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INTRODUCTION

The Thesis is an account of a Nutrition Survey carried out on all the children attending public elementary schools in a town in the North East of England: together with an analysis of special data collected from various groups of children, including 400 who were found to be suffering from malnutrition.

The Survey was carried out during 1940 and 1941. All of the children were examined personally by the writer. The aim of the investigation - which was conducted in two parts, - was, in the first place, the assessing and recording of the nutrition grades of the children; and, secondly, enquiry into the causes of the defective nutritional state of each of the children who had been placed in the lower nutritional grades.

In addition to the Nutrition Survey, various other matters connected with the nutrition of children were investigated. The particular interest of the work lies in the fact that the enquiry covered the whole of the school children in the district, the population of which is well over 30,000 and which, by reason of its geographical position and its industries has led an almost self-contained existence, with very little of that to and fro movement of the population which has been characteristic of many industrial areas since the onset of the depression.
The scope of the work undertaken, with its numerous subdivisions, made it more satisfactory to deal with each subject separately, and to include at convenient points in the text, reference to the views and findings of other observers as well as a discussion of the implications of my own figures.
SECTION 1

LANDMARKS IN THE HISTORY OF NUTRITION
The modern science of nutrition has roots which stretch back almost to the dawn of history. It can be regarded as a development of the older sciences of Dietetics and Metabolism. Interest in dietetics began, when, in prehistoric times, Man learned by a process of trial and error, what articles of food promoted physical well-being and what were deleterious or even dangerous. That certain important food factors were lacking even then, is suggested by the fact that Dental caries though it "was certainly not common in men of the Stone Age, yet examples do occur as in the Neanderthal man at Krapina." (112)

EARLY EGYPT

Also since in Egypt from predynastic times "great masses of the people were illfed and illhoused" (98) there must have been malnutrition among adolescents, for in both quality and quantity, food was deficient. Further, existing records and human remains demonstrate a high incidence of Arthritic complaints in that period of Egyptian history, and though excessive stress and strain probably constituted the principal etiological factor, yet a possible associated dietetic deficiency should not be overlooked. It is recorded also that there was a "wide prevalence of every form of Dental Disease among the wealthy." (98) Examples could be cited from the
old Testament of injunctions to the Jewish people to avoid certain articles of food which were dangerous to health. (63)

ANCIENT GREECE AND ROME.

Some of the earliest observations on Dietetics are contained in the Hippocratic Treatise of Ancient Medicine (circa 430 - 420 B.C.) (55) and his line of argument has its modern parallel in Dietary Surveys. He states that "there would have been no need for medicine if sick men had profited by the same mode of living and regimen as the food, drink and mode of living of men in health." Though nowadays the laws of Dietetics and Nutrition have a scientific basis, yet in many ways we have not departed far from the Hippocratic precept. Even in the matter of the optimum amounts of the proximate principles of food or of the optimum daily intake of Vitamins, we are guided largely by our observations on the amounts which promote the highest state of physical well-being in man or animals. Galen later advanced a stage further when in Scripta Minora (20) he correlated the development of the mind with that of the body. As he himself puts it "When we produce by means of food and drink and by our daily activities a good bodily temperament (eucrasia) we thereby also influence the soul towards greatness."
Later came the "De Re Medica" of Celsus (53 B.C. to 7 A.D.) Celsus was particularly interested in the nature of foods (94) but, as was the case with all the early writers, there was no scientific basis for his theories and many of his pronouncements on dietetics were, to all intents and purposes, valueless.

The first crude beginnings of the experimental study of Metabolism are linked with the name of Erasistratus (310 - 250 B.C.) who devised a respiration calorimeter in which he kept fowls and weighed them and their excreta before and after feeding. After these experiments there ensued a long period of darkness, lightened by the name of Isaac Judaeus (855 - 955 A.D.) whose treatise on dietetics ("De dioeta") later became widely known. One of the most outstanding of mediaeval writings on this subject was the "Regimen Sanitas" which was produced at the famous school at Salerno about 1100 A.D. (118).

**MEDIAEVAL PERIOD**

Information on the dietary habits of mediaeval times is fragmentary, but sufficient emerges from the records to indicate that in the 14th and 15th Centuries the Englishman of every class was better fed than his counterpart on the Continent. Yet his diet lacked variety and in times of famine was woefully insufficient. Bread was indeed the staff of life and fish was cheap and plentiful. It was said at that time that "of all nacyons and countres England is best serued of Fysshe." (17). The supplies of milk and meat, dependent as they were on enlightened agricultural methods, fluctuated
with the season of the year. From lack of fodder, cattle either died of starvation during the winter or were killed off earlier in the season. Milk would therefore be in short supply and butter and cheese, apart from that retained from summer, very scarce. Further, from the absence of specific reference we may infer that the consumption of vegetables was low, and fruit was only available for a short period in the summer. Yet many of the country peasants had quite a well-balanced diet - cereals and beans, milk, whey, cheese and eggs. The townsman, on the other hand, had to fight various dietary deficiencies. Prescorbutic conditions must have been common on a diet of bread, fish, meat and wine, and there was a danger of deficiency of Vitamins A and D on account of the shortage of milk, especially in the case of young children.

The second half of the 16th Century saw a sharp turn for the worse in the diet of the country, brought on by a depression for which the sheep farmer was popularly blamed (42) and it is a matter of history that the unemployed and poor of the towns were reduced almost to starvation level. It was about this time also that there was an increase in the use of sugar coincident with its fall in price, which, in turn, was brought about by expansion of trade with the East.

The earliest English contribution to the study of the health of the child was that of Thomas Phayre (1546) whose "Regiment of Life and Boke of children" contains, in addition to other things, arguments in favour of the
breast feeding of babies. (92). "It is," he says "comely that the own mother should nource the own child."

In the year 1614 there was published by the Paduan Professor Sanctorius a book named "Ars de Statica Medina" which had as a frontispiece a reproduction of the author carrying out on himself an experiment on metabolism, after he had had a meal. It has been said of Sanctorius that his medical fame to-day is best associated with the fact that he founded the physiology of metabolism, through his experiments and data on what he called the "insensible perspiration of the body."

An early reference to chlorosis, or the Green-sickness - a disease, in part at least, the result of dietary insufficiencies - is contained in a book written by Burton, about the year 1621 (23): and recent investigations which throw light on the causes of nutritional Anaemia in Infants, make it plain that, where chlorosis was common among adult women, the children's health and physique must also have suffered (64).

Another disease of considerable interest in relation to the history of Nutrition is Rickets. I have suggested earlier that a deficiency of Vitamin D existed in the diet of infants in the mediaeval period from the shortage of milk and fresh butter: and the amounts of Calcium and Phosphorous ingested must have been equally sub-optimal. The dietary conditions which lead to Rickets undoubtedly, therefore, did exist.
One piece of evidence which is sometimes advanced in support of the view that Rickets was common on the Continent at that period, is that contemporary paintings which include children, portray them as having bent legs, square head and other signs indicative of gross Rickets (39). It was considerably later, however, in the period of rapid industrialisation, that the incidence of Rickets reached its height.

The next outstanding name among those whose activities and discoveries led to the development of the Science of Nutrition, was that of Justus von Liebig (1803-73) whose laboratory experiments on fats, bile, blood and meat juice, paved the way for further advances. Paris, a contemporary, also made a notable advance on previous conceptions of diet, in that he introduced a new classification of foods. He also compiled some interesting data on the use of vegetables at that period.

18th CENTURY ADVANCES IN AGRICULTURE.

