Scientists Found in Nine Countries that Breast Milk isn't the Same Everywhere

Researchers established reference values for mature human milk energy, macronutrients, fatty acids, and gangliosides among mothers of healthy, breastfed infants growing according to World Health Organization (WHO) standards. The analysis found substantial differences in fatty acid and ganglioside concentrations between countries.

The research was conducted primarily by scientists from Nestlé Research in Lausanne, Switzerland, in collaboration with the Department of Pediatrics at the University Medical Center Groningen in the Netherlands.



Study

The researchers conducted a pooled analysis of three observational, longitudinal studies involving mothers and infants from nine countries: France, Italy, Norway, Portugal, Romania, Spain, Sweden, the Philippines, and Singapore. The original studies included 450 mother-infant pairs and collected human milk samples and infant growth measurements during the first four months of lactation.

Eligible participants were healthy, nonsmoking mothers with a healthy prepregnancy body mass index (BMI) of 18.5–24.9 kg/m^2 and no specified medical conditions. Infants were required to be born at term, predominantly breastfed, and monitored using available growth measurements. Growth classification followed WHO standards using weight-for-age, length-for-age, and weight-for-length z-scores. Of the 450 infants, 24 lacked sufficient growth data. Among the remaining 426, 364 infants were classified as growing normally. Of these, 305 had mature milk samples available.

Milk samples from a single breast were collected in the morning using standard procedures. Only mature milk collected more than 21 days after delivery was analyzed. The researchers measured energy, total fat, and lactose using a mid-infrared human milk analyzer. Protein, fatty acids and gangliosides were measured using established laboratory techniques. Using a random-effects meta-analysis, the researchers generated pooled estimates that accounted for differences between countries. Infant growth was used to select the reference population; the researchers did not test whether milk composition influenced growth.

Findings

The final analysis included mature human milk samples from 305 mother-infant pairs. The infants had a mean gestational age of 39.3 weeks and an average birth weight of 3.35 kg (7.36 lb). Just over half were boys, and most were delivered vaginally. The mothers had a mean age of about 31 years and an average BMI of 22.5 kg/m^2.

The pooled mean energy content of human milk was 71.24 kcal/100 mL, ranging from 58.70 kcal/100 mL in Italy to 83.05 kcal/100 mL in Norway. The mean total fat concentration was 4.21 g/100 mL, with country-specific values ranging from 2.85 g/100 mL in Italy to 5.29 g/100 mL in Norway. The Norwegian estimates came from only nine mother-infant pairs. Protein concentration averaged 1.26 g/100 mL, while lactose concentration averaged 7.18 g/100 mL. Lactose and protein concentrations varied less between countries than many fatty acid measures.

Saturated fatty acids (SFAs) and monounsaturated fatty acids (MUFAs) accounted for about 42% and 41% of total fatty acids, respectively. The Philippines had the highest SFA proportion (about 52%), whereas Spain had the lowest (about 38%). Norway recorded the highest MUFA proportion, while Romania had the lowest. Polyunsaturated fatty acids (PUFAs) represented about 16% of total fatty acids, ranging from 11% in the Philippines to 22% in Romania.

Omega-3 (n-3) PUFAs averaged 1.34%, with the highest proportion in Norway (2.49%) and the lowest in the Philippines (0.41%). Omega-6 (n-6) PUFAs averaged about 15%. The pooled proportions of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) were 0.09% and 0.38%, respectively. These percentages describe fatty acid composition, not the proportion of total milk volume.

The researchers also measured two major milk gangliosides, GM3 and GD3. Their mean concentrations were 0.88 and 0.24 mg/100 mL, respectively. Both showed geographical differences, particularly GM3, with the highest concentrations observed in Spain. Only five mother-infant pairs contributed to the Spanish estimates.

Conclusion

The study established reference values for mature human milk energy, macronutrients, fatty acids, and gangliosides among mothers breastfeeding healthy, term infants with normal growth according to WHO standards. Fatty acids and gangliosides showed particularly marked variation between countries. The researchers used data from nine countries and standardized laboratory methods to document variation in milk composition across the participating populations. These reference values may help researchers, clinicians, and product developers understand nutrient concentrations in human milk and inform future nutritional recommendations.

The findings are descriptive and do not establish optimal milk composition or show that any measured component caused healthy growth. The researchers did not measure the volume of milk infants consumed or fully account for factors such as maternal diet and delivery method. Substantial variation between countries, together with small samples in some locations, limits how widely the estimates can be applied. Most samples came from European populations, with no participants from Africa, the Americas, Australia or New Zealand.

Further investigations should include more geographically diverse populations and examine factors influencing milk composition. The study was funded by Société des Produits Nestlé S.A., and all authors were current or former employees of the company.

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