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Evidence of chronic undernutrition in late 19th century German infants of all social classes

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Abstract

125 years ago, European infants grew differently from modern infants. We show weight gains of 20 healthy children weighed longitudinally from birth to age 1 year, published by Camerer in 1882. The data illustrate the historically prevalent concepts of infant nutrition practiced by German civil servants, lawyers, merchants, university professors, physicians, foresters and farmers. Breastfeeding by the mother was not truly appreciated in those days; children were often breastfed by wet nurses or received bottled milk. Bottle feeding mainly used diluted cow's milk with some added carbohydrates, without evidence that appropriate amounts of oil, butter or other fatty components were added. French children from 1914 showed similar weight gain patterns suggesting similar feeding practices. The historical data suggest that energy deficient infant formula was fed regularly in the late 19th and early 20th century Europe, regardless of wealth and social class. The data question current concerns that temporarily feeding energy deficient infant formula may warrant serious anxieties regarding long-term cognitive, social and emotional behavioral development.

Take-home message for students Historical data suggest that energy deficient infant formula was fed regularly in late 19th and early 20th century Europe, regardless of wealth and social class. The data question current concerns that temporarily feeding energy deficient infant formula may warrant serious anxieties regarding long-term cognitive, social and emotional behavioral development.

Introduction

In the late 19th century, European infants grew differently from modern infants. Whereas their intrauterine growth appears to closely match modern references, with birth weights that only slightly differed from modern birth weights (Boyd, 1980), postnatal increments in length and weight were markedly less rapid than suggested by modern standards (Hermanussen et al., 2018; Wilke et al., 2021). James Tanner was among the first to plot a few historical infant weight data on modern reference charts (Tanner, 1981), but these first compilations lack information on variation and, in particular, information on infant nutrition.

The history

In 1882, the well-known German physician Johann Friedrich Wilhelm Camerer (1842–1910), a pioneer in the field of infant and child nutrition and metabolism, who also contributed important work on the composition of breast milk, meticulously described feeding and weight gain in 20 healthy infants and one large for gestational age child (Camerer, 1882). The data, though certainly not obtained from a truly representative sample, illustrate the historically prevalent concepts of infant nutrition practiced by German civil servants, lawyers, merchants, university professors, physicians, foresters and farmers. Quite in contrast to modern practice, breastfeeding by the mother was not truly appreciated in those days – only child #13, until day 146, and child #15 were fed in this way. Children were often breastfed by wet nurses (the twin children #3 and #4 until day 93, the children #5 and #6, child #14 and child #16) or received bottled milk of various composition. The details of the feeding practices are shown in the appendix 2.

Except for the two breastfed children (#13 and #15), the weight increments of Camerer's infants were poor (Figure 1). Particularly wet nurse feeding appeared unsatisfying, except for child #16, where Camerer explicitly mentioned the qualification of the nurse, and child #14, the seventh child of a senior staff physician who presumably was well aware of appropriate child feeding practices. It is worth mentioning that Camerer did not comment on any of these weight curves, possibly because the incremental patterns of the majority of his children closely resembled infant weight increments of other late 19th century authors.

Camerer also published nutritional details of the bottle feeding. Table 1 (appendix) compiles estimates of the daily caloric intake of child #19, which were especially well documented. Feeding mainly used diluted cow's milk with some added carbohydrates. In this context it is surprising to note that the documents lack any comment on adding oil, butter or other fatty components, suggesting that the usual formulas for preparing infant milk propagated in those days were badly energy deficient (Droese and Stolley, 1961). Interestingly, French children presented in 1914 by Variot (Variot, 1914) showed very similar weight gain patterns, suggesting similar feeding practices.