The second half of the 18th Century marks the turning point of British Agriculture - a transition momentous for its bearing on the future history of nutrition in Britain, and one of no little importance in view of the considerable increases in population and the urbanisation of the people which were imminent. In scarcely more than a century, farming methods were revolutionised, and brought from a state almost as primitive as that of the Middle Ages, to something not greatly inferior to those in use to-day. New crops, new methods of cultivation and the breeding of more valuable strains of livestock, increased the potential
and actual resources of nutritious foods of the people of Europe to an unprecedented degree. The possibility - of the improvement of the physique and condition of the people as a whole was unfortunately defeated by two factors: the rapid growth of the cities from the development of industrialisation and, the failure of a coincident progress in methods of transportation, which would have enabled the fruits of the soil to be brought quickly and cheaply to market. The children of the cities "were for the most part pale, puny, lingering and sickly." (38) Recurring epidemics, including Typhus - a disease associated with starvation and malnutrition, played a part in further lowering the health of the people.

THE PHYSIOLOGY OF DIGESTION.

Our knowledge of the processes of digestion was considerably increased by the observations of William Beaumont (1785 - 1853) whose experiments on an accidental Gastric fistula in the Canadian, Alexis St. Martin, threw a new light upon the process of digestion in the stomach. In the study of digestion by fistulae he was preceded by Malpighi (1628-94) the noted histologist, and by the Dutchman, de Graaf (1641-73), both of whom are credited with having performed artificial fistulae on animals.

The brilliant investigations of Lavoisier and Laplace revealed, for the first time, the source of the body heat, and showed that the phenomenon of Respiration is essentially the same as that of combustion. By 1790 the foundations of the knowledge which we use to-day in calculating the food requirements of an individual, were firmly established.
The 19th Century opened with the passing of the iniquitous Corn Law (1815) - a measure which was designed to placate farmers who complained of the low price of Corn following bumper harvests - but which hit the labouring classes and the child population severely. Contemporary accounts of the state of the people at this time make distressing reading. (28) The political enactments, which resulted from the natural reaction and agitation, are well known; and their value was so marked that, within a relatively short period, a general rise in the standard of living of the people was clearly visible.

A notable feature of the later half of this century - and one of more than topical interest - was the increasing popularity of the new white bread and the decreasing consumption of the wholemeal variety. Not only was the valuable germ removed from the grain, but artificial means were introduced to bleach the flour by destroying the traces of the yellow pigment Carotene. It should be noted that it was at this stage also that the consumption of bread and flour fell in proportion to the rising standard of living, and that there was a complimentary increased intake of protein foods, sugar and sweetmeats. In spite of these changes, historical records show that the staple food of the working man was still bread, and the change in its character could not but affect his health by depriving him of vitamins, iron, etc. The use of milk as an article of diet was very limited. There is reliable evidence to show that it was produced unhygienically, and that it was generally unfit for human consumption. It was not until almost the end of the
century that Pasteur's pioneer studies had much influence on the handling of milk.

RESEARCH ON METABOLISM.

A new era was ushered in by the intensive research of Von Voit (1831-1908) and Von Pettenkofer (1818-1901). They estimated, by a special respiration apparatus, the amount of Protein, Carbohydrate and Fat which were broken down in the body, and on that basis they prepared dietetic tables. While this work was being carried out on the Continent, Frederick William Pavy (1829-1911) was quietly studying, in London, the action of the liver in relation to the digestion of Carbohydrate - especially Sugar and Glycogen - and his views were later embodied in a treatise (39). These researches stimulated the interest of other investigators and from that time there has been a rapidly increasing flood of reports on work directed towards the elucidation of the many problems of physiology, metabolism and dietetics.

PRESERVATION OF FOOD.

A survey of the fields of food preservation up to the end of the 19th Century reveals notable progress. The canning of meat, fish and vegetables, developed on behalf of the Admiralty, had become a flourishing business and was extending both in the variety of articles preserved, and in the public demand. Refrigeration of meat and fish, and the chemical preservation of foods brought new overseas sources of supply within reach of industrialised Europe, and a thriving trade developed in Condensed and Dried Milks. Statutory control of these new industries and the protection of the public against exploitation and
danger from unhygienic or dangerous methods, arrived in
due course and have been extended with every decade.

The increasing use of preserved milks is of
particular interest to the investigation of the history
of nutrition. The 19th Century saw a marked decline in
Breast Feeding of infants; and many reasons are advanced,
such as the increasing employment of women in factories
and the hard conditions of life, together with unsuitable
diet. Before the introduction of Condensed Milk later
in the century a mixture of Cow's milk, water and arrowroot
was the most popular substitute for Breast Feeding, but
when large quantities of cheap evaporated skinned milk
were put on the market, and given to children, the diet of
infants, so fed, was almost devoid of Fats and Vitamins A,
D and C. The unfortunate sequel was a rising tide of
Infantile Mortality, and of Scurvy and Rickets. (25). A
report prepared in 1889, at the instance of the Medical
Congress, showed that in the principal industrial areas,
almost every child was affected by Rickets. Fortunately
the almost specific action of Cod Liver Oil on this disease,
which had been recognised long before on the Continent,
received wide recognition among the members of the Medical
Profession in this Country.

NUTRITION IN ENGLAND AT THE COMMENCEMENT OF THE 20TH CENTURY.

It has been said that the opening of the 20th
Century saw malnutrition more rife in England than it had
been since the great dearths of Mediaeval and Tudor times.

The remarkable commercial and industrial expansion
of earlier years was being paid for in the marked
deterioration of physique and health which the appalling
conditions of labour had brought about. The public conscience was not yet fully aroused, though child labour and the extremely long hours of work in the factories had been controlled to some extent. The classical study of the conditions under which the poor were living in the City of York (97) does not appear to have overcome the inertia towards social progress which the policy of laissez-faire, and of free competition in industry, had produced.

Responsible circles in the country, however, became alarmed when it was learned that the Inspector of Recruiting for the South African War was having the greatest difficulty in obtaining sufficient men of satisfactory physique for service abroad. (103). There were 60% rejections in some areas, and over the whole country, nearly 40%.

The legislative action taken as a result of the revelations made in the Report of the Inter-Departmental Committee on Physical Deterioration (1904) make its publication a landmark in the history of the nutrition of the country. The evidence placed before the committee showed that Rowntree had not exaggerated in the least - "half starved children in ragged clothing with pallid faces and deformed limbs: areas with an Infantile Mortality Rate of nearly 250 per 1,000: parents trying to rear large families on little more than bread and tea," these and many other tragic facts were once again made public. Unfortunately, defective diet was regarded as a less important etiological factor than overcrowding and bad sanitation: and the Medical Profession, which was
still obsessed with the quantitative outlook on dietary problems, was partly to blame. Every problem was looked at in the light of the amount of protein needed, or the total number of calories thought to be necessary. Yet it was revealed in the report that 33% of children were undernourished through insufficient food - in the sense that they actually went hungry.

**STATUTORY MEASURES.**

The recommendations of the 1904 Committee were made the subject of Government action, and in 1906 the **Education Act (Provision of Meals)** was passed. This far-reaching measure gave power for Education Committees to provide free meals for all children who were undernourished to a degree that prevented their benefiting fully from the Educational facilities provided. By 1911 more than 200,000 children were obtaining free meals of one sort or another. In 1906 another event took place, which was no less important than the passing of the Bill for provision of meals. This was the first National Conference on Infantile Mortality, and to it we owe the beginning of the Infant Welfare Movement. (72)

Another important step forward was taken by the embodiment in the **Notification of Birth Act (1915)** of powers for local authorities to authorise expenditure on the assistance of expectant mothers. As a result of these measures the Infantile Mortality rate has steadily fallen, and hundreds of thousands of lives have been saved: and with the instruction of mothers on the scientific principles of the care of children, the physique of an even larger number has been saved from irreparable damage.
It should not be overlooked that the children of the well-to-do also suffered from malnutrition, as the diet of Boarding Schools was frequently lacking in nutritive quality. (21) During this period there was a rising tide of important and significant discoveries in the field of experimental dietetics, and each discovery, not only paved the way for others, but reacted directly or indirectly on the growth and health of the people.

