

# Relationships Between Animal Protein, Total Protein and Total Caloric Intakes in the Diets of Children from One to Eighteen Years of Age

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THIS paper is the third in a series dealing with the nutrient intake data of a group of children followed individually throughout the major portion of their growth period. These 125 children, sixty-four boys and sixty-one girls, whose dietary intakes of total calories, total protein and total animal protein have already been reported both cross-sectionally and in terms of individual longitudinal patterns<sup>1,2</sup> from one to eighteen years of age, belong to the Maturity Series of the Longitudinal Studies of Child Health and Development conducted since 1930 by the Department of Maternal and Child Health, Harvard School of Public Health.<sup>3</sup> In order to investigate further the sequential changes in the food intakes of children as individuals during their

years of growth and development, a study has been made of the percentage of total protein derived from animal sources, and the percentage of caloric intake derived from total protein in a manner similar to that used in the previous papers.<sup>1,2</sup>

## PERCENTAGE OF TOTAL PROTEIN FROM ANIMAL SOURCES

The percentage of protein derived from animal sources in the diets of these children offers a practical measurable estimate of the quality of protein eaten in any given age period. Thus, not only the absolute quantity of animal protein, but also the proportion which this forms to the total protein intake has been computed. A summary of the relationship of animal protein to total protein intake in this group of children is given in Table I. The percentages in this table are the mean values of animal protein given in Table I of the preceding paper<sup>2</sup> divided by the corresponding age and sex mean for total protein intake as given in Table I of a previous publication.<sup>1</sup>

These ratios of the means for each sex and at each yearly interval from one to eighteen years represent an average intake of animal protein which is approximately two-thirds or more of the total protein consumed for the same sex and age period. There is relatively little variation in these percentages based on average levels of intake. The lowest is 64.5 per cent of protein from animal sources among thirteen-year old boys, while the highest is 72.6 per cent among four year old girls.

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TABLE I  
Percentage of Total Protein Derived from Animal Sources by Age and Sex

Age (yr.)	Boys	Girls
1-2	70.2	72.5
2-3	70.5	72.3
3-4	71.4	72.1
4-5	70.9	72.6
5-6	69.0	72.3
6-7	69.2	71.3
7-8	68.6	70.4
8-9	67.3	70.3
9-10	68.8	69.4
10-11	68.6	69.2
11-12	66.3	67.3
12-13	65.6	64.6
13-14	64.5	66.3
14-15	65.2	67.2
15-16	66.0	69.7
16-17	68.1	69.8
17-18	68.7	70.0

Within this narrow range, the percentages for girls are slightly higher than those for boys at all ages except age twelve. In both sexes there is a tendency for higher percentages of animal protein to occur at the younger and older ages, with a minimum at twelve to thirteen for girls and thirteen to fourteen for boys. This age pattern is slightly more marked in girls than in boys.

Our figures for per cent of protein from animal sources, while similar to those of Widdowson<sup>4</sup> in age trends, are consistently higher than those for the British children. This is especially true of the early years except for the high figure of 76 per cent for one year old British girls. Only at age two were the British boys eating over 70 per cent of protein

from animal sources, and at three ages twelve, thirteen and seventeen years the girls' intakes of animal protein were below 60 per cent of their total protein intake. The British data did not show a consistent difference between the sexes. The longitudinality of our material may explain this difference, as Widdowson's data from year to year is on different children at each age period.

CLASSIFICATION OF CHILDREN ACCORDING TO LONGITUDINAL PATTERNS OF PER CENT OF TOTAL PROTEIN FROM ANIMAL SOURCES

In order to obtain a more complete picture of individual variation in the source of protein, patterns of the percentage of total protein from animal sources were identified in a manner similar to that used previously in defining patterns of intake for total animal protein, total protein and total calories.<sup>1,2</sup> For each child the cumulative animal protein intakes during the three age periods one to six, six to twelve and twelve to eighteen, and during the entire age span from one to eighteen years were divided by the corresponding cumulative intake of total protein from animal sources. Percentages in the highest and lowest quartiles in each age period were classified as high (H) and low (L), respectively, while the middle two quartiles were designated as medium (M). The values defining these quartiles as well as the extreme values are given in Table II. The lowest and highest values observed during any of these age periods for any child were 50.9 per cent for one boy between twelve and eighteen years of age and 86.4 per cent for a girl between one and six years.