Conclusion

Camerer's article is of particular interest when considering the modern perception of a pivotal role of nutrition for optimum brain development (Cusick and Georgieff,

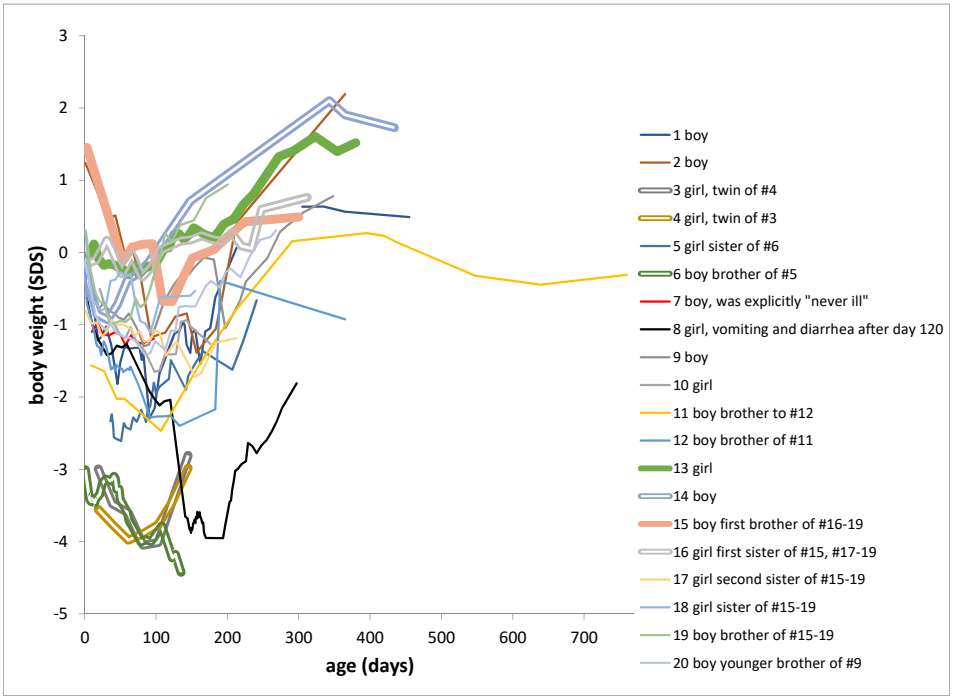

Figure 1 Body weight SDS (WHO, 2006) of 20 infants published by Camerer in 1882. Thick lines indicate maternal breastfed children, double lines indicate wet nurse breastfed children, thin lines indicate bottle feeding. The majority of the children rapidly decline in weight shortly after birth when compared with modern standards.

2016). Our interpretation of Camerer's article strongly questions the 21st century conviction that temporarily feeding energy deficient infant formula during the first 1000 days of life warrants serious anxieties regarding long-term cognitive, social, and emotional behavioral development. It seems that energy deficient infant formula was fed regularly in late 19th and early 20th century Europe and that many future lawyers, doctors, and professors received insufficient caloric intake during the first 1000 days of their lives (Matonti et al., 2020). Generalizing statements such as "Childhood malnutrition is associated with impaired neurodevelopment, academic achievement, cognition and behavioral problems" (Kirolos et al., 2022) and "Macronutrient (protein, fat, glucose) sufficiency is essential for normal brain development. Early macronutrient undernutrition is associated with lower IQ scores, reduced school success, and more behavioral dysregulation" (Schwarzenberg et al., 2018), thus, appear inappropriate and may prompt false decisions in public health and clinical policies. The marked insensitivity of healthy infants to even serious temporary undernutrition appears to support the idea that the abundant fetal fat deposition during the last months of pregnancy serves as an efficient energy buffer against nutritional disruptions that are common at birth and until lactation is established (Kuzawa, 1998; Thayer et al., 2020).

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Appendix

Table 1 Estimated daily caloric intake of child #19. Milk was diluted with water at various partitions from day 2 to day 34 of life and thereafter was given undiluted. After day 54, milk was diluted with rice mucilage. According to modern references, a healthy child from 1 month to 1 year of age should receive around 100 kcal/kg/day. Neonatal (birth to 28 days) caloric requirements are higher at about 110–135 kcal/kg/day (Patel and Rouster, 2022).

