

# **Copenhagen Cohort Study on Infant Nutrition and Growth: Breast-milk intake, human milk macronutrient content, and influencing factors**

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**Jean Liu, 3/10/15**

# Introduction

- In affluent countries, there is a pattern in increased prevalence in breast feeding
- Majority of human milk intake studies are cross-sectional or small selected groups for a longer time period
  - this study follows human milk intake, macro content, macro intake, in a random cohort, describing changes during different stages in lactation (mother-infant pairs terminating breast feeding early and continue for extended periods)
- Breast feeding statuses
  - exclusive = allowed supplements of water, camomile tea w/o sugar or milk and vitamins
  - partially = breast-feeding at least once a day
- **Foremilk** = milk before feeding the infant
- **Hindmilk** = milk after finishing feeding the infant

# Rationale

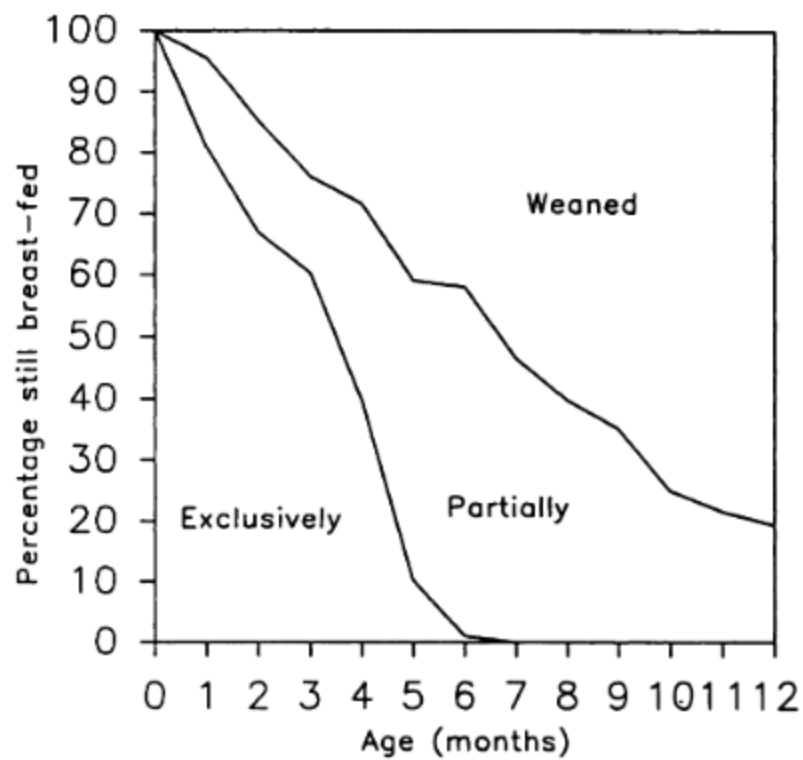
Purpose: Describe food intake, growth, blood indexes, in a cohort representing healthy term infants in Copenhagen and the interrelation of the indexes

- Give a detailed description of human milk intake and protein, fat, carbohydrate, and energy contents of human milk, with the analysis of influencing factors
- Describe the nutritional role of breast feeding

Hypothesis: Maternal fat stores laid down during pregnancy are easier to metabolize during lactation than are other fat stores and, if low, may limit milk fat when exhausted.

# Methods

- Criteria: parents of Danish origin, singleton births, 37-41 week gestational age, no neonatal disease/malformation
- 251 infants born at Hvidovre Hospital → randomly assigned to:
  - study group (91/139; 65% until 12 mo)
  - control group (87/112; 96% until 12 mo)
- Control: examine if frequent contacts between families and investigators was influencing feeding pattern starting @ 9 mo
- Test weighing of milk intake: mothers instructed to use electronic balance programmed to average 40 weighings within 10 seconds
- Weighings were done when infants were 2, 4, and 9 months of age during periods of 2, 2, and 5 days respectively
  - the duration of each feed was registered



