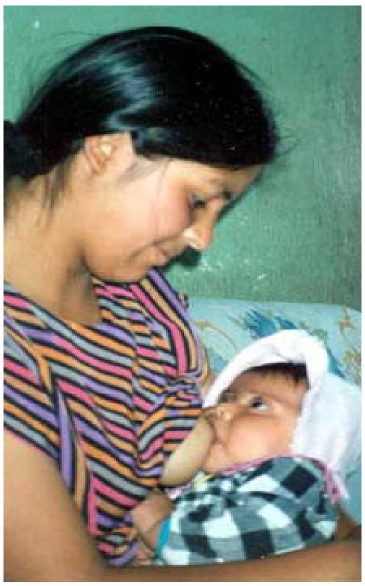
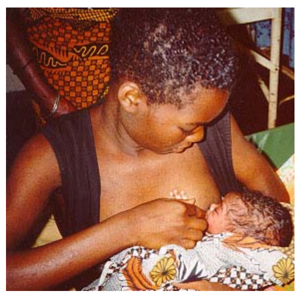
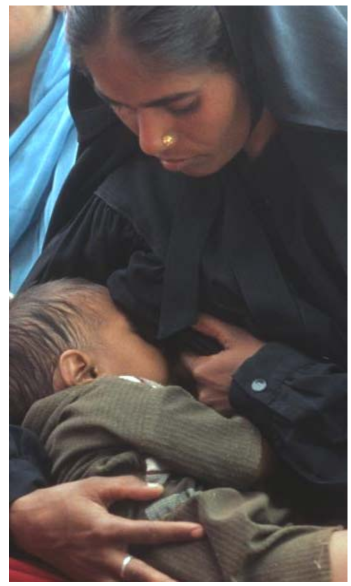
A Guide for Calculating The Benefits of Breastfeeding (BOB)



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LINKAGES
AED Academy for Educational Development
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Contents

A Guide for Calculating the Benefits of Breastfeeding (BOB)[1]

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Background

The many benefits of breastfeeding include improved infant health, increased birth spacing, and economic efficiency in the use of food and other resources. These benefits can now be estimated with some precision. Quantifying them is particularly important where the true value of breastfeeding is unappreciated and where appropriate policies and programs to promote and protect breastfeeding are either absent or poorly implemented. Policy reform efforts are more likely to succeed when the benefits of breastfeeding are expressed in terms that are important to policy makers, their supporters and stakeholders. The models and relationships described here are based on the many valuable efforts to quantify the benefits of breastfeeding that already exist (Huffman et al. 1991, Marquez et al. 1994, Piwoz et al. 1994, Jones et al. 2003).

Users enter situation-specific data on a single "Assumptions" page of a spreadsheet. On subsequent pages, these data are used in a series of mathematical models, based on the published scientific literature, that calculate the benefits of breastfeeding in terms of improved health, survival, child spacing, and the contribution of breastmilk as a food resource.

This spreadsheet model was first used in national-level advocacy in Ghana in September 1997. A French translation was developed for use in Mali in November 1997, and a Spanish version was

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developed for use in Bolivia in March 1998. The model has since been applied in over 20 countries worldwide. The procedure for using the model in all country-level applications has involved in-country technical assistance, including assistance with the development of computer-based communications materials using presentation software. In most cases, use of the benefits of breastfeeding (BOB) model was part of a larger process of nutrition policy dialogue (PROFILES) that includes a number of other similar simulation models to estimate the functional consequences of malnutrition (Burkhalter et al., 1999)[4]. The purpose of this document is to reduce the need for technical assistance by offering users detailed guidance so they can use the BOB spreadsheet independently.

Reliance on commercial spreadsheet software requires users to have the relevant software (Microsoft Excel) on their computer and to be somewhat familiar with its operation. In virtually every application of the benefits of breastfeeding model, new or revised formulas had to be developed to accommodate idiosyncratic data or to describe new relationships. For example, calculation of the cost of illness due to sub-optimal breastfeeding may require a different procedure, depending on the kind of data available on morbidity (incidence or prevalence, etc.) and on how costs are disaggregated (for outpatient treatment and hospitalization, for private and public facilities, for urban and rural patients, etc.). The current version of the spreadsheet is designed to suit the data that are most commonly available. To avoid inadvertent alteration of the structure of the spreadsheets, cells containing formulae and addresses are protected or "locked," but users can unlock these by going to the "Tools" menu and selecting "Protection" and then "Unprotect Worksheet".

The BOB spreadsheets are grouped into a single workbook containing 7 different worksheets as described in Table 1. This guide identifies the main features of each worksheet and the basis for the calculations. Although some basic formulae are offered here, the detailed mechanics of the calculations are better observed directly in the spreadsheets themselves.

