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# Human milk supply in Australia

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**Abstract**

This paper aims to place a monetary value on the actual and potential supply of human milk in Australia. It estimates the quantity of milk produced in 1992. It considers different bases for determining a 'shadow price' for breastmilk, and uses the method established by Oshaug and Botten (Food Policy 19(5), (1994), 479–482). It also calculates scenarios for different prevalences of breastfeeding, looking at the implications on the human milk supply of Australia achieving its National Health Targets, of all mothers breastfeeding according to the optimum regime recommended by the WHO and UNICEF in the *Innocenti Declaration* of 1990, or of a return to the 'human milk famine' of the early 1970s. It concludes that Australian women supplied 33 million kg of breastmilk in 1992, compared to 16 million kg in 1972. Valued at A$67 per litre (the price of expressed human milk) the 1992 production level was worth $2.2 billion. This is around 0.5% of GDP, or 6% of private spending on food. Achieving international standards for 'optimal' levels of breastfeeding, with breastfeeding continuing up to age two and beyond, would nearly triple the supply of human milk. 

*Keywords:* Milk supply; Breastfeeding; Human milk; Economics; Infant feeding; Maternal and child health; Non-marketed goods valuation formula; Food production

## Introduction

In 1973, the Norwegian delegation to the World Food Conference unsuccessfully proposed including human milk in world food production statistics. Since then, the

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value of breastfeeding has been widely endorsed throughout the world and from 1993, human milk output has been included in annual reports on national food production by the Norwegian National Nutrition Council (Oshaug and Botten, 1994).

As Oshaug and Botten point out (p. 479), including human milk in national food production statistics emphasises the extent of breastfeeding and its value. Extensive research, especially in recent years, has documented the diverse and compelling health and nutritional advantages of breastfeeding and human milk, in developed as well as developing countries.[1] Breastfeeding also provides food security for infants in times of war, natural disaster or economic disruption that may be denied to those depending on artificial substitutes.

Placing a dollar value on breastfeeding can make its unique contribution to the community's economic well-being more visible to those who would otherwise be blind to it. While putting a price on mothers' milk might be perceived as offensive, many women view breastfeeding with pride, and including human milk on food balance sheets represents a positive recognition of one of women's unique contributions to society.

More comprehensive knowledge of the nature and locus of economic activity such as breastfeeding should also contribute to more accurate public policy analysis, and more soundly based economic, as well as health, policies.

With policy makers increasingly preoccupied by the 'market' economy, highlighting the national economic impact of breastfeeding serves to underline its importance to broad social and economic welfare, and the desirability of protecting it from replacement by commercially promoted foods.

## Data and methods

Placing human milk on national food balance sheets is relatively simple and accurate—breastmilk is "the only food commodity for which production equals consumption, that is, there are no 'post-harvest losses' or 'plate waste'" (Greiner et al., 1979). The main variables in estimates of human milk production are:

- the number of infants of the relevant age;
- estimated daily volumes of breastmilk production;
- breastfeeding prevalence; and
- the value or 'price' of human milk.

### *Number of infants*

There were 264,151 live births in Australia during 1992, and approximately 257,247 babies born in 1991 who entered their second year of life in 1992. For

[1] For example, see surveys in Popkin et al. (1984); Lawrence (1989); Cunningham (1977, 1979, 1990, 1995); and Cunningham et al. (1991).

simplicity this study assumes that this is the number of infants aged 0–2 living throughout 1992.[2]

Corresponding figures used in human milk production estimates for 1972 are 264,969 and 276,362, respectively.

*Average daily production of human milk*

Oshaug and Botten (1994) concluded that the daily volume of human milk produced by a breastfeeding mother remained uncertain. Studies of human milk production, mainly in developing countries, have used varying assumptions about daily production levels. For example, Berg assumed production of 850 ml per day for the first 6 months of exclusive breastfeeding, 500 ml per day until 18 months, and 200 ml per day from 19 to 24 months. Greiner et al. (1979) assumed that the daily milk production volume averaged to 722 ml for the first 4 months of life, 600 ml for the 4–12 month age group, 400 ml for 12–24 months, and 300 ml for 24–36 months. Rohde's study of Indonesia assumed that production during the second year of breastfeeding averaged 250 ml (ranging from 200 to 450 ml) per day.

The present study uses the daily breastmilk milk production levels assumed by Oshaug and Botten for Norwegian women, set out in Table 1. These average 650 g/day (670 ml/day) for the first year, and 300 g/day (309 ml/day) for the second (Table 1). They imply milk production during the first 2 years of life of 357 litres of milk per infant, compared to conventional assumptions that adequate intake is 375 litres (Berg, 1973).

These assumptions are consistent with recent studies of milk yields (Goldberg et al., 1991; Raaij et al., 1991; Hartmann and Sherriff, 1994; Cox and Owen, 1996), although somewhat conservative for well nourished mothers in developed countries such as Australia. Yields for Australian women tend to be at the high end of estimated ranges of milk yields (Cox and Owen, 1996; Hartmann and Sherriff, 1994). Hartmann et al. (1985) found that actual milk production by well nourished Australian women breastfeeding single babies is well below biological potential, and above the range of 0.7–0.9 kg/day that has been taken as the maximum for human lactation (Jelliffe and Jelliffe, 1978).

*Prevalence of breastfeeding*

Studies of human milk production rely on estimates of national breastfeeding prevalence. Oshaug and Botten used available data on breastfeeding prevalence in Norway at ages 3, 6, 9 and 12 months and beyond to extrapolate national breastfeeding prevalence at each monthly interval up to 2 years of age.

