see Appendix Table A.14). All other coefficients do not change substantially. However, not using any sample weights and not adjusting for strata and clusters changes most coefficients (see Appendix Table A.14) . In the main specification, none of the coefficients were statistically significant. Now,

breastfeeding for 1-6 months and breastfeeding for 7-12 months is associated with a decrease in the probability to be stunted. Both coefficients are statistically significant at the 1% level. Breastfeeding for more than 24 months is associated with an increase in the probability of stunting, which is statistically significant at the 10% level. As stated before, not using sample weights and not adjusting for strata and clusters may bias the results towards associations found in over-sampled sub-populations. There may be a sub-population in the sample where short breastfeeding durations have a positive association with health, and a long breastfeeding duration has a negative association.

Appendix table A.19 shows the OLS regression results separately for each world region. The only world region with a statistically significant effect when using the full specification is the Eastern Mediterranean region. There, breastfeeding for more than 24 months is associated with an increase in the probability of stunting.

Wasting Table 6 shows the OLS regression results of the probability of wasting on breastfeeding duration. Column(1) shows the regression results without any control variables but including country-year fixed effects. Breastfeeding for 1-6 months has a coefficient close to zero and is statistically insignificant. Breastfeeding for 7-12 months is associated with an increase in the probability of wasting by 1 percentage point and it is statistically significant at the 10% level. Breastfeeding for 13-18 months is associated with an increase in the probability of wasting by 0.8 percentage points and it is statistically significant at the 10% level. Breastfeeding for 19-24 months is associated with an increase in the probability of wasting by 1.5 percentage points and it is statistically significant at the 1% level. Breastfeeding for more than 24 months is associated with an increase in the probability by 1.9 percentage points and is statistically significant at the 1% level. Column (5) shows the regression results using all control variables and region-year fixed effects. Compared to the regressions on the probability to be underweight or stunted, the coefficients on wasting did not change substantially when using the full regression specification. The coefficients have become slightly smaller but most of them are still

Table 6: Associations between breastfeeding duration and the probability of wasting

	(1) Wasted	(2) Wasted	(3) Wasted	(4) Wasted	(5) Wasted
Breastfed 1-6 months	0.003	0.005	0.005	0.004	0.004
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Breastfed 7-12 months	0.010**	0.011**	0.010**	0.010**	0.008*
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
Breastfed 13-18 months	0.008*	0.008*	0.007*	0.007*	0.006
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Breastfed 19-24 months	0.015***	0.014***	0.012***	0.012***	0.008*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Breastfed >24 months	0.019***	0.017***	0.014***	0.014***	0.013***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.042	0.045	0.048	0.048	0.072

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

statistically significant. However, the increase in the probability for wasting is quite small. The largest effect can be found for breastfeeding for more than 24 months, which is associated with an increase of 1.3 percentage points. Using the weight-for-length z-scores shows similar results. Breastfeeding for more than 7 months is associated with a decrease in the weight-for-length z-score which is statistically significant (see Appendix table A.20).

The logistic regression results are mainly in line with the OLS regression results (see Appendix table A.21). Using population size adjusted survey weights in the OLS regression, all of the coefficients become statistically insignificant (see Appendix Table A.14). This may indicate that the smaller statistical significance of the main results was driven by smaller countries. Without using sample weights and adjusting for strata and clusters in the OLS regressions, the coefficients on the probability of wasting are closer to zero when compared to the main specification. The coefficients are also statistically insignificant (see Appendix Table A.15).

Appendix table A.22 shows the OLS regression results of the probability of wasting separately for each world region. In Europe, breastfeeding durations below 18 months are associated with a statistically significant increase in the probability for wasting. As with the analysis on the probability to be underweight, this result is mostly driven by one country in the sample [4], and it may therefore not be representative of the average association in the region. In the Eastern Mediterranean region, breastfeeding for more than 24 months is also associated with an increase in the probability for wasting. All other regions do not report statistically significant associations.

Overweight Table 7 shows the OLS regression result of the probability to be overweight on breastfeeding durations for children older than 24 months. Before adding any control variables, only breastfeeding for 19-24 months and breastfeeding for more than 24 months have statistically significant coefficients. Breastfeeding for 19-24 months is associated with a decrease in the probability to be overweight by 1.5 percentage points and is statistically significant at the 10% level. Breastfeeding for more than 24 months is associated with a decrease in the probability to be overweight by 1.8 percentage points and is statistically significant at the 5% level. Adding the full set of control variables and fixed effects does not change the results substantially. All coefficients are negative, but only the coefficient on breastfeeding for more than 24 months remains statistically significant.

The logistic regression results are mostly in line with the OLS regression results (see Appendix table A.23). Using population-size adjusted sample weights in the OLS regression does not lead to large changes in the results (see Appendix table A.14). However, the OLS regression results which do not use any sample weights and are not adjusted for strata and clusters show more statistically significant results (see Appendix table A.15). The breastfeeding duration categories 7-12 months, 13-18 months, 19-24 months and more than 24 months are all associated with a decrease in the probability of being overweight, and the effects are between 0.6 and 1 percentage points.

[4] Moldova

Table 7: Association between the probability of being overweight and breastfeeding duration

	(1) Overweight	(2) Overweight	(3) Overweight	(4) Overweight	(5) Overweight
Breastfed 1-6 months	-0.001	-0.003	-0.003	-0.004	-0.005
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Breastfed 7-12 months	-0.010	-0.010	-0.008	-0.008	-0.010
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Breastfed 13-18 months	-0.012	-0.012	-0.010	-0.010	-0.011
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Breastfed 19-24 months	-0.015*	-0.015*	-0.013	-0.012	-0.014
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Breastfed >24 months	-0.018**	-0.018**	-0.014	-0.013	-0.015*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.030	0.034	0.041	0.041	0.053

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

In Appendix table A.24, I analyze the probability to be overweight for each world region separately. In the Eastern Mediterranean region and in the Americas, breastfeeding for more than 7 months is associated with a statistically significant decrease in the probability to be overweight. Other world regions do not report statistically significant results. However, the magnitude and statistical significance of the results in the Americas and in the Eastern Mediterranean region are both driven by a single country in their respective world region [5].

[5] Jordan and Bolivia

4.2.2 Discussion of Duration Results

Before adding any control variables to the regressions, shorter breastfeeding durations of less than 6 months are associated with a decrease in the probability of being underweight and stunted. As my analysis shows, mothers who breastfeed for shorter durations are more likely to have an occupation outside of the home. Children who were breastfed for shorter durations are also more likely to be larger at birth, and less likely to be born as part of a multiple birth or via cesarean section than children who were not breastfed. This could be the reason why children who were breastfed for less than 6 months, when compared to children who were not breastfed at all, are less likely to be underweight or stunted if we do not control for any confounding variables. Once we control for such factors, this association of a lower probability of being underweight or stunted becomes statistically insignificant. However, when using a logistic regression function or using population-size adjusted sample weights, breastfeeding for 1-6 months is still associated with a decrease in the probability to be stunted, even after controlling for all variables.

Longer breastfeeding durations of more than 24 months are associated with an increase in the probability of being underweight and wasted, and a decrease in the probability to be overweight. Breastfeeding for longer than 7-12 months is also associated with lower weight-for-age, length-for-age and weight-for-length z-scores. One explanation for this could be that breastfeeding has health benefits for the child, up until a certain duration where it starts to have harmful effects. However, these results could also be caused by selection bias, omitted variable bias and reverse causality. As my analysis shows, mothers from a lower socioeconomic status tend to breastfeed longer than mothers from a higher socioeconomic status. Children that were breastfed for longer durations may therefore be more likely to be underweight or wasted and less likely to be overweight due to the socioeconomic status of the household they are growing up in. A lower socioeconomic status may be related to factors which I cannot control for in my analysis.

One such factor could be the amount and quality of the nutrition the child

receives. The literature has shown that breastfeeding and complementary nutrition are related. Brenøe et al., 2022 show that children who receive more breastmilk during the first year of their lives received less low-calorie liquids and have a more calorie-dense diet. This could explain why children who were breastfed for 1-6 months have a lower probability to be stunted, even after controlling for many variables. On the other hand, the literature has also shown that prolonged breastfeeding may be related to a diet which is lower in calories (Cetthakrikul et al., 2018, Victora et al., 1991,Onyango et al., 1998, Fawzi et al., 1998). This could be an explanation why children who were breastfed for more than 7-12 months have a lower length-for-age, weight-for-age and weight-for-length z-score on average, compared to children who were not breastfed. 7-12 months is also the age at which solid complementary foods should be introduced. Prolonged breastfeeding may replace some of the nutrient-rich complementary food that the children would receive if they were weaned. Therefore it may not be the prolonged breastfeeding itself that is causing the lower weight and height for the children, but the complementary food that is being replaced. This may especially play a role in households from lower socioeconomic statuses, which tend to breastfeed longer but may also have less nutrient-rich food available. There may also be other variables that are related to the selection into breastfeeding and the child's health which I cannot control for in this analysis.

Other studies suggest that the reason for the association between the duration of breastfeeding and growth measures may be due to reverse causality (Marquis et al., 1997, Simondon and Simondon, 1998). They suggest that the decision to wean the child is partly based on the child's health condition. Children with higher incidence of diarrhea or children who weigh less and are shorter may be breastfed longer.

To further analyze the role of selection effects in the results, I evaluate whether the types of foods consumed play a role and whether there are heterogeneous effects of breastfeeding depending on the drinking water source of the household.