**SCIENTIFIC PROGRESS.**

The production of Scurvy in Guinea Pigs by Holst and Frolich in 1907 was followed, in 1912, by the publication of the results of the investigations of Sir F.G. Hopkins into the effects of deficient diet on rats. His deductions from these experiments that "accessory factors" are necessary to sustain life, proved to be the starting point of subsequent work on vitamin requirements. Eijkman and Gryns did notable work in determining the relationship between Beriberi and the Vitamin B complex: and the discovery in 1913 of Fat soluble Vitamin A by McCollum and Davis constituted another important advance. In 1919, proof that Rickets was the result of a Vitamin deficiency was put forward by Edward Mellanby. Later some vitamins were isolated in a pure form, or were synthesised and made available for widespread use on a prophylactic or therapeutic basis: while new methods of canning fruits and vegetables ensured the protection of their full vitamin value. Proximate principles and calorific value no longer were considered to be the only criteria on which the value of a diet should be determined; and the emphasis laid on the importance of a protective,
balanced diet of milk, eggs, fresh fruit and leafy vegetables, such as those recommended by Lelean, (62) McCarrison, (71) and others, was final proof that the new era of scientifically planned feeding had been ushered in: while the recent recognition of the 'Oslo breakfast' as an integral part of the Provision of Meals Scheme in certain parts of the country, demonstrates that official circles are alive to the implication of scientific discoveries.

FEEDING EXPERIMENTS AND NUTRITION SURVEYS.

In more recent years the current has flowed from purely statistical studies to the practical application of scientific discovery. The feeding experiments of various types which have been organised throughout the country exemplify this altered trend.

Concurrent with the attention given to the subject in Britain interest in the nutritional state of their nationals was aroused in most European States throughout the British Commonwealth; in the U.S.A. and in the U.S.S.R. Interesting particulars on the methods of statistical approach to, and of attack on, the problem of malnutrition communicated by the various states has been collected by a Commission of the League of Nations and embodied in a recent Report. (59) The League of Nations has acted as a focus for international endeavour to obtain data on the extent of malnutrition and for the pooling of information on all matters connected with nutrition and further it has functioned as a stimulus to enquiry and action among the more backward states. The Reports and Memoranda produced under the auspices of the
League are of the highest order and further reference will be made to them later.

Following the efforts of the National Milk Publicity Council to encourage the consumption of milk among school children in Britain the Milk Marketing Board, in 1934, with the aid of a Government subsidy made one third of a pint available to all school children, at a price of one halfpenny. In 1938 it was estimated that over two and a half million school children consumed milk at school daily under this scheme. (12) The latest step in the direction of improving the nutrition of the nation is that which instituted communal feeding for adults, and meals in school, irrespective of the nutritional state of the child. As an integral part of this scheme, stress is laid on the scientific planning of the meals and on cooking arrangements which conserve the maximum food value.

The relationship of poverty to nutrition, which has been emphasised by so many recent investigators, (73: 85) has roused the public conscience, and various remedial measures are proposed, for example, State family allowances, which are directed towards improving the economic position of people with families.
SECTION II

COMMENT ON CONDITIONS EXISTING IN THE AREA FROM THE POINT OF VIEW OF THE HEALTH OF THE POPULATION:

AND EXPLANATORY NOTES ON NUTRITION ASSESSMENT AND SURVEYS.
Sub-section (1)

FACTS ILLUSTRATIVE OF THE SANITARY AND SOCIAL CONDITIONS IN THE AREA UNDER SURVEY.

In order to provide an indication of the conditions prevailing in the Borough of Blyth at the time of the Nutrition Survey, the following Statistics and descriptive notes are included:

Area (in acres) ........................................ 6,487
Population (Registrar-General's estimate for 1938) .......... 34,470
Population (Registrar-General's estimate for 1940) .......... 33,240
Number of inhabited houses ................................ 9,480
Rateable value ............................................. £163,242
Sum represented by a penny rate ............................. £520.

SLUM CLEARANCE 1933-1938.

Scheduled for clearance (excluding 171 houses to be dealt with as individual unfit houses).

Rehousing to end of 1938 \[\begin{array}{lll} 
\text{Houses} & \text{Families} & \text{Persons} \\
1,431 & 1,551 & 6,170 \\
\end{array} \]

OVERCROWDING.

\[\begin{array}{lll} 
\text{Number of houses overcrowded at end of 1938} & \ldots & 489 \\
\text{Number of families dwelling therein} & \ldots & 489 \\
\text{Number of persons} & \ldots & 3,020 \\
\text{Number of licences to permit temporary overcrowding} & \ldots & 813 \\
\text{Percentage of overcrowded families in the Borough (1938)} & \ldots & 5.12\% \\
\text{Percentage of overcrowded families in the Borough at end of first survey in 1935} & \ldots & 10.93\% \\
\end{array} \]

SANITATION.

Number of Privies in use in the area in 1938 \ldots \ 1,007

VITAL STATISTICS FOR 1940.

\[\begin{array}{lll} 
\text{Birth Rate (per 1,000 population)} & \text{Blyth} & \text{England and Wales} \\
18.00 & 14.6 \\
\text{Infantile Mortality Rate (per 1,000 live births)} & \ldots & 64.5 \\
& & 55.0 \\
\text{Death Rate (per 1,000 population)} & 14.29 & 14.3 \\
\end{array} \]

Consideration of the data recorded above will convey some idea of the district in which the Nutrition Survey was carried out. The density of population amounted to 5
persons per acre, but a true picture will not be obtained unless it is pointed out that large tenement blocks were almost non-existent and that the greater number of the houses consisted of one storey. The actual density, which was high, was achieved by the almost complete absence of gardens and by curtailment of backyards to the bare minimum. The area in acres, as given, is also deceptive because the borough boundaries included extensive farm land on the outskirts.

SANITATION (PRIVY ACCOMMODATION)

An interesting sidelight on the sanitary conditions existing in this sea-side borough is provided by the figures of privy accommodation. Over 1,000 of these were in regular use at the end of 1938 and the conversion of only a few was achieved before the outbreak of war. The particular menace to health of these ash closets consists in their very frequent dilapidated state and in their proximity to dwellings. Plagues of flies (musca domestica) were frequent in the summer months and it is surprising that the incidence of fly-borne disease was not more frequent and that the death rate from summer diarrhoea among infants was not higher. Fortunately a modern water supply was available.

HOUSING AND OVERCROWDING.

About 16% of the houses in the area were scheduled for demolition. Conditions of overcrowding existed among 10.9% of the families in 1935 and active measures were taken to deal with the problem and material reduction was achieved. In any survey of the health of a district, the extent of overcrowding is a factor of major importance
and particularly in connection with the Infantile Mortality Rate, the deaths from Infectious Diseases and the incidence of Tuberculosis.

THE BIRTH RATE.

