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CONTENTS.

SECTION A.

INTRODUCTION.

THIS publication is the last of the series of reports to be issued by the Milk Nutrition Committee in connection with the researches into the nutritive values of raw and pasteurised milk which the Committee planned in 1934–35. It presents the results of the complete analysis of the school feeding experiments (Section A) already partially reported in Part II and summarises the results of all the experimental work carried out by the Milk Nutrition Committee, including results published for the first time (Section B). Finally, an attempt has been made to assess the practical importance of these researches for problems of human nutrition (Section C).

The objectives of the researches undertaken by the Committee were—

(1) To compare the nutritive values of raw and pasteurised milk, and

(2) To ascertain by tests on school children the growth and health promoting properties of supplements of 1/3 or 2/3 pint of milk. These amounts are the same as those which figure in the Milk-in-Schools Scheme; the investigation was therefore a practical trial of the scheme.

The first of these objectives was sought by three types of experiments—

(*a*) Chemical tests on raw and pasteurised milk;

(*b*) Laboratory experiments on animals and feeding trials on calves, and

(*c*) Feeding tests on school children, which also provided material appropriate to the second objective.

Animal experiments were carried out on small animals, principally rats, and the results of these and of the chemical tests have been described in Part I of these reports. The results of the calf-feeding experiments have been reported in Part III.

Part II gives a full account of the methods employed in the feeding experiments on children, including methods of medical examination and also a partial statement of the findings. The results reported in Part II were confined almost entirely to the increments in height and weight of the children between the beginning and end of the experiment. The present report deals with all the other data, subjective and objective, which have been obtained, and those already reported in Part II have also been taken into account.

RESULTS.

During the analysis of the records for this report the figures appearing in the interim report have been revised and certain corrections and adjustments made.

The analysis of the data for the four medical examinations is discussed in the following order—

(1) Objective measurements, *i.e.*, height, weight, chest circumference and pull ; and

(2) Subjective assessments, *i.e.*, clinical assessment of nutrition, posture, expression, complexion, etc.

Number and Classification of Children.

At the commencement of the investigation the children in each school were randomly divided into four feeding groups, the procedure being as follows. The children were taken by classes and No. 1 child was placed in the biscuit group, No. 2 in the 1/3 pint pasteurised, No. 3 in the 2/3 pint pasteurised, No. 4 in the 2/3 pint raw, No. 5 in the biscuit, No. 6 in the 1/3 pint pasteurised group, and so on. The classification was made before the children were medically examined and no account was taken of their physical condition or social or economic status. Consequently, when the experiment started all the 8,435 children who agreed to participate were divided approximately equally between the four feeding groups according to sex, age, and area, so that in any area the number of boys or girls of a given age, say 8 years, was approximately equal in each of the four feeding groups. There were 6,097 children (72 per cent. of the original total), present at all four medical examinations ; the remaining 28 per cent. failed to appear at one or more of the subsequent examinations for various reasons. Only those children who appeared at all medical examinations were taken into account for the Interim Report. The material for the present report also is derived mainly from these children.

The biscuit ration served merely to satisfy the children in the control group ; its nutritive value was negligible. The test cannot be regarded in any sense as a comparison of the nutritive values of biscuits and milk.

Table I shows the numbers of boys and girls who were present at each of the four medical examinations classified firstly according to area and feeding group, and secondly for all areas combined according to feeding group and age group. The age groups adopted were : 5–7, 8–10 and 11–14 years.

It was also found possible to make some use of the data pertaining to the remaining children. Of these children the 11–14 age group provided the only material worth analysing ; that for the other ages was rejected because of small numbers as well as diversity in age, feeding group, area and presence at medical examinations. The 11–14 age group just referred to numbered 695, or roughly 30 per cent. of the 2,338 not included in the main analysis. A summary of the results for these children is shown in Table XXII and it can be seen that the sexes are nearly equally divided and that they are distributed fairly evenly over the four feeding groups. These children were all actually

aged 13–14 years at the time of the 1st examination and they left school soon after the 2nd, having attained the age of 14 years (p. 15). They were included in the experiment mainly to suit the convenience of the school staff. It was obviously desirable that all the children in the school should have the opportunity of participating in the investigation.

As pointed out in Part II, leakage affected the biscuit group slightly more than any of the milk groups. Statistical examination of the data, divided into age and sex groups, of those remaining in the test showed, however, that the original randomness of the samples had not been affected.

The Interval between Medical Examinations.

In considering the growth increases between the four examinations, the interval of time between them is of some importance. The actual examinations took 2–4 weeks in Luton, Wolverhampton and Huddersfield, and 4–7 weeks in Burton and Renfrewshire. The reason for the difference is that only one pair of doctors carried out the examinations in the two latter areas, whereas both pairs worked together in the others. Reckoning from the mid point of one medical examination to the mid point of the next, the intervals between the four medical examinations are shown in Table II. The 1–2 interval is longer than the 2–3 or 3–4 interval by 6–8 weeks in every area except Luton where the 2–3 interval is longer than the 1–2 and 3–4 by 5 and 8 weeks, respectively. Except in Luton, the 2–3 interval is 16–17 weeks long ; the 3–4 interval is 14–15 weeks in all areas. It might be expected that these differences in the length of the intervals would be reflected in the results. This actually happened and the greatest amount of growth in most of the physical measurements for all areas, on the average, occurred between the 1st and 2nd medical examinations. But, as will be observed below, other factors than time were probably concerned.

Objective Measurements.

Height.

Table III shows the average measurements and increases of height for all areas and ages at all four medical examinations and the average increases, absolute and relative, for the 1–2, 2–3, 3–4 and 1–4 intervals. The average heights for boys and girls at the initial examinations are remarkably constant in all four feeding groups, but they show that the boys, on the average, are slightly taller than the girls. The absolute and relative increments for the 1–4 interval resemble closely those published in the interim report and they tell the same story, namely, that the increases are greater for the 1/3 pint than for the biscuit groups, and still greater for both 2/3 pint groups. The excesses over the biscuit group are, however, small and amount only to 0·04–0·10 inches for the boys and 0·00–0·10 for the girls or, relatively, to 0·09–0·22 per cent. for the boys and 0·05–0·24 per cent. for the girls. The differences relative to the controls that were found to be statistically significant are—boys, both 2/3 pint groups, and girls, the 2/3 pint pasteurised group (Table XX). Notwithstanding the fact that the support of formal statistical tests has not been obtained for all the differences, the consistency of the changes make it justifiable to conclude that the milk supplements have, on the average, caused small but regular increases in the rate of growth in height.

The increments for the intervening intervals also reveal the effect of the supplements but the changes are not quite so regular. The changes relative to the controls can be seen more clearly from Table V, in which the increments in the milk groups are shown as percentages of those in the biscuit groups. In the groups of boys, all the values are greater than 100, except in the 1/3 pint group for the 1–2 interval; and in every instance, except the 2/3 pint raw group at the 2–3 interval, those for the two 2/3 pint groups are greater than those for the 1/3 pint group. In the groups of girls all the values, except in the 1/3 pint group for the 1–2 interval, are greater than 100, and all those for the 2/3 pint groups are greater than for the 1/3 pint group, except in the 2/3 pint raw group at the 2–3 interval. The same exception occurs amongst the boys.

Table III also shows that the increases, absolute and relative, for both sexes are greater for the 1–2 interval than for either the 2–3 or 3–4 intervals. These differences clearly cannot be attributed to the milk supplements, since it is common to all groups. In fact, the ratio—increase during the 1–4 interval/increase during the 1–2 interval, is constant at 2·5 for all groups of boys and nearly so at 2·4 for all groups of girls. The greater average length of the 1–2 interval and seasonal variations in the rate of growth are the most likely causes.

To see the influence of these factors it is necessary to turn to the table showing the figures for the separate areas (Table VI). It can be seen that the maximum increments in height, absolute and relative, occurred during the 1–2 interval in both sexes and in all areas, except for the Luton boys and the Wolverhampton girls; there is one other exception, but the difference is too small to be of any importance. The fact that the 2–3 interval was the longest in Luton would explain the discrepancy of the boys in this place, but does not explain the unexpected conformity of the Luton girls to the general trend. Similarly, the differences in the length of the intervals between the examinations cannot be advanced in explanation of the divergence of the Wolverhampton girls from the general trend. According to Orr and Clarke (1), the season of most rapid increase in height is April–June, and that of the slowest October–December, inclusive. The 1–2 interval in Luton lasted from the 7th March to the 26th July and therefore included the period of maximum growth in height. As is pointed out in the interim report and as can be seen from Tables III, IV and VI in the present one, the rate of growth of the girls was greater than that of the boys. The differences between the results for the boys and girls in Luton, therefore, suggest that the effect of season on the rate of growth has more than counteracted the effect of the longer 2–3 interval in the girls but not in the boys. In Wolverhampton the 1–2 interval lasted from 2nd April till 3rd October and so included the time of maximum growth, whereas the 2–3 interval, 3rd October till 30th January, included the period of minimum growth. There is, therefore, no reason on the grounds of season or length of interval, which would account for the Wolverhampton girls showing maximum growth in the 2–3 interval.

Comparisons of the increments for the 2/3 pint pasteurised and 2/3 pint raw group show no constant differences. Sometimes, as Table VI shows, they favour the pasteurised milk groups and sometimes the raw milk groups. Moreover, none of the differences in either direction was found to be significant statistically (Table XXI).

In Table IV are presented the average figures for height and the percentage increments for all areas combined, with the children divided into the three age groups, 5–7, 8–10 and 11–14 years. The initial measurements show that the boys are slightly taller than the girls in the 5–7 and 8–10 age groups, but that the position is reversed in the 11–14 age group. Again, the rate of growth of the girls was slightly greater than that of the boys. The percentage figures also show that the 5–7 years age group, and especially the boys, increased in height throughout the test at a greater rate than the other two age groups. The influence of the milk supplements is shown in all three groups and in both sexes for the 1–4 interval, and the differences in the increments as compared with the controls are in accordance with the amounts of milk fed, except for girls, 11–14 years, in the 1/3 pint group.

The changes observed at the intervening medical examinations, on the whole, tell the same story, but there are some exceptions. The weight of evidence is, however, in favour of the milk supplements, and more in favour of the larger than the smaller. Of the 72 possible comparisons, 50, equally divided between the sexes, demonstrate the good effects of the milk supplements.

Statistical tests of the differences in growth in height as between the control and the milk groups showed the following to be significant—

Interval 1–2—2/3 pint raw, girls 11–14 years.

Interval 1–4—2/3 pint pasteurised, boys 8–10, girls 5–7 years.
2/3 pint raw, boys 5–10 years.

Weight.

Table VII shows the average values for weight for all areas and all ages together at each examination and includes absolute and relative increases.

At the first medical examination the control boys were, on the average, about 0·75 lb. heavier than those in the other three groups, and the boys were roughly 2 lbs. or more heavier than the girls; but during the year the girls increased by 7·2–8·3 lbs., compared with 6·5–7·2 lbs. for the boys. The figures show that 1/3 pint milk has produced an increase in weight, both absolute and relative, greater than biscuits, and 2/3 pint milk, raw or pasteurised, has produced a still greater increase. The increments over the controls during the year are 0·29, 0·50 and 0·66 lbs. or 0·63, 1·01 and 1·26 per cent. for the boys; and 0·39, 0·80 and 1·02 lbs. or 0·94, 1·52 and 1·88 per cent. for the girls, in the 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. Just as for height, the girls increased in weight more rapidly than the boys. There is a slight advantage in favour of the raw milk groups which amounts to 2·6 ozs. for the boys and 3·6 ozs. for the girls, but the differences are not significant statistically (Table XXI). Moreover, when the data are sub-divided into age groups (see Table VIII) only 11 out of 24 possible comparisons are in favour of raw milk.

The figures show that in each feeding group for both sexes the greatest increases occurred between examinations 1 and 2, and they amount roughly to one-half the total increment for the year, irrespective of sex. There are, however,

in this respect some differences between the groups. In the girls of the biscuit group the first increment is *almost exactly half* the final one (3·60 lbs. compared with 7·25 lbs.), whereas in the milk fed groups, the first increments are somewhat *greater than* half the total increment. In the girls 2/3 pint raw group, for instance, the increase for the 1–2 interval is 4·35 lbs., compared with 8·27 lbs. for the 1–4 interval. The boys' figures show a similar change in ratio between the values for the 1–2 and 1–4 intervals. Thus, the initial increment is well below half the total in the biscuit group (2·84 lbs. compared with 6·53 lbs.), but it approaches this level in the milk fed groups, especially in those receiving the larger supplements. The figures for the 2/3 pint raw group, for example, are 3·50 and 7·20 lbs. for the 1–2 and 1–4 intervals, respectively.

The fact that an apparently disproportionate fraction of the total increase in weight during the year occurred during the 1–2 interval and that the disproportion is more accentuated in the milk groups, can be seen best by studying Figure 1 (p. 66). The curves present the average values of the weights of the children for all areas and all ages combined, and have the advantage over the tables that the complication of the variation in the length of the intervals is eliminated. The usual type of weight curve for young mammals is convex upwards as a result of the gradual decline in the speed of growth as age advances. It would not be expected that this characteristic would be much in evidence, in such a relatively slow growing animal as man, during the course of a year. Figure 1, indeed, shows little trace of this convexity in the boys of the biscuit group, and it is just possible to detect it in the 1/3 pint group. By contrast, the convexity is much more obvious in the 2/3 pint groups, and more especially in that section of the curve between the first and third medical examinations. The curves for the girls show convexities in all groups, especially in the milk groups. The latter, which begin below the biscuit group curves, rise more steeply during the 1–2 interval; but the initial slope declines in the next two intrevals, during which the 1/3 pint curve runs practically parallel with the biscuit curve. It is clear that the milk supplements have, in accordance with their amounts, produced an acceleration in weight during the 1–2 interval. This acceleration does not, however, continue, especially in the 1/3 pint groups, during the remainder of the test, with the result that the early advantage is just about maintained by the 1/3 pint pasteurised groups, and little more than maintained by the 2/3 pint groups.

The fact that the biscuit group of girls grew more rapidly during the 1–2 than during the 2–3 or 3–4 intervals might be thought to invalidate the above inference. There can be little doubt, however, that the explanation is that the 1–2 interval for all, except the Luton, children coincided with the period of maximum (July–September) and of the next greatest (October–December) increase in weight (see Orr and Clarke) (1). The effect of this seasonal advantage is naturally greater in the girls because of their more rapid rate of growth during the test. Doubtless, the seasonal variation contributed in some measure to the steepness of the curves of the milk groups but it could not in any way account for the differences between these curves and those of the biscuit groups.

