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# “Lost Milk?” Counting the Economic Value of Breast Milk in Gross Domestic Product

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## Abstract

**Background:** The contribution of breastfeeding and mothers milk to the economy is invisible in economic statistics.

**Objective:** This article demonstrates how the economic value of human milk production can be included in economic statistics such as gross domestic product (GDP) and provides estimates for Australia, the United States, and Norway.

**Methods:** The contribution of human milk and lactation to GDP in these countries is estimated using United Nations (System of National Accounting) guidelines and conventional economic valuation approaches to measuring production in GDP.

**Results:** In Australia, current human milk production levels exceed \$3 billion annually. The United States has the potential to produce human milk worth more than US\$110 billion a year, but currently nearly two thirds of this value is lost due to premature weaning. In Norway, production valued at US\$907 million annually is 60% of its potential value.

**Conclusions:** The potential loss of economic value from not protecting women’s lactation and milk production from competing market pressures is large. Failure to account for mothers’ milk production in GDP and other economic data has important consequences for public policy. The invisibility of human milk reduces the perceived importance of programs and regulations that protect and support women to breastfeed. The value of human milk can be measured using accepted international guidelines for calculating national income and production. It is quantitatively nontrivial and should be counted in GDP.

## Keywords

Australia, breastfeeding, breastfeeding benefits, cost–benefit analysis, cost savings, government policy, milk banking, Norway, United States

## Well Established

*The economic value of breastfeeding includes avoiding health costs of formula feeding. International guidelines for compiling economic statistics like gross domestic product (GDP) now include unmarketed household production of goods, such as human milk. Excluding breast milk production from GDP reduces its visibility to policy makers.*

## Newly Expressed

*Markets in human milk make comprehensive economic valuation easier. Human milk production in Australia, the United States, and Norway has substantial economic value. Premature weaning of infants and toddlers results in substantial loss of potential economic benefit in these countries.*

## Background

Several studies have highlighted the health system costs of premature weaning of infants and young children from breastfeeding.<sup>1–3</sup> A 2002 study in Australia found the attributable health system cost of premature weaning to be over

A\$100 million annually for just 4 acute conditions.<sup>1</sup> The cost of pediatric health care and premature death attributable to formula feeding of infants in the United States was recently estimated to be at least US\$13 billion a year.<sup>2</sup> Moderate increases in breastfeeding were recently shown to produce potential annual savings to the United Kingdom’s National Health Service (NHS) of around £40 million per year including reductions in the costs of maternal breast cancer.<sup>3</sup>

While the health system costs have been evident for at least a decade, the value of breastfeeding is rarely placed in the context of the broader economy. Several studies, mainly in developing countries, have measured the national value of breastfeeding or human milk produced,<sup>4–11</sup> but the economic

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contribution of breastfeeding and mother's milk is invisible to policy makers in economic production statistics such as gross domestic product (GDP).

Measures of economic activity such as GDP are widely used by policy decision makers and managers, and for advocacy by industry. However, GDP is a partial and distorted measure of the economy, as it excludes the substantial, non-marketed production of goods and services by households.<sup>12-16</sup> In 2009, the French Presidential Commission on the Measurement of Economic Performance and Social Progress (S-S-F Commission), led by 2 Nobel Prize winners in economics, Joseph Stiglitz and Amartya Sen, warned of serious bias and distortion of the economy away from what is most valuable if economic statistics failed to note shifts from home production to market production. Human milk was cited as an example of the problem:

There is a serious omission in the valuation of home-produced goods—the value of breast milk. This is clearly within the System of National Accounts production boundary, is quantitatively non-trivial and also has important implications for public policy and child and maternal health.<sup>13</sup>