The Birth Rate for the Borough has declined fairly steadily in the decade 1927/1937: the highest figure recorded in the ten year period being 22.0 in 1928, and the lowest, 16.3, in 1937. The complete figures for the period in question and the respective records for England and Wales are set out below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Blyth figures</th>
<th>England &amp; Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1927</td>
<td>22.3</td>
<td>16.6</td>
</tr>
<tr>
<td>1928</td>
<td>22.0</td>
<td>16.7</td>
</tr>
<tr>
<td>1929</td>
<td>18.3</td>
<td>16.3</td>
</tr>
<tr>
<td>1930</td>
<td>21.0</td>
<td>15.3</td>
</tr>
<tr>
<td>1931</td>
<td>18.6</td>
<td>15.3</td>
</tr>
<tr>
<td>1932</td>
<td>12.6</td>
<td>14.8</td>
</tr>
<tr>
<td>1933</td>
<td>12.1</td>
<td>14.7</td>
</tr>
<tr>
<td>1934</td>
<td>17.7</td>
<td>14.7</td>
</tr>
<tr>
<td>1935</td>
<td>18.7</td>
<td>14.8</td>
</tr>
<tr>
<td>1936</td>
<td>17.4</td>
<td>14.3</td>
</tr>
<tr>
<td>1937</td>
<td>16.3</td>
<td>14.5</td>
</tr>
</tbody>
</table>

INFANTILE MORTALITY.

The Infantile Mortality Rate of a district provides a useful index to the prevailing social conditions and to the efficiency (or otherwise) of the social services which are intended to alleviate the effects of bad conditions. It is instructive, therefore, to observe the substantial differences which occur in the rates for this borough and those for England and Wales. Comment on the figures is superfluous.

<table>
<thead>
<tr>
<th>Year</th>
<th>Blyth</th>
<th>England &amp; Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938</td>
<td>63.3</td>
<td>53</td>
</tr>
<tr>
<td>1939</td>
<td>53</td>
<td>50</td>
</tr>
<tr>
<td>1940</td>
<td>64.5</td>
<td>55</td>
</tr>
</tbody>
</table>

RATEABLE VALUE.

The financial strength of a Local Government Authority is frequently revealed in the extent and development of the Municipal Services. The foundation of local government finance is the local rates. The inequalities in the yield from a penny rate between one district and another largely account for the very considerable differences which are
found in the municipal services and social amenities in various parts of the country. A penny rate in the borough under consideration yields £620 (1938). For comparison purposes the net product of a penny rate of some of the neighbouring towns in the Tyneside area are given together with their respective populations.

<table>
<thead>
<tr>
<th>Place</th>
<th>Estimated population in thousands</th>
<th>Yield (Net)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEWCASTLE</td>
<td>290.4</td>
<td>£10,216</td>
</tr>
<tr>
<td>SOUTH SHIELDS</td>
<td>111.0</td>
<td>£2,083</td>
</tr>
<tr>
<td>WHITLEY BAY</td>
<td>27.0</td>
<td>£1,091</td>
</tr>
<tr>
<td>BLYTH</td>
<td>33.2</td>
<td>£620</td>
</tr>
<tr>
<td>JARROW</td>
<td>31.2</td>
<td>£436</td>
</tr>
</tbody>
</table>

SITUATION AND TOPOGRAPHY.

The town of Blyth is situated on a headland on the coast of Northumberland, a short distance to the north of the Tyne estuary. Its industries and its close association by rail and road together with its proximity to the Tyneside industrial belt make it an integral part of the North Eastern industrial region.

The surrounding country is flat and bare, there being few trees and hills within a distance of ten miles. The frequency with which strong cool winds blow adds to the rigours of life, especially in the winter months; while haze and sea fogs blow up frequently during the summer. Apart from that, the climate is undoubtedly invigorating and pleasant for the active and the robust as the rainfall is lower and the hours of sunshine higher than in many parts of the country, but young children and the feeble may suffer severely during the winter and early spring.
The principal industries are coal mining and coal exporting. There are shipyards for the construction of medium sized vessels and a number of men are employed in the ancillary trades. The coal exporting trade did not fluctuate much in the years of economic depression and most of the coal pits continued to operate almost without intermission. There was, however, considerable unemployment among shipyard workers.
Sub-section (2)

Definitions of certain terms employed.

Good Nutrition may be defined as that state of the body which results from the provision of all of the requirements -- dietetic, physiological, and environmental -- which are necessary for optimum growth, for maintenance and for repair. Sir John Newman has put the matter concisely: "Sound nutrition is the total well-being of the whole body, and the normal functioning of all its parts." (83)

Malnutrition. Malnutrition is the condition of the body which results from the subjection of the system to: (a) dietetic deficiencies in respect of quality or quantity; or (b) to physiological or environmental conditions which interfere with the free utilisation or availability of the nutrients required for good nutrition.

Nutrients. This term is used to denote substances which are necessary for the maintenance of life and health.
Sub-section (3)

THE PROBLEM OF MALNUTRITION.

That the nutrition of all persons should be of the highest order in his own interest, in that of posterity and of the state, is a plea that needs no emphasis. In addition to the discomforts of under-nutrition or of being constantly slightly below par in physical health and well-being, the unfortunate malnourished individual finds himself handicapped, as compared with the better nourished, in his physical and mental activities. In school he is in danger of being placed in classes for slow pupils: and he is not outstanding on the playing field. All too often he develops a sense of inferiority. After school life his competitive value in factory, field or office is less inasmuch as his productive capacity is lower, and through his greater susceptibility to various diseases - his time lost from work is higher. The physique and prospects of his off-spring may be prejudiced in several respects by his subnormal health and he himself is potentially and actually a greater burden on the state both on account of the loss of his contribution to the national wealth and the necessity for others to support him during illness or infirmity.

In war he is unfit for front-line service: and, because of his physical weakness he undoubtedly constitutes an unreliable element in the home front. The more widespread defective nutrition is in the population, the more serious is the problem and the greater is the urgency for action. It is therefore appropriate to draw attention to the records of the extent of malnutrition (Nutrition
C and D) in England and Wales as found during routine school inspection. In recent years (1935-38) these figures have varied between 11.2% and 11.3% of the 1\frac{3}{4} millions of children examined annually. (12) In round figures over 190,000 children are recorded each year as being in a state of subnormal nutrition. Experienced investigators maintain that this is a conservative figure and that if a special nutrition survey of all of the school children were carried out (and not the examination of Routine age groups only as those from which the above data from the Board of Education were compiled) a much higher percentage of cases of malnutrition would be obtained. Be that as it may, the numbers provided by the Board of Education are indicative of a serious state of affairs and no effort directed to the elucidation of the problem and its cure should be spared. It is becoming increasingly recognised that no one all-embracing solution is likely to be obtained, inasmuch as the available information points to a not infrequent individual and personal factor supplementary to, and in some cases clearly distinguishable from, the social and economic factors which have gained widespread publicity.

In the enquiry carried out by me and described here, emphasis was placed on this quest for factors other than the purely economic, which in a particular case may be predisposed to or contributed to the development of malnutrition, and which, failing removal, may continue to prevent good nutrition after all dietetic requirements have been met.
Attention was particularly attracted to this point by the observation that quite a number of children who, having been found to be suffering from malnutrition a year or two earlier and who were given extra milk and the school dinners provided by the Education Committee, failed to show expected improvement at subsequent examinations.
Sub-section (4)

CLASSIFICATION OF NUTRITION,

(a) Clinical Assessment.

The classification employed is that recommended by the Board of Education. It was introduced to encourage uniformity of assessment and of recording of nutrition throughout the country. The method is simple and convenient, but discrepancies in the figures for nutrition of school children submitted from comparable districts, and variation in the results obtained from the grading of the same group of children by independent examiners continue, though to a lesser degree than prior to its use. This difference in the results recorded is perhaps unavoidable to a certain extent because, in spite of the directions given by the Board of Education, the standard adopted by an examiner is dependent, in the last resort, on the mental concept he has formed of a child with excellent or bad nutrition.

Four grades are recognised.

Grade A, denoting excellent nutrition.
Grade B, denoting normal nutrition,
Grade C, denoting slightly subnormal nutrition,
Grade D, denoting bad nutrition.

