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HUMAN MILK AN INVISIBLE FOOD RESOURCE

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ABSTRACT

Human milk is a food that meets all conditions for an infant's nutrition security and is the most important food for more than 10 percent of the population in Sub-Saharan Africa (children less than three years of age). Statistics on production of human milk at local and national levels are lacking for Africa. In this paper, the quantity of human milk production in Mali, Senegal, Nigeria, and Zimbabwe is estimated. The annual production in the urban and rural areas in a county in Mali is estimated at 13 and 17 kilograms per capita, respectively. National annual median production is estimated to be between 144,000 (Mali) and 1.3 million metric tons (Nigeria), and production per capita between 8 (Zimbabwe) and 15 kilograms per year (Mali). In Sub-Saharan Africa, the production of human milk is about 50 percent of that of cow's milk. The paper argues that overlooking human milk production/consumption in data analysis and policymaking has negative consequences for children's health and nutritional status.

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1. INTRODUCTION

Infancy is the only period in life when humans obtain nutrition security by consuming one food, breast milk. When the mother breast-feeds her child, all of the three conditions for "nutrition security: food security, adequate care, and protection against diseases" (Oshaug 1994) are provided simultaneously. The International Conference on Nutrition held by the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) stated: "Breast-feeding is the most secure means of assuring the food security of infants and should be promoted and protected through appropriate policies and programs" (ICN 1992). Breast milk meets all the nutritional requirements, quantitatively and qualitatively, of the infant during the first six months of life. The act of breast-feeding itself is a good example of care, and the disease-preventive and health-promotive effects of breast milk are all well documented (Nicoll 1996). No other single food has such a positive impact on nutrition and health.

Despite all these advantages, data on human milk have never been considered important in the context of food supply statistics and, consequently, have never achieved the societal recognition or status that they deserve. Decisionmakers generally do not consider human milk a food resource, at least not important enough to include in a nation's food balance sheets. Norway has, however, started to include the national production of human milk in the annual food and nutrition reports of the National Nutrition Council (Oshaug and Botten 1994).

As early as 1974, the Norwegian delegation to the Preparatory Committee of the World Food Conference proposed that human milk should be included in food production statistics and reported regularly. For various reasons this was not accepted by FAO, but the health benefits of breast milk have since been widely acknowledged throughout the world as scientific evidence became ever more compelling. This knowledge has led to the development of many programs aimed at support and promotion of breast-feeding by multilateral development agencies, bilateral aid agencies, and nongovernmental organizations (NGOs). Questions researchers and policymakers often raise include (1) Is human milk produced in sufficient quantities to justify its inclusion in food statistics? (2) Will the so-called "development process" lead to a decrease in the production of human milk and, therefore, the loss of a very important food resource for young children?

The purpose of this paper is to estimate the amount of human milk produced in Mali nationally and in urban and rural areas in one county in Mali, and to compare this with other African countries considered more economically developed than Mali.

2. SAMPLING

The calculation of the amount of human milk produced in Mali is based on two surveys carried out in Koutiala County, an agricultural area in the southern part of the country. According to the 1987 census, Koutiala town, the only urban area in the county, had a population of about 48,000. In 1994, the population was estimated at approximately 70,000. In the urban area, a cotton factory dominates the economy, while

the rural population is predominantly farmers producing principally cotton and grain (millet, sorghum, and maize).

Two surveys were carried out, one in September 1994 and another in March 1995, both including rural and urban areas. A modified 30-cluster sampling scheme, as recommended by the United Nations Children's Fund (UNICEF) (Henderson and Sundaresan 1982), was used as the sampling method. First, a list of clusters consisting of all villages in the county was drawn up and their population size estimated on the basis of the administrative census of 1987 (updated in 1994). In each survey, 66 clusters were selected. In each cluster, the first household to be surveyed was randomly selected from a list of heads of households. The next household was the one to the left of the first, and this leftward selection continued until the sample size required for each cluster was reached. The sampling scheme required a minimum of 17 children per cluster in the 6-to-59 month age group. All children residing in a given household were included, even in the households where the 17th child was found. The mean number of children in the 132 clusters was 17.8, with a maximum of 24.