### *The United Nations System of National Accounts and National Accounting Treatment of Goods*

Substantially revised United Nations (UN) guidelines for compiling estimates of economic activity and growth (GDP) were published in 1993.<sup>17</sup> These guidelines, known as the United Nations System of National Accounts or SNA93, continued to exclude the economic value of unpaid services by households from GDP, so that the time that women spend caring for children remains outside of GDP. However, the new guidelines included a new GDP category for production of goods by households. For the first time in the postwar history of GDP measurement, subsistence production in agriculture and other goods produced by households for their own consumption were to be counted as part of the economy. As Ironmonger and Soupourmas<sup>18</sup> pointed out, the changes meant that “growing rice and chickens for use within the household is regarded as production of goods to be included in System of National Accounts (SNA) production even if not for sale.” Official imputations are now routinely made under UN guidelines such as for nonmarketed agricultural production and goods produced by households for their own consumption.<sup>19</sup>

To include a good in GDP, it must be able to be traded in a market, so that it can be valued in monetary terms using a market price. National accounting principles are that production should be valued at market prices, as reflected in market transactions. In the absence of market transactions, valuation is made by reference to market prices for analogous goods or services or, if that is not feasible, according to the costs incurred in their production.<sup>20</sup>

The example of Australia shows how these guidelines have been applied in practice. Since 1997-1998, Australia's GDP has included farm production consumed on the farm, such as eggs, meat, and milk used by farm families. It also includes an estimate of the value of “backyard production” such as homegrown vegetables consumed by households.<sup>20,21</sup> Such production was included because it was believed to be quantitatively important in relation to the total supply of those goods in the country.<sup>19</sup> In 1997, this production was just over A\$1 billion in value.<sup>19</sup> The Australian Bureau of Statistics has explained making such indirect estimates on the basis that (a) a reasonably satisfactory basis for valuing the transaction is available and (b) exclusion could result in distortions to the national accounting figures.<sup>20</sup>

Despite the above changes to the UN guidelines and to national accounting practice, human milk production is still not currently measured in GDP in any country, although Norway routinely enumerates human milk production in with its national food statistics.<sup>22</sup> Even human milk that is expressed or pumped from the breast to be sold (or donated) for feeding to babies by nurses, child care workers, or orphanage staff is not currently counted as production in GDP.

Breastfeeding cannot be reduced to its economic aspects. Breastfeeding is a complex physiological, emotional, and social relationship between mother and child, which is in turn intricately related to the mother's family and the community or society she lives in. Nevertheless, estimating the economic value of breastfeeding is important to (a) emphasize the extent of breastfeeding and its value, (b) acknowledge 1 of women's unique contributions to society, (c) highlight its importance to economic welfare, and (d) contribute to more accurate public policy analysis and more soundly based economic and health policies.<sup>10</sup>

Breastfeeding is vulnerable to market pressures, as its costs and benefits lie across both public and private spheres and there is no profit incentive to protect it.<sup>23</sup> Placing an economic value on breast milk production helps raise awareness of the cost of losing it and illustrates the need for public policy measures to protect and support breastfeeding.

With growing international interest in reforming GDP to measure economic activity more accurately, this article aims to demonstrate that human milk production can be satisfactorily valued in GDP and that its value is large enough to impact economic statistics and public policy making. In the following section, we present estimates of the economic value of human milk in Australia, the United States, and Norway, estimated in accordance with conventional national accounting methods.

## **Methods**

Breastfeeding produces both a good and a service. In economic terms, the physiological process of lactation produces a good, and the act of nursing an infant provides a service.

In this article, the focus is on valuing human milk production as a good. Our attention is on breast milk as a food commodity that falls within the UN SNA definition of economic activity and that should therefore be measured and valued as part of GDP.

Calculating the economic value added by breastfeeding requires, in principle, subtracting its costs of production, including any additional time the mother must be available to maintain milk production and breastfeeding. However, although SNA93 guidelines allow for including the value of nonmarketed human milk in GDP, they exclude from GDP the time costs of producing it. Unpaid household services are to be included in “satellite accounts,” which are outside core GDP. The time costs of producing human milk are therefore not included in the present study as it estimates the value of human milk within a national accounting framework.