[4] More information on the PROFILES process and models is available at http://www.aedprofiles.org/

Table 1. Benefits of Breastfeeding Worksheets

Page Name	Description / Purpose
1. Introduction	basic information and instructions
2. Assumptions	user inputs: demographic, morbidity, breastmilk production, costs, breastfeeding behavior, relative risks (see Appendix 1)
3. Production	total and net value of actual and potential (optimum) breastmilk production
4. Health	excess morbidity, public and private health costs due to sub-optimal breastfeeding
5. Survival	excess infant and young child mortality due to sub-optimal breastfeeding
6. Fertility	fertility reduction due to current breastfeeding, economic value of family planning program savings
7. Summary	summary of results highlighted in worksheets 3 through 6

Worksheet 1. Introduction

Worksheet 1 provides basic information on the BOB spreadsheet software and brief instructions on how to use it for users without access to this more detailed guide. A key, reproduced below, is also provided to help users distinguish five different types of cells in the workbook.

	Format	***Description***
1	(yellow, blank)	if blank, country-specific information requiring user entry and documentation of source
2	**4.2** (yellow)	if not blank, country-specific information provided with spreadsheet, not requiring user entry but should be scrutinized and changed if inaccurate (with documentation of source)
3	**4.2**	constant or coefficient derived from the literature and provided with spreadsheet (should not be changed without good reason)
4	4.2	formula or address (cannot be changed without unlocking worksheet*)
5	**4.2** (blue on green)	special case of #4, estimate with particular significance (cannot be changed without unlocking worksheet*), sometimes includes comment explaining significance

*To unlock a worksheet, go to the *Tools* menu and select *Protection* and then *Unprotect Sheet.*

Worksheet 2. Assumptions

The user is required to enter certain country-specific data only on the Assumptions Worksheet. The data on this page are of several types: demographic, morbidity, costs, breastfeeding behavior, breastmilk production, and relative risks.

Demographic data are generally available at the national level or can be derived from the UN Population Division projections (UNPD, 2004). Some assumptions have to be made about the distribution of children under five into different age groupings, based on estimates of the crude birth rate and of infant and child mortality. For convenience, some additional data in the demography section are calculated or estimated by the spreadsheet and do not require user entry. In particular, the toddler mortality rate is calculated using coefficients derived from our own regression analysis of DHS-1 mortality data from 28 countries provided by Sullivan et al. (1994). We have also calculated the proportion of infant deaths occurring before 6 months of age from DHS data for 67 countries (Ross and Burkhalter, unpublished). These proportions are provided in Appendix 2.

Morbidity data are often the most difficult to obtain. For diarrhea and acute respiratory infections, the model requires an estimate of the number of cases per infant per year, how the cases are divided between the first and second halves of infancy, and what proportion are treated in public facilities, treated in private facilities, otherwise treated (e.g., traditional healers or pharmacies), or not treated. And for each of these treatment options, an estimate of the cost to the government and to families is needed. If there are no published sources for these data, as is often the case, users should consult local experts who may either have access to such information or be able to provide informed estimates. It is important that the lack of precision and accuracy that reliance on "expert opinion" entails is taken into account when reporting results.

Cost data should be available from market studies and other sources. Although the spreadsheet is formatted for "$", any currency can be used as long as the units are consistent throughout. Information on breastfeeding behavior is often available from national demographic and health surveys (DHS) where these exist or from other national surveys. Breastmilk production data are derived from the extensive review of the literature by Hatløy and Oshaug (1997), using median production reported for each 6-month age group. Default estimates for the relative risk of morbidity are taken from the study of Brown et al. (1989) in Peru. Those for mortality are taken from Lauer et al. (2006), based on a re-analysis of data from Brazil originally reported by Victora et al. (1987).

Appendix 1 provides a full list of the data on the Assumptions Worksheet, together with further definitions, clarifications, and usual sources.

Worksheet 3. Production (Actual and Potential Breastmilk Production)

The Production Worksheet calculates the amount of breastmilk actually produced, given the prevalence of different breastfeeding behaviors among infants and children in 4 age categories (<6 months, 6-11 months, 12-23 months, 24-35 months), and the total and net value of this production. The relationship can be expressed as:

$$\text{Value} = \text{Pop} \times \text{Prev} \times \text{Vol} \times \text{Cost}$$

where Pop is the population of the relevant age group, Prev is the prevalence of breastfeeding in this group, Vol is the estimated volume of breastmilk consumed per child, and Cost is the value in U.S. dollars of a liter of breastmilk, generally estimated as the cost of commercial infant formula. The calculation is repeated for each age group and is then summed across age groups[5]. This underestimates the true value of breastmilk produced because substitutes are not as beneficial to the infant as breastfeeding.

This worksheet estimates potential production by repeating the same calculations assuming optimal breastfeeding behavior: exclusive breastfeeding to six months and partial breastfeeding thereafter to two years. The lost value due to sub-optimal breastfeeding is also calculated as the difference between the actual and potential (optimal) value.