4.3 The role of nutrition and water sanitation

As previous literature has shown, breastfeeding has more positive associations on health if water sanitation is low compared to when it is high (Butz et al., 1984, Keskin et al., 2017, VanDerslice et al., 1994). I follow the methodology of Günther and Fink, 2010, who used the DHS data to analyze the association between water sanitation and child health. I divide drinking water qualities into three categories: poor, intermediate and high. The water source is coded as poor if the water comes from surface water, such as springs or rivers. The source is coded as intermediate quality if it is well water or rainwater, and it is coded as high quality if the water is piped water or comes from vendors. The main limitation of this approach is that some of the sources coded as poor or intermediate may actually be of high quality. This is due to the fact that DHS rounds II-IV only report broad categories of water sources. For example, if the surface water comes from a protected spring rather than a pond, it is generally considered safe. However, on average, the categories should reflect the quality of the drinking water.

By adding an interaction term between breastfeeding duration and water quality, I estimate the effects on children's growth measures separately for each quality category. Table 8 shows the regression for weight-for-age, length-for-age and weight-for-length using all control variables and fixed effects. The reference category for the water quality is high quality. The reference group for the breastfeeding duration are never-breastfed children. The coefficients for the variables *poor* and *intermediate* show the change in the growth measure for never-breastfed children compared to never-breastfed children with high quality water. Poor quality water is associated with a lower weight-for-age and length-for-age when compared to high quality water, and is statistically significant. Intermediate quality water is associated with a higher weight-for-age and length-for-age, but a lower weight-for-length. However, these coefficients are not statistically significant. The breastfeeding duration variables without any interaction terms show the associations between child growth and breastfeeding durations if the drinking water comes from high-quality sources.

Table 8: Estimation of breastfeeding duration and water quality

	(1) WAZ	(2) LAZ	(3) WLZ
Poor	-0.221**	-0.378***	-0.004
	(0.105)	(0.130)	(0.099)
Intermediate	0.057	0.167	-0.068
	(0.083)	(0.105)	(0.087)
Breastfed 1-6 months	-0.019	0.027	-0.046
	(0.041)	(0.049)	(0.051)
Breastfed 7-12 months	-0.099**	-0.059	-0.091*
	(0.039)	(0.048)	(0.047)
Breastfed 13-18 months	-0.093**	-0.075*	-0.071
	(0.038)	(0.045)	(0.046)
Breastfed 19-24 months	-0.178***	-0.150***	-0.130**
	(0.041)	(0.049)	(0.050)
Breastfed >24 months	-0.173***	-0.107**	-0.157***
	(0.040)	(0.046)	(0.048)
Poor × Breastfed 1-6 months	0.187	0.359**	-0.036
	(0.124)	(0.150)	(0.125)
Poor × Breastfed 7-12 months	0.211**	0.359***	0.001
	(0.107)	(0.135)	(0.104)
Poor × Breastfed 13-18 months	0.198*	0.343**	0.001
	(0.107)	(0.135)	(0.101)
Poor × Breastfed 19-24 months	0.236**	0.360***	0.038
	(0.112)	(0.131)	(0.107)
Poor × Breastfed >24 months	0.169	0.305**	-0.008
	(0.107)	(0.132)	(0.100)
Intermediate × Breastfed 1-6 months	0.032	0.015	0.038
	(0.100)	(0.121)	(0.102)
Intermediate × Breastfed 7-12 months	-0.002	-0.034	0.030
	(0.085)	(0.100)	(0.083)
Intermediate × Breastfed 13-18 months	-0.018	-0.074	0.035
	(0.081)	(0.099)	(0.079)
Intermediate × Breastfed 19-24 months	-0.001	-0.042	0.035
	(0.082)	(0.100)	(0.083)
Intermediate × Breastfed >24 months	-0.036	-0.121	0.055
	(0.081)	(0.097)	(0.080)
Region x Year FE	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes
Observations	221838	221838	221838
R^2	0.340	0.265	0.181

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed & high-quality water
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

The interaction variables for poor and intermediate quality water and breastfeeding duration shows the additional effect of breastfeeding if the water comes from poor or intermediate quality sources compared to high quality sources. For high quality water, breastfeeding durations above 7 months are associated with a negative effect on weight-for-age and weight-for-length, and durations above 12 months are associated with a negative effect on length-for-age. For poor quality water, all breastfeeding durations have a large positive effect on weight-for-length and length-for-age and are mostly statistically different from the coefficients for the high quality group. The effect on weight-for-length is very small and not statistically significant. The coefficients for the intermediate water quality are small and statistically insignificant. On average, the associations between the breastfeeding duration and child growth measures are the same for high quality and intermediate quality water access.

Appendix table A.25 shows the same analysis for the probability to be underweight, stunted, wasted or overweight. The effects of the breastfeeding durations are mostly small and insignificant for all water quality categories. While breastfeeding is associated with positive effects on z-scores in households with poor water-quality, it is not associated with a change in the probability for undernutrition. However, in households with intermediate water-quality, breastfeeding for more than 7 months is associated with an increase in the probability for wasting. Breastfeeding for more than 24 months is also associated with an increase in the probability of being underweight for this group. The results indicate that it is important to take the water-quality into account when evaluating the effects of breastfeeding.

The results are in line with previous studies on the interaction between water sanitation and breastfeeding (Butz et al., 1984, Keskin et al., 2017, VanDerslice et al., 1994). In households with poor water quality access, breastfeeding may reduce the amount of unsafe water the child consumes. It is also possible that consuming breastmilk helps the child's immune system to protect itself from unsafe water. When analyzing the effects of breastfeeding, it is therefore important to take into account the water sanitation of the household. The increase in the probability for wasting in the intermediate water quality

groups compared to the high quality water group is somewhat surprising. Intermediate quality water is less safe than high quality water, therefore longer breastfeeding would reduce the water consumed and lead to positive associations. These results could be due to the imprecise categorization of the water quality. There could also be omitted variables in the analysis which could be driving the results.

In addition to the water sanitation, I also analyze the role of nutrition. As the foods consumed are only available for the last 24 hours, and not for the whole life of the child, I adapt the methodology slightly. I compare children who have been weaned to children who are still being breastfed for different age groups by using interaction variables. For each outcome, I estimate the effects of children who are still being breastfed compared to children who are not breastfed using all control variables and region-year fixed effects. I also estimate the same regressions adding interaction variables between food groups and age groups. By adding these variables, one can see how the estimated effects change. I interact the food variables with the age groups as different food groups may have different effects on the growth measures, depending on the age of the child. The food groups included in the analysis are the following: water, milk, baby-formula, dairy, meat, grains, fruit and vegetables, juice and legumes. One limitation of this method is that mothers may not fully recall all the types of food they have given the child in the last 24 hours. The food categories are also defined broadly and there may be large differences in the exact food that is given within each category. Additionally, the survey also does not ask about the quantity of the foods given. It is therefore not a perfect representation of the nutrition the child has received.

Table 9 shows the OLS regression results for the probability of being underweight, stunted, wasted and overweight. The coefficients for the variable *Still breastfed* shows the difference between children who are still breastfed to children who are not breastfed for the reference group, which is children aged 0-6 months. The coefficients for the variables *Still breastfed* $\times$ *age group* show the additional effect of breastfeeding in each age group compared to the age group 0-6 months. To get the final effect for each age group, one has to add

Table 9: Effects of Adding Food Information

	(1) Underwght.	(2) Underwght.	(3) Stunted	(4) Stunted	(5) Wasted	(6) Wasted	(7) Overwght.	(8) Overwght.
Still breastfed	-0.083***	-0.055***	-0.058***	-0.026	-0.015	-0.009	0.038**	0.026
	(0.014)	(0.014)	(0.016)	(0.016)	(0.012)	(0.012)	(0.016)	(0.016)
Still breastfed×7-12 m.	0.082***	0.048***	0.031	0.001	0.006	-0.006	-0.017	-0.005
	(0.017)	(0.018)	(0.021)	(0.022)	(0.014)	(0.015)	(0.018)	(0.019)
Still breastfed×13-18 m.	0.098***	0.061***	0.100***	0.051***	0.019	0.007	-0.046***	-0.031*
	(0.016)	(0.016)	(0.019)	(0.019)	(0.013)	(0.013)	(0.017)	(0.017)
Still breastfed×19-24 m.	0.131***	0.095***	0.136***	0.090***	0.021*	0.013	-0.045***	-0.032*
	(0.016)	(0.016)	(0.019)	(0.019)	(0.013)	(0.013)	(0.017)	(0.017)
Still breastfed×25-30 m.	0.136***	0.109***	0.087***	0.045*	0.021	0.017	-0.056***	-0.040**
	(0.018)	(0.018)	(0.025)	(0.026)	(0.014)	(0.013)	(0.019)	(0.019)
Still breastfed×31-36 m.	0.186***	0.158***	0.180***	0.135***	0.017	0.012	-0.059***	-0.046**
	(0.024)	(0.023)	(0.029)	(0.029)	(0.015)	(0.015)	(0.019)	(0.019)
Region x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Food Controls	No	Yes	No	Yes	No	Yes	No	Yes
Observations	188575	188576	188575	188576	188575	188576	188575	188576
R^2	0.123	0.127	0.174	0.179	0.073	0.074	0.063	0.064

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference groups: Children 0-6 months & weaned children
Estimation sample includes children aged 0-36 months
Sample weights were applied, all countries were weighted equally

up the coefficients for *Still breastfed* and the coefficient of the interaction effect of the respective age group. Without adding any food variables, breastfeeding in children aged 0-6 months is associated with a decrease in the probability of being underweight and stunted. The coefficients for wasting are small and statistically insignificant. Breastfeeding is also associated with an increase in the probability of being overweight. For the age group 7-12 months, breastfeeding is associated with an increase in the probability of being underweight compared to the age group 0-6 months, but the overall effect is close to zero. Starting at the ages 13-18 months, breastfeeding is associated with an overall increase in the risk of being underweight. For the probability to be stunted, breastfeeding is associated with a decrease in the probability for the age groups 0-6 months and 7-12 months. Starting at the ages 13-18, breastfeeding is associated with an increase in the probability for being stunted. The probability for wasting is slightly decreased for the ages 0-6 months in breastfed children, and slightly

increases starting at ages 13-18 months. However, the coefficients are mostly statistically insignificant. Breastfeeding is associated with an increase in the probability of being overweight for children aged 0-6 months and 7-12 months, and it is associated with a decrease for all older age groups. Once all food controls are added, most of these associations remain but they become smaller in magnitude. The positive associations of breastfeeding at 0-6 months and 7-12 months are now smaller compared to before. One potential explanation for this could be that weaned children in that age group consume fewer calories than breastfed children. Brenøe et al. (2022) show that weaned children consume more liquids that have fewer calories than breastmilk. The negative associations for durations longer than 13 months are now also smaller. This indicates that weaned children in this age group consume more calorie-dense foods than breastfed children, which is in line with previous literature. Rah et al. (2010) show that in children above the age of 6 months, low food diversity is associated with lower height and is more common in children who are still breastfed. However, the food variables do not explain all of the difference between breastfed and weaned children in my data. This could be partly due to the lack of precise data on food.