**FIG. 1.** Duration of exclusive and partial breast-feeding among the 91 study participants.

# Methods cont.

- Milk samples: collected 4 days after delivery, 14 days after delivery, and every 2 weeks up to 3 months after delivery
  - 8 mL sample of foremilk and hindmilk
  - samples frozen until analyzed
- Blood samples: from infants at 2 months by venipuncture
- Maternal/family characteristics: mother's heights and prepregnancy weights self reported
  - education, smoking habits, social class, etc through a questionnaire

# Results

- total of 1382 milk samples from 88 mothers
  - 713 foremilk
  - 669 hindmilk
- 79% of the 1750 samples that were to be collected
- decline in protein content until 6 months after delivery
- fat concentration changed linearly between foremilk and hindmilk samples - increased
  - varied significantly from woman to woman
  - fat concentration dependent on post-delivery weight gain
- carbohydrates also linear with time, increased overall
  - foremilk and hindmilk samples did not depend on time
  - average concentration of hindmilk was 3 g/L lower than foremilk

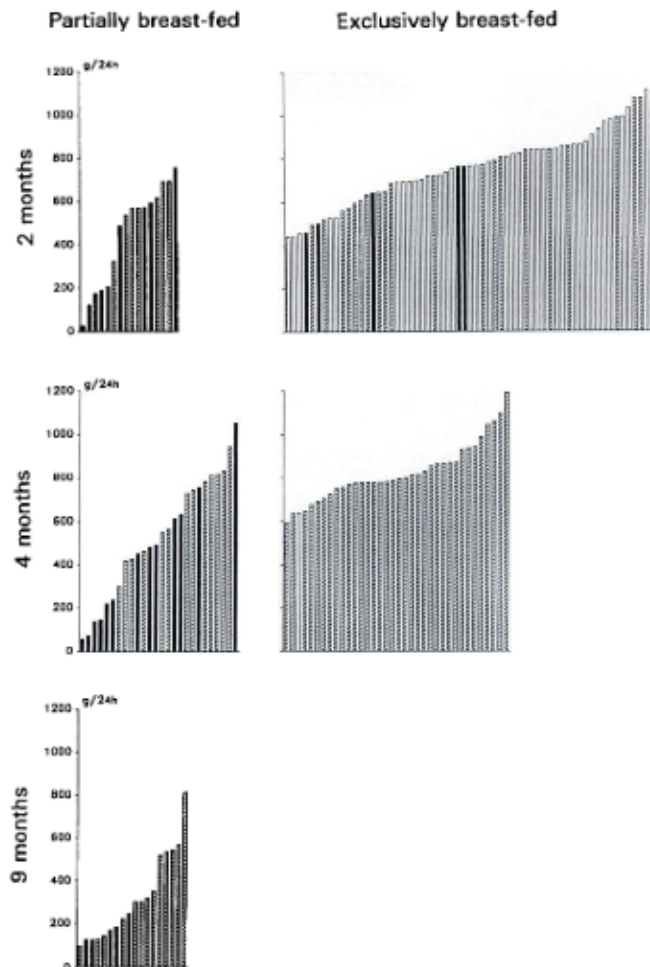


FIG. 2. Milk intake in individual infants in relation to age and breast-feeding status. The pattern of each bar relates to the breast-feeding status of the same infant 2 mo later: □, exclusively breast-fed; ■, partially breast-fed; ■, not breast-fed.