Worksheet 4. Health

Feeding mode influences morbidity during the first year of life and beyond. The prevalence and relative risk of morbidity for exclusive breastfeeding, partial breastfeeding, and no breastfeeding, during each half of infancy are used to compute the contribution of each of these behaviors to diarrheal and acute respiratory infections (ARI). These relative risk estimates, re-calculated by Piwoz (1994) using data from Brown et al. (1989), are presented in Table 2.

The approach taken assumes availability of data on the prevalence of exclusive, partial, and no breastfeeding among infants under six months and of partial and no breastfeeding among infants six

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[5] The algorithm for the calculation uses the cost of the substitute calculated from the estimated volume and the cost for equipment, fuel, etc. estimated as a fixed cost per litre. The algorithm in the spreadsheet is therefore: ((total liters of breastmilk per day / (1– proportion of formula wasted)) * $/liter of formula) + (under 2 breastfed population * $/day for equipment) giving the estimated daily value of breastmilk in terms of the cost of feeding formula as an alternative.

Table 2. Relative risk estimates used to calculate diarrheal and acute respiratory infection morbidity attributable to sub-optimal breastfeeding (Piwoz, 1994, derived from Brown et al. 1989).

Feeding Mode	Diarrhea		Acute Respiratory Infection	
	under 6 m	6-11.9 m	under 6 m	6-11.9 m
Exclusive BF	1.00	—	1.00	—
Partial BF	1.41	1.00	1.40	1.00
No BF	2.59	1.30	2.68	1.00

to twelve months old. The model calculates the population attributable fraction[6] (PAF) of illness due to sub-optimal breastfeeding. This PAF is then used, together with the total number of cases of diarrhea and ARI in each age group, to estimate the excess number of cases that can be attributed to sub-optimal breastfeeding. Then the impact of sub-optimal breastfeeding on the health care expenditure by families and the public sector is calculated, given data on the proportion of these illnesses treated in public and private facilities and treated by other means (traditional healers, pharmacies, shops, etc.) and on the costs of such treatment to the family and the government. Public sector costs are also calculated as a proportion of the health care budget.

A limitation of the model is the use of relative risk estimates from a single study in Peru. There are two major mechanisms of protection of breastfeeding against illness: the immunological protection provided and the avoidance of food-borne pathogens afforded by the relative sterility of breastmilk. The importance of the second mechanism depends to a large extent on the level of hygiene and sanitation in the environment and the relative danger of contamination of foods and fluids given to infants. The Peruvian community where this study was carried out had no piped water, electricity, or sewerage, and fecal contamination of foods was common (Lopez de Romana et al., 1987). In environments with better hygiene and sanitation, the protective benefits of breastfeeding are likely to be lower, especially for protection against diarrheal disease. On the other hand, these estimates may

[6] The population attributable fraction (PAF), also known as the population attributable risk or the etiological fraction, is defined as the proportion of the condition (e.g., illness or death) that is attributable to the risk factor (e.g., sub-optimal breastfeeding). PAF is a function of the prevalence of the risk factor (P) and the relative risk (R) and is calculated as $PAF = (P^* (R - 1)) / (1+(P^* (R - 1)))$. Where there is more than one level of risk, this becomes $PAF = \sum(P^* (R - 1)) / (1 + \sum(P^* (R - 1)))$. These formulae are frequently used to calculate PAF in the Health and Survival Worksheets.

be considered conservative since they do not include the benefits of protection against other common illnesses, such as otitis media and skin infections, that are known to be affected by sub-optimal breastfeeding practices but are not well quantified. Nor do they include any health benefits beyond infancy.

A second problem with the Peruvian relative risk estimates is that they do not correct for potential confounding. If breastfeeding is associated with other practices that benefit (or harm) infant health, then the relative risks used here would underestimate (or overestimate) the actual impact of a change in breastfeeding practices.

Worksheet 5. Survival

Feeding mode is thought to influence survival during infancy by the same mechanisms that are thought to influence infant health. As with morbidity, each half of infancy is treated separately. For infants under six months, the effects of partial breastfeeding and no breastfeeding on diarrheal and acute respiratory infection (ARI) mortality are modeled, with the reference (optimum) behavior being exclusive breastfeeding. For infants six months and older, only the effect of no breastfeeding is estimated, compared to partial breastfeeding. Relative risk estimates used for these calculations are from a study conducted in Brazil (Victora et al., 1987), recalculated for these age categories by Lauer et al. (2006). These relative risk estimates, presented in Table 3, and breastfeeding prevalence data are used to calculate the proportion of diarrheal and ARI deaths attributable to sub-optimal breastfeeding, using the same PAF formula described for the Health Worksheet. Again, since these estimates do not include deaths due to other causes, they should be considered conservative.