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[2] Oshaug and Botten (1994) approximated the population of infants living in 1992 from national data on children born in 1991. In principle, the number of deaths for each annual cohort should be deducted. However, the infant mortality rate in Australia is low, at 6.8 per 1000 live births for 1992. While infant mortality is as much as two to three times higher among Aborigines, this group is less than 1% of the total population.

Table 1
Milk yields

| Age (months) | Average per infant per day (g) |
|---|---|
| Initiating | 600 |
| 1 | 600 |
| 2 | 700 |
| 3 | 800 |
| 4 | 800 |
| 5 | 700 |
| 6 | 700 |
| 7 | 700 |
| 8 | 600 |
| 9 | 600 |
| 10 | 500 |
| 11 | 500 |
| 12 | 400 |
| 13 | 300 |
| 14 | 300 |
| 15 | 300 |
| 16 | 300 |
| 17 | 300 |
| 18 | 300 |
| 19 | 300 |
| 20 | 300 |
| 21 | 300 |
| 22 | 300 |
| 23 | 300 |
| 24 | 300 |

Source: Oshaug and Botten (1994).

Australia remains one of the very few western countries without ongoing and comprehensive national statistics on breastfeeding (Morrow and Barraclough, 1994; NHMRC, 1985). Only two national studies have ever been conducted, one reported by Palmer (1985), and the other by the Australian Bureau of Statistics (ABS, 1991) for 1983 and the period 1985–1989. These showed breastfeeding prevalence in the range 54–66% at 3 months, and 40–49% at 6 months during the 1980s, with around 78–86% of women breastfeeding at hospital discharge. However, both studies have been criticised as biased or unreliable (Bundrock, 1990; Lund-Adams and Heywood, 1996).

Studies at State or local level typically suffer from various inadequacies which limit their comparability and usefulness as measures of national trends. It is therefore necessary to construct estimates of breastfeeding prevalence in Australia in 1992 from a variety of national, State and local collections or studies by official or non-official researchers.

Estimated breastfeeding prevalence at monthly intervals for Australia are set out in Table 2. These are the percentage of mothers who have not completely ceased breastfeeding during a particular time, as in other similar studies (e.g. Berg, 1973;

Table 2
Estimated breastfeeding prevalence in Australia[a]

| Age (months) | 1972 (%) | 1992 (%) | National Health Target levels of breastfeeding (%) | Optimal (WHO) levels of breastfeeding (%) |
|---|---|---|---|---|
| Initiating | **60** | **76** | 90 | 95 |
| 1 | 48 | 70 | 90 | 95 |
| 2 | 37 | 64 | 90 | 95 |
| 3 | **26** | **58** | 80 | 95 |
| 4 | 22 | 53 | 80 | 95 |
| 5 | 18 | 48 | 80 | 95 |
| 6 | **15** | **43** | 80 | 95 |
| 7 | 14 | 39 | 39 | 95 |
| 8 | 13 | 35 | 35 | 95 |
| 9 | 12 | 33 | 33 | 95 |
| 10 | 11 | 27 | 27 | 95 |
| 11 | 10 | 24 | 24 | 95 |
| 12 | 9 | **20** | 20 | 95 |
| 13 | 8 | 18 | 18 | 95 |
| 14 | 7 | 15 | 15 | 95 |
| 15 | 6 | 12 | 12 | 95 |
| 16 | 5 | 9 | 9 | 95 |
| 17 | 4 | 8 | 8 | 95 |
| 18 | 3 | **6** | 6 | 95 |
| 19 | 2 | 6 | 6 | 95 |
| 20 | 1 | 5 | 5 | 95 |
| 21 | 1 | 5 | 5 | 95 |
| 22 | 1 | 4 | 4 | 95 |
| 23 | 1 | 4 | 4 | 95 |
| 24 | 0 | **3** | 3 | 95 |

[a]Bold font refers to survey-based data (NMAA, 1993; Lester, 1994; Jain, 1996). Other observations are linear interpolations.
Because the National Health Target does not specify breastfeeding targets for beyond 6 months, 1992 estimated prevalence is used for National Health Target prevalence after 6 months of age.
Source: see Appendix A.

Rohde, 1974; Greiner et al., 1979). The implied 'breastfeeding' rate therefore includes both fully and partially breastfeeding mothers.

Appendix A reviews available statistics on the prevalence of breastfeeding in Australian, and details the basis of Table 2.

In 1986, the Australian government set a target for breastfeeding by the year 2000 (Nutbeam et al., 1993). The target is for 90% of babies to be breastfeeding on discharge from hospital; 60% fully breastfeeding and 80% at least partially breastfeeding up to 3 months of age; and 50% fully and 80% at least partially breastfeeding at 6 months of age. These national breastfeeding targets are reflected in the fourth column of Table 2.

The optimum breastfeeding scenario may be defined by the WHO/UNICEF *Innocenti Declaration on the Protection, Promotion and Support of Breastfeeding*, signed

in 1990 by representatives from 30 countries (WHO/UNICEF, 1990). Optimal breastfeeding was quoted as:

> all infants should be fed exclusively on breast milk from birth to four to six months of age. Thereafter, children should continue to be breastfed while receiving appropriate and adequate complementary foods for up to two years of age or beyond.