In the sample, 11,972 persons were included, of whom 27 percent were in urban and 73 percent in rural areas. All women (n=714 urban and 1,720 rural) from 15 to 45 years of age in the surveyed households were interviewed about birth history and health status. The same questionnaires were used in the two surveys. One questionnaire was designed to obtain information about children aged 6-59 months and included questions about feeding practices (including breast-feeding) and illness. For comparison with data

from other countries, only children up to three years of age were included in the present analysis (n=373 urban children and 1,193 rural children) (Table 1).

3. METHODS

The estimation of human milk production was based on the ages of the study children, breast-feeding frequency, the proportion of children of each age group in the total population, and the amount of human milk consumed by children of each age group as reported in scientific articles. It was assumed that all children under six months of age were breast-fed. Since neither survey included information on children under six months of age, the proportion of children aged 0-5 months was calculated by using the infant mortality rate (IMR) and the total number of children in the 6-11 and 12-23 months age groups. IMR was calculated by Mortpak-LITE (UNPD 1990) and was 165 per 1,000 in rural and 124 per 1,000 in urban areas (Table 1).

An exact age-estimation was done for each child by using birth registration cards and parental information, which was validated by using events histories and lunar and agricultural calendars (Oshaug et al. 1994). The child's caregiver was asked whether the child was breast-fed or not.

Table 1 Characteristics of the sample in Koutiala from surveys in September 1994 and March 1995

	Urban	Rural
Number of children 0–35 months (percent of total sample)	373 (12.1)	1,193 (13.4)
Number of women aged 15–44 years (percent of total sample)	714 (23.1)	1,720 (19.4)
Total sample	3,086	8,886
Mean household size	9	18
Ever bottle-fed (6–35 months) (percent)	18.4	4.8
Among the bottle-fed, bottle used to give (percent)		
Infant formula	70	96
Animal milk	5	16
Water	5	2
Decoction (tea)	37	6
Infant mortality rate[a]	124	165

[a] Mortality among 0–1 year olds per 1,000 live births, calculated by Mortpak-LITE (UNPD 1990).

Several studies have tried to estimate the volume of human milk production in various settings. Most of them present data for children up to 24 months of age, and there is some variation between studies in reported volume produced. The quantities used for this paper were based on three review articles (WHO 1985; Prentice, Goldberg, and Prentice 1995; Jelliffe and Jelliffe 1978). Measured quantities from different studies were listed in declining order (Table 2). In the calculations, the unweighted median and the 25th and 75th percentile of the amount of milk for each age group was used. The values have been rounded to the nearest 100 grams.

Our results from Koutiala were compared with national data for Mali and other countries in Africa. The national data used in the comparison were taken from Demographic and Health Surveys (DHS) undertaken in Mali, Nigeria, Senegal, and Zimbabwe (Traoré, Konaté, and Stanton 1989; Nigeria 1992; Ndiaye, Diouf, and Ayad 1994; Zimbabwe 1995). Comparison is limited to the age group under 36 months because the DHS only report data on children in this age group. The way of reporting breast-feeding in the DHS and the present surveys in Koutiala was not the same. In the present surveys, the mothers were asked if the child was breast-fed or not; in the DHS, mothers were retrospectively asked how many months they had breast-fed their children.