Deaths from all causes attributable to not breastfeeding in the second year of life are based on a pooled analysis of data from five countries (Senegal, Pakistan, Ghana, Philippines, and Gambia) (Lauer et al., 2006) that yielded an odds ratio of 1.75. The spreadsheet calculates the number of deaths attributable to sub-optimal breastfeeding, by age category and by cause of death as well as the proportion of under-five mortality attributable to sub-optimal breastfeeding.

Worksheet 6. Fertility

The interval from one pregnancy to the next is determined by a wide variety of biological and behavioral factors. Although the effects of breastfeeding on the resumption of menses and on fertility have been extensively documented, the physiological mechanisms underlying this relationship remain a subject of speculation. Most of this speculation has focused on the role of prolactin, produced in response to suckling. It has been proposed that prolactin serves, through unknown mechanisms, to inhibit the return of postpartum ovarian function, including follicular

Table 3. Relative risk estimates used to calculate diarrheal and acute respiratory infection mortality attributable to sub-optimal breastfeeding (Lauer et al., 2006, derived from Victora et al. 1987).

Feeding Mode	Diarrhea		Acute Respiratory Infection	
	under 6 m	6-11.9 m	under 6 m	6-11.9 m
Exclusive BF	1.0	—	1.0	—
Partial BF	2.4	1.0	2.8	1.0
No BF	7.3	2.5	4.7	2.8

development and the production of gonadotrophic hormones. This inhibition is thought not just to delay the return of menses but also to reduce the likelihood that menstruation will be accompanied by ovulation and that a fertilized ovum will successfully implant in the uterus. If so, then a model that describes just the relationship between breastfeeding and the return of menses will underestimate the true relationship between breastfeeding and fecundability because it will not capture the additional delay due to anovulation or reduction in implantation rate following conception.

The purpose of this model is to quantify the links between breastfeeding and fertility. However, because this relationship is modified by a variety of interacting biological and behavioral factors, it is difficult to quantify the unique contribution of breastfeeding. Adding to the difficulty is that breastfeeding is a complex behavior with many dimensions that may be important, including the frequency, duration, and intensity of individual feeds, all of which change over time. These may, in turn, depend on the age and nutritional status of the mother, which may also influence fertility.

The observed relationship between breastfeeding and fertility (or amenorrhea) is further complicated by the possibility that fertility may influence breastfeeding behavior. In many societies, mothers may stop breastfeeding when they discover that they are pregnant, thus strengthening the relationship between breastfeeding and fertility but confusing cause and effect.

Despite these problems, a number of important efforts have been made to estimate the contribution of breastfeeding to a reduction in fertility. Bongaarts (1978) developed a quantitative framework based on observations of birth intervals and overall duration of lactation. This framework is flawed in a number of ways.[7] A physiological and mathematical model that better reflects what we know about lactational amenorrhea has been proposed by Habicht et al. (1985), who describe a conceptual model in which ovulation after delivery depends on a decrease in the level of prolactin (or another hormone) from the level at delivery to a threshold level that triggers ovulation. The rate of decline in the hormone is a function of breastfeeding practices with full, partial, and no breastfeeding distinguished in the model. Using data from the Malaysian Family Life survey in a system of simultaneous equations, the authors estimate the rate of return of ovulation associated with each breastfeeding state. Their results indicate that without breastfeeding, ovulation resumes in 1.237 months, on average. Full breastfeeding delays this resumption by 1.189 months for each month of full breastfeeding. Partial breastfeeding is associated with a rate of return to ovulation that is 0.187 of that associated with no breastfeeding. These coefficients permit a prediction of the delay in ovulation that can be attributed to different breastfeeding patterns. The standard error of estimation is "3.6 months so such predictions are not likely to be precise for individual women, but at a population level they should give unbiased estimates of the mean. Thus the time to ovulation after delivery can be expressed as:

$$T_v = \alpha + \beta t_f + \gamma t_p$$

where T_v is the time to ovulation, α is the time to ovulation if there is no breastfeeding, β is the delay associated with each month of full breastfeeding, γ is the delay associated with each month of partial breastfeeding, t_p is the number of months of partial breastfeeding, and t_f is the number of

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7 The Bongaarts (1978) framework assumes that overall lactation duration adequately captures the effect of lactation on the duration of post-partum amenorrhea (PPA) and that PPA and lactation duration are directly and linearly related over the usual range of lactation duration. We now suspect that breastfeeding reduces the ability to conceive not only through its effect on the duration of PPA but also by increasing the likelihood of anovulatory menstrual cycles and by reducing the readiness of the uterus for implantation of the fertilized ovum. It is also believed that there are factors in addition to lactation (e.g., mother's age and nutritional status) that may influence PPA and are associated with breastfeeding practices, thus confounding the simple relationship between breastfeeding and PPA. There are features of lactation besides overall duration (e.g., the frequency and intensity of the suckling stimulus) that are believed to be more important influences on the period of PPA than overall duration. Finally, in populations where the duration of lactation is typically longer than even the 16 months of PPA cited by Bongaarts (1978) as the high end of the observed range, it is not chronologically possible for longer durations to influence the return of menses since this event has in most cases already occurred.