Only 1–5% of women in industrialised countries are physiologically incapable of sustaining breastfeeding (WHO, 1991). Hence, 'optimal' breastfeeding, by the 95–99% of women physiologically capable of it, would involve exclusive breastfeeding until 4–6 months of age, and then continued breastfeeding for up to 2 years of age or beyond. This breastfeeding scenario, for up to 2 years only, is represented in the final column of Table 2.

*Valuation issues*

A key methodological issue is how breastmilk should be valued or priced. Most human milk production is not supplied to the market, and most human milk consumed is not acquired in the market. For this reason, it is necessary to value human milk production using a 'shadow price'.

Many studies of the economic value of breastfeeding estimate the 'cost avoided' or 'savings' from current breastfeeding by calculating the financial cost of replacing breastmilk with artificial formula milk. That is, using the price of formula as a 'shadow price' for valuing human milk.

For example, to estimate the cost of replacing human milk from recent declines in breastfeeding in Chile, Kenya, Singapore and the Philippines, Berg (1973) used data on breastfeeding prevalence to estimate national human milk output. Its economic value was then measured using a price of US$240 per ton of formula. The study by Greiner et al. (1979) for Ghana and the Ivory Coast estimated the value of national human milk production by calculating the local cost of the formula and bovine milk necessary to provide the equivalent calorie value if breastfeeding mothers switched to artificial feeding. Likewise, Rohde (1974) used the avoided cost of purchasing cows' milk for Indonesia's 1–2 year olds to calculate that the value of extended breastfeeding equalled 80% of the country's health budget.

However, the price of artificial formula is unsatisfactory for valuing human milk because human milk and artificial formula milk are not equivalent products.[3] Formula feeding does not match the health, nutritional, immunologic, developmental and psychological qualities of breastfeeding and human milk. Breastmilk is a 'species specific' infant food that is markedly different from, and 'uniquely superior' to, any artificial substitutes (AAP, 1997).

Advances in the study of human milk constituents show that human milk should

[3] See Minchin (1985, pp. 7–36) for a detailed discussion of the composition of human milk and formula.

be viewed as a 'broad-spectrum medicine' as well as nutrition (Fredrickson, 1995). Human milk promotes proper growth and development and good health because it is an active, living substance containing complex and important anti-bacterial, immunological, hormonal and growth enhancing elements.

While breastmilk adapts to the individual needs and environment of a particular baby, artificial formulas do not. As Newman (1997, p. 23) comments;

> even modern formulas are only superficially similar to breastmilk. Fundamentally they are inexact copies based on outdated and incomplete knowledge of what breastmilk is. Formulas contain no antibodies, no living cells, no enzymes, no hormones. They contain much more aluminium, manganese, cadmium, and iron than breastmilk. They contain significantly more protein than breastmilk. The proteins and fats are fundamentally different from those in breastmilk. Formulas do not vary from the beginning of the feed to the end of the feed, or from day 1 to day 7 to day 30, or from woman to woman or from baby to baby.

While artificially fed babies may survive and gain weight sufficiently, there is increasing evidence that not breastfeeding risks profound adverse health consequences.[4] In *developed* countries, babies who are not breastfed have twice the likelihood of illness of breastfed babies, with a 10-fold higher risk of hospitalisation for bacterial infection (Popkin et al., 1984).

Recent research provides strong evidence that babies who are not breastfed have substantially higher risk of otitis media and diarrhoeal disease, severe rotaviras gastroenteritis; respiratory illness, bacteraemia and bacterial meningitis, necrotising enterocolitis (NEC), botulism, and urinary tract infection. A number of studies link artificial feeding with allergy, juvenile insulin dependent diabetes (IDDM), multiple sclerosis and other auto-immune diseases; Crohn's disease, ulcerative colitis in adulthood and other chronic digestive diseases; Sudden Infant Death Syndrome (SIDS); heart disease; childhood lymphoma; and obesity (AAP, 1997).

Also evident is the important role of breastfeeding and human milk to the development of vision and the central nervous system, to brain, intelligence and cognitive development, and for superior long-term school performance, while other studies show breastfeeding reduces risks of malocclusion and tooth decay (Lucas et al., 1992; Rogan and Gladen, 1993; Birch et al., 1993; Desci and Koletzko, 1994; Lanting et al., 1994; Labbock and Hendershot, 1987; Horwood and Fergusson, 1998).

Important health benefits for mothers are also evident, including lower risk of premenopausal breast cancer, ovarian and cervical cancer and osteoporosis, and benefits of increasing child spacing, while health advantages for mothers due to reduced postpartum bleeding and lower blood loss from lactational amenorrhoea are well established (AAP, 1997; Brodribb, 1997). Lactation hormones facilitate mother–child

[4] See Micozzi (1995) on the complex links between early micronutritional imbalances in formula fed infants, and overnutrition, obesity and breast cancer in women.

bonding so that successful breastfeeding contributes to secure attachments and psychological well being (Newton, 1971; Brodribb, 1997; Kennell and Klaus, 1998).

Based on anthropological and prehistorical data, the 'natural' age of weaning is likely to be some time after 2 and 1/2 years of age (Dettwyler, 1995; Stuart-Macadam and Dettwyler, 1995; Fildes, 1995). Not surprisingly from an evolutionary perspective, the health, development and immunological benefits continue for as long as breastfeeding does (Gulick, 1986; Prentice, 1991).[5]

Even in the second year of life, breastfeeding is a substantial source of protein, fat, calcium and vitamins (Jelliffe and Jelliffe, 1978). Breastmilk also enhances absorption of nutrients from other foods, thereby increasing the nutritional value of the toddler's diet beyond the added value of the milk itself (Rohde, 1974). Immunities in breastmilk increase in concentration as the baby gets older (Goldman et al., 1983). Evidence is accumulating of an increasing 'dose-response' in health benefits—the longer the duration of breastfeeding, the greater the health benefit for the baby (see Fredrickson, 1995), and the mother (see Stuart-Macadam, 1995).