		milk	water/rice mucilage (after day 54)		
day	ml	partition	partition	kcal/day	kcal/kg/day
2	10	1	2	2.3	0.7
3	60	1	2	14.0	3.9
4	70	1	2	16.3	4.6
5	150	1	2	35.0	9.9
6	240	1	2	56.0	15.8
7	238	1	2	55.5	15.6
8	274	1	2	63.9	18.3
9	310	4	5	96.4	27.6
10	320	4	5	99.6	28.5
11	315	4	5	98.0	28.0
12	325	1	1	113.8	32.5
13	295	1	1	103.3	29.5
14	340	1	1	119.0	34.0
15	365	1	1	127.8	36.0
16	330	1	1	115.5	32.6
17	450	1	1	157.5	44.4
18	370	1	1	129.5	35.3
19	368	1	1	128.8	35.1
20	370	1	1	129.5	35.3
21	410	10	9	151.1	41.2
22	315	10	9	116.1	31.6
23	470	10	9	173.2	47.2
24	385	10	9	141.8	38.7
25	350	10	9	128.9	35.2
26	435	6	5	166.1	45.3
27	440	6	5	168.0	45.8
28	330	6	5	126.0	32.7
29	305	6	5	116.5	30.2
30	440	6	5	168.0	43.6
31	355	6	5	135.5	35.2
32	390	6	5	148.9	38.6
33	370	6	5	141.3	36.6
34	375	6	5	143.2	37.1
35	385	only cow's milk		269.5	68.8
36	440	only cow's milk		308.0	78.7

		milk	water/rice mucilage (after day 54)		
day	ml	partition	partition	kcal/day	kcal/kg/day
37	405	only cow's milk		283.5	72.4
38	360	only cow's milk		252.0	64.4
39	295	only cow's milk		206.5	52.7
40	265	only cow's milk		185.5	47.4
41	395	only cow's milk		276.5	70.6
42	395	only cow's milk		276.5	66.9
43	395	only cow's milk		276.5	66.9
44	330	only cow's milk		231.0	55.9
45	400	only cow's milk		280.0	67.7
46	450	only cow's milk		315.0	76.2
47	420	only cow's milk		294.0	71.1
48	520	only cow's milk		364.0	88.0
49	395	only cow's milk		276.5	66.9
50	385	only cow's milk		269.5	65.2
51	475	only cow's milk		332.5	75.6
52	480	only cow's milk		336.0	76.4
53	540	only cow's milk		378.0	85.9
54	380	only cow's milk		266.0	60.5
55	480	5	7*	184.8	42.0
56	410	5	7	157.9	35.9
57	510	5	7	196.4	42.6
58	475	5	7	182.9	39.7
59	510	5	7	196.4	42.6
60	510	5	7	196.4	42.6
61	520	5	7	200.2	43.5
62	400	5	7	154.0	33.4
63	465	5	7	179.0	38.9
64	525	5	7	202.1	41.6
66–72	470	5	7	181.0	37.2
73–78	525	5	7	202.1	38.4
79–80	665	5	7	256.0	47.4
81–88	570	5	7	219.5	38.8
89–93	595	5	7	229.1	38.1
93–106	690	5	7	265.7	49.9
Thereafter	805	5	7	309.9	47.0

*according to modern formula, 100 g of rice mucilage contain some 16 kcal (DEBInet – Deutsches Ernährungsberatungs- & Informationsnetz, 2022)

Appendix 2: Description of infant growth, a partial translation of Camerer, 1882

1st* Boy, 2nd child, age of parents 39 and 25 years, social status unknown, residence Würzburg. Food: 1st week breastmilk; 2nd to 4th week breastmilk and Nestle's flour with cow's milk; 4th to 7th week Nestle and cow's milk alone; 7th to 12th week (because of small weight gain with Nestle) 2 parts cow's milk, 1 part water, some rusk flour; 12th week without proper food because of diarrhea; 13th to 17th week nurse milk and Liebig's soup; 18th to 23rd week Liebig's soup and milk with rusk meal (temporarily without proper food in the 21st and 23rd week because of diarrhea). From the 24th week to the 1st year cow's milk and rusk flour (at $\frac{1}{2}$ year, $1\frac{1}{2}$ liters of milk and 4 tablespoons of rusk flour were consumed per day). At the age of 1 year, besides milk and rusk flour, meat broth soup. Illnesses: severe flu at age 9 month.

2nd* Boy, 4th child, age of parents 40 and 32 years, civil servant, Stuttgart. Food: cow's milk. Birth weight unknown, estimated by physician at a little over 4 kilos. Illnesses: at the beginning of the 4th month severe eczema, at the beginning of the 6th month severe recurrence of the previously not completely healed eczema.

3rd* and 4th* are twins, girls, 2nd and 3rd child, age of parents 43 and 31 years, lawyer, Stuttgart. Food until 93rd day: nurse milk, from then until 152nd day milk and Nestle's infant cereal cooked in meat broth.