### *Estimates of the Economic Value of Human Milk Production*

The main variables in estimating human milk production are the number of infants of the relevant age, breastfeeding prevalence, estimated daily volumes of breast milk production, cost of food inputs to human milk production, and the value or “price” of human milk.

### *Number of Infants*

The first data requirement was for the number of infants and young children (ages 0-2 years) alive during the estimation period/year. The estimated number of births in selected countries in 2010 came from the UNICEF State of the World’s Children database.<sup>24</sup> The number of children born in a given year was taken to also be the number of children born the following year, that is, the same birth rate is assumed for each year. No adjustment was made for infant or young child mortality during the year, consistent with previous studies.<sup>25</sup>

### *Prevalence of Breastfeeding*

In this study, breastfeeding prevalence around 2006-2010 was based on official data collections on infant and young child feeding and nutrition.<sup>22,26-29</sup> Where data were not available for every month to age 2, monthly breastfeeding prevalence was estimated through graphical interpolation of available data points. Because data on exclusive and partial breastfeeding are not consistently available by month of age, we used data on the prevalence of any breastfeeding.

Estimates of human milk production at biologically feasible potential output (BFPO) levels were also made. These estimates assumed 95% prevalence of breastfeeding from 0 to 2 years; according to the World Health Organization (WHO), around 95% to 98% of women are physiologically capable of breastfeeding.<sup>30</sup> Human milk production at BFPO

**Table 1.** Daily Milk Intake of Breastfed Infants<sup>a</sup>: World Health Organization Estimates<sup>31</sup>

Age, mo	Average per Infant per Day, g			
	Developed Countries		Developing Countries	
	Exclusively Breastfed	Partially Breastfed	Exclusively Breastfed	Partially Breastfed
1	699	611	562	568
2	731	697	634	636
3	751	730	582	574
4	780	704	768	634
5	796	710	778	714
6	854	612	804	611
7	867	569	740	688
8	815	417	691	635
9	890	497	NA	516
10	NA	691	NA	NA
11	910	516	NA	565
12	NA	497	NA	511

Abbreviation: NA, not available.

<sup>a</sup>Estimates from meta-analysis, mean values, weighted for sample size.

levels assumed exclusive breastfeeding until 6 months of age, with continued breastfeeding for up to 2 years of age.

### *Average Daily Production of Human Milk*

Previous studies used varying assumptions about daily production levels.<sup>4-11</sup> The most recent estimates by WHO<sup>31</sup> for developed countries range from 699 to 910 grams daily for exclusive breastfeeding and from 569 to 730 grams daily for partial breastfeeding (Table 1). To facilitate comparison with current official estimates of human milk intakes in Norway and with other studies in developed country settings, this study used the more conservative milk intake assumptions that were used to compile 2011 official estimates of mother’s milk consumption in Norway.<sup>22</sup>

### *Additional Food Costs of Lactation*

In principle, for consistency with the economic framework used to measure GDP, the value-added of human milk production should have offset against it the input cost of additional food needed to produce it on a sustainable basis, that is, without depleting the lactating mother.

Several previous studies have found that these costs are insubstantial.<sup>4,8,32,33</sup> Lactation induces changes in metabolism and activity levels, which partly offset the additional energy intake needs of the mother. Assuming an additional energy intake of 1260 to 1280 kJ/d (300-400 kcal/d),<sup>34,35</sup> and based on local food costs,<sup>36</sup> the estimated food expenditures for lactating women in Australia in 1992 were A\$101 for the first year and \$73 for the second year. This amounted to

A\$15 million a year in aggregate, less than 1% of the estimated national value of human milk output.<sup>11</sup>

Official data collections on food consumption expenditures of households do not gather specific information on food costs of lactating mothers. Dietary needs and recommendations for lactating mothers may also vary considerably. Incorporating the monetary cost of additional food intake into country estimates would add complexity and potential inconsistency without adding to the accuracy of the overall estimates. The additional food costs of lactation are therefore assumed to be of insignificant magnitude and are not included in these estimates.