Table 2 Amount of human milk produced (grams per day) for different age groups in different countries, as reported in three studies

Country	0–5 Months	Country	6–11 Months	Country	12–23 Months	Country	24–35 Months
Chile[a]	961	Canada[c]	843	New Guinea[b]	705	New Guinea[b]	488
Burma[a]	934	England[c]	820	New Guinea[b]	600	New Guinea[b]	265
Egypt[b]	922	Sweden[c]	779	Gambia[c]	549	Biak Islands[b]	243
Mexico[a]	885	India[b]	735	Sri Lanka[b]	506	New Guinea[b]	237
Canada[c]	866	New Guinea[b]	660	India[c]	505		
New Guinea[a]	863	Zaire[a]	611	New Guinea[b]	400		
USA[a]	858	New Guinea[b]	600	Mexico[c]	397		
USA[a]	839	Nigeria/Benin[b]	590	Kenya[c]	371		
Kenya[a]	827	Gambia[c]	586	Mexico[b]	350		
Burma[a]	815	Kenya[c]	533	India[b]	350		
USA[a]	811	New Guinea[b]	525	New Guinea[b]	343		
England[c]	798	India[b]	500	New Guinea[b]	295		
Burma[a]	792	Sri Lanka[b]	495	New Guinea[b]	245		
UK[a]	791	Zaire[a]	489	Biak Islands[b]	233		
USA[a]	786	India[c]	472				
UK[a]	783	Mexico[c]	462				
Gambia[a]	782	Mexico[b]	450				
USA[a]	776	New Guinea[b]	415				
Burma[a]	767	Biak Islands[b]	410				
Bangladesh[a]	750	New Guinea[b]	400				
Netherlands[a]	746	Zaire[a]	390				
Java[a]	744	New Guinea[b]	360				
Java[a]	743						
Kenya[a]	741						
Sweden[a]	740						
Gambia[a]	738						
Egypt[b]	733						
New Guinea[b]	720						
India[a]	703						
Sweden[c]	701						
Sweden[b]	689						
Zaire[a]	681						
India[b]	660						
Mexico[b]	650						
Kenya[c]	645						
USA[a]	642						
Gambia[c]	622						
Sweden[b]	622						
Zaire[a]	612						
India[b]	600						
New Guinea[b]	600						
Nigeria/Benin[b]	555						
New Guinea[b]	525						
Mexico[c]	524						
India[c]	481						
Sri Lanka[b]	475						
Biak Islands[b]	427						
New Guinea[b]	400						

Human milk produced per kilogram per child per day

	0–5 Months	6–11 Months	12–23 Months	24–35 Months
25th percentile:	0.6	0.5	0.3	0.2
Median:	0.7	0.5	0.4	0.3
75th percentile:	0.8	0.6	0.5	0.4

[a] Prentice, Goldberg, and Prentice 1995 (and cited in Oshaug et al. 1994).
[b] Jelliffe and Jelliffe 1978 (quantities reported in milliliter per day) (and cited in Oshaug et al. 1994).
[c] WHO 1985.

4. RESULTS

As in other areas in Africa, breast-feeding rates were high in Koutiala (Table 3). Bottle feeding was rare in rural areas (about 5 percent), but more frequent in urban areas (18 percent). The bottle was used for different purposes. In rural areas, it was used mainly for infant formula and animal milk, while in urban areas, it was used for infant formula and decoction (tea) (Table 1).

Table 3 shows the annual estimated production of human milk in urban and rural areas in Koutiala per 1,000 children in the age group 0-35 months. The annual estimated human milk production was about 10 metric tons (9-10 percent) higher in rural than in urban areas. All urban children had been weaned from the breast within the third year of life, while in rural areas, 4 percent of the children were breast-fed for more than 35 months (data not presented).

Estimated milk production was highest for children less than 12 months of age, and accounted for approximately 68 percent of the total production. For children between one and two years of age, the figure was 29 percent. About 97 percent of the milk produced was for children under two years of age.