One notable difference of these results when compared to the main results on the duration of breastfeeding is their magnitude. When comparing children who are not breastfed to children who are still breastfed, the associations are substantially larger in magnitude than when comparing different breastfeeding durations. For example, in my main analysis, children who were breastfed for more than 24 months are associated with an increase in the probability of being underweight by 2.4 percentage points. Here, children aged 25-30 months have a 5.3 percentage point increase in the probability to be underweight compared to weaned children. These differences could be due to the fact that the comparison group is different. In the analysis on breastfeeding durations, breastfed children were compared to children who were never breastfed. In this analysis, children who are still being breastfed are compared to children who are not currently breastfed anymore, but could have been breastfed for any duration. Another difference to the initial analysis on breastfeeding duration

is the positive effect of breastfeeding on health outcomes for younger children. Children aged 0-6 months have a lower probability of being underweight or stunted than weaned children, and a higher probability of being overweight. However, in the analysis on breastfeeding durations, shorter breastfeeding durations are only associated with a decrease in the probability of stunting. This could be explained by the fact that the main analysis on the duration only includes children older than 24 months. It is possible that the effects of shorter breastfeeding durations mostly go away once the child becomes older. One also has to consider that some children aged 0-6 months who are still being breastfed are continued to be breastfed for various durations.

4.4 Within-family estimates

To further analyze selection and omitted variable bias, I compare health outcomes between siblings. Using a sample of siblings who are older than 24 months, I estimate between- and within-family estimates. Comparing between- and within-family estimates allows me to evaluate whether there is a selection bias. To estimate the effects on health outcomes, there needs to be enough within-family variation in health outcomes. Therefore, this part of the analysis focuses on weight-for-age, length-for-age and weight-for-length rather than probabilities of undernutrition. Table 10 shows the between-family and within-family estimates. The reference category is children who were not breastfed. The between-family estimates include all control variables and region-year fixed effects, as well as country-year-of-birth fixed effects. Without using family fixed effects, all breastfeeding durations are associated with a decrease in weight-for-age and weight-for-length. Once I add family fixed effects, all of the coefficients become statistically insignificant. Previous studies which have used a within-family approach to analyze the effects of breastfeeding also found statistically insignificant results for most of their outcomes once they use family fixed effects (Colen and Ramey, 2014, Evenhouse and Reilly, 2005).

The results suggest that there is a negative bias when comparing breastfeeding duration of children between different families, which comes from se-

Table 10: Between- and Within-Family estimates of breastfeeding duration

	(1) WAZ between	(2) WAZ within	(3) LAZ between	(4) LAZ witin	(5) WLZ between	(6) WLZ within
Breastfed 1-6 months	-0.101*	-0.069	0.095	-0.056	-0.221***	-0.055
	(0.055)	(0.093)	(0.075)	(0.095)	(0.065)	(0.109)
Breastfed 7-12 months	-0.118**	-0.035	0.035	-0.041	-0.191***	-0.012
	(0.051)	(0.089)	(0.070)	(0.091)	(0.060)	(0.105)
Breastfed 13-18 months	-0.137***	-0.035	-0.016	0.005	-0.178***	-0.047
	(0.051)	(0.089)	(0.069)	(0.092)	(0.060)	(0.104)
Breastfed 19-24 months	-0.223***	-0.105	-0.073	-0.116	-0.257***	-0.052
	(0.055)	(0.093)	(0.074)	(0.100)	(0.065)	(0.110)
Breastfed >24 months	-0.213***	-0.076	-0.025	-0.002	-0.276***	-0.105
	(0.052)	(0.090)	(0.071)	(0.096)	(0.062)	(0.104)
Observations	33873	33873	33873	33873	33873	33873
R^2	0.361	0.080	0.256	0.122	0.252	0.052

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes siblings older than 24 months
Sample weights were applied, all countries were weighted equally

lection bias and unobserved confounders. As shown in section 4.3, inadequate nutrition could be one possible explanation for this negative bias. Children from the same family most likely receive similar types of food, meaning within-family estimates can control for available nutrition. Within-family estimates can also control for health-related habits of the parents for which there is no data in the DHS. Such factors could be the smoking or drinking habits of family members. However, reverse causality could still bias the within-family estimations.

4.5 Exclusive Breastfeeding

The WHO recommends exclusive breastfeeding for the first 6 months of a child's life (WHO, 2021b). To analyze the effects of exclusive breastfeeding, I compare children who are breastfed and children who are exclusively breastfed to children who are weaned or have never been breastfed. Table 11 shows the regression of the probability to be underweight, stunted, wasted or overweight on the breastfeeding status for children aged 0-6 months. I use all control variables and region-year fixed effects. To analyze whether the effects of breastfeeding differ depending on the age of the child, I separate the effects

Table 11: Estimation of exclusive breastfeeding

	(1) Underweight	(2) Stunted	(3) Wasted	(4) Overweight
Still bf=1	-0.053***	-0.023	0.017	0.031
	(0.013)	(0.019)	(0.011)	(0.022)
Still bf=1 × 4-6 months	0.009	0.025	-0.025*	0.012
	(0.018)	(0.023)	(0.015)	(0.023)
Exclusive bf=1	-0.004	-0.014**	-0.009	0.002
	(0.006)	(0.007)	(0.008)	(0.007)
Exclusive bf=1 × 4-6 months	0.002	0.028***	0.004	0.002
	(0.008)	(0.010)	(0.009)	(0.009)
Region x Year FE	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes
Observations	69460	69460	69460	69460
R^2	0.120	0.120	0.080	0.085

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed/weaned children
Estimation sample includes children younger than 7 months
Sample weights were applied, all countries were weighted equally

for children aged 0-3 months and children aged 4-6 months. The coefficient *Still breastfed* shows the difference between breastfed and weaned children for children aged 0-3 months. *Still breastfed×4-6 months* shows the additional effect of being breastfed for more than 3 months. I also analyze whether exclusive breastfeeding is associated with any additional effect on health. The coefficient *Exclusive breastfed* shows the effect of being exclusively breastfed in addition to being breastfed in general. The coefficient of *Exclusive breastfed×4-6 months* shows the additional effect of continued exclusive breastfed, for more than 3 months.

Even when controlling for many factors which are associated with health and breastfeeding, some associations remain statistically significant. Breastfeeding at 0-3 months is associated with a decrease in the probability to be underweight. There is also some evidence that it is associated with a decrease in the probability to be stunted, and an increase in the probability to be wasted and overweight, but these coefficients are not statistically significant. Compared to non-breastfed children aged 4-6 months, breastfeeding at 4-6 months is associated with a decrease in the probability of being under-

weight and a small decrease in the probability to be wasted. However, there is mixed evidence on exclusive breastfeeding. Exclusive breastfeeding at 0-3 months is associated with a decrease in the probability to be stunted compared to breastfeeding in general, but exclusive breastfeeding at 4-6 months is associated with an increase in the probability to be stunted compared to general breastfeeding. Appendix table A.28 presents the same analysis on weight-for-age, length-for-age and weight-for-length z-scores. Breastfeeding at 0-3 months is associated with an increase in weight-for-age, length-for-age and weight-for-length. At the ages 4-6 months, the effects on weight-for-age and length-for-age go towards zero, while there is still a positive association with weight-for-length. Exclusive breastfeeding at 0-3 months is associated with an additional increase in weight-for-age, but at the ages 4-6 months this additional effect goes towards zero.

As stated before, comparing children who are currently breastfed to children who are not currently breastfed differs from the analysis on breastfeeding duration in older children. Children who are currently being breastfed may be continued to be breastfed for various durations. Furthermore, children who are not currently being breastfed may have been breastfed previously in their lives. This may be the reason why I find positive associations between breastfeeding and health outcomes in very young children, but fewer positive associations in older children. There is also evidence in the literature that the initial weight gain of breastfed children compared to children who have received less breastmilk disappears after 12 months (Kramer et al., 2002). The effects of exclusive breastfeeding on health outcomes are rather small. This could be due in part to imprecise data on exclusive breastfeeding. The share of exclusive breastfeeding is most likely underestimated in the data, as mothers may not remember if they have given a certain food to the child or because children who were exclusively breastfed on the day of the interview may still have received some food at earlier points. It is also possible that the additional benefits of exclusive breastfeeding are truly small.

5 Conclusion

This thesis aims to analyze the selection into breastfeeding in developing countries and the effects of breastfeeding on health outcomes. Using data from the DHS, I show that mothers from a lower socioeconomic status tend to breastfeed longer in developing countries. After accounting for these selection effects, shorter breastfeeding durations of less than 6 months are associated with a small decrease in the probability of stunting. Longer breastfeeding durations of more than 24 months are associated with an increase in the probability to be underweight and wasted, and a decrease in the probability to be overweight. However, these results most likely still suffer from selection bias. Once I use family fixed effects, these associations become statistically insignificant. I also show that the household's water quality access is important when evaluating the effects of breastfeeding. All breastfeeding durations are associated with an increase in weight-for-age, length-for-age and weight-for-length if the water quality is poor. Furthermore, I also provide evidence that the difference in the diet between weaned and breastfed children can explain part of the associations found in the data. However, the DHS does not provide information on the amount of foods consumed. Future research may address this issue with more high-quality data.