### Valuing Human Milk Production

This study applies an innovative economic approach and national accounting method to valuing breast milk. In calculating GDP, economists value production at market prices, as reflected in market transactions, even if some production is not sold. Where markets exist, the preferred national accounting approach is to use the market price of an analogous product or, if a market price is not available, to infer its value by measuring the cost of inputs to its production.<sup>37-39</sup>

Earlier economic studies of breastfeeding commonly view the value of breastfeeding as the avoided food and/or health treatment costs of formula feeding.<sup>1-5,7,8,40,41,43</sup> Using the price of formula as a proxy for the food value of breastfeeding, these studies implicitly take formula milk as the relevant benchmark for valuing mothers' milk. In practice, the avoided morbidity or mortality costs of formula feeding could rarely be included in these developing country estimates,<sup>8</sup> though there are now estimates of the health costs of formula feeding for some developed countries.<sup>1-3</sup>

Here, the approach used in recent studies in developed countries<sup>10,11,25,38,39</sup> is followed. This values human milk as part of the national food system or GDP and uses the price of milk in milk banks to measure the value of human milk in its own right as a food/medicine.<sup>42</sup> A 1998 study in sub-Saharan Africa<sup>43</sup> also used this approach. This is consistent with WHO guidelines, which indicate that where a mother cannot breastfeed, expressed breast milk or another mother's milk (expressed or by wet nursing), not formula, are the next best alternatives.<sup>44,45</sup>

In principle, the same results should be obtained regardless of whether breastfeeding is valued as the cost of replacing it with formula or with expressed breast milk. However, obtaining comprehensive estimates of the societal and individual health costs of formula feeding is impractical.<sup>10</sup> Using the market price of expressed breast milk implicitly incorporates its value for health and so avoids the need to separately identify and estimate the health costs of formula feeding.

Several markets exist for human milk, and a range of market prices for expressed breast milk was considered. Hospitals and milk banks exchange and sell donated breast

milk in many countries, with more than 300 milk banks worldwide in 2009.<sup>46</sup> Corporations now acquire and sell human milk-based products to hospitals.<sup>47</sup> Human milk is also exchanged via the Internet and through employment of wet nurses.<sup>48</sup>

For several reasons, this study valued human milk production at the price of expressed human milk sold by North American milk banks. The high price of commercial human milk products is unsuitable as it reflects a highly specialized medical market, while using a formula price is arbitrarily low. Available data on the cost of hiring a wet nurse are ad hoc. Milk banks on the other hand are the largest, most established, institutionally organized market in human milk. Their prices are better documented and closely reflect prices in transactions. Milk supplied by milk banks also most closely approximates mothers' own milk, having controls on quality. North American milk bank prices were most relevant to the United States, and as medical facilities and professionals are the main customers, the milk bank price may best reflect an informed consumer's "willingness to pay." Health services' valuations of human milk may also incorporate a societal perspective on health cost savings.

## Results

### Births and Breastfeeding Rates

The number of infants born in Australia in 2010 was 303 000. In the United States, the reported number of births in 2010 was 4 301 000.<sup>24</sup> Estimates for Norway are based on official estimates of human milk production, which assume 58 545 births, for 2010 (compared to 60 000 reported in UNICEF data).<sup>22</sup>

Table 2 shows breastfeeding rates in the 3 countries. In Australia, the 2010 Infant Feeding Study found that 90% were ever breastfed, and 60% were breastfeeding at 6 months<sup>27,28</sup>; at least 23% breastfed to 12 months.<sup>27,29</sup> The Centers for Disease Control in the United States<sup>26</sup> estimated that in 2009, 77% of infants were ever breastfed, with around 47% breastfed at 6 months, 26% at 12 months, and 9% at 18 months (Table 2). In Norway, breastfeeding initiation is near universal, with 80% of mothers breastfeeding at 6 months, and 46% at 12 months.<sup>22</sup> However, this falls away rapidly to 4% by 2 years.<sup>49</sup>

Daily milk intake assumptions for each month are presented in Table 3. For example, at 6 months, intake is 700 mL per day, at 12 months, 400 mL per day, and at 24 months, 200 mL per day.

