Bone stable isotope evidence for infant feeding in Mediaeval England

S.A. MAYS, M.P. RICHARDS & B.T. FULLER*

This paper is a first study of duration of breastfeeding using bone stable isotopes in infants in a British palaeopopulation, from the deserted Mediaeval village of Wharram Percy, England. Nitrogen stable isotope analysis suggests cessation of breastfeeding between 1 and 2 years of age. Comparison with Mediaeval documentary sources suggests that recommendations of physicians regarding infant feeding may have influenced common practice in this period.

Key-words: $\delta^{15}N$, breastfeeding, weaning, Mediaeval, Wharram Percy

Introduction

In most cultures, babies are breastfed initially, but at some point the infant is introduced to other foods and breastfeeding declines and eventually ceases, a process known as weaning. Infant feeding practices in past populations are becoming an increasingly important field of study. To some extent this can be viewed in terms of the rise of the archaeology of gender, which has resulted in an increased focus upon women's roles and activities in earlier societies. However, breastfeeding practices also have wider implications for population dynamics in earlier human groups. There is evidence that lactation suppresses ovulation, and so breastfeeding is a major determinant of fecundity and birth spacing in societies lacking reliable artificial contraception (Vitzthum 1994). This also has implications for maternal health, as lengthening the birth interval helps avoid the draining of maternal nutritional reserves associated with short-spaced, repeated pregnancies (Vitzthum 1994). Breastfeeding also promotes infant health because of the milk's immunological content, and because it enables early avoidance of potential infection from food and water (Katzenberg *et al.* 1996).

In an attempt to derive a biologically based 'hominid blueprint' for duration of breastfeeding, Dettwyler (1995) suggested, taking into account variables including length of gestation, birth weight and dental eruption patterns, that a *natural* age for cessation of human breastfeeding might lie in the range 2·5–7 years. However, cultural rather than physiological factors in influencing infant feeding practices in human societies are of great importance (e.g. Stuart-Macadam 1995).

Nitrogen stable isotope analysis of skeletal remains may be used to study duration of breastfeeding in palaeopopulations. There are two stable isotopes of nitrogen, ^{14}N and ^{15}N, and the ratio of the two, the nitrogen stable isotope ratio, is measured by $\delta^{15}N$, expressed in parts per thousand (‰). $\delta^{15}N$ increases as one ascends a food chain, the magnitude of the trophic level effect being approximately 3–4‰ (Schwarcz & Schoeninger 1991). A foetal or newborn infant has a $\delta^{15}N$ similar to that of its mother. Breastfeeding infants are in effect consuming their mother's tissues, so that they are at a higher trophic level. $\delta^{15}N$ rises during breastfeeding to give a collagen $\delta^{15}N$ about 3–4‰ greater than maternal collagen. During the weaning process, as mother's milk is replaced by other foods, $\delta^{15}N$ normally declines (Mays 2000: 429).

In recent years, a number of studies using nitrogen isotopes to investigate infant feeding in palaeopopulations have appeared (refs. in Mays 2000). However, little work has been done on populations outside North America (although see Dupras *et al.* 2001). The present work rep-

* Mays, Ancient Monuments Laboratory, English Heritage Centre for Archaeology, Fort Cumberland, Portsmouth PO4 9LD, England. simon.mays@english-heritage.org.uk Richards, Department of Archaeological Sciences, University of Bradford, Bradford BD7 1DP, England; Fuller, Department of Biochemistry, University of Oxford, South Parks Road, Oxford OX1 3QU, England.

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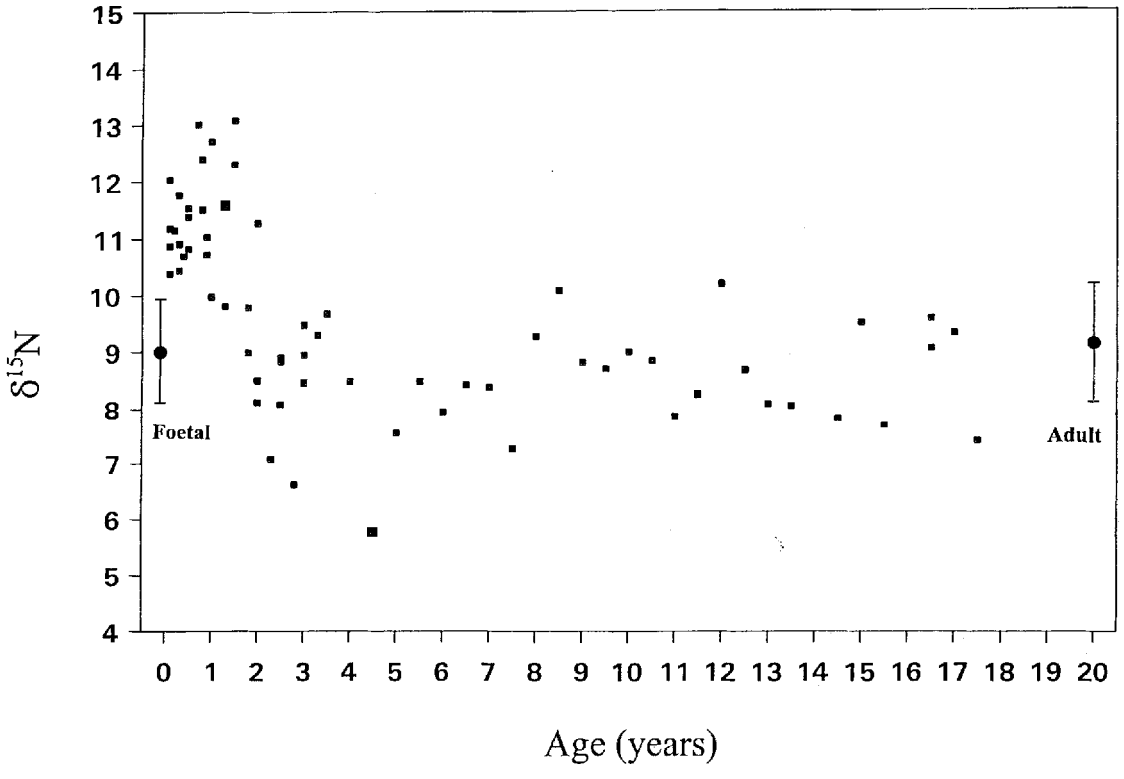

