Invited commentary

Fatty acid profiles of maternal adipose tissue in relation to infant development

There is considerable debate at present about the merits of adding long-chain polyunsaturated fatty acids (LC-PUFA), namely docosahexaenoate (DHA) and arachidonate (AA), to infant formulas. Some agencies, especially in Europe, have endorsed this practice, resulting in the availability of LC-PUFA-enriched formulas. Others, including the recent Life Sciences Research Office report commissioned by the American Food and Drug Administration (LRSO Report, 1998), continue to recommend exclusion of LC-PUFA from infant formulas.

One important reason for including DHA and AA in infant formulas is that their absence prevents the infant brain from accumulating DHA at a rate comparable to that in breast-fed infants (Farquharson *et al*. 1992; Makrides *et al*. 1994). Taking into account both brain growth rate and the actual amount of DHA in the brain, the rate of brain DHA accumulation in formula-fed infants not receiving DHA or AA is about 50 % of that in breast-fed infants (Cunnane *et al*. 1999) and is independent of the intake of α-linolenic acid (Farquharson *et al*. 1992). Unlike most tissues, the brain is relatively resistant to changes in fatty acid intake so this degree of DHA depletion from the brain is a fairly clear indication of a conditional requirement by infants for dietary DHA.

Normal reference values for the PUFA content of human tissues are only sparsely available but are valuable for better defining the conditional DHA requirement in infants. These measurements are semi-standardized in many laboratories and animal studies have clearly demonstrated the link between low brain DHA content and poor vision and cognitive function. Restricted access to human tissue material has meant that only the fatty acid profiles of infant plasma have really been studied in any depth. Nevertheless, infant brain fatty acid profiles are starting to become better known (Farquharson *et al*. 1992; Martinez, 1992; Makrides *et al*. 1994), and, with further research, will clarify the importance of the reports that brain DHA accumulation is impaired in the absence of dietary DHA.

By reporting the adipose tissue fatty acid profile of women of childbearing age, the paper by Pugo-Gunsam *et al*. (1999) makes an important contribution towards expanding the database for tissue fatty acid profiles of living humans. Maternal supplies of PUFA are predominantly in adipose tissue but little is known about the possible relationships between these maternal PUFA stores and pregnancy outcome, milk fatty acid profiles or infant health. In adults it is as ethically appropriate to collect a needle biopsy of fat as a blood sample, but the former may be more valuable because it represents long-term stores of PUFA. More information about adipose tissue fatty acid profiles is necessary to understand better how maternal PUFA supply to the fetus and/or breast-feeding infant may be related to infant health and development. Measuring fatty acid profiles of adipose tissue biopsies therefore provides a potentially important perspective on the PUFA adequacy of mothers, fetuses and infants.

Fatty acid profiles of adipose tissue biopsies from living infants have not been reported but if they had a clear diagnostic value, this should become an acceptable, if limited, procedure. Further work with necropsy samples will still be required, but attempts to broaden the frame of reference linking tissue PUFA levels to normal *v.* abnormal infant development are needed to resolve the amount of dietary LC-PUFA that is required to support normal development fully in the first year of life.

Fatty acid profiles of neonatal adipose tissue obtained at necropsy after sudden death indicate that breast-fed infants retain some adipose DHA 6 months postnatally but this store is completely depleted in formula-fed infants (Farquharson *et al*. 1993). We have calculated that the term infant is born with about 1 g DHA in adipose tissue (Cunnane *et al*. 1999). Despite this store, the formula-fed infant that is not consuming DHA cannot sustain brain DHA accumulation equivalent to that of breast-fed infants (Farquharson *et al*. 1992). Estimated lean tissue DHA accumulation is also seriously impaired in formula-fed infants (Cunnane *et al*. 1999). Thus, while some studies may have difficulty in identifying functional deficits in infants that are not consuming DHA (LSRO Report, 1998), it may well be that such deficits are occurring in tissues other than the brain and eye. Hence, tissue fatty acid data provide some of the strongest evidence to date in support of a conditional DHA requirement in term infants.

The paper by Pugo-Gunsam *et al*. (1999) also reports that growth over the first 6 weeks of life was comparable in healthy term infants born to French compared with Mauritian women, regardless of significant differences in infant erythrocyte fatty acid profiles in these two culturally and geographically distinct locations. They showed that a difference of almost two-fold can exist in the DHA content of infant erythrocyte phosphatidylethanolamine without growth being significantly different in the first 6 weeks of life, a period during which body weight increased about 40 %. Hence, erythrocyte and, by inference, plasma fatty acid profiles are not necessarily predictive of normal infant growth or health.

In conclusion, broadening the database for human tissue fatty acid profiles is important to define better the conditional requirement for LC-PUFA in infants and to evaluate health and nutritional status at other stages of the lifecycle.

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References

Cunnane SC, Francescutti V, Brenna JT & Crawford MA (1999) Whole body fatty acid accumulation data suggest that without pre-formed dietary docosahexaenoate, the formula-fed infant cannot meet its docosahexaenoate requirement. *Proceedings of the Nutrition Society* (In the Press).

Farquharson J, Cockburn F, Patrick WA, Jamieson EC & Logan RW (1992) Infant cerebral cortex phospholipid fatty acid composition and diet. *Lancet* **340**, 810–813.

Farquharson J, Cockburn F, Patrick WA, Jamieson EC & Logan RW (1993) Effect of diet on infant subcutaneous tissue triglyceride fatty acids. *Archives of Diseases in Childhood* **69**, 589–593.

LSRO Report (1998) Assessment of nutrient requirements for infant formulas. *Journal of Nutrition* **128**, 2059S–2078S.

Makrides M, Neumann MA, Byard RW, Simmer K & Gibson RA (1994) Fatty acid composition of brain, retina and erythrocytes in breast- and formula-fed infants. *American Journal of Clinical Nutrition* **60**, 189–194.

Martinez M (1992) Tissue levels of polyunsaturated fatty acids during early human development. *Journal of Pediatrics* **120**, 129S–138S.

Pugo-Gunsam P, Guesnet P, Subratty AH, Rajcoomar DA, Maurage C & Couet C (1999) Fatty acid composition of white adipose tissue and breast milk of Mauritian and French mothers and erythrocyte phospholipids of their full-term breast-fed infants. *British Journal of Nutrition* **82**, 263–271.