months of full breastfeeding[8]. This formulation only works if the period of partial breastfeeding does not extend beyond the return to ovulation. For the purposes of estimating actual delays, the following formulas were therefore derived:

months of full breastfeeding before ovulation = t_f

If $t_p \geq ((t_f(1-\beta))-\alpha)/(\gamma-1)$, then ovulation occurs before partial breastfeeding stops and

months of partial breastfeeding before ovulation = $((t_f(1-\beta))-\alpha)/(\gamma-1)$, and

months of no breastfeeding before ovulation = 0.

Otherwise, if $t_p < ((t_f(1-\beta))-\alpha)/(\gamma-1)$, then ovulation occurs after partial breastfeeding stops and

months of partial breastfeeding before ovulation = t_p, and

months of no breastfeeding before ovulation = $\alpha+(t_f(\beta-1))-(t_p(\gamma-1))$.

This model has a number of problems. First, extrapolation beyond the range of breastfeeding behavior represented in the Malaysian sample is probably invalid. For example, although the results suggest that the return of menses could be delayed *for ever* by continuing full breastfeeding (because each month of full breastfeeding is estimated to result in more than a month's delay in the return of ovulation), this conclusion is unlikely to hold, being an extrapolation from much more limited durations of full breastfeeding. Second, the model implies that there is no additional advantage to partial breastfeeding beyond a certain age (depending on the duration of full breastfeeding). In fact, although ovulation may occur, on average, after a particular duration of partial lactation, longer durations may delay fertility further for some women. The model therefore cannot be used to estimate the maximum benefit of partial lactation.

Third, the model assumes a chronological sequence of full to partial to no breastfeeding. Although this pattern may prevail in many cases, for most mothers breastfeeding behavior is more complex, with reversals from partial back to full or from no breastfeeding back to partial. The model should therefore be seen as a simplification of reality. Analyses and reports of Demographic and Health Surveys and other sources of information on breastfeeding behavior also generally make the same simplifying assumptions.

Finally, the return of menses is taken as the return of full fecundability (ability to conceive). This should therefore be considered an underestimate of the effect of breastfeeding on fertility since it

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[8]Estimates for the coefficients α, β and γ are 1.237, 1.189 and 0.813, respectively (Habicht et al., 1985).

does not include additional effects on anovulatory cycles or implantation.

Although this model should be verified in other contexts, for now it provides the best theoretical and empirical basis for estimating the fertility reduction benefits of breastfeeding. The model suggests that optimal breastfeeding—six months of full breastfeeding followed by 18 months (to age 2 years) of partial breastfeeding—results in a total duration of postpartum anovulation of 18.7 months, 17.4 months longer than the period of anovulation if there were no breastfeeding.

The Fertility Worksheet uses the Habicht et al. (1985) model and coefficients to estimate the delay in fertility afforded by breastfeeding and the value of this delay, measured in terms of the cost of family planning programs that would be needed to achieve the same child spacing benefit. This calculation requires the user to specify the cost per couple year of protection[9], preferably based on the current mix of modern contraceptive methods used in the country.

Worksheet 7. Summary

The Summary Worksheet presents all the highlighted results from the previous four worksheets, as follows:

Production

Value of ***actual*** breastmilk production to 3 years ($million/y)
Value of ***actual*** breastmilk production to 2 years ($million/y)
Value of ***potential*** breastmilk production to 2 years ($million/y)
Value of ***lost*** breastmilk production to 2 years ($million/y)

Health

Potential savings to ***families*** on costs of health care ($million/y)
Potential savings to ***government*** on costs of health care ($million/y)
Potential ***total*** savings on costs of health care ($million/y)
Government (public) costs as % of health budget

Survival

Child deaths attributable to sub-optimal breastfeeding
Deaths due to sub-optimal breastfeeding as % of child deaths

Fertility

Delay due to breastfeeding (months)
Value of fertility reduction ($million/y)

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[9] A "couple year of protection" (CYP) is the unit used in the evaluation of family planning services. It can be defined as the modern family planning services required to protect a couple against conception for one year. The value of a CYP for the BOB spreadsheet should be the weighted average total cost (including any subsidies) of providing the current mix of modern family planning methods.