Table VIII presents the weight figures classified in age groups. The greatest gains, both absolute and relative, were made by the 11–14 age group, especially the girls; the gains amount to about 13 lbs. or 16–17 per cent. in both the 2/3 pint groups of girls. The increases over the year show advantages in favour of the milk-fed children in every age group, in both sexes and, except for the 11–14 year old group of girls, the increases are consistent with the amount of the supplement. The values for the intervening examinations are, on the whole, in harmony with the changes as recorded at the end of the test. Irrespective of age or sex, the increase in weight recorded at the second examination is about half or more than half that recorded at the final medical examination.

Comparing the growth in weight both between the first and second medical examinations and between the first and fourth examinations in the milk groups with the growth in the biscuits groups, all differences in the 8–10 age group are statistically significant and all but one of the differences in the 5–7 age group (that between the growths for boys in the 1/3 pint group and the biscuit group during the 1–2 interval) are significant. The 11–14 age group is the least satisfactory. Here, none of the differences for both sexes between growth in the 1/3 pint groups and the controls, for both intervals, is significant. All but two of the differences, namely, girls for both intervals, between growth in the 2/3 pint pasteurised group and in the controls, are significant. (Table XX).

In Table IX are shown the average increments in weight for all areas and ages compared with the increments in the biscuit group. The values for the girls are all greater than 100 and they are in accordance with the amount of the milk supplements, with the exception of the 2/3 pint pasteurised group for the 3–4 interval. The values for the boys are all greater than 100, except those for the 2–3 interval, and they are consistent with the amount of the supplements fed for the 1–2 and 1–4 intervals.

The percentage increases in weight for all ages combined for the separate areas are shown in Table X. The values show agreement with those for height in that the increases at the 1–2 interval are the greatest, except in Luton, where the increment for the boys is greatest for the 2–3 interval. The figures for the Wolverhampton girls, contrary to those for height, are maximum at the 1–2 interval.

The effects of the milk supplements are least apparent in the Renfrewshire boys, amongst whom the biggest difference relative to the biscuit group is only 0·21 lbs. or 0·49 per cent. The figures for the Renfrewshire girls, on the other hand, bring out the influence of the milk supplements as well as any other area. The Burton children show the biggest and most consistent effects. The Luton values are the least consistent.

Chest Circumference.

Measurements of the chest circumference were confined to children of 8 years and over. Two measurements were taken at each examination, with the chest expanded and with the chest deflated. Because of the well-known difficulty in getting young children to inspire or expire to the maximum, the separate values for inspiration and expiration, as well as the differences between the two, were ignored and account was taken only of the mean of the two measurements.

Table XI shows the average chest measurements and the actual and percentage increases for all ages and areas. At the start there was no appreciable difference between the values for the four feeding groups of boys or girls, but the boys' girth was roughly about 0·5 inch greater than the girls'. At the end of the test the girls had increased in chest circumference by about 1·5 inches on the whole, compared with about one inch for the boys. Undoubtedly, the earlier onset of puberty in the 11–14 year old girls was mainly responsible for this difference, as the figures in Table XII demonstrate. Taking the biscuit group as an example, the percentage increases for the boys over the year are 3·63 and 4·03, and for the girls 3·98 and 6·93 in the 8–10 and 11–14 age groups, respectively. It can be seen from Table XI that all the milk supplements for the year produced greater increases, absolute and relative, than those observed in the biscuit groups. These increases are consistent with the amounts of the milk fed. The actual excesses over the increase in the biscuit group are:

for boys, 0·031, 0·068 and 0·036 inches,
and
for girls, 0·096, 0·144 and 0·204 inches,

in the 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. Of these, only two, 0·144 and 0·204, are statistically significant. The increases for the 1–2 interval are also in favour of the milk groups (the differences between both the 2/3 pint groups and the biscuit group, girls, are significant) and are, on the whole, consistent with the amounts of milk. The increases for the 2–3 and 3–4 intervals are irregular.

As for the weight figures, those for chest at the 1–2 interval are greater than for the 2–3 and 3–4 intervals, and the ratios between the increases for the 1–2 and those for the 1–4 intervals show trends similar to the same ratios for weight. Thus, the increase for the 1–2 interval in the biscuit group in both sexes is *scarcely half* that for the 1–4 interval, whereas in the 1/3 pint group the former is *just about half* and in the two 2/3 pint groups *more than half* the corresponding increases for the 1–4 interval. The actual increases at the fourth medical examination divided by those at the second examination are :—

	Biscuits	1/3 *pint*	2/3 *pint pasteurised*	2/3 *pint raw*
Boys ..	2·17	2·00	1·88	2·02
Girls ..	2·12	2·06	1·99	1·96

The consistency of these results is a clear indication that the beneficial effects of milk on chest growth, just as for weight, were exerted especially in the early part of the feeding test. The greater increase in chest girth in the 1–2 than in the 2–3 and 3–4 intervals, as shown by the control children, can very likely be explained by the greater average length of the 1–2 interval and by the fact that it also included for most of the children the season of maximum growth in height and weight.

As pointed out above, the 11–14 year old children increased in chest girth more rapidly than the 8–10 year old group. The difference is especially evident in the girls, as can be seen from Table XII. The percentage figures, on the whole, illustrate the beneficial effect of milk, but there are a few irregularities.

Table XIII shows the increases in the milk groups relative to those in the biscuit groups when the latter are expressed as 100. The values are greater than 100 for the 1–2 and 1–4 intervals in both sexes and they are consistent with the amounts of the supplements fed amongst the girls, and, for the 1–4 interval, amongst the boys. The values are less than 100 in all the groups of boys for the 2–3 and 3–4 intervals; the corresponding ones for the girls are somewhat irregular, two out of the six of them being less than 100.

It will be observed from Table XI that the differences between increments in the milk groups and increments in the biscuit groups are very small. The largest for boys over the year is 0·068 inches and for girls 0·204 inches. Only the increments in the 2/3 pint groups of girls are significantly different from those in the biscuit group. The increments for these two groups in the 1–2 interval are, together with 2/3 pint pasteurised group, boys, also significantly different from the increments in the controls in that period. (see Table XX).

Analysis of the data for the comparison, 2/3 pint raw *v.* 2/3 pint pasteurised did not reveal any significant differences in either direction; moreover the differences are irregular, sometimes in favour of one group and sometimes another. (see Table XXI).

Table XIV shows the figures for the five areas separately, all ages being combined in each. In Luton, Wolverhampton and Burton the increases over the year in the milk fed groups all show consistent superiority over the biscuit groups. In Renfrewshire, all the milk groups of boys are inferior to the controls, and the Huddersfield boys in the 2/3 pint raw group show a lower rate of growth than the biscuit group. The values for the 2–3 and 3–4 intervals are irregular in both sexes, but those for the 1–2 interval bring out fairly consistently the beneficial effect of milk. The increment for the 1–2 interval is greater than for the 2–3 or 3–4 intervals in both sexes and in every area except Luton, where the 2–3 increment is the greatest for boys and also for girls, except for the 2/3 pint raw group. These differences agree with those observed in the height and weight figures.

Pull.

The dynamometer test was done only on children of 8 years and over. The measurement itself is expressed quantitatively, but the test cannot be regarded as wholly objective since the psychological make-up of the child, so far as concerns the will to succeed, is also a factor. The latter can be stimulated by the introduction of competition and rivalry, and, generally, boys are more affected in this way than girls. The psychological factor would not, however, affect one feeding group more than another and may be ignored as a complication.

The average pulls and the actual and relative increases observed at each medical examination for all areas and ages are set out in Table XV. At the first examination the pulls for the boys are distinctly greater than those for the girls, being about 130 lbs. compared with 98 lbs. The increment over the year, however, is the same, about 34 lbs., for both sexes, so that the percentage increase is much greater for the girls.

The absolute and relative increases in pull over the year are, for the girls, greater in the 1/3 pint group than in the biscuit group, and still greater in the two 2/3 pint groups. The results are not, however, consistent for the boys. The 1/3 pint and 2/3 pint pasteurised groups show definite increases over the biscuit groups of about the same amount, but the increases for the 2/3 pint raw group are the lowest of all.

The measurements at each examination were spread over a very wide range from about 60 lbs. among the younger children to over 200 lbs. among the 14 year olds. Taking the increments over the year in the biscuit group, the co-efficient of variation for boys and girls together amounted to about 79 per cent., compared with 30 per cent. for height, 59 per cent. for weight and 68 per cent. for chest circumference.

Table XVI, which gives the age classification of the pulls, shows that it is the figures for the 11–14 year old boys which are most out of step with the other results; and Table XVIII, which gives the area classification, shows that it is the Luton and Renfrewshire results which fail to show an advantage for the 2/3 pint raw group over the biscuit group. It, therefore, looks as if the irregularities in the results in these two places, and especially in the 11–14 age group, are the main cause of the discrepancies shown in the combined results in Table XV.

The differences in favour of the milk supplements amongst the boys are small, the largest being 0·67 lbs. (0·52%) in the 1/3 pint group, but they are much greater for the girls, the smallest difference being 3·10 lbs. (3·38%) in the 1/3 pint group. These sex differences are in harmony with the similar differences observed in favour of girls in regard to growth in height, weight and chest girth, and they indicate that the more rapid growth of the girls was accompanied by correspondingly greater increments in ability to perform muscular work.

The increments for the 1–2 interval are greater than those for the 2–3 and 3–4 intervals and they amount to roughly half that for the 1–4 interval in both sexes. There is, however, evidence of a change in the ratio between the increment for the 1–2 and 1–4 intervals as one passes from the biscuit to the milk groups. It will be remembered that these ratios for weight and chest circumference decrease in this direction. The actual figures for the quotient—increase for the 1–4 interval/increase for the 1–2 interval—are, for the girls, 2·10, 1·92, 2·04 and 2·03 in the biscuit, 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. It, therefore, appears that the beneficial effects of the milk on muscular power were exerted mainly in the early part of the test in the same way, but perhaps not to the same degree, as for weight and chest.

Over the 1–2, 2–3 and 3–4 intervals, the absolute and relative gains for the girls demonstrate the beneficial effects of milk which are in accordance with the amounts, except at the 3–4 interval, where there are some irregularities. The values for the boys at these intervals do not show any definite trend, except that those in the 2/3 pint raw group are uniformly less than those in the biscuit

group. These points can be seen more clearly in Table XVII, which gives the gains in pull in the milk groups compared with those in the biscuit groups. All the values for the girls, except in the 1/3 pint group at the 3–4 interval, are greater than 100 and they increase from the smaller to the larger milk supplements. All the values for the 1/3 pint and 2/3 pint pasteurised groups of boys are also greater than 100, except at the 2–3 interval ; and, on the other hand, all the values for the 2/3 pint raw group of boys are less than 100 for every interval.

Table XVI shows that in both sexes the absolute pull is greater in the 11–14 year old group than in the 8–10 group and the increments over the year are slightly higher for the older children. Thus, the increment for the 8–10 girls is roughly 33 lbs. and that for the 11–14 girls about 36 lbs. The percentage increases over the year, however, are higher for the 8–10 than for the 11–14 year old group in both sexes. In addition, it will be observed (Table XVII) that, among the girls, all the values for the 2/3 pint raw group are slightly but uniformly below those for the 2/3 pint pasteurised group. Table XVI also shows that, of the 16 possible comparisons between the increments at the various intervals in the age classification, 12 are in favour of pasteurised and 4 in favour of raw milk ; and from the area classification in Table XVIII it can be seen that, of ten possible comparisons between the increments for the year, six, equally distributed between the sexes, show an advantage to pasteurised milk. In order to test the matter further, Table XIX has been prepared, and the increases during the year for raw and pasteurised milk are compared in the five areas separately, the children having been divided into the two age groups. The comparisons for the boys show that, out of a total of ten, seven of the differences are in favour of pasteurised and three in favour of raw milk. The comparisons for the girls show five differences in favour of pasteurised milk out of a total of ten. None of these differences was found to be significant statistically.

On turning again to Table XV it can be seen that the results for all areas and all ages for the four intervals, 1–2, 2–3, 3–4 and 1–4, show all the 8 possible comparisons between the pasteurised and raw milk groups to be in favour of the pasteurised groups.

Attention is directed to the similar comparison between the average pulls of those children aged 13–14 years who left school just after the 2nd medical examination (Table XXII). The results for these children are discussed in greater detail below (p. 15). Here it will suffice to refer only to the comparisons of the results for pull as between the groups receiving 2/3 pint pasteurised and 2/3 pint raw milk. Amongst the boys the percentage increase in pull in the 2/3 pint raw group is below that in the biscuit group. The actual deficiency amounts to 0·68 lbs., 0·40 per cent. The percentage increment in the 2/3 pint raw group is also less than that in the 2/3 pint pasteurised group. It can also be seen that the increment in the 2/3 pint raw group of girls is less than that in the 2/3 pint pasteurised group. These differences, as between raw and pasteurised milk, confirm those obtained in the larger group of children but none of them was found to be statistically significant.

Although all the above differences between the increments attributable to raw and to pasteurised milk failed to pass formal tests of significance, the fair degree of consistency cannot be ignored. It cannot be concluded from these differences that raw milk is definitely inferior to pasteurised milk in regard to the promotion of muscular strength. Nevertheless, the consistency of the results in favour of the pasteurised milk groups is worthy of attention.

Children who attended at Examinations 1 *and* 2 *only.*

As pointed out above, this group consisted of the 695 children who left school after the 2nd medical examination on reaching the age of 14 years. The results are stated in an abbreviated form in Table XXII, which gives the number of children in each feeding group and the average percentage increases in height, weight, chest circumference and pull up to the time of the 2nd medical examination. It can be seen from the table that the numbers of boys and girls were fairly evenly distributed between the four feeding groups. The numbers in each group are, however, small and a degree of consistency and regularity similar to that found for the 6097 children, who attended all medical examinations, is not to be expected.

In regard to height and weight the figures show that the milk supplements induced improvements in the rate of growth over those in the biscuit groups. The increases, however, are not consistent with the amounts of milk fed. The actual values of the excesses over the biscuit groups are, for height—

0·13, 0·06 and 0·07 inches for the boys
and 0·09, 0·12 and 0·08 inches for the girls,

in the 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. In weight the actual excesses are :—

0·88, 0·24 and 0·76 lbs. for the boys,
and 1·15, 0·88 and 1·41 lbs. for the girls,

in the 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. These increases in weight, which occurred in about 22 weeks, are on the whole larger than the increases over the year for children of all ages who attended all the medical examinations.

In regard to chest circumference, only for girls are the increments in the milk groups greater than those in the corresponding biscuit group. The actual differences in favour of the milk-fed girls are 0·05, 0·28 and 0·11 inches in the 1/3 pint, 2/3 pint pasteurised and 2/3 pint raw groups, respectively. These increments show conformity with the amounts of the supplements. For boys, the actual and percentage increments are all less in the milk groups than in the biscuit group. The deficiency is, however, very small.