TABLE 2

Energy and protein intakes, energy concentration of breast milk, breast milk intake, number of meals, and duration of feedings in exclusively and partially breast-fed infants

	Exclusively breast-fed				Partially breast-fed			
	Value	Percentiles			Value	Percentiles		
		10th	50th	90th		10th	50th	90th
<b>Daily energy intake (kJ/kg body wt)</b>								
2 mo	428 ± 82 [60]*	299	423	523	269 ± 108 [15]	96	299	393
4 mo	381 ± 74 [36]*	270	385	488	236 ± 114 [23]	68	224	438
9 mo	—				108 ± 73 [18]	38	88	245
<b>Daily protein intake (g/kg body wt)†</b>								
2 mo	1.31 ± 0.27 [60]	0.99	1.26	1.70	0.84 ± 0.35 [15]	0.24	0.98	1.22
4 mo	1.01 ± 0.17 [36]	0.83	1.00	1.22	0.62 ± 0.33 [26]	0.14	0.59	1.02
9 mo	—				0.29 ± 0.20 [18]	0.10	0.24	0.60
<b>Energy concentration of breast milk (MJ/L)</b>								
Ages combined‡	3.07 ± 0.44 [96]	2.55	3.09	3.67	2.91 ± 0.47 [64]§	2.24	2.89	3.49
<b>Daily volume (g)</b>								
2 mo	754 ± 167 [60]	506	765	989	488 ± 232 [16]	97	553	713
4 mo	827 ± 139 [36]	645	795	1057	531 ± 277 [26]	121	524	680
9 mo	—				318 ± 201 [18]	125	276	596
<b>Daily volume (g/kg body wt)</b>								
2 mo	140 ± 24 [60]	106	140	168	88 ± 42 [16]	19	107	130
4 mo	124 ± 17 [36]	103	120	150	80 ± 38 [26]	19	81	128
9 mo	—				36 ± 22 [18]	13	32	74
<b>Number of breast-feedings per day</b>								
2 mo	6.9 ± 1.8 [60]	5.0	6.5	9.0	5.5 ± 2.1 [16]	3.5	5.0	8.0
4 mo	7.1 ± 1.9 [36]	5.0	6.5	10.5	5.4 ± 2.8 [26]	1.5	5.0	10.0
9 mo	—				3.4 ± 1.7 [18]	1.0	2.8	5.0
<b>Duration of feedings (min/d)¶</b>								
2 mo	154 ± 43 [60]	101	151	205	127 ± 47 [14]	44	138	188
4 mo	121 ± 37 [35]	79	125	171	87 ± 37 [24]	29	93	137
9 mo	—				45 ± 24 [15]	12	42	89

\*  $\bar{x} \pm SD$ ;  $n$  in brackets.

† Values represent true protein.

‡ No significant differences between ages.

§ Significantly different from exclusively breast-fed group,  $P = 0.03$ .

¶ Information missing on some registrations.



**TABLE 4**  
**Protein, fat, and carbohydrate concentrations of milk\***

	Percentiles		
	10th	50th	90th
	<i>g/L</i>		
<b>Protein†</b>			
4 d ( <i>n</i> = 74)	14.8	17.3	21.8
14 d ( <i>n</i> = 75)	10.3	12.7	17.0
28 d ( <i>n</i> = 79)	9.4	11.0	13.2
42 d ( <i>n</i> = 62)	8.4	10.2	12.3
56 d ( <i>n</i> = 60)	7.8	9.4	11.2
70 d ( <i>n</i> = 59)	7.5	9.1	11.2
84 d ( <i>n</i> = 54)	7.2	8.7	10.8
4 mo ( <i>n</i> = 41)	7.2	8.2	10.3
5 mo ( <i>n</i> = 35)	6.5	8.1	10.2
6 mo ( <i>n</i> = 27)	6.0	7.7	10.1
7 mo ( <i>n</i> = 15)	6.6	7.9	9.8
8 mo ( <i>n</i> = 14)	6.5	7.7	9.3
<b>Fat</b>			
Ages combined ( <i>n</i> = 661)	23.8	39.2	58.7
Foremilk ( <i>n</i> = 713)	12.9	24.5	42.4
Hindmilk ( <i>n</i> = 669)	29.3	53.3	80.8
<b>Carbohydrate</b>			
Ages combined ( <i>n</i> = 661)	67.2	71.5	74.2

\* All values are means of the fore- and hindmilk sample, except where fore- and hindmilk are specified. Only samples collected within  $\pm 4$  d of the scheduled collection date are included.