Estimates of the quantities of human milk produced annually in Australia, the United States, and Norway are presented in Table 4. Production ranges from around 11 million liters per year in Norway, a small industrialized country with relatively high breastfeeding prevalence, to the United States, where production was around 526 million liters per year. Australian mothers produced around 42 million liters per

**Table 2.** Breastfeeding Prevalence, Selected Countries<sup>22,26,27,65,66</sup>

Age, mo	Australia, %	United States, %	Norway, %
Initiating/any	90	77	99
1	75	72	95
2	73	67	91
3	70	61	88
4	69	54	85
5	63	50	82
6	60	47	80
7	54	47	75
8	48	42	69
9	42	34	63
10	36	34	56
11	30	29	48
12	23	26	46
13	22	22	25
14	20	20	19
15	20	20	15
16	18	18	13
17	14	14	11
18	9	9	8
19	8	8	7
20	8	8	6
21	7	7	5
22	6	6	5
23	6	6	4
24	5	5	4

**Table 3.** Daily Milk Intake of Breastfed Infants: Norwegian Estimates

Age, mo	Average per Infant per Day, mL <sup>25</sup>	Average per Infant per Day, mL <sup>22</sup>
1	600	700
2	700	700
3	800	800
4	800	700
5	700	700
6	700	700
7	700	600
8	600	600
9	600	600
10	500	500
11	500	500
12	400	400
13	300	300
14	300	300
15	300	300
16	300	200
17	300	200
18	300	200
19	300	200
20	300	200
21	300	200
22	300	200
23	300	200
24	300	200

year. Our results for Norway align with official estimates that 10.5 million liters of mothers' milk were produced in 2011.<sup>22</sup>

### Market Prices for Human Milk

Table 5 presents relevant available information on economic characteristics of various markets in human milk. These include milk banks, Internet trading, commercial infant feeding products, and women's employment as wet nurses.

In recent years, milk banks in the United States have sold human milk at a price of around US\$3 per ounce (US\$85 per gram) or more, and this is the price used to value human milk production in this study.<sup>50</sup> In Norway in 2009, it was being sold for €130 (US\$100) per liter, after covering a payment of US\$20 for donor expenses.<sup>51</sup> Human milk sold on Internet milk trading sites such as Only the Breast also typically commands a price of US\$3 per ounce for mothers with health certification.<sup>52</sup> Human milk-based commercial infant feeding products in the United States are sold at US\$1183 per liter or more.<sup>54</sup>

### Actual and Biologically Feasible Potential Levels of Human Milk Production, 2010

The estimated value of human milk production in 2010 ranged from just under US\$1 billion in Norway to US\$45 billion in the United States, and \$3.6 billion in Australia (Table 4).

Breastfeeding prevalence in these countries is well below its biologically feasible potential. Table 4 compares potential BFPO production in 2010 with actual production for these countries. Around 60% of potential human milk production in the United States and Australia is lost due to premature weaning from breastfeeding. This is a loss of economic value of around US\$63 billion every year in the United States and over \$4 billion in Australia. The comparable figure for Norway is a loss of 40% of value, US\$598 million, which is mainly due to the high rates of complete weaning between 12 and 24 months.

### Discussion

The contribution of this article is to produce illustrative estimates of the economic value of actual and potential human milk production in 3 industrialized countries, using economic and national accounting approaches and direct valuation methods. It shows that national production of human milk is quantitatively important and of significant economic value in the 3 countries examined. Based on OECD national accounts data, the value of human milk production equals 5% to 7% of food consumption in these countries, and it would be 7% to 16% at BFPO levels.<sup>55</sup>

Even if valued at US\$1 per liter, the US value of human milk output exceeds US\$500 million per year. At the