That expressed breastmilk or other mothers' milk, not artificial formula, is the recommended alternative where a mother cannot breastfeed emphasises that the latter is not the closest substitute for human milk (UNICEF/WHO/UNESCO, 1989; AAP, 1997).

If there were perfect knowledge and informed choices by consumers about such nutritional and health impacts of not breastfeeding, if infant feeding 'preferences' were meaningful, forward looking and faithfully reflected in decisions taken by their caregiver, and if there were no societal 'externalities' in the production or consumption of breastmilk, economic theory suggests that the market price of formula would more fully reflect its inferior nutritional and health qualities compared to human milk. Formula demand and price would be lower. A shadow price for breastmilk might be derived by increasing the commercial price of formula to account for the true economic value of expected additional health costs and lost benefits from not breastfeeding.

However, this approach is unrealistic, and is impractical for the foreseeable future. The ultimate 'consumer' is the baby, but the mother or caregiver, as 'agent' for the baby, may not properly reflect the infant's preferences or 'willingness to pay' in her decisions. Also, many of the health risks of not breastfeeding are not factored into the market price of formula. These costs are borne substantially by the baby, the individual parent or market purchaser of formula, and the wider community (and the infant) in the form of current and future health expenses.

Such an approach would also require comprehensive and detailed knowledge of all long-term as well as short-term health consequences of artificial feeding. The research agenda is shaped by the commercial interests of infant food manufacturers and producer interests as well as by scientific inquiry and public health priorities

[5] Some studies valuing breastmilk at the cost of artificial formula assume the price falls in the second year because the toddler is assumed to drink cows' milk rather than the more expensive formula milk. However, this is not based on evidence regarding the health benefits of human milk beyond 12 months of age, but the comparative merits of feeding the older baby unmodified, as against, modified, cows' milk.

(Palmer, 1988; Minchin, 1985; Baumslag and Michels, 1995). A prerequisite for accurate adjustment of formula prices would be a large quantity of high quality research generating accurate and reliable data on the relative risks of artificial feeding for different types of illness or condition, based on full understanding of how early infant nutrition affects long-term health. An extensive research program of 'cost of illness' studies would also be necessary before accurate estimates could be made. Only a handful of such studies on infant feeding presently exist.[6]

A great deal remains unknown about the long-term implications of infant nutrition, and given the limitations of knowledge, will remain so (Cunningham, 1995). Such gaps, or lags in the accumulation of knowledge about the diseases that result from formula feeding mean that notwithstanding attempts to adjust for breastmilk's superior qualities, the 'formula price' approach will result in significant downward bias in estimates of the value of breastfeeding.

The preferable, more accurate approach to determining an economic value for breastfeeding or human milk is to implicitly incorporate breastfeeding's health-protective effects in the shadow price by exploring ways of deriving a market value for expressed human milk or for replicating or replacing the services of a breastfeeding mother. In this sense, the study by Oshaug and Botten (1994) of the value of human milk production in Norway is path-breaking, being the first study to use a price for human milk to measure its national production value. Oshaug and Botten use the price of expressed breastmilk sold by the main hospital in Oslo to private persons or other hospitals (344 Kroner or $US50 per litre) to estimate the value of breastfeeding in Norway in 1992.

This approach represents one of three conventional economic methods used by economic statisticians for valuing unmarketed products (ABS, 1990). Establishing the price of expressed breastmilk prevailing in 'the market' created by medical facilities and individuals that trade in human milk[7] is a 'market alternative' valuation approach. The method has its problems, the price used by Oshaug and Botten for example, probably reflecting in substantial part the costs of supply and the particular economic and institutional characteristics of a particular small and restricted market.

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[6] See Broadfoot (1995) on the attributable hospitalisation costs associated with diarrheal disease in the UK; Riordan (1997) for US costs from higher rates of infant diarrhoea, respiratory syncytial virus, otitis media and insulin dependent diabetes mellitus (IDDM) in non-breastfed infants; and Drane (1997) for Australian estimates of attributable public hospitalisation costs from necrotising enterocolitis, gastroenteritis and ezcema. Drane also calculates the very high lifetime remedial education costs attributable to the IQ effects of not breastfeeding premature infants.

[7] In Europe or the US, some hospitals maintain human milk banks to provide for premature babies or other infants who cannot receive their own mothers' milk. In some cases milk is donated free by mothers, in other cases donors receive small gifts such as stationary as recompense for their effort. In some countries mothers receive payment. Milk banks vary in their approach to ensuring the safety of donor milk. Pasteurisation is known to prevent the transfer of HIV and related viruses, and is practiced by UK and US milk banks. However, some vitamins and immunological properties are lost through pasteurisation. Where there is a known donor and low risk of AIDS, the use of unpasteurised milk is acceptable. Norwegian milk banks screen donors, and test initial milk samples, using unpasteurised milk. Milk samples are also randomly tested.

It has the likely advantage on the other hand, of being a relatively well informed 'market', comprising mainly health practitioners and medical decisionmakers.