In regard to pull, the increments in the two groups of girls receiving the larger milk supplements are greater, relatively and absolutely, than the increment in the biscuit group ; but in both respects the increment in the 1/3 pint group is less than that in the biscuit group. In the boys, on the other hand, the relative and absolute increases in the 1/3 pint and 2/3 pint pasteurised groups are greater than the increment for the biscuit group ; but, as in the case

of the larger group of children, the increment in the 2/3 pint raw group is definitely less than that in the biscuit group. The actual deficiency amounts to 0·68 lbs., 0·40 per cent. Furthermore, it can be seen that the percentage increase in the 2/3 pint raw group of girls is less than that in the 2/3 pint pasteurised group. The difference amounts to 0·9 per cent., actually 0·57 lbs. The differences between pasteurised and raw milk have been referred to on page 14.

It may be concluded from the data of this smaller group of children that the results, on the whole, confirm those obtained in the larger group in regard to height, weight and pull and also in regard to chest circumference for the girls. They are contrary to the other findings in regard to chest measurements for boys.

Subjective Assessments.

The list of these and the manner in which they were made is stated in the interim report. The purely subjective assessments are—clinical assessment of the state of nutrition, of posture, expression and complexion. There are a number of other assessments, namely, the condition of the tonsils, conjunctivae and eyelids and of the teeth, and the modified Romberg test, which are neither strictly subjective nor strictly objective, but which, for convenience, are considered in this section. In regard to teeth it was realised, but unfortunately only when too late to change, that the method of classification was faulty; the examination of the teeth was therefore abandoned. The Romberg test was also given up, not because it was considered to be valueless, but because it was found that the period of standing decided on (5 minutes) was much too short, again, unfortunately when it was too late to make a change.

In addition to the above assessments, another was made by the teachers in immediate charge of the children at the end of each medical examination. This was based on the teacher's estimate of the child's intellectual ability; results of examinations as well as class performance were also taken into account.

There remain two other types of recorded data which are in a category by themselves; there is little to say about them and they can be disposed of here. These records are grouped under the headings of "after-effects of preceding illness" and "absences since the last medical examination." During the course of the test some differences of opinion arose among the doctors as to the clinical criteria of assessment of "after-effects of preceding illness" and as to the recording of absences. For example, there was some doubt as to whether absences of single days should be entered at all and as to whether absences on non-school days should be taken into account. The doctors were very sceptical of the value of the data and a scrutiny of them confirmed their impressions. The data recorded under these headings were, in fact, found to be so confusing that they were not considered to be worth analysing.

In order to ensure, as far as possible, identity of standards of clinical assessments, the four doctors, as pointed out in the interim report, received a special period of training before the investigation started, and, during the course of each medical examination, they met three times and examined the

same children in order to compare their standards. It is, therefore, extremely probable that the standards in the minds of the four doctors were as uniform and as reasonably constant as it is possible to make them. It does not follow, however, that the standards remained the same from examination to examination; indeed, the results about to be discussed show definite indications of change in the standards during the course of the test.

A distinction must be drawn between the assessment of the doctors and that of the teachers. The doctors during the medical examinations were not aware of the feeding groups to which the children belonged, since the children were examined by classes, and the data were entered on the special forms according to age and sex and not according to feeding group. Moreover, as has been pointed out, all practicable precautions were taken to ensure uniformity of standards. The teachers, on the other hand, were in daily contact with the children and they knew the feeding group of each child. Furthermore, nothing could be done to bring about uniformity in their criteria of scholastic ability. It might, therefore, be argued that the teachers were naturally prejudiced in favour of milk. If this had been so an overwhelming case in favour of milk would have been almost certainly revealed by the results. This did not happen, and it follows that if such a bias existed it cannot have been general amongst the teachers. Again, there were other issues involved besides the clear-cut one of biscuits versus milk. There was that between 1/3 pint and 2/3 pint milk, and that between pasteurised and raw milk; and, in addition, a number of the teachers may have attached an undue amount of nutritive value to the biscuits, the composition of which they did not know. There was, indeed, some evidence that such an opinion existed in the minds of several teachers and that they regarded the biscuits as of a very special type. Finally, the large number of teachers involved in the test, somewhat over 200, would presumably act as a check on bias. We, therefore, have no hesitation in accepting the results of the teachers' assessments at their face value.

Clinical Assessment of State of Nutrition.

It was stated in the interim report that, owing to the small numbers of children found in the 4th clinical category, the 3rd and 4th categories were combined in one group, designated 3. Group 1 therefore corresponds to category A, group 2 to B and group 3 to C and D combined, of the Board of Education nutritional categories. The average percentage of children present in each of the three categories at the four medical examinations is shown in Table XXIII. The values for the 1st medical examination are reasonably constant over the four feeding groups of boys and girls, respectively, but the girls show higher clinical levels of nutrition than the boys. Thus, in the top category there are roughly 8 per cent. more, and in the poorest category about 4 per cent. fewer, girls than boys.

The values in Table XXIII indicate a definitely higher nutritional level than those given for 1936 in the School Medical Officers' Annual Reports for the respective areas (see Table XXIV). It is, however, impossible to say whether this difference between the assessments is genuine or merely the result of differences in the standards held by the examining doctors. It is also

necessary to point out that the Board of Education classification is not operative in Scotland, and that the designations used by the School Medical Officer for Renfrewshire are not the same as those used in England and Wales. The designations used by the Renfrewshire School Medical Officer are—" above average," " average " and " below average " state of nutrition. These titles probably correspond roughly with the 1, 2 and 3 used in the present report, that is, with the A, B and C+D of the Board of Education's classification ; but the standards may have been different.

In discussing the results in Table XXIII attention is confined to the proportions of children in categories 1 and 3. It is obvious that category 2 is a " buffer " category and that the proportions in it vary with the extent and direction of the changes in the other two categories. For example, an increase in category 2 might be due to transfer upwards from 3 or downwards from 1 ; the first change would be regarded as for the better and the second for the worse.

Table XXIII shows that at the 1st examination, roughly one-third of the boys in all the feeding groups are in the first clinical category, and that the proportion rises rapidly at first in the milk groups at the succeeding examinations to reach 38 per cent. in the 1/3 pint, 40·4 per cent. in the 2/3 pint pasteurised and 41·0 per cent. in the 2/3 pint raw group at the 4th examination. The proportion in category 1 in the biscuit group remains fairly steady until the 4th examination when it rises to a value of 37·2 per cent. The group differences are, therefore, in favour of milk and in accordance with the amounts of the supplements. In category 3 the proportions of boys at the 1st examination are fairly even in the four feeding groups. No definite change takes place until the 3rd examination when there is a general fall of from 1–2 per cent. followed by a more marked fall at the 4th examination. The proportions at the 3rd and 4th examinations are in favour of milk and in accordance with the amounts.

Amongst the girls the proportions in the first category at the start are higher than those for the boys, and they rise fairly steadily in all feeding groups at the succeeding examinations. The figures at the 2nd examination are in favour of the milk fed groups but those at the 3rd and 4th examinations are indefinite. On the other hand, the proportions in category 3 at the 3rd and 4th examinations are definitely in favour of the milk supplements and in accordance with the amounts of milk.

The changes in the numbers of children at the different medical examinations can be seen more clearly in Table XXV, which shows the changes in the numbers of children in categories 1 and 3 at the 2nd, 3rd and 4th examinations expressed as percentages of the numbers present in the respective categories at the 1st examination. It will be noted that all the values in category 1, except one, are positive, and that they increase in magnitude from the 2nd to the 4th examination, thus indicating an all-round improvement in the clinical assessments. The values for the boys at the 2nd and 3rd examinations show advantages to the milk supplements in accordance with the amounts ; but at the 4th examination only the two larger supplements maintain

this advantage. The values for the girls are in favour of the milk groups and are consistent with the amounts at the 2nd examination, but at the 3rd and 4th examinations only the figures for the two 2/3 pint groups are superior to those for the biscuit group.

The values for category 3 are all negative, except two, thus indicating a marking-up in the clinical category which is to the advantage of the milk fed groups and also in accordance with the amounts of milk amongst the girls at the 3rd and 4th examinations. Amongst the boys the values are in favour of the milk-fed groups only in the two 2/3 pint groups at the 2nd, 3rd and 4th examinations.

Tests of the statistical significance of the differences between the changes, over the year, in the numbers of children in clinical categories 1 and 3, in the milk groups compared with the biscuit groups, showed that (*a*) amongst the girls, the changes in favour of the 1/3 pint and 2/3 pint raw group for category 1, and in favour of both 2/3 pint groups for category 3, are significant ; and (*b*) amongst the boys, none of the changes is significant.

The differences between the changes produced by 2/3 pint pasteurised and 2/3 pint raw milk are irregular as Tables XXIII and XXV show, and none of them was found to be significant statistically.

From this analysis it may be concluded that the two larger milk supplements, as compared with biscuits, produced consistent improvements in the clinical assessment of nutrition, but that the differences in favour of the 1/3 pint group are not so definite.

Teachers' Assessment of Intellectual Capacity.

The proportions of children placed in each category at the four examinations are given in Table XXVI. It can be seen that, initially, the proportions of boys and girls is slightly higher in category 1 and slightly lower in category 3 for the biscuit groups than for the others.

On account of this initial irregularity, comparisons between the percentages present in the 1st and 3rd categories at the different examinations are difficult. Attention is therefore drawn to Table XXVII, which sets out the percentage changes in the numbers of children in categories 1 and 3 in the respective feeding groups at the 2nd, 3rd and 4th examinations, as compared with the numbers in these categories at the first examination. It will be observed that there is a progressive shifting in all feeding groups from lower to higher categories throughout the year, except in the biscuit group of girls, where the proportion remains fairly constant. The change is, however, more irregular than the similar change in clinical assessment. Amongst the girls in all the milk groups, there is evidence of a movement upwards into category 1 and away from category 3, of greater magnitude than in the biscuit group. In fact, the proportions in categories 1 and 3 in the biscuit group, as pointed out above, remain fairly constant throughout the test. Amongst the boys, the movement upwards into category 1 is regular throughout the year in the biscuit, 1/3 pint

and 2/3 pint pasteurised groups ; but at the 4th examination the change into category 1 is smaller for the 2/3 pint pasteurised group than for any of the other feeding groups. The next smallest is in the biscuit group ; that in the 1/3 pint group is highest and the one for the 2/3 pint raw group is intermediate. As regards the 3rd category, the changes for the boys indicate a steady upward trend away from this category only in the biscuit and 2/3 pint pasteruised groups. In the other two feeding groups there is a movement away from category 3 at the 3rd and 4th examinations. At the end of the year, however, the figures show that the upward trend from the 3rd category is about 7 per cent. greater for the 1/3 pint group and about 10–11 per cent. greater for the two 2/3 pint groups, as compared with the change in the biscuit groups.

Tests of the statistical significance of the changes in the milk groups relative to the biscuit groups showed that (*a*) for category 1, those in favour of the 2/3 pint raw group of boys and of both 2/3 pint groups of girls, and (*b*) for category 3, those in favour of all 3 milk groups in both sexes are significant.

It may be concluded from this analysis that the supplements of milk produced an improvement in the intellectual ability of the children compared with the biscuit group, and there is also a suggestion that the larger supplements of milk produced greater improvement than the smaller supplements.

Other Assessments.

The results of the remaining medical assessments were so indefinite or contradictory, or both, that no inferences germane to the object of the research could be drawn from them. The results for posture only are published as an example (see Tables XXVIII and XXIX). From Table XXVIII it can be seen that, in the course of the year, there is a fairly steady shift downwards from the 1st category in the assessment of posture in both sexes, and that the percentages in the 2nd category rise roughly by corresponding amounts. Thus, in the boys, in whom the shift was more pronounced, the proportion in category 1 falls from about 50 per cent. at the 1st to about 30 per cent. at the 4th examination ; while the proportions in category 2 rise from about 44 per cent. to about 60 per cent. in all groups. There is little change in the proportion of children in the 3rd category during the year. Neither the figures in this table nor those in Table XXIX, which shows the percentage of children in the three categories at the 4th compared with the 1st examination, afford any evidence for or against milk as regards its effect on the clinical assessment of posture. The only inference that can be made from these results, therefore, is that there was a downward shift in the assessment of posture in all feeding groups throughout the year. This was the only inference which could be drawn from the data for complexion, condition of the tonsils and of the conjunctivae and eyes. The data for expression showed an upward trend in the assessment common to, and of approximately the same degree in, all the feeding groups, but there was no evidence of an effect, good or bad, attributable to any of the supplements.

Effect of Milk on Children differing in Initial Physical Condition.

As pointed out in the interim report, the most rapid rate of growth in the biscuit as well as in the milk groups was not found in the children who were clinically assessed below the average, but instead in those assessed above the average at the first medical examination. This finding prompted an analysis to determine whether the initial physical build of the children had any influence on their response to the supplements. The ratio, weight in lbs./height in inches, (W/H), was chosen as the criterion of physical build, not because any special nutritional significance is attached to it, but because it is a convenient means of classifying physical types of children. A low ratio means that the child's body weight is low relative to its height, and a high ratio means the reverse. Children with low ratios would invariably be thin and the lowest ratios would occur in tall, thin children. Similarly, the highest ratios would be found in short, plump children. The analysis was restricted to the 8–10 year old group and to the total increases which occurred, over the year, in the biscuit group and in the 2/3 pint pasteurised group, as representative of the milk-fed groups. The data considered were for height, weight, chest and pull.

The results given in Table XXX show the changes in height, weight, chest and pull over the year for children who fell into different W/H ratios. The changes in the 2/3 pint group were, of course, greater than those in the biscuit group for each grade of W/H ratio. The important point of this analysis is, however, to compare the *trend of increments* during the year in the respective feeding groups as the ratio W/H changes ; it is not to contrast the corresponding values in the two feeding groups. Hence the increases for children with W/H of less than 1 are placed at 100 and those for the other W/H values are expressed as a percentage of them.

Considering the biscuit group first, it will be observed that, for all four measurements, there is a progressive rise in the increments from the lowest W/H grade to the highest. There are only three exceptions ; height : boys, W/H 1·30 + ; pull : girls, W/H 1·30 + ; pull : boys, W/H 1·30 +.

The trend of values for the milk group is not materially different. There are, however, two exceptions, namely in height and chest circumference for the boys. Here the progressive improvement in growth as one passes from the lower to the higher W/H grades is less regular.

It may, therefore, be concluded that children in the higher W/H categories, like those in the higher clinical nutritional categories, on the whole, showed more improvement in physique and muscular power than those in the respective lower categories, and that the milk-fed children did not differ appreciably from the biscuit-fed children in this respect.

DISCUSSION.