**Table 4.** Annual Production of Human Milk for Infants, 0-24 Months, 2009-2010

Country	Actual Human Milk Production Volume, <sup>a</sup> million L	Biologically Feasible Potential Volume of Production, <sup>b</sup> million L	Actual Value of Milk Production, <sup>c</sup> US\$ million	Biologically Feasible Potential Value of Production, <sup>c</sup> US\$ million	Lost Production Value, <sup>d</sup> US\$ million	Lost Production Value, <sup>e</sup> % of potential
Australia	42	89	3584	7601	4016	53
United States	526	1269	44 774	107 887	63 113	58
Norway	11	18	907	1505	598	40

<sup>a</sup>Production volume calculated as the sum of total numbers breastfeeding each month from age 0 to 24 months, multiplied by monthly milk intake for each age.

<sup>b</sup>As above, assuming breastfeeding prevalence of 95% from 0 to 24 months.

<sup>c</sup>Valued at US\$85.05 per gram (US\$3.00 per oz), assuming that 1 mL is equivalent to 1 gram.

<sup>d</sup>Difference between actual and biologically feasible potential value of production.

<sup>e</sup>Actual value of milk production divided by biologically feasible potential value of production.

**Table 5.** Markets for Human Milk

Market	Price, US\$ per oz	Location	Comment/Source
Human milk banks			
HMBANA	\$3.00-\$4.50 <sup>50</sup>	United States	Currently, there are 12 HMBANA member milk banks providing donor human milk in the United States and Canada. HMBANA milk banks charge no fee for the actual milk, but they charge a processing fee to offset the milk bank's overhead costs. This fee ranges from US\$3.00 to US\$4.50 per ounce, plus shipping costs. Each milk bank has the authority to determine the processing fee for its facility, which is the reason for the wide variation in price.
Norwegian milk banks	\$3.42 (US\$100 per L) <sup>51</sup>	Norway	Thirteen milk banks were operating in Norway in 2009, all located in hospitals with level 3 neonatal intensive care units. All preterm infants are offered donor milk if mothers' milk is unavailable or insufficient, and all infants who need milk from the milk bank are offered it. Donors are given a free hospital-grade breast pump and US\$20 per liter to cover electricity and travel expenses, and they donate for 6 months. At the main Oslo hospital where 2000 of the country's 60 000 annual births occur, the milk bank collects around 1000 to 1100 liters of human milk per annum. There is a charge of US\$100 for milk transferred to other hospitals.
Standardized human milk formulations	\$35.00 (US\$1183 per L) <sup>54</sup>		Products are for in-hospital use only and the company does not supply or charge directly to parents for its products. The cost is absorbed by the hospital or covered by medical insurance, where the infant is prescribed human milk products. <sup>53</sup> The company's website explains its "co-promotion" arrangement with a major formula manufacturer, which is involved in promoting and distributing these human milk products to hospitals.
Human milk fortifier	\$6.25/mL (US\$6250 per L) <sup>54</sup>	United States	
Internet milk exchange			
Only the Breast	\$1.00-\$3.00 (\$2.00-\$8.00) <sup>52</sup>	online	Milk can be bought and sold, as well as shared (donated). Exchange is organized into various categories, including by age of the infant, fresh (rather than shipped frozen), milk bank certified mother, milk bank screened mother, bulk sales, local sales, fat babies, and special diet (vegan, etc). The site offers donor blood testing at US\$219.45. Also has trading from Canada, United Kingdom, and elsewhere.
Wet nurse employment			
Wet nursing	daily rate between US\$50.00 and US\$200.00 (2012 prices) <sup>52</sup> ; US\$1000.00/wk (2007 prices) <sup>67</sup>	United States	Offered at between US\$50 and US\$200 per day. Also has trading from Canada, United Kingdom, and elsewhere. Equivalent to US\$71 to US\$286 per liter at 700 mL daily intake.
Wet nursing	US\$2585.00/mo <sup>68</sup>	China	Chinese wet nurses earned up to 18 000 Yuan/month in 2008. Exchange to USD is based on 2008 exchange rates. Equivalent to US\$121 per liter at 700 mL daily intake.