It it important to note several limitations to this study. First, there are a number of variables which are important for health outcomes but could not be included. Such variables include the gestational age of the child, smoking and alcohol consumption of the mother and household members. I am also not able to control for reverse causality in my analysis. Furthermore, this thesis only considers the duration of the breastfeeding, but not the quantity of breast milk a child receives.

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Appendix A. Placeholder

Table A.1: Number of Observations per Country

	Freq.		Freq
Albania	3594	Jordan	9931
Armenia	2626	Kenia	17513
Bangladesh	14630	Kyrgyz Republic	3610
Benin	28957	Lesotho	3877
Bolivia	15949	Liberia	6412
Burkina Faso	6239	Malawi	16704
Burundi	9005	Mali	9883
Cameroon	9018	Moldova	1139
Chad	18435	Morocco	5115
Colombia	4385	Mozambique	15982
Comoros	1725	Myanmar	3796
Congo	7409	Namibia	4308
Congo Democratic Republic	7411	Nigeria	42312
Cote d'Ivoire	2877	Pakistan	6514
Dominican Republic	6128	Peru	56031
Egypt	52327	Rwanda	10910
Eswatini	1802	Senegal	9021
Ethiopia	28823	Tajikistan	9282
Gabon	2868	Tanzania	21201
Gambia	2891	Timor Leste	11046
Ghana	7621	Togo	3033
Guatemala	14000	Turkey	1540
Haiti	9853	Uganda	10763
Honduras	17948	Zambia	15345
India	74357		

Table A.2: Selection into continued breastfeeding in Europe

	(1) Continued Breastfeeding	
Mother Characteristics		
Mother's age	0.019	(0.020)
Mother's age squared	−0.000	(0.000)
Highest eduation, omitted: No education		
-Primary	−0.184***	(0.047)
-Secondary	−0.193***	(0.053)
-Higher	−0.185***	(0.063)
Occupation, omitted: Not working		
-Low-skilled	−0.057	(0.041)
-Medium-skilled	−0.038	(0.033)
-High-skilled	0.031	(0.041)
Marital status, omitted: Single		
-Living with partner/husband	0.231*	(0.127)
-Widowed/Divorced/Separated	0.171	(0.140)
Children older than 5 years	−0.009	(0.023)
Births in last 5 years	−0.129***	(0.038)
Children who have died	0.023	(0.034)
Age of mother at 1st birth	0.004	(0.005)
Mother currently pregnant	0.011	(0.052)
Was pregnancy intended? omitted: Yes		
-Later	−0.001	(0.036)
-No more	−0.017	(0.044)
Mother's weight for height percent of median	0.000	(0.000)
Mother's height for age percent of median	−0.002	(0.003)
Number of Antenatal Visits	0.005*	(0.003)
Rural region	0.017	(0.031)
Wealth Index	−0.034***	(0.012)
Source of drinking Water, omitted: piped water		
-Well water	0.008	(0.041)
-Surface water	−0.095**	(0.039)
-Tanker truck	−0.077	(0.075)
-Bottled water	0.002	(0.042)
-Other	−0.161**	(0.080)
Child Characteristics		
Child's age in months	−0.015***	(0.004)
Child's age squared	0.000***	(0.000)
Child gender: female	0.041**	(0.020)
Birth order, omitted: only child		
-First Child	0.045	(0.051)
-Middle Child	0.099	(0.062)
-Last Child	0.076*	(0.042)
Preceding birth <25 months	0.052	(0.037)
Multiple Birth	−0.172*	(0.095)
Caesarean section	−0.039	(0.029)
Size at birth, omitted: Average		
-Very large	−0.061	(0.069)
-Larger than average	0.025	(0.026)
-Smaller than average	0.006	(0.043)
-Very small	−0.188***	(0.044)
Place of delivery, omitted: Home		
-Public Sector	0.038	(0.047)
-Private Sector	−0.056	(0.059)
-Other	0.271***	(0.086)
Total number of vaccines	0.002	(0.009)
Constant	0.675	(0.443)
Region x Year FE	*Yes*	
Observations	4000	
R^2	0.073	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.3: Selection into continued breastfeeding in Africa

	(1) Continued Breastfeeding	
Mother Characteristics		
Mother's age	−0.004	(0.002)
Mother's age squared	0.000	(0.000)
Highest education, omitted: No education		
-Primary	0.006	(0.004)
-Secondary	−0.017***	(0.006)
-Higher	−0.162***	(0.024)
Occupation, omitted: Not working		
-Low-skilled	0.005	(0.004)
-Medium-skilled	−0.001	(0.006)
-High-skilled	0.011	(0.019)
Marital status, omitted: Single		
-Living with partner/husband	0.051***	(0.012)
-Widowed/Divorced/Separated	0.036***	(0.012)
Children older than 5 years	0.004**	(0.002)
Births in last 5 years	−0.021***	(0.004)
Children who have died	−0.002	(0.002)
Age of mother at 1st birth	0.000	(0.001)
Mother currently pregnant	−0.044***	(0.005)
Was pregnancy intended? omitted: Yes		
-Later	−0.006	(0.005)
-No more	−0.001	(0.007)
Mother's weight for height percent of median	−0.000	(0.000)
Mother's height for age percent of median	−0.001	(0.000)
Number of Antenatal Visits	−0.001*	(0.001)
Rural region	0.020***	(0.006)
Wealth Index	−0.012***	(0.002)
Source of drinking Water, omitted: piped water		
-Well water	0.007	(0.006)
-Surface water	0.014**	(0.007)
-Rain water	0.025*	(0.014)
-Tanker truck	0.039	(0.024)
-Bottled water	−0.001	(0.019)
-Other	0.044**	(0.019)
Child Characteristics		
Child's age in months	−0.004***	(0.001)
Child's age squared	0.000***	(0.000)
Child gender: female	−0.001	(0.003)
Birth order, omitted: only child		
-First Child	−0.080***	(0.011)
-Middle Child	−0.045***	(0.011)
-Last Child	0.014*	(0.008)
Preceding birth <25 months	−0.019***	(0.005)
Multiple Birth	0.034***	(0.011)
Cesarean section	−0.011	(0.011)
Size at birth, omitted: Average		
-Very large	−0.006	(0.005)
-Larger than average	−0.007	(0.004)
-Smaller than average	−0.014***	(0.005)
-Very small	−0.022***	(0.007)
Place of delivery, omitted: Home		
-Public Sector	−0.009**	(0.004)
-Private Sector	−0.030***	(0.007)
-Other	−0.016	(0.015)
Total number of vaccines	0.003***	(0.001)
Constant	1.121***	(0.059)
Region x Year FE	*Yes*	
Observations	128704	
R^2	0.107	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.4: Selection into continued breastfeeding in the Eastern Mediterranean

	(1) Continued Breastfeeding	
Mother Characteristics		
Mother's age	−0.003	(0.005)
Mother's age squared	0.000	(0.000)
Highest education, omitted: No education		
-Primary	−0.022*	(0.013)
-Secondary	−0.027***	(0.010)
-Higher	−0.023	(0.018)
Occupation, omitted: Not working		
-Low-skilled	0.042**	(0.017)
-Medium-skilled	−0.081***	(0.023)
-High-skilled	−0.052***	(0.015)
Marital status, omitted: married		
-Widowed/Divorced/Separated	−0.073	(0.049)
Children older than 5 years	0.015***	(0.005)
Births in last 5 years	−0.036***	(0.009)
Children who have died	−0.006	(0.006)
Age of mother at 1st birth	−0.001	(0.002)
Mother currently pregnant	−0.009	(0.011)
Was pregnancy intended? omitted: Yes		
-Later	0.005	(0.012)
-No more	−0.029**	(0.012)
Mother's weight for height percent of median	−0.001***	(0.000)
Mother's height for age percent of median	−0.002	(0.001)
Number of Antenatal Visits	−0.001	(0.001)
Rural region	0.087***	(0.021)
Wealth Index	−0.017***	(0.004)
Source of drinking Water, omitted: piped water		
-Well water	0.044***	(0.013)
-Surface water	0.078**	(0.033)
-Rain water	0.088***	(0.024)
-Tanker truck	−0.005	(0.029)
-Bottled water	−0.010	(0.013)
-Other	0.050*	(0.027)
Child Characteristics		
Child's age in months	0.001	(0.002)
Child's age squared	−0.000	(0.000)
Child gender: female	−0.012*	(0.007)
Birth order, omitted: only child		
-First Child	−0.068***	(0.021)
-Middle Child	−0.007	(0.021)
-Last Child	0.064***	(0.015)
Preceding birth <25 months	−0.025***	(0.009)
Multiple Birth	−0.190***	(0.028)
Casarean section	−0.033***	(0.011)
Size at birth, omitted: Average		
-Very large	0.003	(0.033)
-Larger than average	−0.017	(0.013)
-Smaller than average	−0.022**	(0.011)
-Very small	−0.064***	(0.020)
Place of delivery, omitted: Home		
-Public Sector	−0.044***	(0.011)
-Private Sector	−0.066***	(0.010)
-Other	−0.064	(0.060)
Total number of vaccines	0.004	(0.003)
Constant	1.204***	(0.130)
Region x Year FE	*Yes*	
Observations	38145	
R^2	0.171	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.5: Selection into continued breastfeeding in the Americas