In Table 4, the estimated production of human milk in Koutiala is compared with production at the national level in Mali, Senegal, Nigeria, and Zimbabwe. All four nations had very high levels of human milk production. The highest level of production (119 kilograms per child per year) was in rural Koutiala, Senegal, and Nigeria, while the overall production in Zimbabwe was the lowest (105 kilograms per

Table 3 Estimated human milk production in urban and rural areas, Koutiala County, Mali

Age (Months)	Percent breast-fed	Proportion per 1,000 children	Estimated human milk produced			Estimated human milk produced			Human milk produced		
			Median	25p	75p	Median	25p	75p	Median	25p	75p
			(kilograms/child/day)			(kilograms/child/year)			(metric ton/year/1,000 children)		
Urban											
0-5	100	164	0.7	0.6	0.8	255	219	292	41.80	35.83	47.77
6-11	97	179	0.5	0.5	0.6	183	183	219	31.79	31.79	38.15
12-17	74	190	0.4	0.3	0.5	146	110	183	20.41	15.31	25.52
18-23	54	148	0.4	0.3	0.5	146	110	183	11.56	8.67	14.45
24-29	11	148	0.3	0.2	0.4	110	73	146	1.73	1.15	2.31
30-35	6	172	0.3	0.2	0.4	110	73	146	1.16	0.78	1.55
Total production (0-35 months)									108.46	93.53	129.75
Rural											
0-5	100	164	0.7	0.6	0.8	255	219	292	41.89	35.90	47.87
6-11	98	208	0.5	0.5	0.6	183	183	219	37.39	37.39	44.87
12-17	91	157	0.4	0.3	0.5	146	110	183	20.82	15.61	26.02
18-23	61	152	0.4	0.3	0.5	146	110	183	13.65	10.23	17.06
24-29	21	151	0.3	0.2	0.4	110	73	146	3.42	2.28	4.56
30-35	8	167	0.3	0.2	0.4	110	73	146	1.42	0.95	1.90
Total production (0-35 months)									118.58	102.37	142.27

Notes: 25p refers to 25th percentile; 75p refers to 75th percentile.

Table 4 Human milk production in selected areas in Africa for children aged 0-35 months

Area	Human milk produced			Annual human milk produced per capita[a]			National human milk produced		
	Median	25p	75p	Median	25p	75p	Median	25p	75p
	(metric tons/year/1,000 children[b])			(kilograms)			(metric tons per year)		
Urban Koutiala 1994/95	108.5	93.5	129.8	13	11	15	...	...	...
Rural Koutiala 1994/95	118.6	102.4	142.3	17	14	20	...	...	...
All Koutiala 1994/95	116.3	100.3	139.4	16	13	19	...	...	...
DHS[c] Mali 1987	109.4	94.5	130.6	15	13	17	146,072	126,226	174,404
DHS[c] Senegal 1992/93	118.6	101.9	141.5	12	10	14	96,559	82,935	115,163
DHS[c] Nigeria 1990	118.3	101.7	141.6	11	9	13	1,303,824	1,120,194	1,560,003
DHS[c] Zimbabwe 1994	104.7	91.3	124.7	8	7	10	90,918	79,242	108,251

Sources: Data for Koutiala come from the study surveys; for Mali, from Traoré, Konaté, and Stanton 1987; for Senegal, from Ndiaye, Diouf, and Ayad 1994; for Nigeria, from Nigeria 1992; and for Zimbabwe, from Zimbabwe 1995.

Notes: 25p refers to 25th percentile; 75p refers to 75th percentile.

[a] The proportion of the population in the age group 0-35 months is as follows: urban Koutiala 116/1,000; rural Koutiala 140/1,000; all Koutiala 134/1,000; Mali 132/1,000; Senegal 102/1,000; Nigeria 92/1,000; Zimbabwe 80/1,000. Total population: Mali 10,100,000; Senegal 8,000,000; Nigeria 119,300,000; Zimbabwe 10,900,000.

[b] Children from 0-35 months of age.