European milk bank price of US\$100 per liter, the value would be some US\$8 billion larger. If 5% of breastfed US newborns (ages 0-1 month) were instead fed commercial preterm human milk formula purchased at market prices

(US\$1183 per liter), the value of US human milk production would be raised by US\$3.6 billion per year.

The relative magnitude of human milk production emphasizes the extent of the production loss implicit in present

practices of early weaning from optimal breastfeeding. Alongside human milk production estimated for the United States at US\$45 billion per year, the commercial formula market is reported to be US\$1.5 billion a year.<sup>56</sup> In Australia, it was estimated at US\$132 million in 1992.<sup>10</sup> If formula companies sell more formula, this is currently measured as an increase in GDP, but this economic gain is more than offset by an unmeasured loss of more valuable human milk production because breastfeeding declines. If human milk were counted appropriately in GDP, this economic loss would be more evident.

Previous studies in a national accounting framework have shown that the value of human milk is quantitatively important and of a magnitude that is comparable with other production—like backyard production of food or on-farm consumption of farm product—for which values are already imputed in GDP. It is also now well documented<sup>38,39,57</sup> and agreed on by international accounting experts<sup>13</sup> that breast milk meets current UN guidelines for inclusion in GDP.

A strength of this study is that we provide a more comprehensive and robust measure of the economic value of breastfeeding by using a conventional economic valuation methodology that directly incorporates market evidence of willingness to pay for avoiding health consequences of formula feeding into the price used to value human milk production. Conceptualizing human milk as a marketable commodity consistent with national accounting approaches is an innovation that enables a broad and more accurate approach to measuring its economic value.<sup>10</sup> As argued in more detail elsewhere,<sup>10</sup> a great deal still remains unknown about the long-term implications of infant nutrition. Because of these gaps and lags in accumulation of knowledge, using the “avoided cost of formula” approach underestimates the economic value of breastfeeding, and such estimates are quickly dated by new knowledge.

Our estimates are approximations based on publicly available data. National accounts statisticians with access to unpublished price and quantity data from official surveys could produce more precise estimates.

Our assumed daily volume of human milk production is very conservative. Milk production by well-nourished women breastfeeding single babies may be much higher. Altering the assumed daily milk production to around 850 mL daily measured among mothers who are exclusively breastfeeding during the first 6 months,<sup>31</sup> the volume of biologically feasible potential milk production rises, for example, by 5 million liters or 14% in Australia, by 61 million liters or 13% in the United States, and by 1.3 million liters or 12% in Norway. We also ignore production and consumption of human milk by children older than 2 years of age, although this is known to be substantial in developing countries.<sup>5,43</sup>

On the other hand, our estimates exclude input costs, such as any additional food intake by lactating mothers, and so

overestimate net production values slightly. A comprehensive economic perspective on breastfeeding would also involve adjusting for the time costs of breastfeeding, but these are excluded from this study in accordance with UN SNA guidelines. These economic costs of breastfeeding to women are poorly measured due to lack of adequate time use statistics and have rarely been acknowledged by public health policy makers.<sup>58</sup> Only 2 studies<sup>8,11</sup> of the economic value of breastfeeding incorporate estimates of the time costs to women; it is unknown whether breastfeeding is time saving or more time consuming than formula feeding.

The North American milk bank price may be criticized on various grounds and may be considered too high or too low. The price of milk supplied by milk banks may be considered excessively high for valuing human milk production, if this price is relevant only for premature rather than for healthy, older infants. Using a market price for expressed breast milk may underestimate the economic value of breastfeeding. There are distinct, additional values for the process of breastfeeding and for using the mother’s own milk rather than another mother’s milk, such as for promoting maternal attachment and for strengthening the immune system.<sup>59,60</sup> Also, the price that individual consumers are willing to pay for breast milk may be lower than its economic value from a societal perspective, for example, because consumers are not fully informed about its health and development importance, because the optimal feeding of the child is not the only consideration in infant feeding decisions, or because personal valuations may not take into account wider societal cost impacts.