Table III shows the distribution of boys and

TABLE II  
Percentages of Total Protein Derived from Animal Sources Which Define the Extreme Quartiles by Sex and Age Intervals

Age (yr.)	Boys				Girls			
	Lowest Value	25th Percentile	75th Percentile	Highest Value	Lowest Value	25th Percentile	75th Percentile	Highest Value
1-6	53.2	67.5	73.8	78.5	63.5	69.0	75.4	86.4
6-12	55.8	64.6	71.7	77.8	53.1	66.6	72.5	78.5
12-18	50.9	62.2	69.8	79.7	52.8	64.2	71.1	81.5
1-18	57.6	64.9	71.2	75.4	57.7	66.8	71.7	78.0

TABLE III

Frequency of Occurrence of Individual Longitudinal Patterns of Percentage of Total Protein Derived from Animal Sources

Patterns	No. of Boys	No. of Girls
HHH	8	6
MMM	9	8
LLL	3	4
MLL, HLL, HMM	(3 + 0 + 4) = 7	(1 + 1 + 2) = 4
LMM, LHH, MHH	(4 + 0 + 2) = 6	(7 + 0 + 2) = 9
MML, HHL, HHM	(7 + 0 + 2) = 9	(8 + 0 + 4) = 12
LLM, LLH, MMH	(7 + 0 + 4) = 11	(3 + 1 + 4) = 8
LML, LHL, LHM, MHL, MHM	(1 + 0 + 0 + 1 + 3) = 5	(0 + 0 + 0 + 0 + 3) = 3
MLM, MLH, HLM, HLH, HMH	(3 + 0 + 0 + 0 + 1) = 4	(4 + 1 + 0 + 0 + 1) = 6
LMH	1	0
HML	1	1

NOTE: H = High; M = Medium; L = Low.

girls according to the various longitudinal patterns. The first three patterns in this table (HHH, MMM and LLL), imply relatively consistent percentages of animal protein throughout the three age periods one to six, six to twelve and twelve to eighteen. The next four lines refer to patterns with either descending or ascending trends between two of the age periods. The eighth and ninth lines contain patterns characterized by increase, followed by decrease, or the reverse. The last two (LMH and HML) describe continuous increase or continuous decrease from period to period. It is interesting to note that as in the previous dietary pattern distributions, patterns involving extreme shifts between high and low ratings are very rare, whereas patterns involving consistent ratings in successive age periods are relatively common. Only one boy and three girls were found with any of the following patterns: HLL, LHH, HHL, LLH, LHL, LHM, MHL, MLH, HLM and HLH. If the combinations of ratings in successive age periods occurred by chance these patterns should have occurred in sixteen boys and fifteen girls. On the other hand, the pattern HHH which should have occurred by chance in about one boy and one girl was observed in eight boys and six girls.

Some of the more extreme types of variation between children in the pattern of percentage of total protein intake derived from animal sources are shown in Figure 1. In each of the four

sections of this figure two strikingly different cases are shown in comparison with the mean value for the appropriate sex. In the upper two sections the contrast is between children rated as having consistently high and consistently low intakes of animal protein. The lower left section shows two boys, both of whom obtained about 68 per cent of their protein from animal sources during the age period from twelve to eighteen, but whose previous intakes were strikingly different, particularly from about age four to age ten. Still another contrast is shown by the two girls in the lower right section. One (Case 159) started with relatively low percentages of animal protein which increased markedly between six and twelve years of age, while the other (Case 217) followed a reverse type of pattern with an abrupt decline in percentage of animal protein between the ages of nine and twelve years.