[c] DHS = Demographic and Health Survey (Enquête Démographique et de Santé).

child per year). Regarding annual production per head of population, Koutiala was highest (16 kilograms), followed by all Mali (15 kilograms), with the lowest per capita production in Zimbabwe (8 kilograms). In Nigeria, the most populous country in Africa, the total national production was estimated at 1.3 million metric tons annually, with an annual per capita production roughly equal to that of Senegal (11-12 kilograms).

One way to put the economic value of the human milk in perspective is to compare human milk production with the production of cow's milk. The FAO has estimated the cattle population in Sub-Saharan Africa to be 171 million in 1994 and the total volume of cow's milk produced to be 11,526,000 metric tons. The estimated population in Sub-Saharan Africa in 1994 was 538 million inhabitants (FAO 1995). In Table 5, a comparison of estimated human milk production and cow's milk production from 1991 to 1994 is presented. Based on calculations presented in Table 4, an estimate of the annual human milk production in this region would be at least 10 kilograms per capita, leading to an annual human milk production in Sub-Saharan Africa of about 50 percent of the cow's milk produced in the period 1991 to 1994 (Table 5).

5. DISCUSSION

A striking feature of these data is the high output of human milk. A volume of at least 50 percent of cow's milk production in Sub-Saharan Africa is surely surprising.

Table 5 Comparison of annual human and cow's milk production in Sub-Saharan Africa

	1991	1992	1993	1994
Population (1,000)	491,992	507,051	522,520	538,323
Cow's milk production (1,000 metric tons)	9,768	9,966	10,430	11,526
Human milk production (1,000 metric tons)	4,920	5,071	5,225	5,383
Cow's milk production (kilograms per capita)	19.9	19.7	20.0	21.4
Estimated human milk production (kilograms per capita)	10	10	10	10

Source: Population and cow's milk production data are from FAO 1995.

Notes: Estimated level of human milk production is based on results from Table 4. The results varied between 8 and 16 kilograms per capita (median value). Ten kilograms were chosen as an estimated of the minimum production level for the area.

This confirms that human milk is a very important food for 10 percent of the African population, i.e., children below three years of age, and the most important food for children up to 24 months of age. This high rate of breast-feeding is an important health advantage in poor countries in Africa, which, to an increasing degree, have been faced with food insecurity problems, provoking serious nutrition and health consequences. In poor countries and communities, the mortality rate of breast-fed children has always been lower than that of bottle-fed children (Wray 1990).

It is clear from the data presented here that the lack of reporting of human milk in food statistics represents an omission with important strategic consequences. The omission probably has an impact on policy decisions relating to women, breast-feeding practices, and the nutrition and health of children. The quantities of human milk produced (Tables 4 and 5) would in themselves justify human milk's inclusion in food supply and food disappearance[1] statistics. Economists, statisticians, and others who are central actors in the decisionmaking process should be charged with the task of putting human milk higher on the scale of data collection and analysis.

We maintain that by not including human milk in food disappearance statistics, the attention to this economic asset, and nutritionally adequate and health-promoting food, will continue to be low, and inadequate attention to lactating women and their young children will continue to exist with serious health consequences. This is particularly important today when urbanization and other types of social change are taking place. The

[1] A standard term used on food balance sheets.

effect of these changes may contribute to the decline of breast-feeding. The urbanization process is especially high in developing countries, and it is expected that by the year 2000, 18 of 21 megacities (more than 10 million inhabitants) will be found in the developing world (Wielgosz 1995). This trend most probably will result in a substantial decline in breast-feeding.

Our data show that the production of human milk was lower in urban than rural areas (Tables 3 and 4). Other studies in Africa have shown that urban mothers are likely to wean their children earlier than rural mothers (Uwaegbute and Nnanyelugo 1987). Popkin and Bisgrove (1988) reported a declining trend in breast-feeding in urban areas and in both urban and rural areas that had experienced a fast rate of modernization. Atkinson (1992) observed that urban women were more inclined to early weaning and less inclined to breast-feeding. These observations support our findings. Similar trends were also found in Asia (Popkin and Bisgrove 1988; Doan and Popkin 1993) and Latin America (Popkin and Bisgrove 1988; Cohen et al. 1995). Causes mentioned for these trends are a changing lifestyle, an increasing workload and time constraints on women, a separation of child and mother for long hours due to work outside the household, an increasing education of women (which, in many poor countries, has led to a decline in breast-feeding, while in many industrialized countries, education has had an opposite effect), of education can be observed), a change in employment pattern, and perceptions that breast-feeding is time-consuming and old-fashioned.