Considering the results of this investigation as a whole they indicate that the milk supplements had beneficial effects on bodily development as represented by measurements of height, weight and chest, and also on muscular strength, the clinical estimate of the state of nutrition and the teacher's estimate of intellect. This is the first investigation we know of, in which an attempt was made to ascertain the effect of supplementary foods on characteristics other than those of physique. There are, it is true, references in the reports of the researches of Orr (2), Leighton and Clarke (3), and of others, to improvements in general condition having been brought about by milk supplements, but no systematic attempt was evidently made to express these improvements quantitatively. Thus, Dr. Douglas, who examined all the children taking part in the above experiment (3) reported . . . " the children receiving milk showed, even where there was obviously poor maternal care, that sleekness peculiar to a well-nourished animal. Their hair had a glossy and bright appearance. Their nails were smooth, resilient, and looked as if polished. General alertness was common to all the children fed on milk." In a milk feeding test on under-nourished children Lininger (4) noted scholastic improvement in 45 per cent. of the milk group compared with 24 per cent. of the controls. In a similar test in Tokyo, Tsurumi (5) found that the milk-fed children had better skin and complexions, were more cheerful, attended school more regularly and were better at athletics than the controls.

It is an important point that the increased rate of growth in stature in the present study was accompanied by improvements in functional efficiency in at least two respects, as well as in clinical condition. This is not surprising, since a proper state of nutrition is a fundamental necessity for the proper functioning of the body in all its parts. The state of nutrition, as has been frequently emphasised by Magee (6), Dunstan (7) and others, is a functional state, and the most logical and most direct method of assessing this state is to secure a measure of the functional capacity of the individual. Unfortunately, the present state of knowledge does not permit of an objective appraisal of functional capacity. Of the several categories of functions which constitute the active life of man, data bearing on only two have been recorded in the present research, namely, on voluntary functions of the neuro-musuclar tissues and on intellectual functions. The attempt made by means of the modified Romberg test to assess the efficiency of those functions which are exercised just below the plane of consciousness, *i.e.*, the semi-automatic functions, such as muscular co-ordination, as pointed out, had to be abandoned owing to defects of method.

In recent years several other tests of functional capacity have been developed, but it will suffice to refer to only a few of the more representative of these. For several years Woolham (8) has been using tests of vital capacity and of breath holding, as well as certain other tests, to measure the progress of children admitted to an open-air school. Milligan (9), in addition to the dynamometer pull, has also been employing an endurance test to assist him in assessing the state of nutrition of children. Both authors claim that these functional tests have been of great assistance to them in their work. A few

School Medical Officers are using these or similar tests in different parts of England. In addition, a number of methods, mainly of a biochemical nature have been developed in recent years to detect deficiencies in the intake of vitamins A, B_1 and C. These tests have been reviewed by Harris (10). The assessment of the state of nutrition in children by the so-called "clinical method," which in reality consists mainly of inspection, is very difficult and often uncertain. It has been shown by Jones (11) that experienced doctors can differ considerably in their classification of the same children into the four nutritional categories of the Board of Education, and that the same doctor may classify the same children differently at different times.

The inconclusive results revealed in the present study by the assessments of complexion, expression, posture, etc. are of interest in the light of these observations. The assessments of these characteristics in our investigation showed nothing more than a shift, up or down, in the categories, of approximately the same degree in all the feeding groups; and there were no differences which could be interpreted as in favour of or against the milk-fed groups as compared with the biscuit groups. It is scarcely conceivable that there should be improvement in the rate of growth, in muscular strength, in nutrition as "clinically" assessed and in scholastic ability without corresponding changes in general health. Since such improvements were brought about by the milk supplements, evidence of improvement in general health was to be expected. The fact that no such evidence was obtained, under such carefully controlled conditions, from the subjective evaluations of complexion, expression, etc. suggests either that these characteristics cannot be regarded invariably as indicative of the state of health or, more probably, that the method of assessing them was faulty. It is, at any rate, clear from the results of this research that assessments of these characteristics in large numbers of children by inspection only is of very doubtful value. In regard to the value of assessments of complexion and expression in particular, as criteria of health, there is much difference of opinion among physicians, but posture is of a different order. Posture depends mainly on the state of muscular tone and, although the emotions are also a factor (12), it is not influenced by them to anything like the same extent as complexion and expression. Improvement in muscular strength is inconceivable without a corresponding change in muscular tone, so that the state of posture should afford some indication of the state of nutrition. The absence of such evidence in this research most probably signifies that the method of examination was defective. The method of inspection implies a non-material, mental, standard which, if consistent results are to be obtained over large numbers of children, must remain unaltered in the mind of the examining doctor. When large numbers of children of varying posture are inspected, the standard will naturally tend to lose definition and, perhaps, to be replaced by a different mental picture. If it were possible for the examining doctor to check his standard from time to time, by inspecting a child of ideal posture, the chances of the standard fading could be obviated to a great extent. This was obviously impossible during the present research and, unfortunately, the photographic method of Schiotz (13) was not published in time to be considered. In this method every child is photographed under standard conditions of lighting, distance and bodily position and, from the records obtained, children are classified into different postural categories. By this means

posture can be assessed objectively, and the non-material standard, which the doctor endeavours to carry in his mind, is replaced by an objective pictorial standard. It is of interest to know that this method was employed in the Carnegie Nutritional Research which was conducted in different parts of Great Britain during 1937/39 (14).

The need for objective tests to assist the School Medical Officer in his nutritional work has been emphasised again and again, but there has been no general adoption of any objective tests by the School Medical Service ; obviously because these have not yet been developed to a sufficient degree of certainty and simplicity. The degree of parallelism found in this research between the rate of growth in physique and that in muscular strength (with the exception of boys aged mainly 11–14 years receiving raw milk), as well as the experience of Woolham (8), Milligan (9) and others, shows that a test of muscular strength may be a useful help for assessing the state of nutrition of children.

In the interim report attention was drawn to the fact that the gains in height and weight, attributable to milk, were in this research definitely less than those observed by previous workers in this country (Mann (15), Orr (2), Leighton and Clarke (3), Leighton and McKinlay (16)). It was suggested in the interim report that the most probable reasons for the smaller effects of milk in the present research were—

(1) general improvement in the diets of the people, compared with 7–12 years previously, thus leaving less scope for improving the home dietary by supplements given at school, and

(2) the supplements of milk fed in the present research, 1/3 and 2/3 pint, are definitely less than those fed in previous tests, namely, 3/4 to 1¼ pints, according to age.

The additional data considered for this report do not make it possible to add anything further to this opinion.

In the interim report an analysis was made to ascertain whether the gains in height and weight were affected by the clinical condition of the children at the start of the experiment. The analysis showed that there was no evidence indicating that the *relative* gains in the children of the lower nutritional categories were either greater or less than those in the higher categories. In fact, the *absolute* gains were greater for the " well nourished " than for the " badly nourished " children. This analysis was not repeated but, instead, comparisons were made to ascertain whether variations in physical build, *i.e.* in the W/H ratio, had any effect on the gains in height, weight, chest and pull. The results showed that the increases in height, weight, chest and pull, tended on the whole to rise as the W/H ratio rose, but that there was no difference between the control children and the milk-fed children in regard to the degree of the trend. This additional analysis, therefore, provides no support for the opinion expressed in the interim report (page 15) " that the tendency for the well nourished children to respond to milk better than those in the lower nutritional grades may have been due to . . . the fact that the skeleton in ill-nourished children tends to be deficient in calcium and perhaps other constituents. Normal

growth could not therefore begin in such children until these deficiencies were made good and the more malnourished the child, the more would the additional nourishment be diverted to making good the deficiencies in the existing bony structures and the less to increasing the rate of growth."

On the other hand, the results of some researches, in which very striking increases in growth have been recorded, suggest that these have been possible because of the general poorness of the basal diet of the children. In an experiment published by Roberts *et al* (17), milk supplements of one pint were found to produce, on an average, increases of 0·35 inches in height and 1·37–2·25 lbs. in weight greater than those of the controls in the course of a year, or about double or more the increases obtained in the present research. The authors point out that the children were below the average size at the start of the test and that their basal diet was below the optimum. The most striking increases in growth in experiments of this sort recorded in recent years are those reported by Tsurumi (5) in Tokyo, and by Aykroyd and his colleagues (18) in India. Tsurumi found that the addition of 200 ml. milk for six months to the diet of elementary school children caused increases in weight of 86 per cent., and in height of 16 per cent., greater than those found in the control children who did not receive milk. The Indian tests were carried out with skimmed milk. In one of these, for example, girls aged 10–16 years received 1½ ozs. of skimmed milk powder (equivalent to 12 ozs. of liquid skimmed milk) daily for six months. The milk-fed girls showed increases in height of 0·77 inches and in weight of 5·8 lbs. greater than the control children who did not receive milk.

There have been few experiments carried out in recent years on human beings to compare the nutritive values of pasteurised and raw milk, but many on laboratory and other animals ; the latter have been discussed in Parts I and III. It will therefore suffice to mention only the human experiments.

In a four-month test on about 12,000 children, half of whom received 0·75 pint pasteurised milk and the other half 0·75 pint raw milk daily, Leighton and McKinlay (16) were unable to detect any significant difference in the average rate of growth of the two groups. Frank *et al* (19), from the growth data of about 3,600 children aged 10 months to 6 years, half of whom had received pasteurised or evaporated milk and half raw milk for more than the latter half of their life, were unable to detect any significant difference between the average rates of growth in the two groups of children. They concluded that the growth-promoting capacity of heated milk is not less than that of raw milk.

The present test confirmed these findings. It must be remembered, however, that in all these tests milk was not the only food consumed ; it formed part of a mixed diet, so that any deficiencies that may have existed in the pasteurised milk may have been compensated in some measure by the nutritive factors in the rest of the diet. For instance, as the experiments reported in Part I have shown, pasteurisation reduces the vitamin C content of milk by about 20 per cent. but in a mixed diet of which pasteurised milk formed a part, the deficiency in vitamin C would almost certainly be corrected by the vitamin C present in fruit, potatoes and vegetables. It cannot be concluded from the results of the present investigation that there are no nutritional

differences of any kind between pasteurised and raw milk. To provide a decisive answer to this question, so far as man is concerned, it would be necessary to conduct an investigation on artificially fed babies living under controlled conditions in an institution and fed exclusively on cow's milk. An investigation of this sort formed part of the original research plans of the Milk Nutrition Committee ; but, owing to our inability to secure a sufficient number of suitable babies, this part of the research had to be abandoned. Even if these had been available, it would not have been justifiable to feed them exclusively on cow's milk, raw or pasteurised, without any supplement. Cow's milk is too poor in iron for the nutrition of the human infant, and pasteurisation destroys a significant portion of the vitamin C, which is present in raw milk in but small amounts. Both kinds of milk would, in fact, in a test on babies, have to be supplemented with iron in some form, preferably egg yolk, in which the iron is easily utilisable, and also with vitamin C, preferably orange juice, to prevent the possible occurrence of nutritional anaemia and scurvy, respectively. These supplements, in addition to correcting the specific deficiencies, might conceivably correct others due to pasteurisation which we do not know of at present.

An uncomplicated test of the nutritive values of raw and pasteurised milk on human beings is scarcely possible. However, the important point in any comparisons between the nutritive values of raw and pasteurised milk is not to demonstrate the presence of defects in one or other which are of merely academic interest, but rather of defects which are manifested under purely practical conditions.

The results obtained in the present investigation, while they add nothing further to our academic knowledge of differences which may exist between raw and pasteurised milk, nevertheless demonstrate that, under purely practical conditions, there is no difference in nutritive value between them.

CONCLUSIONS.

The supplements of 1/3 pint pasteurised and 2/3 pint pasteurised or raw milk produced in both sexes, irrespective of age, increments in height, weight and chest circumference greater than those which occurred in the control or biscuit groups. These increases were greater in the groups receiving 2/3 pint raw or pasteurised milk than in those receiving 1/3 pint pasteurised milk. The increments produced by milk in height and chest circumference were smaller, absolutely and relatively, than those in weight, but, on the whole, they were consistent and in accordance with the amount of milk in the supplements, more especially in the girls. The increases in weight and chest circumference, but not in height, in the milk groups for the interval between the first and second medical examination, were disproportionately greater than those observed at subsequent examinations, compared with the corresponding increases in the biscuit groups. This difference is taken to mean that the stimulating effects of milk on growth in weight and chest circumference were exerted particularly in the early part of the test.

No constant differences could be detected between the growth promoting effects of 2/3 pint pasteurised and 2/3 pint raw milk in either height, weight or chest circumference.

In girls 8–14 years old, the milk supplements caused consistent increments in muscular strength greater than those observed in the controls and in accordance with the amounts of the supplements. The disproportionately high increase between the 1st and 2nd examinations indicates that the stimulating influence of milk on muscular power was felt mainly in the early part of the test.

In boys 8–14 years, the supplements of 1/3 pint pasteurised and 2/3 pint pasteurised milk caused small but consistent increases over the controls in muscular strength, but the increases were not in accordance with the amount of the milk supplement. In boys aged 8–10 years, 2/3 pint raw milk also caused an increase in muscular strength above that in the controls, but in boys aged 11–14 years the increase in the 2/3 pint raw group was less than that in any of the other feeding groups. The 8–10 year old boys and the 11–14 year old girls, as well as six of the ten possible comparisons between pasteurised and raw milk in the five areas, showed slightly greater increases in muscular strength, during the year, attributable to 2/3 pint pasteurised milk than to 2/3 pint raw milk. In the children considered as a whole, the differences between the increments in the 2/3 pint raw and the 2/3 pint pasteurised groups were in favour of pasteurised milk at every medical examination. This evidence is not regarded as conclusive that raw milk is inferior to pasteurised in promotion of muscular power, since none of the differences is statistically significant. The matter obviously demands further attention.

Comparisons of the rate of growth and pull of children aged 8–10 years and varying in the ratio, weight/height, showed that, on the whole, children in the higher W/H categories at the first medical examination, whether milk-fed or biscuit-fed, improved more in the course of the year than those in the lower categories. In other words, the influence of W/H on growth and strength was not appreciably altered by the milk supplements. This result is in harmony with that published in the interim report, where the gains in height and weight during the year were compared for children belonging to all feeding groups classified according to clinical nutritional grade at the first medical examination. The gains tended to be greater in the higher than in the lower clinical grades irrespective of feeding group.

The boys 5–10 years old were initially taller and heavier than the girls of the same age ; this initial advantage was not fully maintained during the year as the girls grew at a slightly faster rate than the boys. The girls aged 11–14 years were taller and heavier initially and they grew more rapidly, absolutely and relatively, during the year than the corresponding groups of boys. Initially, the 8–10 year old boys slightly exceeded, and the 11–14 year old boys were about the same as, the corresponding groups of girls in chest circumference ; but the girls grew in this respect, absolutely and relatively, at a greater rate than the boys. The boys aged 8–14 years were able to pull about 32 lbs. more than the girls at the start of the experiment. The strength of both sexes increased during the year by about 34 lbs. on the average, but the relative improvement in strength of the girls was greater than that of the boys.