Use and Interpretation

The estimates derived from these models are often based on imprecise estimates of the prevalence of a behavior, its functional impact, or its economic benefit. Sensitivity analysis using a plausible range of assumptions will sometimes help to establish boundaries for the estimates. Sensitivity analysis is most useful when an estimate or coefficient is in dispute or to test the implications of achieving different policy objectives. Although many of the models can be used for policy analysis, the data and assumptions should be carefully scrutinized when used as a tool in decision-making or when precise estimates are important. The strongest role for estimates of this nature may be in advocacy and policy reform. Although these calculations should be based on the best information available, minor deficiencies in this information should not prevent their use for advocacy. It is the order of magnitude of these estimates, rather than their precision, that is most important. In the meantime we should work to improve both the quality of data available and the scientific strength of the models used.

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Appendix 1: List of Data Inputs Required with Notes, Clarifications, and Usual Sources

The following tables provide further definition and clarification of the variables on the "Assumptions" worksheet. Some of these variables are calculated by the worksheet and do not require user entry. Some country-specific values may be provided with the spreadsheet, but these should be scrutinized carefully and replaced if more accurate local information is available. The breastmilk production estimates and relative risks are derived from the international scientific literature and should not be changed without good reason.

1. Demographic

Most demographic data are available from national statistics offices and other sources. Variables asterisked in the table below may be provided with the spreadsheets but should be scrutinized and replaced if inconsistent with accepted national estimates.

Variable	Notes & Clarifications	Usual Source
Births this year*	Number of births in the current year	UN or national statistics
Births in previous year*	Number of births in the previous year	UN or national statistics
Infant mortality rate (IMR) (deaths/1000 live births)	Self explanatory	UN or national statistics
Under five mortality rate (U5MR) (deaths/1000 live births)	Self explanatory	UN or national statistics
Child mortality rate (CMR) (deaths to 5 years, per 1000 survivors to age 1 year)*	Not commonly reported	Calculated from IMR and U5MR
Toddler mortality rate (deaths to 2 years, per 1000 survivors to age 1 year)*	Not commonly reported	Calculated using regression coefficients derived from analysis of 28 DHS data sets
Population under 1*	Self explanatory	UN or national statistics
Proportion of under 1's 0-<6 months*	A function of the distribution of mortality during infancy	Default: 0.508, a global average
Population under 6 months*	Self explanatory	calculated
Population 6-<12 months*	Self explanatory	calculated
Population 12-<24 months*	Self explanatory	UN or national statistics
Infant deaths*	Number of infant (<12 months) deaths this year	Calculated from births and IMR
Child deaths*	Number of child (< 5 years) deaths this year	Calculated from births and CMR
Proportion of infant deaths <6 months*	Proportion of infant deaths occurring before 6 months of age	Appendix 1 provides regional averages, derived from analysis of 67 DHS data sets
Second year deaths*	Number of deaths among children 12-23 months old	Calculated from the number of births in the previous year and the infant and toddler mortality rates

2. Morbidity

2A. Diarrhea

Variable	Notes & Clarifications	Usual Source
Proportion of under-five (U5) deaths due to diarrhea	Proportion of all deaths under five years due to diarrhea	WHO or national health statistics
Proportion of U5 diarrhea deaths <6 months	Proportion of all diarrhea deaths under five years that occur among infants < 6 months old	Global estimate: 0.36 (WHO)
Proportion of U5 diarrhea deaths 6-<12 months	Proportion of all diarrhea deaths under five years that occur among infants 6 to 12 months old	Global estimate: 0.14 (WHO)
Diarrhea cases/infant/year	Number of cases of diarrhea per infant per year	Local health statisticians or planners
Proportion of infant diarrhea cases <6 months	Proportion of infant diarrhea cases that occur among infants < 6 months old	Local health statisticians or planners
Proportion of infant diarrhea cases treated in public facilities	Proportion of infant diarrhea cases treated in the public (government) health system†	Local health statisticians or planners
Proportion of infant diarrhea cases treated in private facilities	Proportion of infant diarrhea cases treated by private practitioners†	Local health statisticians or planners
Proportion of infant diarrhea cases treated by other means (shop, traditional...)	Proportion of infant diarrhea cases treated by other means such as by traditional healers or using over-the-counter medicines†	Local health statisticians or planners
Proportion of infant diarrhea cases non-treated	Proportion of infant diarrhea cases not treated†	Local health statisticians or planners
Cost to government of a diarrhea-related clinic attendance (public facility)	Government's full cost of treating a case of diarrhea	Local health economists or health planners
Cost to family of a diarrhea-related clinic attendance (public facility)	Family's full cost of treating a case of diarrhea in the public health system	Local health economists or health planners
Cost of a diarrhea-related clinic attendance by a private facility	Family's full cost of treating a case of diarrhea by a private practitioner	Local health economists or health planners
Cost of other (shop, traditional, etc.) treatment of diarrhea	Average cost of treating a case of diarrhea by other means, considering the average "mix" of alternative treatments	Local health economists or health planners

†Unlike other proportions in this spreadsheet, these treatment categories need not sum to one because an episode of illness may be treated in more than one way.