	(1) Continued Breastfeeding	
Mother Characteristics		
Mother's age	0.006*	(0.003)
Mother's age squared	−0.000**	(0.000)
Highest education, omitted: No education		
-Primary	−0.004	(0.009)
-Secondary	−0.051***	(0.011)
-Higher	−0.075***	(0.013)
Occupation, omitted: Not working		
-Low-skilled	−0.025***	(0.006)
-Medium-skilled	−0.019***	(0.006)
-High-skilled	−0.050***	(0.012)
Marital status, omitted: Single		
-Living with partner/husband	0.019	(0.012)
-Widowed/Divorced/Separated	−0.019	(0.014)
Children older than 5 years	0.008***	(0.003)
Births in last 5 years	−0.041***	(0.007)
Children who have died	0.004	(0.004)
Age of mother at 1st birth	−0.003**	(0.001)
Mother currently pregnant	−0.057***	(0.008)
Was pregnancy intended? omitted: Yes		
-Later	−0.006	(0.006)
-No more	−0.002	(0.006)
Mother's weight for height percent of median	−0.000*	(0.000)
Mother's height for age percent of median	−0.003***	(0.001)
Number of Antenatal Visits	−0.001	(0.001)
Rural region	0.011	(0.008)
Wealth Index	−0.040***	(0.003)
Source of drinking Water, omitted: piped water		
-Well water	−0.002	(0.009)
-Surface water	−0.004	(0.008)
-Rain water	−0.019	(0.025)
-Tanker truck	−0.027	(0.017)
-Bottled water	−0.049***	(0.014)
-Other	−0.003	(0.011)
Child Characteristics		
Child's age in months	−0.004***	(0.001)
Child's age squared	0.000***	(0.000)
Child gender: female	0.003	(0.005)
Birth order, omitted: only child		
-First Child	−0.120***	(0.013)
-Middle Child	−0.073***	(0.013)
-Last Child	0.025***	(0.009)
Preceding birth <25 months	−0.019***	(0.006)
Multiple Birth	−0.061**	(0.026)
Cesarean section	−0.025***	(0.008)
Size at birth, omitted: Average		
-Very large	−0.005	(0.015)
-Larger than average	0.005	(0.005)
-Smaller than average	−0.013**	(0.006)
-Very small	−0.023*	(0.013)
Place of delivery, omitted: Home		
-Public Sector	−0.017***	(0.006)
-Private Sector	−0.097***	(0.012)
-Other	−0.035	(0.024)
Total number of vaccines	0.003***	(0.001)
Constant	1.121***	(0.097)
Region x Year FE	*Yes*	
Observations	75550	
R^2	0.202	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.6: Selection into continued breastfeeding in South East Asia

	(1) Continued Breastfeeding	
Mother Characteristics		
Mother's age	0.004	(0.004)
Mother's age squared	−0.000	(0.000)
Highest education, omitted: No education		
-Primary	0.004	(0.008)
-Secondary	−0.011	(0.009)
-Higher	−0.045***	(0.017)
Occupation, omitted: Not working		
-Low-skilled	0.003	(0.010)
-Medium-skilled	−0.005	(0.015)
-High-skilled	−0.002	(0.027)
Marital status, omitted: Single		
-Living with partner/husband	−0.064**	(0.031)
-Widowed/Divorced/Separated	−0.098**	(0.039)
Children older than 5 years	0.002	(0.004)
Births in last 5 years	−0.053***	(0.011)
Children who have died	0.002	(0.006)
Age of mother at 1st birth	−0.000	(0.002)
Mother currently pregnant	−0.085***	(0.014)
Was pregnancy intended? omitted: Yes		
-Later	−0.010	(0.011)
-No more	−0.047***	(0.009)
Mother's weight for height percent of median	−0.001**	(0.000)
Mother's height for age percent of median	−0.001	(0.001)
Number of Antenatal Visits	−0.000	(0.001)
Rural region	0.028***	(0.008)
Wealth Index	−0.009***	(0.003)
Source of drinking Water, omitted: piped water		
-Well water	−0.002	(0.011)
-Surface water	−0.004	(0.014)
-Rain water	0.016	(0.033)
-Tanker truck	0.061	(0.053)
-Bottled water	−0.023	(0.056)
-Other	0.000	(0.031)
Child Characteristics		
Child's age in months	−0.003**	(0.001)
Child's age squared	0.000***	(0.000)
Child gender: female	0.010*	(0.006)
Birth order, omitted: only child		
-First Child	−0.204***	(0.020)
-Middle Child	−0.127***	(0.019)
-Last Child	0.033***	(0.011)
Preceding birth <25 months	−0.005	(0.009)
Multiple Birth	−0.013	(0.050)
Cesarean section	0.008	(0.014)
Size at birth, omitted: Average		
-Very large	0.001	(0.021)
-Larger than average	−0.015	(0.010)
-Smaller than average	−0.028**	(0.011)
-Very small	−0.023	(0.016)
Place of delivery, omitted: Home		
-Public Sector	−0.007	(0.013)
-Private Sector	−0.037***	(0.014)
-Other	−0.026	(0.024)
Total number of vaccines	0.006***	(0.002)
Constant	1.221***	(0.124)
Region x Year FE	*Yes*	
Observations	66858	
R^2	0.164	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.7: Selection into short breastfeeding durations in Europe

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	0.018	(0.012)
Mother's age squared	−0.000	(0.000)
Highest education, omitted: No education		
-Primary	−0.131***	(0.044)
-Secondary	−0.104**	(0.050)
-Higher	−0.136***	(0.052)
Occupation, omitted: Not working		
-Low-skilled	−0.036	(0.022)
-Medium-skilled	−0.018	(0.016)
-High-skilled	0.037**	(0.018)
Marital status, omitted: Single		
-Living with partner/husband	−0.169**	(0.072)
-Widowed/Divorced/Separated	−0.190**	(0.079)
Children older than 5 years	−0.040***	(0.012)
Births in last 5 years	−0.051***	(0.015)
Children who have died	−0.080***	(0.025)
Age of mother at 1st birth	−0.010***	(0.004)
Mother currently pregnant	0.057***	(0.014)
Was pregnancy intended? omitted: Yes		
-Later	0.019	(0.017)
-No more	−0.034	(0.025)
Mother's weight for height percent of median	−0.000	(0.000)
Mother's height for age percent of median	−0.001	(0.002)
Number of Antenatal Visits	0.001	(0.001)
Rural region	0.024	(0.018)
Wealth Index	−0.002	(0.006)
Source of drinking Water, omitted: piped water		
-Well water	−0.018	(0.018)
-Surface water	0.031	(0.019)
-Tanker truck	0.011	(0.030)
-Bottled water	0.050***	(0.015)
-Other	−0.379***	(0.093)
Child Characteristics		
Child's age in months	−0.003	(0.003)
Child's age squared	0.000	(0.000)
Child gender: female	−0.002	(0.012)
Birth order, omitted: only child		
-First Child	0.067**	(0.026)
-Middle Child	0.140***	(0.032)
-Last Child	0.063***	(0.021)
Preceding birth <25 months	0.003	(0.024)
Multiple Birth	0.038	(0.050)
Cesarean section	0.016	(0.014)
Size at birth, omitted: Average		
-Very large	0.010	(0.023)
-Larger than average	0.012	(0.014)
-Smaller than average	0.006	(0.017)
-Very small	−0.225***	(0.067)
Place of delivery, omitted: Home		
-Public Sector	−0.040	(0.036)
-Private Sector	−0.013	(0.036)
-Other	0.064	(0.045)
Total number of vaccines	0.007	(0.006)
Constant	1.360***	(0.262)
Region x Year FE	*Yes*	
Observations	2359	
R^2	0.087	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.8: Selection into short breastfeeding durations in Africa

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	−0.010	(0.006)
Mother's age squared	0.000*	(0.000)
Highest education, omitted: No education		
-Primary	0.012	(0.011)
-Secondary	0.023*	(0.013)
-Higher	0.016	(0.027)
Occupation, omitted: Not working		
-Low-skilled	0.041***	(0.010)
-Medium-skilled	0.035***	(0.011)
-High-skilled	0.022	(0.023)
Marital status, omitted: Single		
-Living with partner/husband	−0.007	(0.019)
-Widowed/Divorced/Separated	−0.014	(0.020)
Children older than 5 years	−0.001	(0.006)
Births in last 5 years	0.025***	(0.007)
Children who have died	−0.013**	(0.007)
Age of mother at 1st birth	0.002	(0.002)
Mother currently pregnant	0.027***	(0.010)
Was pregnancy intended? omitted: Yes		
-Later	−0.010	(0.010)
-No more	0.004	(0.015)
Mother's weight for height percent of median	0.000	(0.000)
Mother's height for age percent of median	−0.000	(0.001)
Number of Antenatal Visits	−0.001	(0.002)
Rural region	0.001	(0.014)
Wealth Index	−0.008	(0.005)
Source of drinking Water, omitted: piped water		
-Well water	−0.010	(0.015)
-Surface water	0.006	(0.017)
-Rain water	0.052*	(0.027)
-Tanker truck	0.087***	(0.025)
-Bottled water	0.064***	(0.021)
-Other	0.037	(0.028)
Child Characteristics		
Child's age in months	−0.005**	(0.002)
Child's age squared	0.000**	(0.000)
Child gender: female	0.006	(0.008)
Birth order, omitted: only child		
-First Child	−0.002	(0.024)
-Middle Child	0.001	(0.023)
-Last Child	0.008	(0.018)
Preceding birth <25 months	0.015	(0.010)
Multiple Birth	−0.055*	(0.033)
Cesarean section	−0.019	(0.022)
Size at birth, omitted: Average		
-Very large	−0.016	(0.011)
-Larger than average	−0.012	(0.011)
-Smaller than average	−0.024*	(0.013)
-Very small	−0.048***	(0.018)
Place of delivery, omitted: Home		
-Public Sector	−0.014	(0.010)
-Private Sector	−0.000	(0.014)
-Other	−0.008	(0.034)
Total number of vaccines	−0.003*	(0.002)
Constant	0.850***	(0.134)
Region x Year FE	*Yes*	
Observations	19382	
R^2	0.117	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.9: Selection into short breastfeeding durations in the Eastern Mediterranean