Initially, a greater proportion of girls than of boys was placed in the higher nutritional categories as assessed clinically by the doctors. The proportions in the teachers' assessments of scholastic ability at the beginning of the test were about equal for both sexes. All the supplements of milk resulted in larger

numbers of children being placed in the higher nutritional and scholastic categories by the doctors and teachers than did the supplements of biscuits. The changes attributable to milk were greater, on the whole, for the two larger supplements than for 1/3 pint. No constant differences could be discerned between the effects, on either assessment, of 2/3 pint pasteurised and 2/3 pint raw milk.

The data for the assessments of the condition of complexion, expression, posture, tonsils, teeth and eyes, as well as for " after effects of preceding illness " and " absences since last examination " were found to be ambiguous or inconclusive or both.

SECTION B.

SUMMARY OF RESULTS AND CONCLUSIONS FROM THE RESEARCHES SPONSORED BY THE MILK NUTRITION COMMITTEE.

The object of this summary is to present the main findings and the practical conclusions which may be drawn from the researches initiated by the Committee. The researches fall into three groups—

(1) Laboratory experiments.*

(2) Feeding trials on calves.*

(3) School feeding experiments.

The first two of these researches and part of the third were designed to test the effect of commercial pasteurisation on the nutritive value of milk.

The feeding trials on school children were also planned to show the effects on growth and stamina of supplements of milk of the same amounts as those which figure in the Milk-in-Schools Scheme. The school feeding trial, therefore, provided a practical measure of the benefits for children to be expected from the Milk-in-Schools Scheme.

Laboratory Experiments.

The laboratory experiments were carried out mainly at the National Institute for Research in Dairying at Reading; some of them were repeated and confirmed at the Rowett Institute, Aberdeen. The object was to compare the nutritive values of pasteurised and raw milk. The work consisted of—

(*a*) Feeding experiments on rats where milk was the sole constituent of the diet.

(*b*) " Balance " experiments on rats where the intake and excretion of protein, calcium and phosphorus were carefully determined and from the data the amounts retained were calculated.

(*c*) Estimations of the vitamin contents of the milk before and after pasteurisation.

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* For detailed results of these researches see " Milk and Nutrition " Parts I. and III.

Conclusions from Laboratory Experiments.

The results led to the following conclusions. Commercial pasteurisation, so far as can be demonstrated—

(*a*) did not affect the total nutritive value of milk when it formed the sole food of rats during most of their period of growth ;

(*b*) did not detrimentally affect the availability or nutritive value of the protein, calcium or phosphorus of milk ;

(*c*) reduced the vitamin C content of milk by about 20 per cent. and the B complex (presumably the B_1 fraction) slightly, but did not alter the content of vitamin A or of its precursor carotene.

The effect of pasteurisation on the vitamin D content was not tested, but as this vitamin is known to be very resistant to heat, it may be presumed that it is not affected by pasteurisation.

Calf-Feeding Experiments.

Three calf-feeding tests in all were made, two at the Rowett Institute, Aberdeen, and one at the National Institute for Research in Dairying at Reading. For the Aberdeen tests 48, and for the Reading test 32 newly born calves were employed. The general plan was the same for all the experiments. The calves were randomly divided into two groups, one of which received a certain quantity of raw milk and the other an equal quantity of the same bulked milk after pasteurisation. The calves were placed on the experiment a few days after birth and they remained on it for six months. At first they were fed on milk only ; later known amounts of solid foods were given. The calves were weighed weekly and measurements of certain long bones and determinations of the composition of the blood were made at regular intervals.

Conclusions from Calf-feeding Experiments.

The combined results of the three experiments showed no significant differences between the groups of calves fed on raw milk and those fed on pasteurised milk, in regard to rate of growth in weight or in the long bones, in the composition of the blood or in general health. There was, however, a difference between the groups in regard to reaction to the tuberculin test for tuberculosis, namely, that 46 per cent. of the calves which received raw milk reacted positively, compared with 13 per cent. of the calves fed on pasteurised milk.

Effects of one-third pint pasteurised and two-thirds pint Pasteurised or Raw Milk on the Growth and Stamina of School Children.

There were 8,435 children, aged 5–14 years about equally divided between the sexes, who agreed to participate in the test. The children were randomly divided according to age and sex into four feeding groups, the first of which received biscuits, the second 1/3 pint pasteurised milk, the third 2/3 pint pasteurised milk, and the fourth 2/3 pint raw milk during school hours for a year. No supplements were given on Saturdays or Sundays or during holidays. The milk, both pasteurised and raw, was all obtained from the same source in each of the five areas, Luton, Wolverhampton, Burton-on-Trent, Renfrewshire and

Huddersfield, in which the test was conducted. The children were weighed, measured and medically examined by four specially trained doctors at the beginning and end of the trial and twice in between these times. The teachers in charge of the children also recorded their estimate of the scholastic ability of the children at the time of each medical examination.

Of the children who started in the test, 6,097 were present at all four medical examinations and of the remainder, 695 children aged 13–14 years were present at the first and second medical examinations. The data from the remaining 1,643 children were found unsuitable for statistical analysis. The material for the present report was, therefore, taken from the 6,097 children who attended all four medical examinations, and the 695 who attended the first and second. Statistical tests showed that the randomness of the sampling was not upset by the absences.

Conclusions from the School Feeding Experiment.

The results obtained from the school feeding experiment led to the following conclusions.

The supplements of 1/3 pint pasteurised and 2/3 pint pasteurised or raw milk produced, in both sexes irrespective of age, increments in height, weight and chest circumference greater than those which occurred in the control or biscuit group. These increases were greater in the groups receiving 2/3 pint raw or pasteurised milk than in those receiving 1/3 pint pasteurised milk. The increments produced by milk in height and chest circumference were smaller, relatively, than those in weight, but on the whole they were consistent and in accordance with the amounts of milk in the supplements. The stimulating effects of milk on growth in weight and chest circumference were exerted particularly in the early part of the test.

No constant differences could be detected between the growth-promoting effects of 2/3 pint pasteurised and 2/3 pint raw milk in either height, weight or chest circumference.

In girls 8–14 years old, the milk supplements caused consistent increments in muscular strength greater than those observed in the controls and in accordance with the amounts of the supplements fed. The greater part of the increase due to milk evidently occurred in the early stages of the test.

In boys aged 8–14 years, the supplements of 1/3 pint pasteurised and 2/3 pint pasteurised milk caused small but fairly consistent increases over the controls in muscular strength, but the increases were not in accordance with the amount of the milk supplement. In boys aged 8–10 years, 2/3 pint raw milk also caused an increase in muscular strength larger than that in the controls. In the 11–14 year group of boys, on the contrary, the increase in the 2/3 pint raw group was less than that in any of the other feeding groups. There was also some other, but inconclusive, evidence suggesting that 2/3 pint raw milk may not be as conducive to muscular exertion as 2/3 pint pasteurised milk, especially in boys aged 11–14 years.

The supplements of 1/3 pint and of 2/3 pint milk, pasteurised and raw, resulted in larger numbers of children being placed in the higher nutritional and intellectual categories by the doctors and teachers than supplements of biscuits. The improvements in these assessments, attributable to milk, were roughly in accordance with the supplements. Assessments were also made at every medical examination of the condition of the complexion, expression, posture, eyes, tonsils and teeth, but the data were too irregular or ambiguous to permit of any conclusion.

SECTION C.

PRACTICAL CONCLUSIONS FROM ALL THE RESEARCHES.

Nutritive Value of Milk for Children.

The great value of milk for the growth and health of growing children, already established, has been abundantly confirmed by the results of the school feeding test. This experiment, which amounted to a practical trial of the Milk-in-Schools Scheme, has shown that definite improvements in physique, in general appearance and scholastic ability and to a somewhat lesser extent in muscular strength are to be expected from the consumption by school children of 1/3 pint or, better still, of 2/3 pint pasteurised or raw milk.

The Nutritive Value of Pasteurised and Raw Milk.

It is necessary to emphasise that raw cow's milk is the natural food of the young calf during the early period of life and before it is capable of subsisting on foods such as grass, which the adult of the species consumes. Cow's milk is not an ideal food for the human infant before weaning. Nature's food for the human infant is its mother's milk. Human milk differs in many respects from cow's milk; it contains less protein, less calcium and phosphorus and less of most of the other minerals in milk, but it contains more sugar and more iron. (The two kinds of milk are compared in Table XXXI). These differences must be borne in mind when the results of experiments on calves are being applied to human nutrition. Since raw cow's milk is the natural and exclusive food of the young calf until it is capable of digesting and utilising solid food, it may be assumed that cow's milk is exactly suited to meet all the nutritional needs of the calf at the period of its most rapid growth and development. Rapidly growing animals, like the young calf, are particularly sensitive to food deficiencies and for this reason, the calf is the most suitable test animal which can be used to detect small nutritional differences in cow's milk.

The fact that no statistically significant differences in growth rate, in general health or in the composition of the blood could be detected in groups of calves fed on raw and pasteurised milk, respectively, during a six months' feeding trial is, therefore, of great importance. It may be argued that there are defects in pasteurised milk relative to raw milk, which these experiments could not be expected to demonstrate, and that these defects were neutralised by constituents of the other foods, hay and concentrates, which were fed to the calves in the latter part of the experiments. The answer is that it is not small defects which are important but only those which become manifest under strictly practical conditions.

In addition to these experiments, six others of a similar nature and with a similar objective have been carried out since 1926 in this country. The results of these experiments have been reviewed and summarised in Part III and it is worth while repeating the general conclusion reached from a weighing-up of all the results.

" Raw milk has for calves a nutritive value almost identical with that of pasteurised milk. If there is any difference in favour of raw milk it is so small that it is readily masked by quite small variations in the experimental conditions."

It is true that pasteurisation has been shown to lessen slightly the amounts of soluble calcium and phosphorus, and perhaps to a greater extent the total iodine content, and to cause changes in the physico-chemical nature of the proteins and in the reaction of milk (see Stirling and Blackwood (20), Savage (21) and Kon (22) for references). But in the light of the results obtained in the several experiments on calves and on rats these chemical changes can only be regarded as of academic importance. Furthermore, it would appear that these, and perhaps other changes, which may be caused by pasteurisation, but which have not been demonstrated so far, in the physico-chemical composition of milk are so slight that the physiological adaptability of the calf is able to cope with them without detriment to its growth and well-being. For example, there can be no doubt that the hydrochloric acid in the gastric juice of the normal calf (or other young mammal) would suffice to bring into soluble form all the calcium and phosphorus rendered insoluble by pasteurisation. It is, however, conceivable that a calf, ailing, whether because of an hereditary trait or of accident or disease, might, if fed on pasteurised milk, reveal the existence of nutritive defects, as compared with raw milk. It would, however, be extremely difficult, if not impossible, to demonstrate such defects by means of a suitable experiment, and in any case the results could not be regarded as generally applicable.

In view of the above it is not surprising that the addition to the home diets of school children of 2/3 pint of raw or pasteurised milk did not reveal any nutritive differences. The supplements formed only a part of the total diet of the children, and for this reason, defects in one or other would have had to be fairly gross to have influenced the growth and health of the children. The results showed that there were no differences of practical importance between them.

It may, therefore, be concluded that there are no differences between the nutritive values of raw and pasteurised milk of any practical importance for school children who receive milk as part of their ordinary diet.

The matter is different for infants who might be fed exclusively or almost so on cow's milk. In the first place, cow's milk contains too little iron for the proper nutrition of the infant and it has, therefore, to be supplemented with iron in some form. As recommended by the Technical Commission of the League of Nations (23), egg yolk is the most suitable form in which to administer iron to infants; but egg yolk contains other nutritive elements, especially vitamins A (and its pro-vitamin carotene), B_1, B_2 complex and D, so that the addition of this supplement would counteract any deficiencies in these respects

which might exist in pasteurised milk. Again, commercial pasteurisation, as has been reported in Part I, lowers the vitamin C content of milk and it is usual to add some fruit juice to the milk of infants to counteract this defect. Moreover, even raw cow's milk is not a good source of vitamin C and it is open to question whether babies fed exclusively on such milk would be free from any risk of C-avitaminosis. On the basis of existing knowledge, therefore, it would be unjustifiable not to supplement cow's milk, raw or pasteurised, intended for infants, with these or similar supplements ; and, as has been seen from these researches, such additions would remove those small defects which are brought about in cow's milk by commercial pasteurisation.

It should be made clear that the loss in vitamin C following pasteurisation is not *primarily* due to the heat treatment, but to previous exposure of the milk to light. The vitamin is secreted by the cow as ascorbic acid and, if it were all in this form at the time of pasteurisation, the heating would not, according to present knowledge, have any effect on it. Under prevailing conditions all milk intended for pasteurisation is exposed to light for varying times. The shorter light rays cause some of the ascorbic acid to combine with the oxygen dissolved in the milk. The resulting oxidation product—dehydro-ascorbic acid, is easily destroyed by heat and the experimental evidence shows that it is only this fraction which is inactivated by pasteurisation. The presence of minute traces of copper will also, without previous exposure of the milk to light, cause the oxidation of ascorbic acid. It, therefore, follows that pasteurisation, conducted in copper-free vessels, would have no effect on the vitamin C of milk, provided the milk were not previously exposed to light. This matter is discussed more fully in a review by Kay (24).

Cow's milk is perhaps just as unsuited for the nutrition of the rat as it is for the human infant, but, whereas it is in general too rich in constructive matter (proteins and minerals) for the human infant, it is not sufficiently so for the rat. The rat grows much more rapidly than the calf and, as pointed out by Bunge (25) in 1874, the more rapid the rate of growth the higher the concentration of constructive constituents in the milk of the species. Rats are, however, in many ways very convenient for experiments on nutrition. They can be used in large numbers, so that the effects of uncontrollable factors can be eliminated, and, because of their very rapid rate of growth, dietary defects quickly become apparent. A further point in favour of the rat as an experimental animal is that it is very suitable for special kinds of nutritional experiments designed to throw light on the fate of the food factors and food derivatives within the living body. The laboratory experiments which formed part of these investigations may, therefore, be said to provide a microscopic picture of the details of what took place in the " gross " feeding experiments on children and calves. If differences of any nutritional significance existed between pasteurised and raw milk it is these detailed and precise experiments which would have been expected to reveal them. The fact that they failed to do so is good proof of the non-existence of nutritional differences of any importance between the two kinds of milk. There, therefore, remain, as the only changes attributable to pasteurisation which have been detected in these investigations, a diminution of 20 per cent. in the vitamin C content (but due primarily to exposure to light) and a slight decrease in the heat labile fraction of vitamin B (presumably the B_1 fraction).