2B. Acute Respiratory Infections (ARI)

Variable	**Notes & Clarifications**	**Usual Source**
Proportion of under-five (U5) deaths due to ARI	Proportion of all deaths under five years due to ARI	WHO or national health statistics
Proportion of U5 ARI deaths <6 months	Proportion of all ARI deaths under five years that occur among infants < 6 months old	Global estimate: 0.58 (WHO)
Proportion of U5 ARI deaths 6-<12 months	Proportion of all ARI deaths under five years that occur among infants 6 to 12 months old	Global estimate: 0.17 (WHO)
ARI cases/infant/year	Number of cases of ARI per infant per year	Local health statisticians or planners
Proportion of infant ARI cases <6 months	Proportion of infant ARI cases that occur among infants < 6 months old	Local health statisticians or planners
Proportion of infant ARI cases treated in public facilities	Proportion of infant ARI cases treated in the public (government) health system†	Local health statisticians or planners
Proportion of infant ARI cases treated in private facilities	Proportion of infant ARI cases treated by private practitioners†	Local health statisticians or planners
Proportion of infant ARI cases treated by other means (shop, traditional...)	Proportion of infant ARI cases treated by other means such as by traditional healers or using over-the-counter medicines†	Local health statisticians or planners
Proportion of infant ARI cases non-treated	Proportion of infant ARI cases not treated†	Local health statisticians or planners
Cost to government of a ARI-related clinic attendance (public facility)	Government's full cost of treating a case of ARI	Local health economists or health planners
Cost to family of a ARI-related clinic attendance (public facility)	Family's full cost of treating a case of ARI in the public health system	Local health economists or health planners
Cost of a ARI-related clinic attendance by a private facility	Family's full cost of treating a case of ARI by a private practitioner	Local health economists or health planners
Cost of other (shop, traditional, etc.) treatment of ARI	Average cost of treating a case of ARI by other means, considering the average "mix" of alternative treatments	Local health economists or health planners

†Unlike other proportions in this spreadsheet, these treatment categories need not sum to one because an episode of illness may be treated in more than one way.

3. Costs

Although the spreadsheet is formatted for “$”, costs can be provided in any currency.

Variable	Notes & Clarifications	Usual Source
substitutes: artificial formula ($/liter)	Cost per liter of commercial artificial formula, usually tinned powder	Local market surveys (check mixing instructions to calculate cost per liter of mixed formula)
equipment, fuel, soap ($/day)	Average daily total additional cost of using formula, may include transport	Local experts, mothers
dietary energy required to support lactation (kcal/liter)	Additional maternal energy intake needed for physiological support of lactation	Use 640 (NAS estimate of 500 kcal for 0.78L)
cost per 2250 kilocalories (adult equiv.) of balanced diet ($)	Cost of providing an “adult equivalent” daily requirement as a balanced diet	Local market surveys or national “food basket” survey
cost of mother's food to support lactation ($/liter)	Cost of additional food required by the mother to produce a liter of breastmilk	Calculated from $/adult equivalent and Kcal/L
proportion of substitutes wasted	Proportion of commercial infant formula that is mixed but not fed and must be discarded	Use 0.1 (informed guess)
modern contraceptive cost ($/CYP)	Cost per “couple year of protection” using the average current mix of modern family planning methods	Local family planning experts or health economists
total health sector budget ($ million)	Total government allocation for health care	Government accounts, Ministry of Health

4. Breastfeeding Prevalences

Breastfeeding prevalences are typically taken from relevant national surveys such as Macro International's Demographic and Health Surveys (DHS) (see http://www.statcompiler.com/statcompiler/) or UNICEF's Multiple Indicator Cluster Surveys (MICS) (see http://www.childinfo.org/).

Variable	Notes & Clarifications	Usual Source
exclusive breastfeeding 0-5.9 months	Proportion of infants under 6 months of age who consumed only breastmilk in the previous 24 hours	DHS, MICS or other national survey
partial breastfeeding 0-5.9 months	Proportion of infants under 6 months of age who consumed breastmilk and any other food or fluid in the previous 24 hours	DHS, MICS or other national survey
no breastfeeding 0-5.9 months	Proportion of infants under 6 months of age who were not breastfed in the previous 24 hours	DHS, MICS or other national survey or Calculated (1 minus exclusive + partial)
exclusive breastfeeding 6-11 months	Proportion of infants 6 to <12 months of age who consumed only breastmilk in the previous 24 hours	DHS, MICS or other national survey
partial breastfeeding 6-11 months	Proportion of infants 6 to <12 months of age who consumed breastmilk and any other food or fluid in the previous 24 hours	DHS, MICS or other national survey
no breastfeeding 6-11 months	Proportion of infants 6 to <12 months of age who were not breastfed in the previous 24 hours	DHS, MICS or other national survey
partial breastfeeding 12-23 months	Proportion of infants 12 to <23 months of age who consumed breastmilk and any other food or fluid in the previous 24 hours	DHS, MICS or other national survey
partial breastfeeding 24-35 months	Proportion of infants 24 to <36 months of age who consumed breastmilk and any other food or fluid in the previous 24 hours	DHS, MICS or other national survey
duration of exclusive breastfeeding (months)	Median duration of exclusive breastfeeding	DHS, MICS or other national survey
duration of full breastfeeding (months)	Median duration of full breastfeeding	DHS, MICS or other national survey
duration of lactation (months)	Median duration of any breastfeeding	DHS, MICS or other national survey