A second method, used to value human blood or sperm for national accounting purposes, is to price human milk at the time cost of extracting it. This is the 'opportunity cost' approach. Blood products are a good parallel because like breastmilk only a small amount is actually traded, although 'supply' and 'demand' is very large. An estimate of the time cost of expressed breastmilk might be derived, for example, by assuming that on average, expressing 150 ml of breastmilk would take approximately 1 h including transportation or travelling costs.[8]

Breastfeeding has long been a commercial activity in Western societies (Fildes, 1988), pointing to a third method of establishing a 'price' for human milk. This is the 'replacement cost' approach. In the past, many upper class European women employed wet-nurses to breastfeed their infants. Even as late as the turn of this century, French and Russian foundling hospitals employed commercial wet-nurses to reduce the appallingly high death rate for abandoned children. Average milk yields for commercial wet-nurses employed in French orphanages in the late 19th century are reported to be around 3 pints (1.875 litres) per day each, representing a maximum of 34 feeds per working day set for each wet-nurse (Wickes, 1953). Using such data, it is therefore possible to estimate the present day replacement cost of a breastfeeding mother's time by the cost of employing wet-nurses. The cost of replacing the breastfeeding functions of the mother with a commercial wet-nurse (the 'replacement cost' method) might be compared with the cost of employing a childcare worker, because breastfeeding requires certain skills as well as knowledge of infant care and handling.

As there are presently no human milk banks operating in Australia, this study takes the price of expressed human milk in Norway ($US50 or A$67 per litre) as the 'market alternative' price for breastmilk in Australia.[9]

Using the 'opportunity cost' approach suggests a wage rate of $11.16 per hour used by the ABS (1992, p. 23) for valuing 'other housework', to approximate the value of nursing mothers' time. In this case, the shadow price for donated human milk in Australia would be around A$75 per litre.

For the 'replacement cost' approach, the official wage for childcare workers in Australia in 1992 was around A$13 per hour. The cost of employing three such workers for an 8-hour day, and assuming average daily milk production per shift of 1.875 litres each, implies an approximate cost per litre of replacing mothers' milk of A$55.

[8] The mother of a premature baby, might travel three or four times a day to a regional hospital to deliver supplies of her expressed milk for her baby for several weeks until the infant is discharged into home care. It may take this mother an hour or more to express small amounts of around 50 ml, and the time cost of supplying this milk is very high. At the other extreme would be a mother with a well-established milk supply who expresses 100–150 ml in around 15–45 min, then stores the milk for once or twice daily transportation to a milk bank, or to her sick baby in hospital.

[9] All exchange conversions in this study are at a rate of $A1 = $US.75.

## Human milk production in Australia: results

This section reports estimates of Australia's human milk production for 1992. It also estimates two 'high case' breastfeeding scenarios, representing achievement of national targets for increasing breastfeeding, and of internationally defined 'optimal' breastfeeding patterns, and a 'low case' measuring the implications of breastfeeding rates falling to the low levels of 1972.

### *Estimates for 1992*

Based on the assumed prevalence of breastfeeding in 1992 and assumed daily milk yields as indicated in Tables 1 and 2, Australian women's production of human milk for infants up to 2 years old was approximately 33 million kg of human milk in 1992 (Table 3).

Table 3
Human milk production in Australia, 1992

| Age in months | Percent of infants breastfeeding at start of period | Average no. of infants living | No. of infants breastfed each month | Kg of breastmilk per infant per day | Estimated kg per month per infant | Production of breastmilk (million kg) |
|---|---|---|---|---|---|---|
| 0–1 | 76 | 264 151 | 200 755 | 0.60 | 18 | 3.67 |
| 1–2 | 70 | 264 151 | 184 906 | 0.60 | 18 | 3.38 |
| 2–3 | 64 | 264 151 | 169 057 | 0.70 | 21 | 3.60 |
| 3–4 | 58 | 264 151 | 152 415 | 0.80 | 24 | 3.71 |
| 4–5 | 53 | 264 151 | 140 000 | 0.80 | 24 | 3.41 |
| 5–6 | 48 | 264 151 | 126 792 | 0.70 | 21 | 2.70 |
| 6–7 | 43 | 264 151 | 114 906 | 0.70 | 21 | 2.45 |
| 7–8 | 39 | 264 151 | 103 019 | 0.70 | 21 | 2.19 |
| 8–9 | 35 | 264 151 | 92 453 | 0.60 | 18 | 1.69 |
| 9–10 | 33 | 264 151 | 87 170 | 0.60 | 18 | 1.59 |
| 10–11 | 27 | 264 151 | 71 321 | 0.50 | 15 | 1.09 |
| 11–12 | 24 | 264 151 | 63 396 | 0.50 | 15 | 0.96 |
| 12–13 | 20 | 257 247 | 51 449 | 0.40 | 12 | 0.63 |
| 13–14 | 18 | 257 247 | 46 304 | 0.30 | 9 | 0.42 |
| 14–15 | 15 | 257 247 | 38 587 | 0.30 | 9 | 0.35 |
| 15–16 | 12 | 257 247 | 30 870 | 0.30 | 9 | 0.28 |
| 16–17 | 9 | 257 247 | 23 152 | 0.30 | 9 | 0.21 |
| 17–18 | 8 | 257 247 | 20 580 | 0.30 | 9 | 0.19 |
| 18–19 | 6 | 257 247 | 15 435 | 0.30 | 9 | 0.14 |
| 19–20 | 6 | 257 247 | 15 435 | 0.30 | 9 | 0.14 |
| 20–21 | 5 | 257 247 | 12 862 | 0.30 | 9 | 0.12 |
| 21–22 | 5 | 257 247 | 12 862 | 0.30 | 9 | 0.12 |
| 22–23 | 4 | 257 247 | 10 290 | 0.30 | 9 | 0.09 |
| 23–24 | 4 | 257 247 | 10 290 | 0.30 | 9 | 0.09 |
| | | | | | Total (million kg) | 33.23 |

Table 4
Australia's human milk production, alternative pricing methods

| Valuation method | A$ billion pa |
|---|---|
| Market alternative | 2.2 |
| Opportunity cost | 2.5 |
| Replacement cost | 1.8 |

This has a value of A$2.2 billion at a 'market alternative' shadow price of A$67 per litre, equivalent to around 0.5% of GDP, or 15% of public spending on health. It is also equal to around 6% of private final consumption expenditure on food.