To quote from the memorandum: assessment of nutrition "cannot as a rule be based upon any single criterion, such as ratio of age, sex, height and weight, but should also have regard to other data derived from clinical observation: for example the general appearance, facies and carriage: the condition of the mucous membranes: the tone and functioning of the muscular system and the amount of subcutaneous fat." "It is the general impression which
decides the issue." "An alert cheerful child with bright eyes and good colour may usually be accepted as well nourished without demur." "On the other hand a child who appears dull, listless and tired, who has a muddy complexion and stands slackly is at once under suspicion." Further, in the opinion of the Board, the child who should be classified as D is one for whom a period of open air treatment is patently indicated.

These quotations show the general lines on which nutrition grading of children is carried out in this country. No official support has been given by the Board of Education to the employment in the Nutrition surveys conducted under its aegis of any of the mathematical tests or indices which have been advocated.

(b) **Indices.**

It is generally agreed that fewer mistakes result from clinical methods of assessment than from the use of the alternative more precise methods so far devised. Hutchison strongly supports this view. He maintains that malnutrition is essentially a clinical conception to be gauged by the state of the skin, the lustre of the hair, the appearance of the eyes, the colour of the membranes and the alertness and attitude of the child. (54) The principal reason for this has been stressed by Magee who stated that, as malnutrition in its true sense is the state of disordered function brought about by faulty diet, the derangements of function included under the term malnutrition are as varied as the physiological effects of deficiency or excess of any one of the numerous essential food constituents. (68)
Some indices which have been advocated - of which Quetelet's is a well-known example - depend upon weight and height. Tuxford's Index, on the other hand, makes allowance for age and for sex in addition to weight and height. The index for males is represented as follows:

\[
\frac{\text{Weight in pounds}}{\text{Height in inches}} \times \frac{379 - \text{age in months}}{0.3}
\]

Normality is taken as 1000

As the term malnutrition embodies more than a consideration of height and weight in relation to age, no arithmetical manipulation dependent upon these variables can provide accurate information on nutritional state though they may give some indication of the degree of development. In illustration of the difficulty Simpson (102) compared the clinical classification of 3000 children with their height and weight records, and these variables when taken alone or together were found to be quite unreliable. A high figure selected many children who were passed as normal on clinical examination, and a low figure omitted many who were plainly below standard.

Other methods have been proposed and investigated which were based on such measurements as those of chest, arm or sitting height but in them, as in others, the principal defect lay in that, in their preparation, average figures were used which might not be applicable to any one individual of even a large group. This difficulty underlies all standards based on average figures. Destructive criticism of such methods of nutrition assessment is included in a special report to the Medical Research Council (88) and the authors state in conclusion, "the question of what is the best index of nutrition is thus left unanswered."
Interesting trials are being made with special dynamometers to determine muscular efficiency by ratio of pull to body weight; and by a modification of Romberg's test in which the tone of the muscles of the legs and the efficiency of the circulation are tested. In unfit children gross instability ensues in less than 10 minutes, whereas fit children can stand steadily without discomfort for 20 minutes or more.

It would appear that interesting if not valuable results might well accrue from the application of either of these methods to large groups of children but their function should be ancillary to a clinical examination and no method of estimation of nutrition based on measurements should, in the present state of our knowledge, be allowed to supersede the more thorough individual medical examination. As Simpson has said "the objection to methods of precision appear to be that they take into consideration only a limited number of factors; and that comparatively little is known about physiological variation of such things as physical measurements, muscle tone and the like; and that one had to take as standards figures which are averages and have a very imperfect relationship to individuals." (102)
Sub-section (5)
LEAGUE OF NATIONS AND CONDUCT OF NUTRITION SURVEYS.

The technical Commission on Nutrition of the League of Nations in their Report published in 1938 (60) included, in outline form, three methods for the conduction of Nutrition Surveys. The aim and scope of each is different. For example, Type 1, which, it was stated, is suitable for large demographic surveys, does not include complete dietary enquiry and analysis of the foods used by the people.

The Nutrition Survey carried out by me was, in the main, based on the recommendations for Type 1. The principle steps which should be taken and the points which have been accorded particular emphasis by the Commission are noted below.

Stage 1. Attention should be paid to:

Age, sex, physical appearance, build, height and weight.

Each child should receive a simple clinical examination especially with regard to colour: elasticity and firmness of the skin; state of the teeth; condition of subcutaneous fat layer; the state of the muscles and signs of abnormal fatigue.

Stage 2. All children whose nutrition appears to be defective should receive a medical examination and should become the subject of a medico-social inquiry dealing especially with diet.

This type of investigation is of particular value in two respects, first, when it is desired to obtain data on the nutritional state of a district or of the child population of a community: and secondly, when the preliminary survey is being followed up by an attempt to discover and eliminate the cause of the defective nutrition in each individual case in so far as that is possible.
The necessity to have complete and accurate data on other cognate matters - as, for example, facts connected with the amounts and nature of the foods used: the size of the family income and its allocation - in order to provide a basis for a national nutrition policy is recognised by the inclusion of appropriate methods by which this information can be secured.

But the method outlined in Type 1 and followed by me, deals more with the individual and with the detection of the causes of his defective nutritional state.
DIET SCALES.

It is appropriate at this point to refer to the various Diet Scales which have received recognition by various authorities. They have been prepared on the basis of well established facts and of intelligent estimation when scientific evidence was not available. Modifications of these scales may be made as hypothesis receives confirmation or merits correction with the advance of knowledge. It is maintained by the originators and exponents of these diet scales that they are adequate for the maintenance of the health, strength and well-being of all, but some are constructed on more generous lines than others in order to provide a margin for exceptional requirements and to allow for the lack of accurate data of optimum needs.

The value of these diet scales is twofold. First, they have an important function as a guide to the construction of dietaries for institutions of all kinds and for menus suitable for use under circumstances in which food must be prepared centrally for communal consumption as in Residential Schools, in H.M. Forces, or on board merchant or passenger liners. Without such a guide it is highly probable that various defects of excess or of insufficiently would be present in the meals with eventual harmful results on the people affected. Secondly, they could be used to estimate the extent of malnutrition generally throughout the country or in sections of the community. If the nutrient constituents of the normal diet of the people under investigation are compared with those of the Standard Dietary then an indication is
obtained as to whether the diet is satisfactory by modern standards or whether it is such that malnutrition might supervene. Very many standards have been prepared but four which have obtained world-wide publicity are:

1. The B.M.A. Scale. This diet scale aimed at adequacy for nutritional requirements at minimum cost. An additional milk allowance of 1 Pint for children age 1 to 5 years and of \( \frac{1}{2} \) Pint to age 10 was advocated by the Association. (19) The recommendations were qualified by the publication in 1934 of the Sliding Scale of calorie requirements in the special report of a conference held between representatives of the former Advisory Committee on Nutrition of the Ministry of Health and representatives of the Committee on Nutrition of the British Medical Association.

2. The 'Stiebeling' Scale prepared for the U.S.A. Government Department of Home Economics. This diet is more generous and the cost is correspondingly greater. It has been considered to be suitable for dietary survey work in this country and it was employed by Orr in his enquiries. (110)

3. The League of Nations Scale. The aim of the committee which constructed this diet scale was the determination of optimum amounts irrespective of cost. (60) For this reason it can be used as a guide to actual nutritional requirements.