It may be argued that the price of formula, which is lower, should be used to value the lost economic value when human milk production is replaced by formula feeding, as the mothers who formula feed may not value breast milk as highly as breastfeeding mothers. However, market prices for formula only show that consumers value bovine-based milk or plant-derived formula milk products at this price, not how much they may be willing to pay for human milk. The price of formula may be low because women consider breast milk substitutes to have a lower economic worth. At present, some formula-feeding mothers may not be able to purchase breast milk.

The price of milk sold by North American milk banks may reflect the particular economic and institutional characteristics of a specific, small, and restricted market. The market for human milk is admittedly still small, and most human milk production is not bought, sold, or donated. Some countries may not yet have significant trading in human milk especially for older infants; in Norway, for example, milk is usually supplied by milk banks only for infants younger than 3 months old. Pricing mechanisms may be relatively undeveloped in these markets and price may be little used in supply or demand decisions. This can be tested<sup>10</sup>; an input cost approach such as replacement cost or opportunity cost can be used as an alternative to directly observing market prices.

Prices of human milk derived using other valuation methods (such as using time input or wage costs) are consistent and comparable with the level of milk bank prices.<sup>10,11</sup> This suggests that valuing expressed breast milk using milk bank prices is a reasonably valid representation of the market value of human milk.

Furthermore, there is other evidence of supply and demand effects on the market price of human milk, suggesting economic pricing. The prices for specialized human milk formula products for premature infants are very high, perhaps because of the cost-saving potential such as in reducing necrotizing enterocolitis.<sup>54</sup> The price of human milk in the Internet market is slightly lower and more variable than at milk banks, perhaps because breast milk is seen as less valuable for older, healthy infants, and there is more risk and less quality control than through milk banks.

## Conclusions

The economic value of production of human milk is quantitatively important, including relative to the supply of commercially marketed alternatives and by comparison with other goods for which values are imputed in GDP.

Breast milk not only should, but can, be counted in GDP. The markets for human milk are expanding rapidly due to technological and demand factors. The nonmeasurement of human milk production devalues and makes invisible the quantitatively significant economic contribution by women and households to the supply of a valuable commodity. The exclusion of human milk from GDP is not only inconsistent with UN guidelines; it also seriously distorts measurement of national food production and public policy priorities.

Breastfeeding decisions and behaviors are influenced to a degree by economic factors such as time opportunity costs and by markets supplying low cost, bovine milk alternatives to human milk. Breastfeeding and human milk production in effect “compete” with women’s other paid and unpaid work activities, and with commercially marketed baby food products, for maternal time and money resources.<sup>23</sup> Our calculations highlight the economic relevance of addressing cultural and institutional barriers to breastfeeding and of regulating the market forces that undermine it.

As the World Bank has commented, “Why do statistics matter? In simple terms, they are the evidence on which policies are built.”<sup>61</sup> The invisibility of human milk production significantly distorts public policy priorities. Its invisibility means that fewer financial and economic resources are likely to be allocated to facilitating more human milk production and breastfeeding, which are not marketed or measured in economic growth statistics. Resources will instead be directed to encouraging production of market commodities, which are counted.

For example, in the United States, large public resources are expended on programs that lower household financial costs of formula feeding, such as the Special Supplemental

Nutrition Program for Women, Infants and Children (WIC).<sup>62,63</sup> Similarly, other countries such as Australia and the United Kingdom subsidize the health costs of formula feeding such as through taxpayer-funded health care systems.<sup>1,3</sup>

If breast milk were more visible in economic statistics such as GDP, greater funding priority might be given to potentially more cost-effective programs that expand human milk production by increasing breastfeeding. Such programs might include, for example, implementing the Baby-Friendly Hospital Initiative including restraining unethical marketing through hospitals, financing access to peer counselor or health professional lactation support, or introducing paid maternity leave and requiring breastfeeding accommodation in workplaces.<sup>64</sup>

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