Using the replacement cost, rather than 'market alternative' price approach, (A$55 per litre), human milk production was worth A$1.8 billion. Using the opportunity cost approach, with a price of $77 per litre, human milk production in 1992 was A$2.5 billion (Table 4).

Thus a plausible range for the gross value of human milk production in Australia in 1992 was A$1.8–2.5 billion.

*National Health Target breastfeeding levels*

Increasing Australian breastfeeding rates in accordance with the National Health Target for breastfeeding would raise breastmilk production by around 10 million kg, worth $700 million pa at a 'market alternative' shadow price of A$67 per litre (Table 5). Achieving the Target would raise the national value of human milk production to A$2.9 billion, representing a 32% increase on 1992 levels.

*WHO/UNICEF optimal breastfeeding levels*

Although Australia has relatively high breastfeeding rates compared to most other Western countries, breastfeeding prevalence is well below 'optimal' levels as defined by the WHO/UNICEF *Innocenti Declaration*. If breastfeeding had been at such levels in Australia in 1992, the value of human milk production would have been A$3.4

Table 5
Production of human milk in Australia

| | 1972 | 1992 | National Health Target levels of breastfeeding | Optimal (WHO/UNICEF) levels of breastfeeding |
|---|---|---|---|---|
| Human milk volumes | 16 million kg | 33 million kg | 43 million kg | 84 million kg |
| Value of human milk production | $1.1 million | $2.2 billion | $2.9 billion | $5.7 billion |

billion higher, with a potential volume of production estimated at 84 kg pa (Table 5). The total value of production would have been A$5.7 billion at a 'market alternative' shadow price of A$67 per litre.

This is potentially worth around 1.3% of GDP, or 40% of public sector spending on health. It also represents around 17% of private final consumption expenditure on food in Australia.

Human milk consumed in the second year of life adds A$1.8 billion of the A$3.4 billion potential increase under the WHO/UNICEF optimal breastfeeding scenario in Australia. That is, a higher prevalence of breastfeeding into the second year would account for more than half the potential production gain from achieving optimal breastfeeding, even though daily production volumes are assumed to drop to 300 ml in the second year (Table 1).

*'Low case': 1972 breastfeeding rates*

As noted above, breastfeeding rates reached an all time low during the early 1970s. Only two in 10 babies were fully breastfed at 12 weeks compared to around six in 10 by 1992. Only around 11% were fully breastfeeding at 6 months of age (NMAA, 1993).

Based on Tables 1 and 2, total Australian production of breastmilk in 1972 was around 16 million kg. This was worth around A$1.1 billion pa at 1992 prices, again using the 'market-alternative' pricing method.

Australian breastfeeding rates for 1972 emphasise the potential annual losses in national human milk production from breastfeeding decline. Human milk production in 1972 was around 27 million kg lower than if National Health Target breastfeeding rates had prevailed. Compared to 1992 levels, this represents an annual loss of human milk worth A$1.8 billion or A$1.1 billion (Table 5).[10]

Judged against the WHO/UNICEF breastfeeding optimum, the annual production loss during Australia's 'mothers' milk famine' of the early 1970s was even greater, at 68 million kg or around A$4.8 billion pa.

## Discussion

This paper has estimated the value of breastmilk produced in Australia, and compared human milk production in 1992 with levels under three alternative scenarios.

The calculations use assumptions about daily milk yields, and estimates of national breastfeeding prevalence constructed from available statistics. Values determined for this output are based on the price of expressed human milk, of A$67 per litre.

As noted above, assumptions about daily milk yields used in this study are conservative, and could justifiably be increased for a developed country like Australia.

[10] Demographic changes between 1972 and 1992 have no significant effects on production estimates.

However, using the yields in Table 1 facilitates comparison with published estimates for Norway.

While some judgement underpinned construction of the breastfeeding prevalence estimates in Table 2, these estimates are sufficiently accurate for present purposes.

- Although there are inter-state differences in breastfeeding prevalence (Palmer, 1985), Victorian breastfeeding prevalence figures correspond closely with national data in the mid-1980s.[11] The national average is strongly influenced by Victorian patterns because this State accounts for around 25% of the Australian population.[12] If either the most optimistic or the most pessimistic breastfeeding prevalence rate for each age evidenced in existing studies is used to recalculate human milk production in 1992, the 33 million kg estimate varies 3–4 million kg (12%) either way.[13]
- Although the Table 2 estimate for total breastfeeding in 1972 is derived from data on fully breastfed infants, recent data suggests only around 3–4% of infants below 6 months are partially breastfed. Partial breastfeeding at this level has only a slight impact on the estimates of human milk production.[14] Deducting 4 percentage points from the Table 2 prevalence at each age up to 6 months to remove partial breastfeeding reduces the production estimate by 2 million kg.