4. Cathcart and Murray's Scale. (24) This scale, which has been extensively employed in Surveys in Britain, has been criticised on the ground that the increase in the daily Calorific allowance for each year of age is of equal amount from birth to age 14 years whereas in practice the
extra requirements with each year of age for the growing child is greater in the early teens than is the increase necessary between, for example, ages 3 and 4 years. The Scale of Holt and Fales (51) recognises this physiological fact and whereas a child of 4 years if given 115 calories more than the child age 3 years, the child of 13 years has 225 calories in addition to that deemed adequate for a child of 11 years. The question of whether the Holt and Fales increases are sufficiently high is undecided but the principle that a flat rate of increase is not correct is recognised. The proportionate increase over the previous year's allowance should be higher in the first 3 or 4 years of life and in the teens than in the intervening period. Another point which has not received the attention it merits by the authors of some diets is that boys in their early teens require more than the allowance for the adult male. This point has been conceded in the Diet Scales prepared by the Ministry of Health, the League of Nations and by Stiebeling but not in that sponsored by Cathcart and Murray. In estimating whether the Calorie allowance for children of different ages is adequate, the coefficient must be taken into account. Coefficients. It is customary to express the Calories which have been allocated to women and children as a decimal of the allowance of the adult male (with no exceptional needs.) These are spoken of as Man-Values because they are a ratio-based on his needs which are graded 1.00. A woman, whose
Physiological requirements are less, is usually given the man-value of coefficient of between 0.83 and 0.7. The man-value of a youth of 15 or 14 years will be 1.0 plus and children of lesser ages will be below unity. The position is complicated because several Coefficients (or scales of man-values) are in use and because the figure (the Calorie allowance for an adult male) varies also.

As the investigation carried out by me did not include a dietary survey of the type in which accurate records are kept of the foodstuffs used by the families (with data for waste, etc.) but was restricted to enquiry on general lines with a view to the detection of serious errors such as insufficient First-class Protein or Vegetables or excessive carbohydrate, a detailed account, of the requirements of the child in respect of Calories, Protein, Fat, Vitamins and minerals would be superfluous. Basic principles were however kept in mind and it was on that basis that criticism was made of the food the child received and that advice as given to the parents.
SECTION III

PART I. NUTRITION CLASSIFICATION OF 4,628 SCHOOL CHILDREN
Sub-section (1)
ASSESSMENT OF NUTRITION GRADES.

Each class was examined in school in turn; the schools being taken in rotation. Under the supervision of the school nurses the children were undressed to the waist and brought one by one to the Medical Examination Room. Particular attention was paid to the general bearing of the child, whether alert, bright and carrying the body well, or dull, tired-looking and stooping. Muscle tone was estimated digitally; the conjunctivae and lips were examined for signs of Anaemia; the amount of subcutaneous tissue was noted and the build taken into consideration. An impression was formed of the child's general state, and in cases which were border-line or below average, questions were asked regarding diet, (especially likes and dislikes) hours of sleep and other related matters. When a decision had been arrived at as to the nutrition grade or a tentative estimation made in the case of a few children, the nutrition grade was inserted on the Medical Inspection Card.

Later the cards were arranged according to the Board of Education system of age grouping, and the numbers in the four nutrition grades in each age group were determined. By the Board's system children age 5 and 6; 8 and 9; 12, 13 and 14; and 7, 10 and 11 are placed together, making four age groups. No further action was taken in the case of the A and B children, but advice on general lines connected with diet and hours of sleep was given to many of the B group, who, though not found to be subnormal and suitable for Grade C, yet had various dietetic errors and physiological defects which could have affected their nutrition adversely, if not
corrected. These were earmarked for re-examination in six month's time. The aim in this case was preventative.

The parents of all children belonging to the C and D nutrition classes and those for whom only a provisional estimation was arrived at in the school were invited, by post-card at subsequent dates to bring the child to the school clinic for a more thorough examination. The method followed in this part of the Survey will be described later.
Sub-section (2)
CLASSIFICATION OF THE CHILDREN AND NUMBERS IN EACH AGE GROUP

(a) Total Figures.

The complete figures for the children examined, who comprised the vast majority of the school population of the area, are tabulated below. For school session 1940-1, during which the survey was carried out there were 5,125 scholars on the school registers and the average daily attendance was 4528. The total examined during the survey was 4,628.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Nutrition</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>768</td>
<td>493</td>
</tr>
<tr>
<td>B</td>
<td>3,360</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>16.6%</td>
<td>10.6%</td>
</tr>
<tr>
<td>D</td>
<td>72.6%</td>
<td>10.6%</td>
</tr>
</tbody>
</table>

Comments on Table I. The figures reveal the nutritional state of the children of the area. One's first impression is that they are surprisingly good in view of the proximity to the depressed industrial towns of Tyneside. The proportion of children classified as slightly subnormal, namely 10.6%, though lower, in some cases much lower, than that recorded for other comparable industrial communities on the North East coast must nevertheless be considered to be a serious reflection on the care of youth by parents, on the extent and efficiency of our child care services, and, in so far as it is blameworthy, on the economic resources of the parents.
Two reasons can be advanced for the better figures obtained in the survey of this district. The first is that unemployment did not become the serious problem here which it was in some nearby districts such as Jarrow or Sunderland. It was not classed as a depressed area, and, though unemployment did exist (as will be shown later), the majority of the industrial population continued at work. The second important factor which kept the numbers of subnormal nutrition cases as low as they are, lay in the efforts of the School Medical Service to discover children requiring special care and supervision. It should be emphasised that the 500 children who were classified as subnormal (493, C cases and 7, D cases) were such as any observer would have agreed were in a poor nutritional state. Many of those placed in the B category, on the other hand, were borderline and might have been included in the lower grade. These cases were noted for re-examination and were given advice where indicated.

(b) Arrangement of Data according to Age Groups. **TABLE II.**

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Totals in Each Age Group</th>
<th>Nutrition Grade</th>
<th>A</th>
<th>Number</th>
<th>Percentage</th>
<th>B</th>
<th>Number</th>
<th>Percentage</th>
<th>C</th>
<th>Number</th>
<th>Percentage</th>
<th>D</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-6</td>
<td>996</td>
<td></td>
<td></td>
<td>129</td>
<td>12.9%</td>
<td></td>
<td>764</td>
<td>76.7%</td>
<td></td>
<td>104</td>
<td>10.4%</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8-9</td>
<td>1067</td>
<td></td>
<td></td>
<td>190</td>
<td>17.8%</td>
<td></td>
<td>745</td>
<td>69.8%</td>
<td></td>
<td>129</td>
<td>12.1%</td>
<td></td>
<td>3</td>
<td>0.3%</td>
</tr>
<tr>
<td>7-10/11</td>
<td>1541</td>
<td></td>
<td></td>
<td>267</td>
<td>17.8%</td>
<td></td>
<td>1092</td>
<td>70.9%</td>
<td></td>
<td>178</td>
<td>11.5%</td>
<td></td>
<td>4</td>
<td>0.26%</td>
</tr>
<tr>
<td>12-15/14</td>
<td>1024</td>
<td></td>
<td></td>
<td>182</td>
<td>17.9%</td>
<td></td>
<td>760</td>
<td>74.2%</td>
<td></td>
<td>82</td>
<td>8.0%</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Comment on Table II

The total children examined in each of the age groups are surprisingly similar except in the case of the 7/10/11 group. For example, there were 996 children in the first age group (age 5/6 years) 1067 in the second (8/9 years) and 1024 in the Leaver group (12/13/14 years). The composite 7/10/11 group is somewhat larger: 1541 children of these ages having been examined.

The middle age group has the highest percentage of C and D cases and it is followed closely by the 7/10/11 group which is formed from children still younger and older. Taken together, there is a higher percentage of subnormal cases in these two age groups than in either the younger or the older classes. The Leaver age group shows the lowest percentage of C nutrition children and, indeed, it has the best figures all round although the decrease in the number of slightly subnormal children has led to a higher total of B children and left the A class practically unchanged.