PERCENTAGE OF TOTAL CALORIES OBTAINED FROM TOTAL PROTEIN

Consideration of protein nutrition also involves the adequacy of the caloric intake in conjunction with the quantity and quality of the protein intake. Over the years it has been common practice to express the needs of the growing child for protein as a percentage of his total daily caloric needs. It is, therefore, of interest to determine not only the proportion of total protein derived from animal



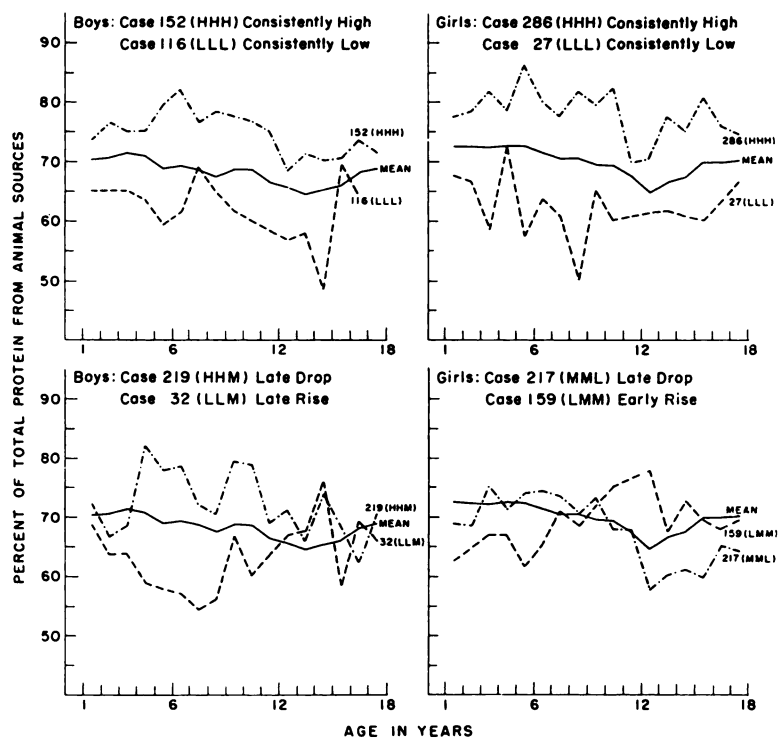


FIG. 1. Selected individual curves of the percentage of total protein derived from animal sources.

TABLE IV  
Percentage of Total Calories Derived from Total Protein by Age and Sex

Age (yr.)	Boys	Girls
1-2	13.5	13.9
2-3	13.1	13.7
3-4	13.0	13.2
4-5	13.1	13.3
5-6	12.9	13.3
6-7	12.9	13.1
7-8	13.0	13.2
8-9	12.9	12.9
9-10	13.0	13.1
10-11	13.0	13.0
11-12	12.6	12.5
12-13	12.2	12.4
13-14	12.4	12.7
14-15	12.2	12.5
15-16	12.3	12.7
16-17	12.5	12.8
17-18	12.5	12.8

sources, but also the percentage of total calories derived from total protein.

Table IV gives by age and sex the percent-

age of total calories derived from the protein in the diet of these children. It should be remembered that these figures are computed from the means and do not indicate the rather striking individual variabilities which exist within this group of 125 children followed longitudinally from one to eighteen years.

Table V gives the lowest and highest percentages of total calories derived from protein for each sex and in each age interval, one to six, six to twelve, twelve to eighteen and one to eighteen, and also shows the values defining the quartiles. While it can be said that the majority of the children at all ages had protein intakes represented by 12 to 14 per cent of their caloric intakes, there is a wide variation around this middle zone. The values range as high as 16.1 per cent for a girl in the age range twelve to eighteen, and as low as 9.7 per cent for a boy in the age range six to twelve.