The main area of debate relates to the method of valuing the human milk produced. For reasons noted earlier, this study argues that the price of artificial formula is not an adequate indicator of the economic value of human milk, and adjusting formula prices for the cost of illness associated with not breastfeeding will still considerably understate the true economic value of human milk output.

While three methods are canvassed for valuing human milk appropriately, the 'market alternative' is preferred.

- Using this method allows estimates of the value of Australia's human milk production which are directly comparable with those for Norway for the same year.
- While the price of expressed breastmilk used in the study may have some practical and conceptual problems, it is a more accurate representation of the economic value of human milk than the price of formula.

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[11] For example, for 1983 Palmer (1985) reports a 3 month national breastfeeding rate of 54% while Victorian data shows 52% fully and 3% partially breastfeeding at 3 months in 1985–86. Likewise the 40% prevalence reported by that study for age 6 months is identical to that for Victoria in 1985–86.

[12] Around 60% of Australia's population live in New South Wales (NSW) and Victoria. While there is only very sporadic, city-based breastfeeding prevalence data for NSW, the socio-economic characteristics of these two south-eastern states are broadly similar. A 1992 survey in Newcastle, a large industrial city in New South Wales, suggests a 61% breastfeeding rate (Redman et al., 1992), not significantly different from the Victorian 58%.

[13] In 1972, the range of estimates for breastfeeding initiation is from 59 to 73%, compared to the 60% used in this study. For 1992, the range of 84–88% compares with the 76% used here. At 3 months, a 1972 range of 23–31% compares with a Table 2 estimate of 26%, while the 1992 range is 51–62% compared to the estimate of 58%.

[14] A Tasmanian survey in 1974 showed a 6% partial breastfeeding rate. More recent surveys point to partial breastfeeding rates between 2 and 7%.

- The 'market alternative' method is also most consistent with national statistical procedures for valuing market production, and results can be directly compared with national accounting aggregates such as Gross Domestic Product (ABS, 1992). The Australian Bureau of Statistics used this method to estimate the economic value of unpaid work in Australia in accordance with the international convention for 'satellite accounts' of unmarketed household production (ABS, 1990).
- Although the economic theoretical 'willingness to pay' concept raises a number of fundamental issues about 'agency', and 'externalities' as well as information and preference formulation problems, the price which health providers will pay for human milk is likely to reflect a relatively informed view of its health benefits.

The results of this study show that production of human milk in Australia is significant in amount and economic value, and has risen dramatically since 1972. Further increases would be achieved if National Health Targets were met. Human milk output in Australia is presently only around a third of its potential if optimal breastfeeding were practiced according to the internationally agreed optimal standard specified by the WHO/UNICEF *Innocenti Declaration*.

The latter scenario for 'optimal' breastfeeding also highlights the potential economic importance of extending breastfeeding duration, and the extent of the production loss implicit in the present Australian practice of sub-optimal early weaning.

## Conclusions

Including human milk in national food production statistics emphasises the extent of breastfeeding and its value to societies as well as to economies. Incorporating human milk in food supply and other economic statistics improves the quality of economic policymaking and helps prevent policies being distorted by a narrow focus on market production and commercial objectives.

A national culture and institutions which are supportive of breastfeeding and of the transfer of breastfeeding knowledge and skills from one generation to the next in effect creates and maintains an asset that yields economic value for the community year after year.

However, there is no profit motivation to protect and promote a nation's breastfeeding culture and capability. Rather, there is a strong commercial incentive to undermine it. Protecting the breastfeeding 'resource', namely women's ability to breastfeed successfully, rests in the realm of public policy, and cannot be left to the market.

Because human milk is not included in GDP or other national economic statistics, potential gains in human milk production are given less priority than, for example, increasing commercial food production, in formulating public policy. Yet this study shows human milk is important enough economically that increasing breastfeeding in Australia ranks with major government microeconomic reform measures in raising national output.

For example, meeting the unambitious National Health Target for breastfeeding

in the year 2000 would increase human milk production by $500 million annually (0.1% of GDP); WHO/UNICEF optimal feeding of most Australian infants implies an national output rise of 0.7% of GDP. By comparison, the estimated economic output gain from major tax reform in Australia is around $1 billion or 0.2% of GDP (Chisholm, 1993), while for deregulation of telecommunications and public utilities it is 0.1–0.6% of GDP pa over 5–10 years (IC, 1995a, b; Quiggin, 1996). Tax reform and reform of telecommunications and public utilities are economic policy priorities for the Australian Government, but encouraging human milk production is not.

Likewise, infant feeding practices are significant to public health. Rising health costs are leading to a focus on preventing health problems, rather than treating illness and disease after it occurs. Breastfeeding is a key preventative health measure. Indeed, as a leading US physician and breastfeeding expert recently commented, for the many nations struggling with rising health costs, "affordable health care begins with breastfeeding" (Lawrence, 1995).

However, unless the nutritional and health value of human milk is clearly visible to policymakers, production of this unique food and 'broad-spectrum medicine' will be undervalued, and promoting breastfeeding will remain a low priority for governments. Human milk should be included in national and international economic statistics so that breastfeeding is given the importance it deserves in the formulation of economic, fiscal and preventative health policy.

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## Appendix A

For the purposes of this study, the requirements are for nationwide estimates of breastfeeding prevalence at intervals during the first 2 years of life. For comparability with the study by Oshaug and Botten, and the availability of a number of State estimates around that time, it is desirable to make an estimate for a year as close as possible to 1992. The most recent Victorian statewide data collated by NMAA are for 1992–93 (NMAA, 1993), while the Scott et al. surveys in Perth and Melbourne were in 1993–94 (Scott et al., 1996, 1997). On the other hand, national estimates by Palmer (1985), and ABS (1991) relate to the mid to late 1980s.