This is general finding throughout the country. In the Annual Report of the Chief Medical Officer to the Board of Education for the year 1937, (11) the percentages of slightly subnormal children obtained at Routine Medical Inspections in England and Wales are as follows:

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and 6 years</td>
<td>10.2%</td>
</tr>
<tr>
<td>8 and 9 years</td>
<td>12.3%</td>
</tr>
<tr>
<td>12 to 14 years</td>
<td>9.9%</td>
</tr>
</tbody>
</table>

These data bear out the observation of Sir Arthur MacNalty that in London and other areas the poorest nutrition figures are obtained from children age eight and nine years. (10).
The improved nutritional condition of many children in the later years of school life is probably due to the influence of several factors such as:

(1) Earlier detection and treatment of many cases.
(2) Recovery from the after effects of debilitating disease and the improved appetite and digestion which accompany this recovery.
(3) Interest in physical fitness together with a development of pride in personal physique and of prowess on the playing field.
(4) The beneficial results of education, for example, the knowledge of the relative values of foods to health.

The Entrants Group of children (age 5/6) has a relatively high proportion of B and C cases with a correspondingly low number of children of excellent nutrition (Grade A). In the opinion of the writer it is in this age group that the operation of the personal factor in assessment of nutrition may influence results unduly. More difficulty is experienced in determining grade and more mistakes are made when dealing with this age group than in the others. This is unfortunate because it is of even greater importance in the case of these young children than the older, to detect the preceding lowered functional efficiency, than to wait for the onset of slowing of growth or any other organic change which makes the presence of frank malnutrition self-evident. The importance of this can be gauged from the results of follow-up examinations of Entrants who had been passed as not suffering from defective nutrition. These later examinations reveal that many children, who to all appearance were in a sound state of health and nutrition must nevertheless have been suffering from a deficient intake of nutrients, and to have been, at that time, the subjects of incipient malnutrition; or, as it has been named, Latent Malnutrition.
### TABLE III.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Totals</th>
<th>Nutrition Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Boys</td>
<td>2,265</td>
<td>311</td>
</tr>
<tr>
<td>Girls</td>
<td>2,363</td>
<td>457</td>
</tr>
</tbody>
</table>

### TABLE IV.

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Sex</th>
<th>Nutrition Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>5/6</td>
<td>Boys (499)</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Girls (497)</td>
<td>82</td>
</tr>
<tr>
<td>8/9</td>
<td>Boys (544)</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Girls (623)</td>
<td>107</td>
</tr>
<tr>
<td>7/10/11</td>
<td>Boys (727)</td>
<td>103</td>
</tr>
<tr>
<td></td>
<td>Girls (814)</td>
<td>164</td>
</tr>
<tr>
<td>12/13/14</td>
<td>Boys (495)</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>Girls (529)</td>
<td>104</td>
</tr>
</tbody>
</table>
(c) Variation in the proportions of the sexes affected.

It is interesting to enquire whether any difference exists between the sexes in the incidence of malnutrition or in the proportions of those who were considered to be Grade B and Grade A.

An almost equal number of boys and girls were examined by me during the Survey. The actual figures are included in Table III which shows that two more boys than girls were examined. This slight difference is of no importance statistically in view of the large numbers involved.

The first observation that falls to be made is that almost identical numbers of boys and girls were classified subnormal. It has been found in some Nutrition Surveys that boys are more prone to show signs of defective nutrition than are girls and, though the over-all figures in this Survey (Table IV) do not bear that out, yet in certain of the age groups more boys than girls were recorded as being of subnormal nutrition. This is seen in the Leaver Group (age 12/13/14 years) and in the 7/10/11 Age Group, in both of which groups proportionately more boys than girls were graded C. In the other age groups there are more C nutrition cases among the girls than the boys. The reason for this variation is not easy to establish. However as has already been pointed out when the data for all of the groups combined are considered, the difference between the sexes is of very slight degree.

Though this difference between boys and girls in respect of undernutrition is hardly material, it is however significant that girls have a distinct superiority in the A class which is reserved for those whose nutritional
state is excellent. The extent of this superiority is as high as 5.6%, and it was obtained, as is seen from the table, at the expense of the Nutrition B class. The effect of this has been to make the figure for boys of nutrition B to stand at a higher level than the girls, and, when comparing the nutritional status of the sexes this should be kept in mind. The position created by this shift to the A side means that the general nutritional state of the girls is better than that of the boys. This striking difference between the boys and the girls in the A nutrition section is present in all of the age groups and in each instance it has produced a fall in the number in the B class.

A possible reason for this lies in the difference in the habits of many boys and girls. On the whole boys are much more likely to over-exert themselves and to continue their activities and play even when tired or not feeling quite well. Girls, on the other hand, are frequently much less active and boisterous and tend to rest more readily when tired. Thus the evil effects of over-fatigue and of lack of sufficient rest are more in evidence in boys than in girls and, as will be discussed more fully in a later section, the unavoidable reactions on physiological efficiency and nutritional state are therefore greater among boys than girls.
TABLE V.

<table>
<thead>
<tr>
<th>Ages of Malnutrition Cases</th>
<th>14</th>
<th>13</th>
<th>12</th>
<th>11</th>
<th>10</th>
<th>9</th>
<th>8</th>
<th>7</th>
<th>6</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Each Age</td>
<td>3</td>
<td>38</td>
<td>38</td>
<td>57</td>
<td>50</td>
<td>48</td>
<td>54</td>
<td>41</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>0.75</td>
<td>8.5</td>
<td>9.5</td>
<td>9.75</td>
<td>14.25</td>
<td>12.5</td>
<td>12.0</td>
<td>13.5</td>
<td>10.25</td>
<td>9.0</td>
</tr>
</tbody>
</table>

GRAPH I.
The arrangement of school children in four main age groups is suitable for the statistical purposes of the Board of Education and convenient for the purposes of routine medical inspection, but greater detail may be helpful when investigating nutrition. For this reason it was thought that to arrange the Nutrition C children into smaller groups according to age to the nearest year might provide additional information.

The resulting data have been arranged in Tabular and in Graph form (Table V; Graph I) and certain interesting facts emerge. For example more children age 7 and 10 years had been graded C than those age 8 and 9, the two ages usually regarded as producing the worst results. The low figure recorded for children age eleven, diminished the combined percentage for the 7-10-11 group (Board of Education classification) by an appreciable amount. The arrangement prescribed by the Board whereby children age eleven are included with those age 7 and 10 would have, in this Survey, obscured the fact that the numbers of children age 7 and 10, who were suffering from defective nutrition, were in excess of those age 8 and 9.

This point merits further enquiry in other districts in view of the evidence given on page 41 that over the country as a whole, and in both routine medical inspection and special Nutrition Surveys, the 8/9 age group has a worse record for malnutrition than any of the other Board of Education age groups.
### TABLE VI.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1927</th>
<th>1928</th>
<th>1929</th>
<th>1930</th>
<th>1931</th>
<th>1932</th>
<th>1933</th>
<th>1934</th>
<th>1935</th>
<th>1936</th>
<th>1937</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUM.</td>
<td>1513</td>
<td>1748</td>
<td>1677</td>
<td>14565</td>
<td>3868</td>
<td>3157</td>
<td>2506</td>
<td>2524</td>
<td>2580</td>
<td>2076</td>
<td>1717</td>
</tr>
<tr>
<td>MALE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNEMPL.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AGE (at time of survey)</td>
<td>14 Years</td>
<td>13 Years</td>
<td>12 Years</td>
<td>11 Years</td>
<td>10 Years</td>
<td>9 Years</td>
<td>8 Years</td>
<td>7 Years</td>
<td>6 Years</td>
<td>5 Years</td>
<td>4 Years</td>
</tr>
</tbody>
</table>

### GRAPH II.

- **Malnutrition Cases**
- **Male Unemployed**

**Graph legend:**
- Year: x-axis
- Number of cases of malnutrition: y-axis
- Male unemployed: y-axis (dashed line)
Sub-section (4)
POSSIBLE CONNECTION BETWEEN THE RISE AND FALL OF UNEMPLOYMENT AND VARIATIONS IN THE AGE INCIDENCE OF MALNUTRITION.