Table VI shows the distribution of the sixty-four boys and sixty-one girls according to their various longitudinal patterns and pattern groups representing the percentage of

TABLE V  
Percentages of Total Calories Derived from Total Protein Which Define the Extreme Quartiles by Sex and Age Intervals

Age (yr.)	Boys				Girls			
	Lowest Value	25th Percentile	75th Percentile	Highest Value	Lowest Value	25th Percentile	75th Percentile	Highest Value
1-6	10.5	12.4	13.7	15.1	11.3	12.7	14.2	15.7
6-12	9.7	12.2	13.4	15.6	10.3	12.2	13.6	15.5
12-18	10.1	11.8	13.0	14.9	10.1	12.0	13.3	16.1
1-18	10.7	12.3	13.1	15.0	10.7	12.3	13.8	15.0

TABLE VI  
Frequency of Occurrence of Individual Longitudinal Patterns of Percentage of Total Calories Derived from Total Protein

Patterns	No. of Boys	No. of Girls
HHH	4	4
MMM	9	12
LLL	4	4
MLL, HLL, HMM	(2 + 0 + 2) = 4	(1 + 0 + 1) = 2
LMM, LHH, MHH	(5 + 1 + 2) = 8	(3 + 0 + 5) = 8
MML, HHL, HHM	(5 + 1 + 4) = 10	(4 + 0 + 5) = 9
LLM, LLH, MMH	(3 + 0 + 5) = 8	(2 + 0 + 1) = 3
LML, LHL, LHM, MHL, MHM	(2 + 0 + 1 + 0 + 3) = 6	(4 + 0 + 0 + 0 + 1) = 5
MLM, MLH, HLM, HLH, HMH	(4 + 2 + 1 + 0 + 2) = 9	(6 + 1 + 1 + 0 + 2) = 10
LMH	0	2
HML	2	2

total calories derived from total protein in the various age groups one to six, six to twelve and twelve to eighteen. Values in the highest quartile are designated as high (H), those in the two middle quartiles as medium (M), and those in the lowest quartile as low (L).

COMMENTS

Consideration of protein nutrition involves consideration of the adequacy of caloric intake as well as the quality and quantity of protein consumed. This is especially true in young children when a deficiency of only 100 calories may result in 25 gm. of total protein intake needed for growth being burned for energy. Macy<sup>5</sup> has stated "that a difference of 10 cal. per kilogram of body weight may spell success or failure in making satisfactory progress in visible and invisible growth."

SUMMARY

The percentage of total protein derived from

animal sources in the diets of children is presented and is followed by the percentage of total calories derived from total protein. These data have been compiled for each of 125 children at each age interval from one to eighteen years.

In both sexes there is a tendency for higher percentages of animal protein to occur at the younger and older ages, with a minimum at twelve to thirteen years for girls, and thirteen to fourteen years for boys. These ratios of the means for each sex and at yearly intervals represent an average percentage of animal protein which is approximately two-thirds or more of the total protein consumed. The average values for the girls for the first nine years are somewhat higher than those of the boys.

The majority of these boys and girls at all ages had protein intakes representing approximately 12 to 14 per cent of their total caloric intakes.



A more complete picture of the individual variations in the percentage of animal protein consumed is obtained from a study of the longitudinal patterns of the percentage of total protein from animal sources at certain specified age intervals, i.e., one to six, six to twelve, twelve to eighteen and one to eighteen years.

The lowest and highest percentage of calories derived from total protein were 9.7 per cent and the highest 16.1 per cent, respectively. Data are presented showing the distribution of these boys and girls according to their longitudinal patterns of percentage of total calories derived from protein, and allow consideration of their variability from one age period to another.

Finally, with the completion of this report, we have comparable nutrient intake material over a seventeen-year span on these 125 children in five categories: (1) total caloric intakes; (2) total protein intakes; (3) total animal protein intakes; (4) percentages of

animal protein from total protein; and (5) percentage of total calories from total protein.

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