TABLE I.

Number of Children attending all Examinations.

		BOYS					GIRLS				
		Biscuit	1/3 pint past.	2/3 pint past.	2/3 pint raw	All Groups	Biscuit	1/3 pint past.	2/3 pint past.	2/3 pint raw	All Groups
Area	Luton	133	131	129	125	518	81	77	83	87	328
	Wolverhampton	141	141	152	140	574	119	120	121	120	480
	Burton-on-Trent	198	208	213	215	834	202	196	192	180	770
	Renfrewshire	209	192	196	196	793	185	182	178	166	711
	Huddersfield	121	149	149	157	576	92	144	141	136	513
Ages	5– 7	215	240	253	237	945	221	254	244	213	932
	8–10	306	309	323	322	1260	261	283	268	280	1092
	11–14	281	272	263	274	1090	197	182	203	196	778
	All Ages	802	821	839	833	3295	679	719	715	689	2802

TABLE II.

Average period between Examinations.

Number of Children	Interval between Medical Examinations	Weeks			
		1—2	2—3	3—4	1—4
846	Luton	18	23	15	56
1054	Wolverhampton	23	17	15	55
1604	Burton-on-Trent	22	16	15	53
1504	Renfrewshire	22	16	14	52
1089	Huddersfield	22	16	14	52
6097	*Weighted Average ...	22	17	15	54

* Weighted by the number of children in each area.

TABLE III.

Average Height. All Areas. All Ages.

	Average Age Years	Height (inches)				Increase between Examinations (inches)				Percentage Increase			
		Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
BOYS													
Biscuits	9·1	50·631	51·507	52·158	52·817	0·876	0·651	0·659	2·186	1·73	1·26	1·26	4·32
1/3 pint past.	9·0	50·447	51·320	51·998	52·671	0·873	0·678	0·673	2·224	1·73	1·32	1·29	4·41
2/3 pint past.	8·9	50·433	51·343	52·046	52·721	0·910	0·703	0·675	2·288	1·80	1·37	1·30	4·54
2/3 pint raw	9·0	50·512	51·403	52·074	52·774	0·891	0·671	0·700	2·262	1·76	1·31	1·34	4·48
GIRLS													
Biscuits	8·8	50·227	51·215	51·906	52·589	0·988	0·691	0·683	2·362	1·97	1·35	1·32	4·70
1/3 pint past.	8·6	49·647	50·614	51·319	52·006	0·967	0·705	0·687	2·359	1·95	1·39	1·34	4·75
2/3 pint past.	8·7	49·896	50·884	51·615	52·361	0·988	0·731	0·746	2·465	1·98	1·44	1·45	4·94
2/3 pint raw	8·8	50·086	51·104	51·801	52·521	1·018	0·697	0·720	2·435	2·03	1·36	1·39	4·86

TABLE IV.

Average Height. All Areas. Age Classification.

		Average Age, Years	Average Height (inches)				Percentage increase between Examinations			
			Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4
	BOYS									
5– 7 years	Biscuits	5·9	44·229	45·238	45·940	46·602	2·28	1·55	1·44	5·37
	1/3 pint past. ...	5·9	44·255	45·232	45·965	46·668	2·21	1·62	1·53	5·45
	2/3 pint past. ...	5·9	44·437	45·483	46·202	46·895	2·35	1·58	1·50	5·53
	2/3 pint raw ...	6·0	44·598	45·643	46·224	47·085	2·34	1·27	1·86	5·58
8–10 years	Biscuits	9·0	50·570	51·386	51·970	52·582	1·61	1·14	1·18	3·98
	1/3 pint past. ...	9·0	50·879	51·694	52·311	52·930	1·60	1·19	1·18	4·03
	2/3 pint past. ...	9·0	50·988	51·845	52·487	53·147	1·68	1·24	1·26	4·23
	2/3 pint raw ...	9·0	50·731	51·591	52·224	52·825	1·70	1·23	1·15	4·13
11–14 years	Biscuits	11·7	55·595	56·433	57·121	57·827	1·51	1·22	1·24	4·01
	1/3 pint past. ...	11·6	55·419	56·222	56·966	57·673	1·45	1·32	1·24	4·07
	2/3 pint past. ...	11·7	55·498	56·319	57·104	57·801	1·48	1·39	1·22	4·15
	2/3 pint raw ...	11·7	55·370	56·165	56·958	57·633	1·44	1·41	1·19	4·09
	GIRLS									
5– 7 years	Biscuits	5·9	44·290	45·328	46·019	46·674	2·34	1·52	1·42	5·38
	1/3 pint past. ...	6·0	43·919	44·877	45·594	46·322	2·18	1·60	1·60	5·47
	2/3 pint past. ...	6·0	43·972	44·945	45·682	46·484	2·21	1·64	1·76	5·71
	2/3 pint raw ...	6·0	43·886	44·880	45·589	46·336	2·26	1·58	1·64	5·58
8–10 years	Biscuits	9·0	50·602	51·537	52·165	52·846	1·85	1·22	1·31	4·43
	1/3 pint past. ...	9·0	50·457	51·423	52·084	52·754	1·91	1·29	1·29	4·55
	2/3 pint past. ...	9·0	50·650	51·618	52·293	53·027	1·91	1·31	1·40	4·69
	2/3 pint raw ...	8·9	50·313	51·289	51·904	52·636	1·94	1·20	1·41	4·62
11–14 years	Biscuits	11·7	56·392	57·391	58·166	58·883	1·77	1·35	1·23	4·42
	1/3 pint past. ...	11·6	56·380	57·364	58·118	58·773	1·75	1·31	1·13	4·24
	2/3 pint past. ...	11·6	56·020	57·052	57·852	58·547	1·84	1·40	1·20	4·51
	2/3 pint raw ...	11·6	56·499	57·605	58·404	59·079	1·96	1·39	1·16	4·57

TABLE V.

The relative increase in Height in the Milk Groups as a percentage of the relative increase in Height in the Biscuit Group.

All Areas. All Ages.

	Growth between Examinations			
	1—2	2—3	3—4	1—4
BOYS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	100·00	104·76	102·38	102·08
2/3 pint past.	104·05	108·73	103·17	105·09
2/3 pint raw	101·73	103·97	106·35	103·70
GIRLS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	98·98	102·96	101·51	101·06
2/3 pint past.	100·51	106·67	109·85	105·11
2/3 pint raw	103·05	100·74	105·30	103·40

TABLE VI.

The percentage increase in Height between examinations. All Ages. Area Classification.

Feeding Group	BOYS				GIRLS			
	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
Luton								
Biscuits	1·34	1·57	1·23	4·19	2·00	1·46	1·36	4·90
1/3 pint past. ...	1·32	1·64	1·29	4·31	1·90	1·37	1·26	4·60
2/3 pint past. ...	1·40	1·75	1·28	4·49	1·99	1·53	1·25	4·84
2/3 pint raw ...	1·45	1·57	1·26	4·33	2·02	1·52	1·25	4·86
Wolverhampton								
Biscuits	1·39	1·19	1·09	3·72	1·27	1·32	1·23	3·87
1/3 pint past. ...	1·39	1·20	1·15	3·79	1·35	1·40	1·18	3·98
2/3 pint past. ...	1·53	1·20	1·11	3·88	1·38	1·41	1·30	4·14
2/3 pint raw ...	1·46	1·27	1·20	3·98	1·31	1·38	1·19	3·94
Burton-on-Trent								
Biscuits	2·17	1·24	1·53	5·01	2·41	1·42	1·41	5·32
1/3 pint past. ...	2·17	1·37	1·45	5·08	2·47	1·45	1·44	5·46
2/3 pint past. ...	2·35	1·36	1·50	5·30	2·53	1·48	1·70	5·81
2/3 pint raw ...	2·19	1·37	1·46	5·10	2·53	1·38	1·59	5·59
Renfrewshire								
Biscuits	1·93	1·22	1·14	4·35	1·99	1·35	1·19	4·60
1/3 pint past. ...	1·91	1·19	1·16	4·32	1·98	1·43	1·18	4·66
2/3 pint past. ...	1·94	1·24	1·15	4·39	1·98	1·49	1·31	4·86
2/3 pint raw ...	1·92	1·30	1·13	4·40	2·15	1·38	1·26	4·87
Huddersfield								
Biscuits	1·55	1·11	1·29	4·00	1·85	1·12	1·42	4·46
1/3 pint past. ...	1·58	1·26	1·39	4·29	1·75	1·26	1·58	4·67
2/3 pint past. ...	1·51	1·37	1·42	4·36	1·76	1·29	1·53	4·65
2/3 pint raw ...	1·55	1·02	1·68	4·31	1·91	1·18	1·57	4·73

TABLE VII.

Average Weight. All Areas. All Ages.

	Average Weight (lbs.)				Increase between Examinations (lbs.)				Percentage Increase			
	Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
BOYS												
Biscuits ...	60·107	62·945	65·245	66·641	2·838	2·300	1·396	6·534	4·72	3·65	2·14	10·87
1/3 pint past.	59·295	62·482	64·680	66·115	3·187	2·198	1·435	6·820	5·37	3·52	2·22	11·50
2/3 pint past.	59·219	62·622	64·827	66·256	3·403	2·205	1·429	7·037	5·75	3·52	2·20	11·88
2/3 pint raw	59·320	62·812	65·061	66·518	3·492	2·249	1·457	7·198	5·89	3·58	2·24	12·13
GIRLS												
Biscuits ...	57·555	61·151	63·292	64·801	3·596	2·142	1·508	7·246	6·25	3·50	2·38	12·59
1/3 pint past.	56·472	60·404	62·567	64·110	3·932	2·163	1·543	7·638	6·96	3·58	2·47	13·53
2/3 pint past.	57·031	61·181	63·544	65·079	4·150	2·363	1·535	8·048	7·28	3·86	2·42	14·11
2/3 pint raw	57·165	61·511	63·848	65·435	4·346	2·337	1·587	8·270	7·60	3·80	2·49	14·47

TABLE VIII.

Average Weight. All Areas. Age Classification.

		Average Weight (lbs.)				Percentage Increase between Examinations			
		Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4
	BOYS								
5– 7 years	Biscuits	43·741	46·100	47·309	48·392	5·39	2·62	2·29	10·63
	1/3 pint past.	43·471	46·030	47·256	48·380	5·89	2·66	2·38	11·29
	2/3 pint past.	44·165	46·963	48·243	49·290	6·34	2·73	2·17	11·60
	2/3 pint raw	44·213	47·222	48·412	49·596	6·81	2·52	2·45	12·18
8–10 years	Biscuits	58·246	61·185	63·020	63·938	5·05	3·00	1·46	9·77
	1/3 pint past.	58·867	62·269	64·150	65·067	5·78	3·02	1·43	10·53
	2/3 pint past.	59·132	62·764	64·544	65·594	6·14	2·84	1·63	10·93
	2/3 pint raw	58·524	62·221	64·183	65·217	6·32	3·15	1·61	11·44
11–14 years	Biscuits	74·657	77·751	81·392	83·548	4·14	4·68	2·65	11·91
	1/3 pint past.	73·744	77·119	80·657	82·952	4·58	4·59	2·85	12·49
	2/3 pint past.	73·751	77·394	81·063	83·391	4·94	4·74	2·87	13·07
	2/3 pint raw	73·321	76·991	80·494	82·683	5·01	4·55	2·72	12·77
	GIRLS								
5– 7 years	Biscuits	42·717	45·100	46·242	47·078	5·58	2·53	1·81	10·21
	1/3 pint past.	41·808	44·613	45·704	46·629	6·71	2·45	2·02	11·53
	2/3 pint past.	42·277	45·273	46·591	47·617	7·09	2·91	2·20	12·63
	2/3 pint raw	41·885	44·847	46·055	47·035	7·07	2·69	2·13	12·30
8–10 years	Biscuits	56·685	59·979	61·967	63·105	5·81	3·31	1·84	11·33
	1/3 pint past.	57·146	61·016	63·031	64·239	6·77	3·30	1·92	12·41
	2/3 pint past.	57·257	61·170	63·437	64·686	6·83	3·71	1·97	12·97
	2/3 pint raw	55·900	59·880	62·105	63·282	7·12	3·72	1·90	13·21
11–14 years	Biscuits	75·354	80·709	84·178	86·929	7·11	4·30	3·27	15·36
	1/3 pint past.	75·890	81·489	85·380	88·305	7·38	4·77	3·43	16·36
	2/3 pint past.	74·467	80·319	84·064	86·589	7·86	4·66	3·00	16·28
	2/3 Pint raw	75·578	81·950	85·672	88·503	8·43	4·54	3·30	17·10

TABLE IX.

The relative increase in Weight in the Milk Groups as a percentage of the relative increase in Weight in the Biscuit Group.

All Areas. All Ages.

	Growth between Examinations.			
	1—2	2—3	3—4	1—4
BOYS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	113·77	98·44	103·74	105·80
2/3 pint past.	121·82	96·44	102·80	109·29
2/3 pint raw	124·79	98·08	104·67	111·59
GIRLS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	111·36	102·29	103·78	107·47
2/3 pint past.	116·48	110·29	101·68	112·07
2/3 pint raw	121·60	108·57	104·62	114·93

TABLE X.

The percentage increase in Weight between Examinations. All Ages. Area Classification.

Feeding Group	BOYS				GIRLS			
	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
Luton								
Biscuits	2·51	6·05	3·43	12·44	5·55	5·01	4·24	15·54
1/3 pint past.	2·72	5·91	3·61	12·72	6·03	5·48	4·38	16·74
2/3 pint past.	3·42	6·62	3·90	14·58	6·35	5·17	3·21	15·43
2/3 pint raw	3·19	6·69	3·62	14·08	7·85	4·85	4·38	18·04
Wolverhampton								
Biscuits	3·95	2·99	2·84	10·10	5·03	3·33	3·37	12·19
1/3 pint past.	4·51	3·27	2·60	10·73	6·48	3·87	3·39	14·35
2/3 pint past.	5·35	2·83	2·45	10·98	6·56	4·29	3·28	14·78
2/3 pint raw	5·38	3·27	2·64	11·70	6·38	3·77	3·28	14·02
Burton-on-Trent								
Biscuits	5·32	3·07	2·34	11·10	6·74	3·75	1·90	12·85
1/3 pint past.	5·89	3·37	2·44	12·13	7·22	3·49	2·13	13·32
2/3 pint past.	6·21	3·16	2·66	12·47	7·58	3·97	2·39	14·51
2/3 pint raw	6·73	3·30	2·24	12·73	7·59	4·23	2·30	14·72
Renfrewshire								
Biscuits	5·18	3·10	1·45	10·01	6·43	2·69	1·68	11·14
1/3 pint past.	5·87	2·98	1·18	10·31	6·73	2·71	1·74	11·53
2/3 pint past.	6·15	2·66	1·00	10·06	7·59	3·30	1·92	13·28
2/3 pint raw	6·12	2·91	1·19	10·50	7·95	2·97	1·72	13·08
Huddersfield								
Biscuits	6·90	3·22	0·46	10·85	7·17	3·30	1·58	12·45
1/3 pint past.	7·77	2·20	1·39	11·68	7·97	3·33	1·73	13·50
2/3 pint past.	7·48	2·65	1·06	11·50	7·81	3·14	1·72	13·10
2/3 pint raw	7·60	2·14	1·81	11·90	8·16	3·48	1·42	13·51

TABLE XI.