FIGURE 1. *Rib $\delta^{15}N$ data for immature individuals (aged from birth to 17 years) from Wharram Percy (N=65). Mean values for foetal material (aged 28–39 weeks gestation; N=5) and adults (aged 18+ years; N=29) are superimposed.*

resents a first application of nitrogen isotope analysis to investigate infant feeding in a British palaeopopulation.

This study

The study material comes from the churchyard at the deserted Mediaeval village of Wharram Percy, North Yorkshire, England (Beresford & Hurst 1990). The skeletal material dates primarily from the 10th–16th century AD, and represents interments of ordinary peasants; the assemblage was chosen because it provides a large sample of infant and child skeletons for study. The existence of Mediaeval documentary sources concerning infant feeding provides an opportunity to compare archaeological and written evidence.

Collagen was extracted and analysed, following protocols outlined elsewhere (Richards & Hedges 1999), from ribs of 99 individuals, of which 70 were infants or juveniles and 29 were adult (aged 18+ years). Age was determined using dental development (Schour & Massler 1941). Mean error in age estimation using this technique is likely to be about 0·1 years in those under 5 years (Liversage 1994). Long-bone lengths (Scheuer *et al.* 1980) were used to provide more precise age estimates (to within about 2 weeks) for perinatal material.

Results (FIGURE 1)

As expected on theoretical grounds, $\delta^{15}N$ for foetal skeletons (herein taken to be those aged under 40 weeks gestation) resemble adult values. From birth onwards there is a rapid rise in $\delta^{15}N$, presumably reflecting the incorporation of the isotopic signal of breastmilk into rib collagen. Highest $\delta^{15}N$ occur at about one year and are about 3–4‰ greater than foetal or adult values. This is in accord with the generally accepted magnitude of the trophic level effect in $\delta^{15}N$. After this age, nitrogen isotope ratios show a rapid decline, so that by about 2 years of age they once more resemble adult values.

Discussion

Mediaeval documentary evidence on infant feeding is sparse and comes mainly from medical

works, many of which were heavily influenced by Classical authorities such as Soranus and Galen. These works generally recommended cessation of breast-feeding by about two years. In addition, some writers recommended that boys be weaned from the breast 6–12 months later than girls. However, the sources give no adequate indication of whether this influenced common practice (Fildes 1986: 45–58, 66).

Our data suggest that at Wharram Percy, cessation of breastfeeding normally occurred when the infant was between about one and two years of age. Although it seems clear that breast milk was no longer making a detectable contribution to diet by about two years, it is difficult to be more precise about the timing and duration of weaning because of uncertainties over collagen turnover rates in the bones of the young. It is possible, however, that work currently in hand involving micro-sampling of collagen from dentine of deciduous teeth from Wharram Percy may help here. In addition, one could make the case that, because the present results are based upon individuals who failed to survive childhood, they may not wholly typify feeding regimes for those who did survive — weaning practices as reconstructed here may have been an unsuccessful strategy which increased risk of death at weaning. Although the lack of a marked peak in infant numbers in the Wharram Percy collection as a whole at our inferred age of weaning (N=30 for the interval 1–2 years, against 69 and 21 for preceding and succeeding one-year lustra) suggests that this was not the case, on-going work on the analysis of dental material from older children who did survive the weaning period may help address the question of mortality bias more fully.

The inferred duration of breastfeeding at Wharram Percy appears somewhat earlier than the age range suggested by Dettwyler (1995) as 'natural' for the human species, emphasising the primacy of cultural rather than physiological factors in influencing breastfeeding practices in human populations. In general, our inferred age at cessation of breastfeeding appears to correspond fairly well with that recommended by Mediaeval physicians. The strong age-related pattern in $\delta^{15}N$ between one and two years, with little spread of data points, indicates relatively restricted inter-individual variation in timing of weaning, suggesting that breastfeeding duration was generally constrained by community-wide cultural factors rather than decisions being made freely according to individual circumstances. That the patterning in the results is consistent despite the fact that the Wharram Percy burials cover a period of at least 600 years, suggests that culturally accepted patterns of weaning may have remained essentially unchanged for a prolonged period in this rural community.

Given the problems of sexing immature skeletal remains, it is difficult to comment upon whether there was a systematic difference in duration of breastfeeding accorded to male and female infants, as recommended by some Mediaeval writers. The close clustering of datapoints, referred to above, may suggest that if a sex difference did exist it was not very great.

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