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	−0.013	(0.009)
Mother's age squared	0.000	(0.000)
Highest education, omitted: No education		
-Primary	−0.002	(0.015)
-Secondary	0.027*	(0.016)
-Higher	0.062***	(0.020)
Occupation, omitted: Not working		
-Low-skilled	0.011	(0.029)
-Medium-skilled	0.049**	(0.025)
-High-skilled	−0.001	(0.021)
-Widowed/Divorced/Separated	−0.162**	(0.064)
Children older than 5 years	0.021***	(0.007)
Births in last 5 years	0.031***	(0.011)
Children who have died	−0.020**	(0.009)
Age of mother at 1st birth	0.000	(0.003)
Mother currently pregnant	0.034**	(0.014)
Was pregnancy intended? omitted: Yes		
-Later	0.008	(0.016)
-No more	−0.056***	(0.019)
Mother's weight for height percent of median	−0.000**	(0.000)
Mother's height for age percent of median	−0.003*	(0.002)
Number of Antenatal Visits	0.001	(0.001)
Rural region	0.026*	(0.015)
Wealth Index	0.007	(0.005)
Source of drinking Water, omitted: piped water		
-Well water	0.013	(0.017)
-Surface water	0.032	(0.023)
-Rain water	0.039**	(0.018)
-Tanker truck	0.026	(0.031)
-Bottled water	−0.048***	(0.010)
-Other	0.039	(0.041)
Child Characteristics		
Child's age in months	−0.000	(0.002)
Child's age squared	−0.000	(0.000)
Child gender: female	0.013	(0.009)
Birth order, omitted: only child		
-First Child	0.003	(0.024)
-Middle Child	0.026	(0.025)
-Last Child	0.002	(0.021)
Preceding birth <25 months	−0.007	(0.014)
Multiple Birth	−0.146***	(0.033)
Cesarean section	−0.068***	(0.019)
Size at birth, omitted: Average		
-Very large	0.020	(0.033)
-Larger than average	−0.010	(0.014)
-Smaller than average	−0.019	(0.014)
-Very small	−0.094***	(0.030)
Place of delivery, omitted: Home		
-Public Sector	−0.012	(0.014)
-Private Sector	0.018	(0.017)
-Other	0.085**	(0.037)
Total number of vaccines	0.003	(0.004)
Constant	1.269***	(0.210)
Region x Year FE	*Yes*	
Observations	9675	
R^2	0.065	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.10: Selection into short breastfeeding durations in the Americas

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	0.002	(0.004)
Mother's age squared	−0.000	(0.000)
Highest education, omitted: No education		
-Primary	−0.016	(0.010)
-Secondary	−0.016	(0.012)
-Higher	−0.006	(0.015)
Occupation, omitted: Not working		
-Low-skilled	0.013	(0.008)
-Medium-skilled	0.012*	(0.007)
-High-skilled	0.030***	(0.010)
Marital status, omitted: Single		
-Living with partner/husband	0.025	(0.016)
-Widowed/Divorced/Separated	0.018	(0.017)
Children older than 5 years	0.006*	(0.003)
Births in last 5 years	0.008	(0.006)
Children who have died	−0.015***	(0.006)
Age of mother at 1st birth	0.002*	(0.001)
Mother currently pregnant	0.030***	(0.008)
Was pregnancy intended? omitted: Yes		
-Later	0.000	(0.007)
-No more	−0.017**	(0.008)
Mother's weight for height percent of median	−0.000***	(0.000)
Mother's height for age percent of median	−0.000	(0.001)
Number of Antenatal Visits	0.002**	(0.001)
Rural region	0.014*	(0.007)
Wealth Index	0.002	(0.004)
Source of drinking Water, omitted: piped water		
-Well water	0.001	(0.008)
-Surface water	0.014	(0.010)
-Rain water	−0.014	(0.020)
-Tanker truck	−0.030	(0.029)
-Bottled water	0.004	(0.012)
-Other	0.012	(0.012)
Child Characteristics		
Child's age in months	0.002	(0.001)
Child's age squared	−0.000	(0.000)
Child gender: female	−0.001	(0.005)
Birth order, omitted: only child		
-First Child	0.025**	(0.012)
-Middle Child	0.067***	(0.013)
-Last Child	0.057***	(0.010)
Preceding birth <25 months	0.003	(0.007)
Multiple Birth	−0.091***	(0.031)
Caesarean section	−0.019**	(0.009)
Size at birth, omitted: Average		
-Very large	−0.002	(0.013)
-Larger than average	0.004	(0.006)
-Smaller than average	−0.027***	(0.007)
-Very small	−0.060***	(0.016)
Place of delivery, omitted: Home		
-Public Sector	−0.003	(0.007)
-Private Sector	−0.016	(0.011)
-Other	−0.004	(0.027)
Total number of vaccines	0.001	(0.001)
Constant	0.878***	(0.104)
Region x Year FE	*Yes*	
Observations	26973	
R^2	0.052	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.11: Selection into short breastfeeding durations in South East Asia

	(1) Short Breastfeeding	
Mother Characteristics		
Mother's age	−0.003	(0.006)
Mother's age squared	0.000	(0.000)
Highest education, omitted: No education		
-Primary	0.009	(0.012)
-Secondary	−0.015	(0.011)
-Higher	0.049***	(0.019)
Occupation, omitted: Not working		
-Low-skilled	−0.018	(0.014)
-Medium-skilled	−0.010	(0.015)
-High-skilled	−0.020	(0.034)
Marital status, omitted: Single		
-Living with partner/husband	−0.215***	(0.078)
-Widowed/Divorced/Separated	−0.240***	(0.083)
Children older than 5 years	0.004	(0.005)
Births in last 5 years	0.001	(0.008)
Children who have died	−0.005	(0.009)
Age of mother at 1st birth	0.001	(0.002)
Mother currently pregnant	−0.004	(0.011)
Was pregnancy intended? omitted: Yes		
-Later	0.033**	(0.014)
-No more	−0.027	(0.031)
Mother's weight for height percent of median	0.000	(0.000)
Mother's height for age percent of median	0.002	(0.001)
Number of Antenatal Visits	−0.003*	(0.002)
Rural region	0.013	(0.012)
Wealth Index	0.003	(0.004)
Source of drinking Water, omitted: piped water		
-Well water	0.006	(0.011)
-Surface water	0.050***	(0.013)
-Rain water	0.199	(0.139)
-Tanker truck	−0.214	(0.178)
-Bottled water	0.025	(0.018)
-Other	0.035**	(0.015)
Child's Sociodemographic Characteristics		
Child's age in months	0.000	(0.002)
Child's age squared	0.000	(0.000)
Child gender: female	−0.000	(0.007)
Birth order, omitted: only child		
-First Child	−0.088***	(0.021)
-Middle Child	−0.067***	(0.021)
-Last Child	0.003	(0.017)
Preceding birth <25 months	−0.004	(0.009)
Multiple Birth	−0.024	(0.048)
Caesarean section	0.005	(0.017)
Size at birth, omitted: Average		
-Very large	−0.062**	(0.028)
-Larger than average	−0.030**	(0.012)
-Smaller than average	−0.070***	(0.021)
-Very small	0.009	(0.027)
Place of delivery, omitted: Home		
-Public Sector	−0.013	(0.014)
-Private Sector	−0.002	(0.020)
-Other	0.085***	(0.031)
Total number of vaccines	0.002	(0.002)
Constant	0.854***	(0.160)
Region x Year FE	*Yes*	
Observations	17562	
R^2	0.197	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Estimation sample includes children older than 12 months.
Sample weights are applied, all countries are weighted equally

Table A.12: Association between weight-for-age and breastfeeding duration

	(1) WAZ	(2) WAZ	(3) WAZ	(4) WAZ	(5) WAZ
Breastfed 1-6 months	0.075*	0.039	0.022	0.016	0.004
	(0.039)	(0.038)	(0.037)	(0.037)	(0.037)
Breastfed 7-12 months	-0.111***	-0.110***	-0.086**	-0.080**	-0.082**
	(0.037)	(0.037)	(0.035)	(0.035)	(0.035)
Breastfed 13-18 months	-0.139***	-0.138***	-0.104***	-0.093***	-0.082**
	(0.036)	(0.036)	(0.034)	(0.034)	(0.034)
Breastfed 19-24 months	-0.269***	-0.255***	-0.196***	-0.180***	-0.153***
	(0.037)	(0.037)	(0.035)	(0.035)	(0.035)
Breastfed >24 months	-0.309***	-0.291***	-0.207***	-0.187***	-0.176***
	(0.037)	(0.036)	(0.034)	(0.034)	(0.034)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.204	0.252	0.317	0.320	0.339

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.13: Logit Regression of the probability to be underweight on breastfeeding duration

	(1) Underweight	(2) Underweight	(3) Underweight	(4) Underweight	(5) Underweight
underweight					
Breastfed 1-6 months	-0.219***	-0.155*	-0.117	-0.106	-0.071
	(0.083)	(0.084)	(0.088)	(0.088)	(0.093)
Breastfed 7-12 months	0.078	0.091	0.072	0.057	0.070
	(0.068)	(0.068)	(0.072)	(0.072)	(0.076)
Breastfed 13-18 months	0.044	0.072	0.042	0.025	0.022
	(0.066)	(0.067)	(0.071)	(0.070)	(0.074)
Breastfed 19-24 months	0.225***	0.217***	0.154**	0.129*	0.088
	(0.070)	(0.071)	(0.075)	(0.075)	(0.079)
Breastfed >24 months	0.390***	0.378***	0.267***	0.232***	0.214***
	(0.064)	(0.065)	(0.069)	(0.069)	(0.072)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	223722
R^2					

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.14: Regression of growth measures on breastfeeding duration using population-adjusted sample weights