Mean Chest Circumference. All Areas. All Ages.

	Mean Chest Circumference (inches)				Increase between Examinations (inches)				Percentage Increase			
	Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
BOYS												
Biscuits	25·667	26·120	26·395	26·650	0·453	0·275	0·255	0·983	1·76	1·05	0·97	3·83
1/3 pint past. ...	25·638	26·146	26·399	26·652	0·508	0·253	0·253	1·014	1·98	0·97	0·96	3·96
2/3 pint past. ...	25·634	26·194	26·435	26·685	0·560	0·241	0·250	1·051	2·18	0·92	0·95	4·10
2/3 pint raw ...	25·595	26·100	26·360	26·614	0·505	0·260	0·254	1·019	1·97	1·00	0·96	3·98
GIRLS												
Biscuits	25·143	25·774	26·138	26·480	0·631	0·364	0·342	1·337	2·51	1·41	1·31	5·32
1/3 pint past. ...	25·138	25·835	26·181	26·571	0·697	0·346	0·390	1·433	2·77	1·34	1·49	5·70
2/3 pint past. ...	25·088	25·834	26·224	26·569	0·746	0·390	0·345	1·481	2·97	1·51	1·32	5·90
2/3 pint raw ...	25·001	25·788	26·204	26·542	0·787	0·416	0·338	1·541	3·15	1·61	1·29	6·16

TABLE XII.

Average Chest Circumference. All Areas. Age Classification.

	Average Chest Circumference (inches)				Percentage Increase between Examinations			
	Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4
BOYS								
8–10 years								
Biscuits	24·699	25·178	25·375	25·595	1·94	0·78	0·87	3·63
1/3 pint past. ...	24·747	25·263	25·448	25·638	2·09	0·73	0·75	3·60
2/3 pint past. ...	24·816	25·404	25·576	25·799	2·37	0·68	0·87	3·96
2/3 pint raw ...	24·712	25·251	25·456	25·666	2·18	0·81	0·82	3·86
11–14 years								
Biscuits	26·722	27·145	27·505	27·799	1·58	1·33	1·07	4·03
1/3 pint past. ...	26·650	27·149	27·478	27·805	1·87	1·21	1·19	4·33
2/3 pint past. ...	26·634	27·162	27·487	27·769	1·98	1·20	1·03	4·26
2/3 pint raw ...	26·617	27·805	27·413	27·717	1·76	1·21	1·11	4·13
GIRLS								
8–10 years								
Biscuits	23·966	24·479	24·686	24·919	2·14	0·85	0·94	3·98
1/3 pint past. ...	24·115	24·701	24·911	25·197	2·43	0·85	1·15	4·49
2/3 pint past. ...	23·961	24·603	24·820	25·083	2·68	0·88	1·06	4·68
2/3 pint raw ...	23·869	24·500	24·787	25·024	2·64	1·17	0·9 6	4·84
11–14 years								
Biscuits	26·690	27·486	28·047	28·540	2·98	2·04	1·76	6·93
1/3 pint past. ...	26·716	27·580	28·142	28·693	3·23	2·04	1·96	7·40
2/3 pint past. ...	26·564	27·448	28·070	28·223	3·33	2·27	1·61	7·37
2/3 pint raw ...	26·618	27·638	28·227	28·703	3·83	2·13	1·69	7·83

TABLE XIII.

The relative increase in Chest Circumference in the Milk Groups as a percentage of the relative increase in Chest Circumference in the Biscuit Group.

All Areas. All Ages.

	Growth between Examinations			
	1—2	2—3	3—4	1—4
BOYS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	112·50	92·38	98·97	103·39
2/3 pint past.	123·68	87·62	97·94	107·05
2/3 pint raw	111·93	95·24	98·97	103·92
GIRLS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	110·36	95·04	113·74	107·14
2/3 pint past.	118·33	107·09	100·76	110·90
2/3 pint raw	125·50	114·18	98·47	115·79

Table XIV.

The percentage increase in Chest Circumference between Examinations. All Areas. Age Classification.

Feeding Group	BOYS				GIRLS			
	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
Luton								
Biscuits	0·53	1·91	0·50	2·96	1·87	2·94	1·48	6·41
1/3 pint past.	0·91	1·90	0·59	3·43	2·45	2·69	1·71	7·00
2/3 pint past.	1·13	1·95	0·78	3·91	2·27	2·84	1·40	6·64
2/3 pint raw	0·67	2·21	0·70	3·62	3·27	2·79	1·72	7·97
Wolverhampton								
Biscuits	2·08	0·65	1·32	4·10	1·99	1·67	1·45	5·20
1/3 pint past.	2·49	0·31	1·27	4·11	2·85	1·71	1·66	6·35
2/3 pint past.	2·57	0·57	1·24	4·43	2·47	1·93	1·32	5·83
2/3 pint raw	2·78	0·52	1·17	4·53	2·76	1·86	1·07	5·80
Burton-on-Trent								
Biscuits	1·78	1·17	1·29	4·30	2·86	1·34	1·43	5·73
1/3 pint past.	2·04	1·22	1·16	4·49	2·82	1·27	1·69	5·88
2/3 pint past.	2·18	0·90	1·22	4·36	3·35	1·59	1·46	6·53
2/3 pint raw	2·06	1·15	1·08	4·35	2·97	1·74	1·58	6·42
Renfrewshire								
Biscuits	2·64	0·55	0·89	4·12	2·74	0·56	1·18	4·53
1/3 pint past.	2·55	0·32	1·01	3·91	2·84	0·15	1·22	4·25
2/3 pint past.	2·82	0·28	0·80	3·93	3·71	0·48	1·33	5·60
2/3 pint raw	2·57	0·17	1·01	3·78	3·88	0·31	1·18	5·44
Huddersfield								
Biscuits	1·72	0·99	0·93	3·68	2·77	1·26	1·00	5·11
1/3 pint past.	1·94	1·11	0·75	3·85	2·80	1·72	1·28	5·90
2/3 pint past.	2·21	0·94	0·66	3·85	2·66	1·25	1·03	5·01
2/3 pint raw	1·71	1·05	0·82	3·61	2·70	1·89	0·91	5·59

TABLE XV.

Average Pull. All Areas. All Ages.

	Average Pull (lbs.)				Increase between Examinations (lbs.)				Percentage Increase			
	Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
BOYS												
Biscuits ...	130·997	147·312	157·924	165·058	16·315	10·612	7·134	34·061	12·45	7·20	4·52	26·00
1/3 pint past.	130·960	147·810	157·216	165·693	16·850	9·406	8·477	34·733	12·87	6·36	5·39	26·52
2/3 pint past.	129·217	145·439	155·867	163·869	16·222	10·428	8·002	34·652	12·55	7·17	5·13	26·82
2/3 pint raw ...	130·656	146·875	157·331	164·109	16·219	10·456	6·778	33·453	12·41	7·12	4·31	25·60
GIRLS												
Biscuits ...	98·791	113·674	120·855	129·971	14·883	7·181	9·116	31·180	15·07	6·32	7·54	31·56
1/3 pint past.	98·090	115·921	123·444	132·365	17·831	7·523	8·921	34·275	18·18	6·49	7·23	34·94
2/3 pint past.	97·562	115·148	123·933	133·393	17·586	8·785	9·460	35·831	18·03	7·63	7·63	36·73
2/3 pint raw ...	98·218	115·607	124·092	133·446	17·389	8·485	9·354	35·228	17·70	7·34	7·54	35·87

TABLE XVI.

Average Pull. All Areas. Age Classification.

	Average Pull (lbs.)				Percentage Increase between Examinations			
	Exam 1	Exam 2	Exam 3	Exam 4	1–2	2–3	3–4	1–4
BOYS								
8–10 years								
Biscuits	112·924	129·668	138·847	146·125	14·83	7·08	5·24	29·40
1/3 pint past. ...	112·768	131·223	138·544	146·107	16·37	5·58	5·46	29·56
2/3 pint past. ...	112·498	129·792	139·009	146·135	15·37	7·10	5·13	29·90
2/3 pint raw ...	112·880	130·586	139·477	146·170	15·69	6·81	4·80	29·49
11–14 years								
Biscuits	150·425	165·968	178·292	185·546	10·33	7·43	4·07	23·35
1/3 pint past. ...	151·578	166·617	178·387	187·963	9·92	7·06	5·37	24·00
2/3 pint past. ...	149·888	164·370	176·406	185·380	9·66	7·32	5·09	23·68
2/3 pint raw ...	151·384	165·888	177·830	185·150	9·58	7·20	4·12	22·30
GIRLS								
8–10 years								
Biscuits	86·915	100·868	107·238	116·089	16·05	6·32	8·25	33·57
1/3 pint past. ...	85·242	103·737	110·596	117·468	21·70	6·61	6·21	37·81
2/3 pint past. ...	85·199	102·406	110·859	119·053	20·20	8·25	7·39	39·74
2/3 pint raw ...	82·946	100·616	108·799	116·651	21·30	8·13	7·22	40·63
11–14 years								
Biscuits	114·750	131·181	139·011	148·723	14·32	5·97	6·99	29·61
1/3 pint past. ...	117·751	134·467	143·768	155·932	14·20	6·92	8·46	32·43
2/3 pint past. ...	114·254	132·181	141·298	152·369	15·69	6·90	7·84	33·36
2/3 pint raw ...	119·801	136·826	145·503	156·995	14·21	6·34	7·90	31·05

Table XVII.

The relative increase in Pull in the Milk Groups as a percentage of the relative increase in Pull in the Biscuit Group.

All Areas. All Ages.

	Growth between Examinations			
	1—2	2—3	3—4	1—4
BOYS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	103·37	88·33	119·25	102·00
2/3 pint past.	100·80	99·58	113·50	103·15
2/3 pint raw	99·68	98·89	95·35	98·46
GIRLS				
Biscuits	100·00	100·00	100·00	100·00
1/3 pint past.	120·64	102·69	95·89	110·71
2/3 pint past.	119·64	120·73	101·19	116·38
2/3 pint raw	117·45	116·14	100·00	113·66

TABLE XVIII.

The percentage increase in Pull between Examinations. All Ages. Area Classification.

Feeding Group	BOYS				GIRLS			
	1–2	2–3	3–4	1–4	1–2	2–3	3–4	1–4
Luton								
Biscuits	10·14	10·46	6·28	29·30	16·66	9·98	8·25	38·89
1/3 pint past.	8·55	9·96	8·17	29·11	21·25	6·98	11·73	44·92
2/3 pint past.	8·92	11·50	8·04	31·20	19·45	8·44	9·16	41·51
2/3 pint raw	7·73	11·10	8·00	29·26	17·87	11·02	11·00	45·26
Wolverhampton								
Biscuits	13·47	4·50	8·35	28·48	17·07	5·79	17·80	45·89
1/3 pint past.	13·90	3·78	9·39	29·30	15·96	8·93	15·04	45·31
2/3 pint past.	12·22	7·23	6·66	28·35	19·63	9·60	18·76	55·71
2/3 pint raw	13·28	5·31	8·71	29·69	12·23	8·81	15·02	40·47
Burton-on-Trent								
Biscuits	10·94	6·18	3·36	21·75	14·96	7·50	5·17	29·99
1/3 pint past.	13·67	7·18	2·02	24·28	18·62	4·53	4·97	31·27
2/3 pint past.	13·40	6·31	4·25	25·68	18·23	8·01	4·59	33·56
2/3 pint raw	14·26	7·10	0·74	23·28	18·81	6·87	3·92	31·95
Renfrewshire								
Biscuits	13·89	7·47	3·16	26·26	13·56	4·66	3·39	22·88
1/3 pint past.	15·10	5·13	4·29	26·20	19·64	3·59	4·19	29·13
2/3 pint past.	12·53	3·97	4·09	21·78	18·22	6·19	4·90	31·69
2/3 pint raw	13·21	5·42	2·37	22·18	21·17	4·16	3·14	30·17
Huddersfield								
Biscuits	14·52	6·73	0·97	23·40	14·16	4·66	7·01	27·86
1/3 pint past.	13·21	5·33	3·12	22·96	14·99	9·88	3·39	30·64
2/3 pint past.	16·64	7·08	2·05	27·46	14·35	6·40	2·42	24·62
2/3 pint raw	13·63	6·58	2·21	23·79	17·58	7·52	6·49	34·62

TABLE XIX.

Percentage increase in Pull between the 1st and 4th Examinations in the 2/3 pint Pasteurised and the 2/3 pint Raw Group.

Area	Age	BOYS		GIRLS	
		2/3 pint past.	2/3 pint raw	2/3 pint past.	2/3 pint raw
Luton	8–10	40·36	38·15	49·17	49·67
	11–14	28·76	27·03	37·13	43·68
	All Ages	31·20	29·26	41·41	45·26
Wolverhampton	8–10	35·81	41·24	65·37	59·20
	11–14	21·44	22·85	49·41	28·97
	All Ages	28·35	29·69	55·71	40·47
Burton-on-Trent	8–10	28·80	26·92	33·02	33·38
	11–14	21·78	17·86	34·25	28·88
	All Ages	25·68	23·28	33·56	31·95
Renfrewshire	8–10	23·73	25·11	35·81	34·75
	11–14	18·34	17·64	26·25	25·19
	All Ages	21·78	22·18	31·69	30·17
Huddersfield	8–10	30·66	26·41	31·32	42·29
	11–14	23·48	21·52	18·36	25·95
	All Ages	27·46	23·79	24·62	34·62

TABLE XX.

Excess of Growth in the Milk Groups over Growth in the Biscuit Group.
All Areas. All Ages.