5th* and 6th* are siblings. The first child a girl, age of parents 30 and 20 years, civil servant, Karlsruhe, food: cow's milk and gruel; the 2nd child a boy, age of parents 31 and 21 years, food: nurse milk, nurses were changed twice. The mother died of puerperal fever on the 34th day after the birth of the 2nd child.

7th* Boy, 3rd child, age of parents 38 and 37 years, merchant, Tübingen. Food: for the first 63 days cow's milk and anise tea, then cow's milk and barley gruel (1 tablespoon of barley with 125 grams of fat-free ox meat and 1 liter of water boiled down to $\frac{1}{2}$ liter of liquid). The child was never sick.

8th* Girl, 2nd child, age of parents 40 and 26 years, professor, Tübingen. Food: Cow's milk with chamomile tea. From the 120th day diarrhea and vomiting for a long time.

9th* Boy, 1st child, age of parents 26 and 20 years, general practitioner in Königsbronn, Württemberg. Food: In the 1st week breastmilk; in the 2nd week breastmilk and diluted cow's milk (1 milk, 2 water, some sodium carbonate and lactose). From the 3rd to the 10th week, diluted cow's milk alone; finally, the mixture consisted of 4 milk and 3 water, always with sodium carbonate and lactose. The child drank an average of 120 ml milk and 90 ml water per meal in the 9th week. In the 11th week, an attempt to add some rusk flour to the diluted milk induced diarrhea, so they returned to the previous diet. In the 13th week, the child drank 220 ml milk and 50 ml water per meal, in the 18th week 270 ml pure milk (with sodium carbonate and lactose) and 1300 ml per 24 hours. From the 20th week, some rusk flour was given together with the milk, at this time 260 ml milk were consumed at a single meal and per day some 1500 ml. The feces were always normal, except in the 11th week; they became harder, so that enemas became necessary when the milk (in the mixture) was increased. From the 186th to the 193rd day severe emetic diarrhea (temperature up to 39.9); various feeding attempts failed until at last, with exclusive use of Nestle's flour boiled with water, the illness ceased without medication. On the 192nd day 7 tablespoons of flour and 490 ml of water were consumed; thereafter per 24 hours until the 197th day: 80 g of flour;

until the 201st day: 100 g of flour, then 114 g and 145 g, the latter amount was not exceeded. From the 212th day: milk was again added to Nestle's flour, starting with one meal of milk porridge of 130 grams and soon increasing again to 1200 grams of milk per day. From the 250th day the child was given 1 soft egg in the morning. In the 10th month the diet was: egg in the morning, soup of meat broth and bread at noon, 1 tablespoon of Nestle boiled with 260 grams of water, 4 portions of milk of 260 grams during the day. From the 160th to the 170th day the child suffered from bronchial catarrh; at 14 months he could walk freely.
10th* Girl, 1st child, age of parents 37 and 23 years, professor, Tübingen. First-born sister of No. 8. Mostly fed on condensed milk.
11th* and 12th* are siblings, both boys. Parents 42 and 30 years old at 1st child's birth, 43 and 31 years old at 2nd child's birth. Head forester, Riedlingen. Food for both children: diluted cow's milk.
13th* Girl, 1st child, age of parents 36 and 31 years. Head forester, Steinheim, Württemberg. Food: until 146th day exclusively breastmilk, from then until 223rd day breastmilk and complementary food (first based on cow's milk, at the end of the period cow's milk and meat soup). Completely weaned on the 223rd day. End of 1st year 6 teeth, walking on one hand.
14th* Boy, 7th child. Parents 40 and 39 years old. Senior staff physician, Ulm. Feeding: 7 months exclusively nurse milk; 7–9 months nurse milk with additional food, namely a semolina soup with an egg during the day; from 9–11 months a soup of cow's milk and bread flour in the evening; from 11 months without breastmilk with cow's milk and soups. At the end of the 11th month with 4 teeth, at the end of the 12th month with 7 teeth; walks led by one hand, is unusually muscular and lively.
The following 5 children are siblings, the weighing was done by the mother (as with several of the children mentioned here) and kindly left to me. May these women find many successors!
15th* Boy, 1st child. Parents 38 and 27 years old, professor, Tübingen. Feeding during the first 4 months breastmilk and nurse's milk. 4 wet nurses, only the 4th had enough milk and stayed until the 12th month; during the change of wet nurses Liebig's soup and cow's milk was given. The child never suffered from indigestion. Around 100 days of life, large boil on thigh.
16th* Girl, 2nd child. Age of parents 40 and 29 years. From the 3rd to the 10th month an excellent wet nurse.
17th* Girl, 3rd child. Age of parents 42 and 31 years. Food: beside and between 3 insufficient wet nurses cow's milk, from the 4th month only cow's milk. In the 5th month pneumonia and scarlet fever.
18th* Girl. 4th child, age of parents 45 and 34 years. In the first 6 weeks trials with wet nurses, thereafter until the 7th month fed exclusively with Nestle. Had 4 teeth in the 7th month, could almost walk alone at 12 months.
19th* Boy, 5th child, age of parents 49 and 38 years. Child got 2 first teeth on 189th and 197th day of life. Food: diluted cow's milk. From day 1 to 34 of life, milk was diluted with water (first 8 days, 1 milk:2 water; 9th, 10th, and 11th days, 4:5; 12th–20th day1:1; 21st–25th day, 10:9; 26th–34th day, 6:5). From day 54 to 150, the milk was diluted with rice water and rice mucilage; initially the mixing ratio was 5 milk:7 mucilage, and finally 2 milk:1 mucilage. From about the 150th day, veal broth was added to the milk once a day; otherwise, the milk was diluted with water (5 milk to 1 water) (details: see table 1).
The number of daily meals averaged 6.7 from day 3 to 27; the minimum of 5 and the maximum of 8 meals occurred twice. From day 28 to 68 of life, the number of daily meals