† Values represent true protein.

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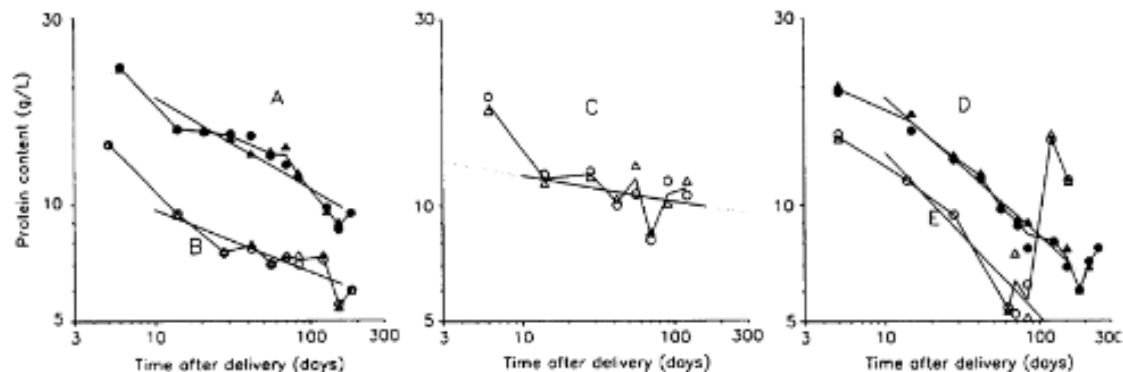


FIG. 4. Protein concentration of foremilk (○) and hindmilk (△) against time after delivery for five different mothers representing different patterns: A, high, medium decrease; B, low, medium decrease; C, medium, slow decrease; D, steep decrease; E, steep decrease, late increase. The broken lines connect the means of fore- and hindmilk. The straight lines represent the fitted relation between protein concentration and time. Only values between 10 and 161 d have been included in the regression. Both axes are logarithmic. Symbols are shaded only to distinguish between different patterns within one graph.

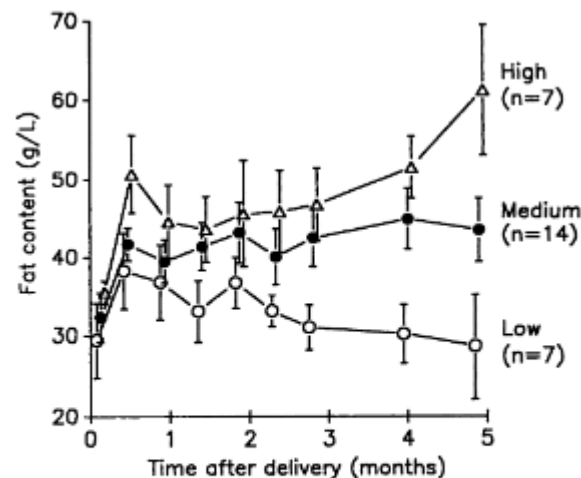


FIG. 7. Fat concentration in human milk in relation to time after delivery in three groups of mothers with different weight gain during pregnancy: low (< 11.2 kg), medium, or high (> 16.8 kg). Error bars indicate  $\pm$  SEM.

# Discussion/Conclusion

- Study was a detailed a description of milk intake, macronutrient concentration, and intake in a representative cohort of healthy infants in Copenhagen
- Data shows a large variation in macronutrient concentration of individual breast milk, therefore a large variation in intake among healthy infants
  - Differences in protein intake among exclusively breast-fed infants reflected in urea nitrogen concentrations in the blood
- Milk intake was mainly determined by the current weight of the infant, the height of the mother, and the infant gender
- Positive association between pregnancy weight gain and milk fat concentrations
- Very large variation of milk intake of infants being partially breast-fed

# Questions?