	(1) Underweight	(2) Stunted	(3) Wasted	(4) Overweight
Breastfed 1-6 months	-0.009	-0.013	-0.003	0.001
	(0.012)	(0.011)	(0.010)	(0.004)
Breastfed 7-12 months	-0.016	-0.009	-0.010	-0.001
	(0.011)	(0.010)	(0.009)	(0.003)
Breastfed 13-18 months	-0.007	0.004	0.001	0.000
	(0.010)	(0.010)	(0.008)	(0.003)
Breastfed 19-24 months	0.005	0.011	0.007	-0.004
	(0.011)	(0.011)	(0.009)	(0.004)
Breastfed >24 months	0.025**	0.028***	0.006	-0.005*
	(0.010)	(0.010)	(0.008)	(0.003)
Region x Year FE	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes
Observations	225360	225360	225360	225360
R^2	0.208	0.178	0.074	0.065

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, countries were weighted according to population size

Table A.15: Association between health outcomes and breastfeeding duration without sample weights

	(1) Underweight	(2) Stunted	(3) Wasted	(4) Overweight
Breastfed 1-6 months	-0.007	-0.026***	-0.002	-0.001
	(0.005)	(0.006)	(0.003)	(0.003)
Breastfed 7-12 months	-0.012**	-0.016***	-0.003	-0.006*
	(0.005)	(0.006)	(0.003)	(0.003)
Breastfed 13-18 months	-0.007	-0.005	0.000	-0.005*
	(0.005)	(0.006)	(0.003)	(0.003)
Breastfed 19-24 months	-0.003	0.002	0.003	-0.008**
	(0.005)	(0.006)	(0.003)	(0.003)
Breastfed >24 months	0.016***	0.012**	0.004	-0.010***
	(0.004)	(0.006)	(0.003)	(0.003)
Region x Year FE	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes
Observations	225360	225360	225360	225360
R^2	0.198	0.184	0.087	0.056

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
No sample weights were applied

Table A.16: Regression of the probability to be underweight on breastfeeding duration in each world region

	(1) Europe underweight	(2) Africa underweight	(3) EM underweight	(4) Americas underweight	(5) South East Asia underweight
Breastfed 1-6 months	0.026**	0.001	-0.011	-0.001	-0.020
	(0.013)	(0.014)	(0.013)	(0.009)	(0.029)
Breastfed 7-12 months	0.038***	0.002	0.007	-0.007	0.011
	(0.012)	(0.013)	(0.014)	(0.009)	(0.027)
Breastfed 13-18 months	0.033***	-0.011	-0.005	0.000	0.024
	(0.012)	(0.012)	(0.012)	(0.010)	(0.026)
Breastfed 19-24 months	0.062**	-0.003	-0.010	-0.001	0.055
	(0.025)	(0.013)	(0.014)	(0.011)	(0.036)
Breastfed >24 months	0.021*	0.018	-0.006	0.017*	0.070***
	(0.011)	(0.012)	(0.012)	(0.010)	(0.025)
Region x Year FE	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes	Yes
Observations	2983	91675	28323	55433	46946
R^2	0.056	0.140	0.064	0.103	0.124

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally within world region
EM: Eastern Mediterranean

Table A.17: Association between length-for-age and breastfeeding duration

	(1) LAZ	(2) LAZ	(3) LAZ	(4) LAZ	(5) LAZ
Breastfed 1-6 months	0.140***	0.106**	0.076*	0.067	0.054
	(0.050)	(0.049)	(0.045)	(0.045)	(0.045)
Breastfed 7-12 months	-0.089*	-0.072	-0.045	-0.035	-0.042
	(0.048)	(0.046)	(0.042)	(0.042)	(0.042)
Breastfed 13-18 months	-0.165***	-0.150***	-0.104**	-0.085**	-0.070*
	(0.046)	(0.046)	(0.041)	(0.041)	(0.041)
Breastfed 19-24 months	-0.300***	-0.266***	-0.188***	-0.161***	-0.129***
	(0.047)	(0.046)	(0.042)	(0.042)	(0.042)
Breastfed >24 months	-0.306***	-0.281***	-0.178***	-0.145***	-0.130***
	(0.046)	(0.045)	(0.041)	(0.041)	(0.041)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225067	225360	225360
R^2	0.138	0.175	0.240	0.246	0.264

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.18: Logit Regression of the probability to be stunted on breastfeeding duration

	(1) Stunted	(2) Stunted	(3) Stunted	(4) Stunted	(5) Stunted
stunted					
Breastfed 1-6 months	-0.256***	-0.207***	-0.169**	-0.155**	-0.135*
	(0.072)	(0.073)	(0.076)	(0.076)	(0.078)
Breastfed 7-12 months	0.061	0.031	-0.010	-0.027	-0.029
	(0.062)	(0.063)	(0.065)	(0.065)	(0.066)
Breastfed 13-18 months	0.104*	0.085	0.026	0.001	-0.027
	(0.060)	(0.061)	(0.063)	(0.063)	(0.065)
Breastfed 19-24 months	0.282***	0.239***	0.144**	0.110*	0.068
	(0.063)	(0.064)	(0.066)	(0.066)	(0.068)
Breastfed >24 months	0.296***	0.278***	0.143**	0.096	0.069
	(0.060)	(0.062)	(0.064)	(0.064)	(0.066)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225268
R^2					

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.19: Regression of the probability to be stunted on breastfeeding duration in each world region

	(1) Europe stunted	(2) Africa stunted	(3) Eastern Mediterranean stunted	(4) Americas stunted	(5) South East Asia stunted
Breastfed 1-6 months	-0.002	-0.016	0.004	-0.013	-0.011
	(0.036)	(0.025)	(0.018)	(0.015)	(0.030)
Breastfed 7-12 months	0.009	-0.019	0.025	-0.009	0.001
	(0.036)	(0.020)	(0.018)	(0.014)	(0.025)
Breastfed 13-18 months	-0.000	-0.029	0.018	0.011	0.014
	(0.037)	(0.019)	(0.017)	(0.014)	(0.025)
Breastfed 19-24 months	0.045	-0.004	0.016	0.010	-0.001
	(0.052)	(0.020)	(0.019)	(0.017)	(0.035)
Breastfed >24 months	0.031	-0.003	0.033*	0.015	0.032
	(0.043)	(0.020)	(0.018)	(0.014)	(0.023)
Region x Year FE	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes	Yes
Observations	2983	91675	28323	55433	46946
R^2	0.096	0.152	0.091	0.278	0.151

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally within world region

Table A.20: Association between weight-for-length and breastfeeding duration

	(1) WLZ	(2) WLZ	(3) WLZ	(4) WLZ	(5) WLZ
Breastfed 1-6 months	-0.008	-0.029	-0.028	-0.029	-0.034
	(0.041)	(0.042)	(0.042)	(0.042)	(0.042)
Breastfed 7-12 months	-0.083**	-0.096***	-0.083**	-0.083**	-0.081**
	(0.036)	(0.036)	(0.036)	(0.036)	(0.036)
Breastfed 13-18 months	-0.062*	-0.072**	-0.061*	-0.062*	-0.059*
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Breastfed 19-24 months	-0.142***	-0.142***	-0.123***	-0.123***	-0.111***
	(0.037)	(0.037)	(0.037)	(0.037)	(0.037)
Breastfed >24 months	-0.183***	-0.176***	-0.144***	-0.144***	-0.140***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.035)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	225360
R^2	0.119	0.135	0.155	0.155	0.181

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.21: Logit Regression of the probability to be wasted on breastfeeding duration for children older than 24 months

	(1) Wasted	(2) Wasted	(3) Wasted	(4) Wasted	(5) Wasted
main					
Breastfed 1-6 months	0.053	0.005	0.086	0.082	0.081
	(0.122)	(0.005)	(0.125)	(0.125)	(0.130)
Breastfed 7-12 months	0.204**	0.011**	0.214**	0.209**	0.168
	(0.102)	(0.005)	(0.104)	(0.105)	(0.107)
Breastfed 13-18 months	0.160	0.008*	0.161	0.159	0.138
	(0.102)	(0.004)	(0.105)	(0.105)	(0.109)
Breastfed 19-24 months	0.324***	0.014***	0.263**	0.259**	0.193*
	(0.105)	(0.005)	(0.108)	(0.108)	(0.112)
Breastfed >24 months	0.399***	0.017***	0.299***	0.295***	0.268**
	(0.098)	(0.004)	(0.102)	(0.102)	(0.105)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	211609
R^2		0.045			

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.22: Regression of the probability to be wasted on breastfeeding duration in each world region

	(1) Europe wasted	(2) Africa wasted	(3) Eastern Mediterranean wasted	(4) Americas wasted	(5) South East Asia wasted
Breastfed 1-6 months	0.027*	-0.003	0.005	0.001	-0.014
	(0.015)	(0.008)	(0.013)	(0.004)	(0.021)
Breastfed 7-12 months	0.034**	0.001	0.005	-0.000	-0.007
	(0.015)	(0.007)	(0.013)	(0.004)	(0.020)
Breastfed 13-18 months	0.033**	-0.003	0.016	-0.002	-0.011
	(0.015)	(0.007)	(0.012)	(0.004)	(0.020)
Breastfed 19-24 months	0.023	-0.001	0.019	0.005	0.016
	(0.024)	(0.007)	(0.014)	(0.005)	(0.029)
Breastfed >24 months	0.011	0.005	0.024*	0.005	0.010
	(0.018)	(0.007)	(0.012)	(0.004)	(0.019)
Region x Year FE	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes	Yes
Observations	2983	91675	28323	55433	46946
R^2	0.059	0.047	0.075	0.036	0.063

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally within world region

Table A.23: Logit Regression of the probability to be underweight on breastfeeding duration for children older than 24 months