averaged 6; the minimum of 5 occurred 13 times, and the maximum of 7 occurred 9 times. From the 69th to the 120th day the number of daily meals was again 6.5; the minimum was 6, the maximum 7. At the 1st day none, at the 2nd day one meal with 10 grams of milk is noted.

20th* boy, 2nd child, brother of No. 9. Age of parents 28 and 22 years. Illnesses: mild measles from the 107th to the 110th day; bronchial catarrh on the 260th and following days. Food: in the first 13 days sparse breastmilk; complementary food: milk and water with some sodium carbonate and lactose: mixture at the beginning 1 milk: 2 water; at the end 3 milk to 4 water. From the 180th day on, digestive disturbances occurred. Therefore, the previous milk regime was completely suspended and only Nestles flour boiled with water, was given. The same from the 210th to the 214th day. Thereafter, the flour was gradually discontinued and cow's milk was added, and on about the 230th day pure cow's milk was given again. A similar procedure was done on day 270 and the following days. Nestle's flour was first boiled with water, during the following weeks, cow's milk was given again. Diarrhea also occurred on the 320th day when pure cow's milk food was given, the stools were slimy, contained some blood and pus cells. Slight increases in temperature. A trial with Nestle's meal and Biedert's cream mixture was unsuccessful. Enemas with starch flour and tannin were then given, and acorn coffee and cream internally; whereupon the disease subsided. The child soon switched to a mixed diet. The first incisors appeared around the 300th day. At 1 year and 1 month the child could not yet walk, but was close to it.

21st* boy (not plotted in Figure 1), 7th child, age of parents 49 and 40 years. Farmer, Dürmentingen near Riedlingen. In this interesting case, unfortunately, only a few and not entirely accurate weighings could be made (the possible weighing error is up to 250 grams), nevertheless it seems to me worth of a report. On the occasion of an operation, I was informed by the assisting surgeon that an unusually heavy child had been born a few days ago. … The boy was weighed 24 hours after birth and is said to have weighed 7500 grams. …

My examination on the 10th day after birth revealed the following: Date from onset of menstruation to birth of the child 299 days. Length of the child 54,4 cm. Head measurements: circumference 38 cm, longitudinal diameter 13 cm, transverse diameter 10.7 cm. Breast measurements: shoulder width 13.8 cm, breast circumference (at nipple height) 37 cm, straight breast diameter 11.4 cm. Distance of troch. major. 10.6 cm, weight 4500 g. Bowel movements regular. He drank on the 11th and on the 12th day of life 650 ml per day on average, half milk, half water.