An estimate is therefore constructed for 1992 to represent recent breastfeeding prevalence in Australia. Likewise, breastfeeding reached its lowest levels in Victoria in 1971–72 (Fig. 1), and survey data is available for four other states around that time (for 1969 and 1972–74). An estimate of breastfeeding prevalence is thus also derived for 1972, representing the historic low point of breastfeeding in Australia.

Lester (1994) summarises and reviews most available breastfeeding statistics mainly using the compilation by the Nursing Mothers Association of Australia

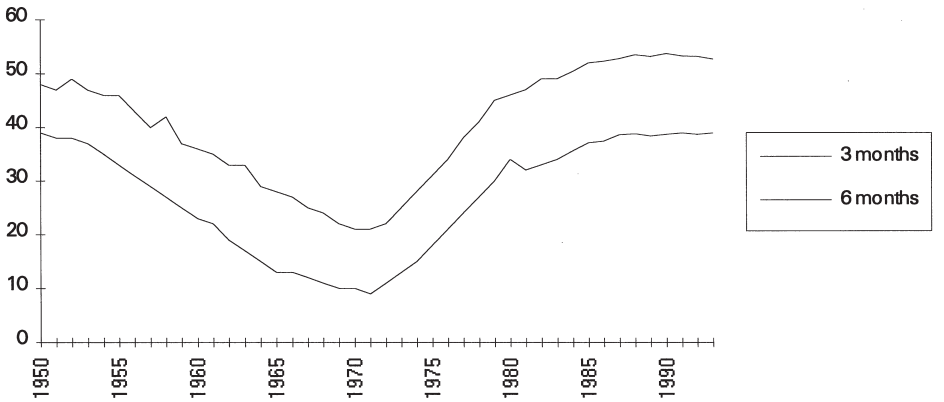


Fig. 1. Breastfeeding in Victoria, Australia, 1950–1993. Source: NMAA (1993, 1995).

(NMAA, 1993). Inconsistent definitions and measurement of breastfeeding rates, and varying methodologies make comparisons of breastfeeding rates over time and across states difficult.

There have been only sporadic collections at the state level, in Western Australia (Hitchcock et al., 1982; Hitchcock and Coy, 1988), Tasmania (Tasmania, 1952, 1966; Coy et al., 1970, 1976; Coy and Lowry, 1980; Hitchcock and Coy, 1988), South Australia (Boulton and Coote, 1979; SA, 1987), Queensland (Qld, 1976; Eaton-Evans et al., 1985), and NSW (Lawson et al., 1978; Allen and Heywood, 1979). More recently there has been a small survey by the Brotherhood of St Laurence in 1992 (Gilley, 1993), a study in Newcastle NSW (Redman et al., 1992), and in urban Queensland between 1982 and 1985 (Siskind et al., 1993; Landers et al., 1995).

However, only Victoria has statewide data consistently on a long-term basis, collected from infant health clinics for infants aged 3 and 6 months. The most recent Victorian data collated by NMAA is for 1992–93 (NMAA, 1995), while the surveys in Perth and Melbourne reported by Scott et al. (1996, 1997) were for 1993–94. National estimates by Palmer (1985), and ABS (1991) are for the mid to late 1980s.

Victorian statistics, reinforced by studies in other states, show breastfeeding prevalence in Australia dropped steadily during the 1950s and 1960s, and reached a low point in the early 1970s (Fig. 1). Breastfeeding increased strongly between the early 1970s and the mid-1980s, when it appeared to level off or perhaps decline. The Perth and Melbourne surveys appear to confirm that breastfeeding stabilised from the mid-1980s.

The main data source for the estimates in Table 2 is Victoria's annual clinic statistics on the prevalence of full breastfeeding among 66,000 infants at ages 3 and 6 months. This is supplemented by information from the national figures, and other data for various states available in NMAA (1993) and Lester (1994), and the more recent studies by Jain (1996) and Scott et al. (1996, 1997).

Initiation rates, which are not available from the Victorian clinic data series, are calculated by assuming initiation rates are about 30% higher than 3 month breastfeed-

ing rates, based on breastfeeding duration reported for other states and allowing for apparent discrepancies between rates reported by clinics, and those by hospitals.[15]

Information on 'non-minimal' breastfeeding (i.e. beyond 6 months) is sparse, but estimates of breastfeeding rates at 6 monthly intervals up to 2 years of age were derived from the reanalysis by Jain (1996) of the National Health Survey (ABS, 1991), together with data from national, Queensland and Tasmanian studies during the 1980s. Around one in five infants breastfeed at 12 months of age (NMAA, 1993; Lester, 1994), with National Health Survey data suggesting around 6% of infants receive breastmilk at 18 months and perhaps 3% at 24 months during the 1980s (Jain, 1996).

Within these intervals, monthly data points have been graphically interpolated on the assumption of a linear trend.

National Health Targets for breastfeeding do not specify a target for older babies so the estimates conservatively assume no increase from 1992 rates of breastfeeding by babies beyond 6 months.

For the WHO/UNICEF optimum, no estimate is made of gains from breastfeeding beyond 2 years, although the *Innocenti Declaration* recommends breastfeeding "up to two years and beyond".

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[15] Clinic figures may be up to 30% higher than statistics derived from hospital discharge data (Bundrock, 1990).

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