Will such a decline be economically important? That will depend on the economic value of human milk. Giving an exact value for human milk is difficult, but in developed countries where human milk banks are established in hospitals, the price is very high (in Norway, hospitals pay US$21 per liter and sell it for US$36-47 per liter). If we estimate a global price, a very conservative and low price would be US$1 per liter. This price would be at least the cost of replacing human milk by formula, including water, fuel, equipment, and cleaning products. If the value of human milk had been included in gross national product (GNP) calculations, based on such a global price, the effect would have been remarkable. For Mali, the GNP was US$270 per capita in 1990. The estimated value of human milk would have added another US$15 per capita, or an increase of more than 5 percent. Even for Senegal, with a GNP of US$710 per capita, the GNP would have increased by nearly 2 percent had the estimated value of human milk been included.

A special feature of human milk is that it is probably the only food that is culturally acceptable in all countries of the world. Besides this, human milk has several advantages when compared to infant formula. Human milk does not need packaging; there is no need for energy to process and transport, or for fuel to heat the milk and clean the milk-processing equipment. Our calculations have accounted for none of these benefits, nor for the health benefits of human milk. Increased modernization leads to decreased breast-feeding, which is linked to increases in morbidity and mortality among infants and young children. Such changes should have been monitored and linked with the changes in breast-feeding patterns and human milk production.

A question of validity and reliability can be raised for the types of calculations and estimates presented here. Our methods differ from the way the DHS collected information on breast-feeding duration. DHS asked mothers how many months they had breast-fed their last child, next-to-last child, and second-to-last child, for all children less than five years of age. This method of recording breast-feeding habits often leads to a heaping of data on particular ages, i.e., 12 months, 18 months, and 24 months. The method we used for estimating a child's accurate age, followed by asking mothers whether the child is breast-fed or not, may lead to more exact results (Oshaug et al. 1994). However, the differences in methodology of recording breast-feeding duration do not seem to cause major problems. Comparing the two methods of estimating breast-feeding duration showed the same pattern, but the DHS method gave a somewhat lower duration, particularly for the 12-24 months age group. The differences are, however, probably within the margin of error, and do not change the conclusions drawn here.

Regarding the reliability of data for quantities of human milk produced monthly after the birth of a child, a range from 25 percentile to 75 percentile is presented for each age group. We calculated human milk production only for children up to 36 months of age, although in rural areas in Koutiala, 4 percent of the children were breast-fed for more than three years. It is likely that in the areas where DHS had collected data, some children were breast-fed for more than three years. If data for children older than three years of age were included, the quantities of human milk produced would have been even higher. We have used the median level of milk production reported in the literature, and a

somewhat lower level when calculating the milk production in Sub-Saharan Africa. It is therefore likely that these levels are not overestimated, but, rather, on the low side. We also conclude that with accelerating urbanization, a substantial reduction in breast-feeding rates and, consequently, in the amount of human milk produced will occur. This will probably add to the burden of morbidity and mortality in developing countries, further draining already scarce resources.

We therefore challenge economists, statisticians, and others who are involved in the generation of health and food statistics throughout the world to include human milk in their calculations of food supply, availability of food and nutrients, and economic value of food. This data should be compared to the economic and social costs of purchasing infant formula due to the decline in breast-feeding, and to additional health expenditures due to the increasing morbidity and malnutrition among children and possible increases of chronic diseases in adult life.

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