	(1) Overweight	(2) Overweight	(3) Overweight	(4) Overweight	(5) Overweight
overweight					
Breastfed 1-6 months	-0.029	-0.052	-0.056	-0.063	-0.092
	(0.135)	(0.135)	(0.137)	(0.136)	(0.138)
Breastfed 7-12 months	-0.144	-0.146	-0.126	-0.130	-0.168
	(0.121)	(0.121)	(0.122)	(0.122)	(0.124)
Breastfed 13-18 months	-0.175	-0.175	-0.152	-0.150	-0.166
	(0.119)	(0.118)	(0.119)	(0.120)	(0.121)
Breastfed 19-24 months	-0.233*	-0.237*	-0.194	-0.189	-0.221*
	(0.126)	(0.125)	(0.126)	(0.126)	(0.128)
Breastfed >24 months	-0.285**	-0.287**	-0.229*	-0.223*	-0.246**
	(0.121)	(0.121)	(0.123)	(0.123)	(0.125)
Country x Year FE	Yes	Yes	Yes	Yes	No
Region x Year FE	No	No	No	No	Yes
Child Controls	No	Yes	Yes	Yes	Yes
Mother Controls	No	No	Yes	Yes	Yes
Household Controls.	No	No	No	Yes	Yes
Observations	225360	225360	225360	225360	222359
R^2					

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.24: Regression of the probability to be overweight on breastfeeding duration in each world region

	(1) Europe overweight	(2) Africa overweight	(3) Eastern Mediterranean overweight	(4) Americas overweight	(5) South East Asia overweight
Breastfed 1-6 months	0.008	-0.003	-0.020	-0.014	-0.006
	(0.037)	(0.017)	(0.014)	(0.010)	(0.012)
Breastfed 7-12 months	-0.002	-0.006	-0.028*	-0.022**	-0.001
	(0.035)	(0.013)	(0.015)	(0.009)	(0.012)
Breastfed 13-18 months	0.016	-0.014	-0.017	-0.018*	-0.005
	(0.035)	(0.013)	(0.014)	(0.009)	(0.011)
Breastfed 19-24 months	-0.042	-0.009	-0.036**	-0.035***	-0.001
	(0.041)	(0.013)	(0.015)	(0.010)	(0.014)
Breastfed >24 months	0.023	-0.016	-0.024	-0.025***	-0.009
	(0.045)	(0.013)	(0.015)	(0.009)	(0.011)
Region x Year FE	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes	Yes
Observations	2983	91675	28323	55433	46946
R^2	0.077	0.037	0.044	0.041	0.033

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally within world region

Table A.25: Estimation of breastfeeding duration and water quality

	(1) Underweight	(2) Stunted	(3) Wasted	(4) Overweight
Poor	-0.005	0.051	0.014	0.042
	(0.024)	(0.044)	(0.021)	(0.029)
Intermediate	-0.044***	-0.018	-0.011	0.003
	(0.015)	(0.029)	(0.011)	(0.023)
Breastfed 1-6 months	-0.004	-0.007	-0.000	-0.002
	(0.008)	(0.013)	(0.006)	(0.013)
Breastfed 7-12 months	-0.001	-0.004	0.002	-0.007
	(0.009)	(0.012)	(0.006)	(0.012)
Breastfed 13-18 months	-0.005	-0.005	0.002	-0.009
	(0.008)	(0.012)	(0.006)	(0.011)
Breastfed 19-24 months	-0.001	0.007	0.002	-0.011
	(0.010)	(0.014)	(0.006)	(0.012)
Breastfed >24 months	0.005	0.003	0.005	-0.019*
	(0.009)	(0.012)	(0.006)	(0.011)
Poor × Breastfed 1-6 months	-0.004	-0.071	-0.020	-0.036
	(0.029)	(0.051)	(0.022)	(0.034)
Poor × Breastfed 7-12 months	0.019	-0.023	-0.013	-0.044
	(0.026)	(0.045)	(0.022)	(0.030)
Poor × Breastfed 13-18 months	0.001	-0.037	-0.020	-0.043
	(0.025)	(0.045)	(0.022)	(0.030)
Poor × Breastfed 19-24 months	-0.002	-0.010	-0.012	-0.038
	(0.027)	(0.045)	(0.022)	(0.030)
Poor × Breastfed >24 months	0.028	-0.025	-0.009	-0.035
	(0.025)	(0.044)	(0.022)	(0.029)
Intermediate × Breastfed 1-6 months	0.012	-0.019	0.018	-0.011
	(0.017)	(0.031)	(0.013)	(0.024)
Intermediate × Breastfed 7-12 months	0.018	-0.004	0.019**	0.001
	(0.014)	(0.028)	(0.009)	(0.019)
Intermediate × Breastfed 13-18 months	0.019	0.004	0.019**	0.006
	(0.014)	(0.027)	(0.008)	(0.019)
Intermediate × Breastfed 19-24 months	0.026	0.010	0.022**	0.003
	(0.016)	(0.028)	(0.009)	(0.019)
Intermediate × Breastfed >24 months	0.044***	0.026	0.022***	0.017
	(0.014)	(0.027)	(0.008)	(0.019)
Region x Year FE	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes	Yes
Observations	221838	221838	221838	221838
R^2	0.190	0.206	0.072	0.054

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed & high-quality water
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.26: Regression of breastfeeding status and food categories on growth measures

	(1) WAZ	(2) WAZ	(3) LAZ	(4) LAZ	(5) WLZ	(6) WLZ
Still breastfed=1	0.324***	0.202***	0.260***	0.171**	0.228***	0.136**
	(0.053)	(0.055)	(0.069)	(0.072)	(0.066)	(0.066)
Still breastfed=1 × 7-12 monts	-0.365***	-0.224***	-0.439***	-0.341***	-0.162**	-0.056
	(0.069)	(0.073)	(0.093)	(0.095)	(0.081)	(0.083)
Still breastfed=1 × 13-18 months	-0.508***	-0.341***	-0.479***	-0.343***	-0.360***	-0.228***
	(0.059)	(0.061)	(0.080)	(0.081)	(0.072)	(0.074)
Still breastfed=1 × 19-24 months	-0.539***	-0.396***	-0.523***	-0.407***	-0.370***	-0.262***
	(0.058)	(0.060)	(0.076)	(0.080)	(0.071)	(0.072)
Still breastfed=1 × 25-30 months	-0.553***	-0.418***	-0.400***	-0.295***	-0.460***	-0.362***
	(0.069)	(0.071)	(0.087)	(0.091)	(0.082)	(0.083)
Still breastfed=1 × 31-36 months	-0.643***	-0.517***	-0.512***	-0.408***	-0.472***	-0.388***
	(0.074)	(0.076)	(0.095)	(0.097)	(0.089)	(0.090)
Region x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	Yes	Yes	Yes	Yes	Yes	Yes
Food Controls	No	Yes	No	Yes	No	Yes
Observations	188575	188576	188575	188576	188575	188576
R^2	0.265	0.269	0.233	0.237	0.162	0.164

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference groups: Children 0-6 months & weaned children
Estimation sample includes children aged 0-36 months
Sample weights were applied, all countries were weighted equally

Table A.27: Regression of growth measures on breastfeeding duration for across and within families

	(1) Underweight across	(2) Underweight within	(3) Stunted across	(4) Stunted witin	(5) Wasted across	(6) Wasted within	(7) Overweight across	(8) Overweight within
Breastfed 1-6 months	0.024	0.031	-0.011	0.026	0.010	0.014	-0.034**	0.009
	(0.016)	(0.026)	(0.024)	(0.032)	(0.010)	(0.019)	(0.014)	(0.027)
Breastfed 7-12 months	0.024	0.014	-0.005	-0.013	0.012	-0.003	-0.022*	0.014
	(0.015)	(0.025)	(0.022)	(0.031)	(0.009)	(0.019)	(0.013)	(0.026)
Breastfed 13-18 months	0.022	0.022	0.017	-0.012	0.015	0.000	-0.017	0.015
	(0.015)	(0.026)	(0.022)	(0.031)	(0.009)	(0.018)	(0.013)	(0.025)
Breastfed 19-24 months	0.037**	0.027	0.026	0.028	0.024**	0.008	-0.024*	0.011
	(0.017)	(0.028)	(0.024)	(0.035)	(0.010)	(0.020)	(0.014)	(0.026)
Breastfed >24 months	0.046***	0.028	0.014	-0.011	0.026***	0.010	-0.020	0.010
	(0.016)	(0.027)	(0.023)	(0.033)	(0.010)	(0.018)	(0.013)	(0.026)
Observations	33873	33873	33873	33873	33873	33873	33873	33873
R^2	0.231	0.042	0.217	0.100	0.113	0.025	0.072	0.021

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed
Estimation sample includes children older than 24 months
Sample weights were applied, all countries were weighted equally

Table A.28: Effect of exclusive breastfeeding

	(1) WAZ	(2) LAZ	(3) WLZ
Still bf=1	0.315***	0.259***	0.164**
	(0.055)	(0.072)	(0.074)
Still bf=1 × 4-6 months	-0.228***	-0.273***	-0.036
	(0.073)	(0.101)	(0.097)
Exclusive bf=1	0.055**	-0.009	0.057
	(0.025)	(0.037)	(0.039)
Exclusive bf=1 × 4-6 months	-0.053	-0.023	0.004
	(0.035)	(0.047)	(0.051)
Region x Year FE	Yes	Yes	Yes
Child Controls	Yes	Yes	Yes
Mother Controls	Yes	Yes	Yes
Household Controls.	Yes	Yes	Yes
Observations	69460	69460	69460
R^2	0.220	0.168	0.141

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Reference Category: Never breastfed/weaned children
Estimation sample includes children younger than 7 months
Sample weights were applied, all countries were weighted equally

Statutory Declaration / Affidavit

I hereby declare that the thesis with title

Breastfeeding in Developing Countries: Selection and Effects

has been composed by myself autonomously and that no means other than those declared were used. In every single case, I have marked parts that were taken out of published or unpublished work, either verbatim or in a paraphrased manner, as such through a quotation.

This thesis has not been handed in or published before in the same or similar form.

Zurich, 26.08.2022

Signature