5. Breastmilk Production

The default values for breastmilk production provided are all taken from Hatløy and Oshaug (1997).

Variable	Notes & Clarifications	Usual Source
breastmilk production, exclusive, 0-5.9 months (l/d)	Average quantity of breastmilk produced by exclusively breastfeeding a 0-5.9 month old infant	Default: 0.750 (Hatløy and Oshaug, 1977)
breastmilk production, partial, 0-5.9 months (l/d)	Average quantity of breastmilk produced by partially breastfeeding a 0-5.9 month old infant	Default: 0.510 (Hatløy and Oshaug, 1977)
breastmilk production, partial, 6-11.9 months (l/d)	Average quantity of breastmilk produced by partially breastfeeding a 6-11.9 month old infant	Default: 0.510 (Hatløy and Oshaug, 1977)
breastmilk production, partial, 12-23 months (l/d)	Average quantity of breastmilk produced by partially breastfeeding a 12-23.9 month old infant	Default: 0.380 (Hatløy and Oshaug, 1977)
breastmilk production, partial, 24-35 months (l/d)	Average quantity of breastmilk produced by partially breastfeeding a 24-35.9 month old infant	Default: 0.250 (Hatløy and Oshaug, 1977)

6. Relative Risks (RR)

Variable	Notes & Clarifications	Usual Source
RR diarrhea mortality partial BF vs exclusive BF (0-5 mo)	Relative risk of diarrheal death among partially breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 2.4 (Lauer et al., 2006)
RR diarrhea mortality no BF vs exclusive BF (0-5 mo)	Relative risk of diarrheal death among non-breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 7.3 (Lauer et al., 2006)
RR diarrhea mortality no BF vs partial BF (6-11 mo)	Relative risk of diarrheal death among non-breastfed infants in comparison with exclusively breastfed infants 6-11.9 months	Default: 2.5 (Lauer et al., 2006)
RR diarrhea morbidity partial BF vs exclusive BF (0-5 mo)	Relative risk of diarrhea among partially breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 1.41 (Brown et al., 1989)
RR diarrhea morbidity no BF vs exclusive BF (0-5 mo)	Relative risk of diarrhea among non-breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 2.59 (Brown et al., 1989)
RR diarrhea morbidity no BF vs partial BF (6-11 mo)	Relative risk of diarrhea among non-breastfed infants in comparison with exclusively breastfed infants 6-11.9 months	Default: 1.3 (Brown et al., 1989)
RR ARI mortality partial BF vs exclusive BF (0-5 mo)	Relative risk of ARI death among partially breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 2.8 (Lauer et al., 2006)
RR ARI mortality no BF vs exclusive BF (0-5 mo)	Relative risk of ARI death among non-breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 4.7 (Lauer et al., 2006)
RR ARI mortality no BF vs partial BF (6-11 mo)	Relative risk of ARI death among non-breastfed infants in comparison with exclusively breastfed infants 6-11.9 months	Default: 2.8 (Lauer et al., 2006)
RR ARI morbidity partial BF vs exclusive BF (0-5 mo)	Relative risk of ARI among partially breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 1.4 (Brown et al., 1989)
RR ARI morbidity no BF vs exclusive BF (0-5 mo)	Relative risk of ARI among non-breastfed infants in comparison with exclusively breastfed infants 0-5.9 months	Default: 2.68 (Brown et al., 1989)
RR ARI morbidity no BF vs partial BF (6-11 mo)	Relative risk of ARI among non-breastfed infants in comparison with exclusively breastfed infants 6-11.9 months	Default: 1 (Brown et al., 1989)

RR all-cause mortality no BF vs partial BF (12-23 mo)	Relative risk of death among non-breastfed infants in comparison with exclusively breastfed infants 12-23.9 months	Default: 1.75 (Lauer et al., 2006)

Appendix 2: Default Regional Values for the Proportion of Infant Deaths Occurring before Six Months of Age

Region	Proportion of Infant Deaths <6 months
Central Asia	0.8087
Latin America and the Carribean	0.8322
North Africa and Western Asia	0.8440
Sub-Saharan Africa	0.7881
South and South-east Asia	0.8816
World	0.8443