		Height Inches	Weight lbs.	Chest Circumference inches	Pull lbs.
Growth between 1st and 2nd exams					
Boys	1/3 pint past. ...	−0·003 ± 0·025	0·349 ± 0·110	0·055 ± 0·033	0·535 ± 1·127
	2/3 pint past. ...	0·034 ± 0·027	0·565 ± 0·107	0·107 ± 0·032	−0·093 ± 1·127
	2/3 pint raw	0·015 ± 0·022	0·654 ± 0·115	0·502 ± 0·032	−0·096 ± 1·108
Girls	1/3 pint past. ...	−0·021 ± 0·026	0·336 ± 0·134	0·066 ± 0·040	2·948 ± 1·353
	2/3 pint past. ...	0·000 ± 0·030	0·554 ± 0·166	0·115 ± 0·040	2·703 ± 1·305
	2/3 pint raw	0·030 ± 0·026	0·750 ± 0·140	0·156 ± 0·040	2·506 ± 1·288
Growth between 1st and 4th exams					
Boys	1/3 pint past. ...	0·038 ± 0·033	0·286 ± 0·035	0·031 ± 0·038	0·672 ± 1·446
	2/3 pint past. ...	0·102 ± 0·035	0·503 ± 0·035	0·068 ± 0·036	0·591 ± 1·408
	2/3 pint raw	0·076 ± 0·032	0·664 ± 0·036	0·036 ± 0·038	−0·608 ± 1·434
Girls	1/3 pint past. ...	−0·003 ± 0·038	0·392 ± 0·243	0·096 ± 0·063	3·095 ± 1·693
	2/3 pint past. ...	0·103 ± 0·040	0·802 ± 0·238	0·144 ± 0·062	4·651 ± 1·657
	2/3 pint raw	0·073 ± 0·038	1·024 ± 0·245	0·204 ± 0·061	4·048 ± 1·607

A difference equal to or greater than twice the corresponding standard error is regarded as significant.

TABLE XXI.

Excess of Growth in the 2/3 pint Raw Group over Growth in the 2/3 pint Pasteurised Group.

	Height inches	Weight lbs.	Chest Circumference inches	Pull lbs.
Growth between 1st and 2nd exams				
Boys	−0·019 ± 0·025	0·089 ± 0·113	−0·055 ± 0·032	−0·003 ± 1·058
Girls	0·030 ± 0·028	0·196 ± 0·141	0·041 ± 0·042	−0·197 ± 1·207
Growth between 1st and 4th exams				
Boys	−0·026 ± 0·035	0·161 ± 0·187	−0·603 ± 1·529	−1·199 ± 1·321
Girls	−0·030 ± 0·038	0·222 ± 0·246	0·060 ± 0·061	0·032 ± 0·036

A difference equal to or greater than twice the corresponding standard error is regarded as significant.

TABLE XXII.

Growth between the 1st and 2nd Examinations of Children not attending all Examinations. All Areas. Ages 13–14.

	No. of Children	Growth as a percentage of initial measurement			
		Height	Weight	Chest Circum-ference	Pull
BOYS					
Biscuits	82	1·50	4·68	2·12	5·98
1/3 pint past.	83	1·74	5·76	2·00	10·06
2/3 pint past.	91	1·63	5·09	1·81	8·85
2/3 pint raw	84	1·64	5·58	1·89	5·58
Total	340				
GIRLS					
Biscuits	84	1·57	6·62	3·19	13·02
1/3 pint past.	100	1·69	7·93	3·36	11·11
2/3 pint past.	83	1·74	7·60	4·22	14·74
2/3 pint raw	88	1·68	8·02	3·51	13·89
Total	355				

Table XXIII.

The percentage of Children in each Clinical Category at each Examination.

Examination	1			2			3			4		
Clinical Category	1	2	3	1	2	3	1	2	3	1	2	3
BOYS												
Biscuits	33·1	52·6	14·3	32·9	52·1	15·0	33·0	53·5	13·5	37·2	52·2	10·6
1/3 pint past. ...	34·1	52·3	13·6	35·8	49·0	15·2	35·3	51·8	12·9	38·0	51·8	10·2
2/3 pint past. ...	34·3	53·5	12·2	37·2	51·0	11·8	38·3	50·9	10·8	40·4	50·7	8·9
2/3 pint raw ...	34·0	53·0	13·0	35·7	51·6	12·7	38·7	49·8	11·5	41·0	50·1	8·9
GIRLS												
Biscuits	41·5	49·9	8·6	42·9	51·2	5·9	46·5	45·2	8·3	47·0	45·5	7·5
1/3 pint past. ...	44·1	46·6	9·3	47·0	44·8	8·2	48·7	43·9	7·4	46·6	46·3	7·1
2/3 pint past. ...	41·8	47·8	10·4	46·3	45·9	7·8	51·2	42·4	6·4	50·3	43·5	6·2
2/3 pint raw ...	37·2	54·1	8·7	45·7	47·6	6·7	46·2	48·0	5·8	46·7	47·3	6·0

TABLE XXIV.

School Medical Officers' Nutritional Assessments, 1936. *Percentage of Children in Categories A, B, C and D* (from Annual Reports of School Medical Officers).*

Area	A	B	C & D
Luton	22·20	74·00	3·85
Wolverhampton	15·54	58·73	25·71
Burton-on-Trent	20·33	70·21	9·45
†Renfrewshire	0·43	97·88	1·69
Huddersfield	14·03	78·97	7·00

*Classification of Board of Education — Administrative Memorandum No. 124, 1934.
†See text p. 18.

TABLE XXV.

Percentage change in proportions of Children assigned to Clinical Categories 1 *and* 3 *at the* 2*nd,* 3*rd and* 4*th Examinations, as compared with those at Examination* 1.

Examination	2		3		4	
Clinical Category	1	3	1	3	1	3
BOYS						
Biscuits	−0·38	4·35	0·00	−6·09	12·45	−27·09
1/3 pint past. ...	5·36	10·71	3·57	−5·36	11·43	−25·00
2/3 pint past. ...	8·33	−2·94	11·46	−10·78	17·71	−27·47
2/3 pint raw ...	4·95	−1·85	13·78	−11·11	20·85	−31·48
GIRLS						
Biscuits	3·19	−31·03	12·06	−3·45	13·12	−12·07
1/3 pint past. ...	6·62	−11·94	10·41	−20·90	5·68	−23·88
2/3 pint past. ...	10·70	−24·32	22·41	−37·84	20·40	−40·53
2/3 pint raw ...	23·05	−23·32	24·22	−33·33	25·78	−31·67

TABLE XXVI.

Percentages of Children in Teachers' Assessment Categories at the four Medical Examinations.

Examination	1			2			3			4		
Teachers' Category	1	2	3	1	2	3	1	2	3	1	2	3
BOYS												
Biscuits	30·7	51·0	18·3	31·4	50·3	18·3	31·6	51·7	16·7	33·8	50·4	15·8
1/3 pint past. ...	26·6	52·9	20·5	27·7	50·4	21·9	28·3	51·7	20·0	30·8	53·0	16·2
2/3 pint past. ...	28·7	51·0	20·3	29·8	50·0	20·2	29·9	51·9	18·2	31·1	53·8	15·1
2/3 pint raw ...	27·9	52·6	19·5	28·6	51·1	20·3	27·7	53·4	18·9	31·1	54·1	14·8
GIRLS												
Biscuits	30·9	53·8	15·3	30·9	53·3	15·8	29·4	54·8	15·8	31·1	53·3	15·6
1/3 pint past. ...	27·3	52·8	19·9	27·4	53·7	18·9	28·9	52·9	18·2	30·3	52·9	16·8
2/3 pint past. ...	30·5	52·3	17·2	32·2	51·7	16·1	28·4	55·8	15·8	31·5	53·8	14·7
2/3 pint raw ...	29·5	53·1	17·4	29·8	53·1	17·1	30·2	54·2	15·6	32·3	52·9	14·8

TABLE XXVII.

Percentage change in proportions of Children assigned to Teachers' Categories 1 *and* 3 *at the* 2*nd*, 3*rd and* 4*th Examinations, as compared with those at the* 1*st Examination.*

Examination	2		3		4	
Teachers' Category	1	3	1	3	1	3
BOYS						
Biscuits	2·06	0·00	2·88	−8·97	9·88	−13·79
1/3 pint past. ...	4·19	6·02	6·51	−2·41	15·81	−21·08
2/3 pint past. ...	3·80	−0·60	4·22	−10·71	8·44	−25·60
2/3 pint raw ...	2·63	3·75	−0·44	−3·12	11·84	−24·37
GIRLS						
Biscuits	0·00	2·88	−4·76	2·88	0·48	1·92
1/3 pint past. ...	0·51	−4·90	6·12	−8·39	11·22	−13·38
2/3 pint past. ...	5·50	−6·50	−6·88	−8·13	3·21	−14·63
2/3 pint raw ...	0·99	−1·67	2·46	−10·83	9·36	−15·00

TABLE XXVIII.

Percentage of Children in the 3 Categories of Posture at each Medical Examination.

Examination	1			2			3			4		
Assessment of Posture	1	2	3	1	2	3	1	2	3	1	2	3
BOYS												
Biscuits	49·3	44·0	6·7	44·3	48·4	7·3	32·4	57·0	10·6	30·0	60·6	9·4
1/3 pint past. ...	51·9	42·1	6·0	44·3	49·0	6·7	33·7	54·7	11·6	29·0	61·4	9·6
2/3 pint past. ...	47·1	47·1	5·8	46·2	45·6	8·2	32·8	53·9	13·3	31·5	58·0	10·5
2/3 pint raw ...	48·1	43·7	8·2	45·4	46·8	7·8	33·7	55·6	10·7	32·8	59·4	7·8
GIRLS												
Biscuits	47·0	48·6	4·4	43·7	49·2	7·1	34·5	58·0	7·5	34·7	57·9	7·4
1/3 pint past. ...	49·7	44·9	5·4	45·3	49·5	5·2	38·4	53·7	7·9	33·5	59·5	7·0
2/3 pint past. ...	47·3	47·4	5·3	45·5	50·2	4·3	41·0	51·9	7·1	34·0	58·2	7·8
2/3 pint raw ...	45·4	48·2	6·4	44·9	46·7	8·4	38·6	54·7	6·7	33·2	57·9	8·9

TABLE XXIX.

Percentage increase of the number of Children in each Category of Posture between Examinations 1 *and* 4.

Category	BOYS			GIRLS		
	1	2	3	1	2	3
Biscuits	−38·99	37·68	38·89	−26·02	19·09	66·67
1/3 pint past.	−44·13	45·66	61·22	−32·49	32·51	28·21
2/3 pint past.	−33·16	23·04	83·33	−29·11	22·71	47·37
2/3 pint raw	−31·92	35·99	− 4·41	−26·84	20·18	38·64

TABLE XXX.

Growth between the 1st and 4th Examinations classified by Weight/Height at the 1st Examination.

Growth in the lowest Grade = 100·0

All Areas. Ages 8–10.

W/H at Exam. 1	HEIGHT		WEIGHT		CHEST CIRCUMFERENCE		PULL	
	Biscuits	2/3 pint past.	Biscuits	2/3 pint past.	Biscuits	2/3 pint past.	Biscuits	2/3 pint past.
BOYS								
Under 1·00	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
1·00 —	118·3	88·6	128·0	104·5	103·8	91·2	108·9	124·9
1·15 —	121·9	89·0	133·3	121·3	118·8	98·0	120·4	135·9
1·30 + ...	121·3	101·7	164·6	157·1	133·8	107·8	120·4	148·5
GIRLS								
Under 1·00	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
1·00 —	101·4	110·2	127·4	110·2	97·8	113·1	103·7	104·0
1·15 —	112·0	121·4	156·6	154·3	112·4	159·5	104·9	94·7
1·30 + ...	151·0	143·7	225·3	198·8	164·0	209·5	82·9	111·0

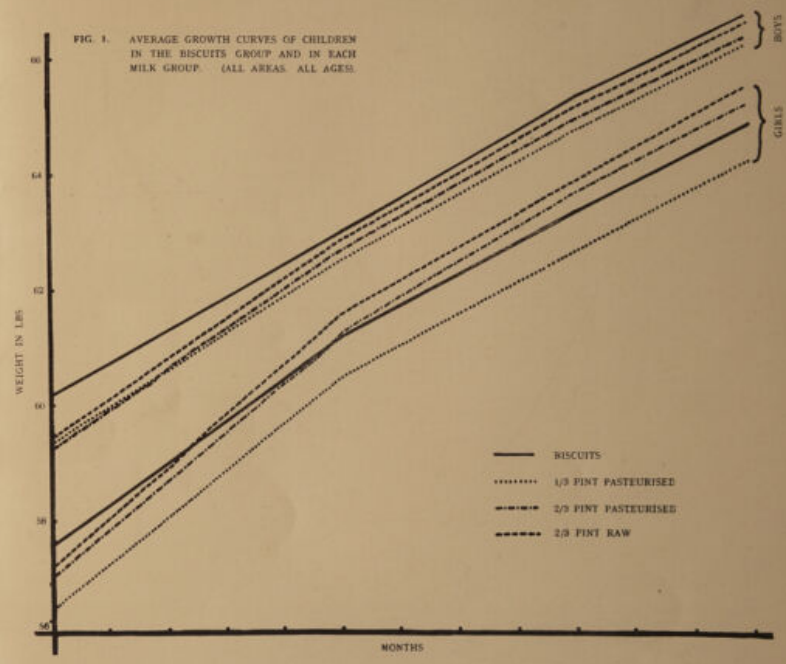
TABLE XXXI.

Comparison of Human Milk and Cows' Milk.

	Human Milk	Cow's Milk
Water gm. per 100 ml.	87·96	87·32
Casein gm. per 100 ml.	0·87	3·00
Other Protein gm. per 100 ml.	0·40 to 1·23	0·40
Fat gm. per 100 ml.	3·60	3·75
Sugar gm. per 100 ml.	6·49	4·75
Ash gm. per 100 ml.	0·26	0·75
Calcium gm. per 100 ml.	0·007 to 0·072	0·12
Phosphorus gm. per 100 ml.	0·0061 to 0·0324	0·099
Iron mg. per 100 ml.	0·05 to 0·19	0·027 to 0·140 (average 0·089)
Copper mg. per 100 ml.	0·04 to 0·08	0·012 to 0·02
Iodine γ per 100 ml.	4·3 and 4·6‡ (2 Cases)	4 to 7‡
Manganese γ per 100 ml.	No information	4 to 5
Vitamin A Int. Units per 100 ml. ...	200 to 500	140 to 340
Vitamin B_1 Int. Units per 100 ml. ...	< 2 to > 4*	5 to 23*
Vitamin B_2 mg. per 100 ml.	No information	0·1 to 0·3
Vitamin C mg. (ascorbic acid) per 100 ml.	1·10 to 11·48*	<0·3 to 2·92†

‡The value depends on the iodine content of the diet.
* The value depends on the vitamin content of the diet.
† Varies with diet and handling.

FIG. 1. AVERAGE GROWTH CURVES OF CHILDREN IN THE BISCUITS GROUP AND IN EACH MILK GROUP. (ALL AREAS. ALL AGES).



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