In order to determine whether variation in the extent of unemployment was related to the differences in the percentages of children of different ages found to be subnormal, the numbers of men unemployed in each of the years from 1927 to 1937 were obtained from the local Labour Exchange. Records for the years prior to 1937 were not available. It should be pointed out that the total unemployed in the area was much higher in each year than the figures indicate. The figures used relate solely to men and exclude women, girls and boys. This was done because it was thought that it would be more correct to consider men only and exclude women and juveniles when a correlation between unemployment and malnutrition was being sought. In Table VI there is given the numbers of male unemployed for each year from 1927 to 1937 and in addition, for ease of reference, the ages (at the time of the Survey) of the children born in each separate year. The same data are represented graphically, (Graph II) together with the particulars detailed in Table VI.

Comments on Table VI and Graph II.

With regard to the unemployment figures, first of all, after a steep rise between 1929 and 1930 there is a steady annual decline in the numbers of men unemployed, more rapid at first, but slowing in recent years. The inclusion of data connected with the years prior to 1927 would have been instructive in connection with the numbers of subnormal nutrition cases in the 12/13/14 age group, but for the reason already given the figures could not be obtained.
It would appear from the graph (II) that a definite relationship may exist between unemployment immediately prior to the birth of the child and the demonstration in the same child after an interval of over 5 years (i.e. during school life) of a condition of subnormal nutrition. The rise and fall in the numbers of unemployed men appears to be associated with a corresponding rise and fall in the incidence of malnutrition among the children born during that particular year.

This appearance of correlation may be fortuitous. On the other hand it may strengthen the case that has been made, following investigation in other areas, that the unemployment of the Breadwinner reacts unfavourably on the nutrition of the child. Though it has been proved beyond dispute that diminished family income affects the health and vitality of the children by its action on the physical and psychological health of the mother prior to and subsequent to the birth of the child, and by reducing the amounts of the more expensive body building and protective foods which can be purchased, there are two reasons why such deductions from the findings noted above would not be justified. The first is that in almost all Nutrition Surveys in Great Britain the middle age group (age 8/9 years) has the highest figures of subnormal children, and, secondly, as surveys have been carried out for well over a decade with similar results in respect of children age eight and nine years, some children who were that age at the time of the survey must have been born at a time when unemployment was below average. Further many of the nutrition C cases were the children of miners, and as
unemployment was less severe in the coal industry in this district than among shipyard workers, the incidence of subnormal nutrition would need to be related to the occupation of the parent before connection with unemployment could be established.
SECTION III

PART II

MEDICO-SOCIAL INQUIRY IN THE CASE OF 400 CHILDREN GRADED C AND D.
Sub-section (1)
DETAILS OF THE METHOD OF EXAMINATION.

The Nutrition Survey was, as has already been stated, carried out in two sections. In the first section all the children in attendance were examined individually in school and the nutrition grade assessed. The second section, which was conducted in the school clinic was devoted to the examination, in the presence of the parents, of each child who had been placed in nutrition groups C and D: that is children whose nutrition was slightly subnormal or bad. Parents were requested by post card to bring the child at a stated time for a special examination. A quarter of an hour was allocated for each child and groups of ten were sent for during afternoon sessions over several months.

The aim of this part of the survey was threefold. First, the discovery by a clinical examination of any condition which could affect the health adversely and to advise appropriate treatment. Secondly, to conduct a Medico-Social inquiry relating particularly to illness: domestic habit in connection with diet, bedtime, etc: the personal attitude of the child to food, e.g. appetite, dislikes: and, in the third place, in association with the above, to investigate the family's economic position on general lines, with emphasis on unemployment, size of family, cultivation of garden or allotment, and income on the basis of the Income Scale of the Provision of Meals Scheme. Records were kept in each case. A special table for record-purposes was prepared. The data analysed in this section and certain later sections were obtained from the records of 400 of these subnormal nutrition cases.
Further Particulars.

Each child was undressed to pants and stockings, and weight and height were taken. This was followed by the clinical examination. The heart and lungs were examined; muscular tone of the Pectorals and of the forearm muscles was estimated digitally; the amount of adipose tissue was taken note of; the teeth and throat were inspected and the presence or absence of otorrhoea confirmed; the cervical glands were palpated and consideration given to the possibility of anaemia. Abdominal examination in the supine position was carried out when there was a suggestion that some condition such as abdominal adenitis might be present.

Deformities such as those of the chest which might influence the development of Respiratory disease were noted, but other deformities, for example, those of the lower limbs were disregarded because their etiological bearing on malnutrition, at that late stage, was considered to be negligible.
Sub-section (2)

SUMMARY OF ADVICE GIVEN AND OF TREATMENT RECOMMENDED.

In accordance with the usual practice for obtaining treatment for defects in school children discovered at Routine Medical Inspections, all cases of defects requiring active treatment - other than defects of diet or hygiene - were referred to the appropriate specialist, or when domiciliary care was required, to the family doctor. For example, cases of diseased tonsils which were thought to be contributing to the low state of health of the child were sent to the Ear, Nose and Throat specialist (under the Education Committee's Scheme) for opinion and treatment. Close co-operation was maintained between the School Medical Service and the General Practitioners. Details of the physical defects found are given on page 83 (Section VI).

Advice on diet and hygiene was most conveniently given during the course of the examination of the child, because it was usually possible to emphasise the points by direct reference to the defects or errors detected. Parents, for the most part, were eager to take advantage of the opportunities granted them and a notable feature of this enquiry was the desire they exhibited to do their best for their children. Follow-up of many of the cases later revealed a creditable effort on the part of all except an apathetic minority, to follow the advice given.

The following list indicates the measures adopted in our attempt to improve the general health of the children found to be below normal. The figures record the number of cases requiring such advice or treatment.
PROVISION OF MEALS
(a) Recommended

(b) Agreed to make application

Advised to take MILK IN SCHOOL

Recommended for FREE MILK (two one-third pint bottles)

Various DIETETIC MEASURES recommended

Recommended to take VITAMIN PRODUCTS

(Cod Liver Oil, Marmite, Numol, Maltoline)

Recommended to take IRON TONIC

" for U.V. RAY THERAPY

" to have INCREASED SLEEP

* Issued free or at reduced prices.
<table>
<thead>
<tr>
<th>Number of Families Affected</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Children in Family</td>
<td>32</td>
<td>63</td>
<td>92</td>
<td>75</td>
<td>86</td>
<td>33</td>
<td>23</td>
<td>16</td>
<td>7</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Percentage</td>
<td>8.0</td>
<td>17.0</td>
<td>23.0</td>
<td>18.7</td>
<td>9.0</td>
<td>8.2</td>
<td>5.7</td>
<td>4.0</td>
<td>1.7</td>
<td>1.0</td>
<td>0.25</td>
<td>0.75</td>
<td>0.75</td>
<td>0.25</td>
<td>1.0</td>
</tr>
</tbody>
</table>
Sub-section (3)
CONSIDERATION OF VARIOUS FACTS ELICITED AT THE EXAMINATION.

(a) SIZE OF FAMILIES TO WHICH THE NUTRITION C CASES BELONGED.

A record was kept of the numbers of children in the families of the 400 cases of subnormal nutrition examined, and the figures are set out in Table VII.

When the data are analysed some very unexpected results are obtained. Contrary to expectation a larger proportion of the children with nutritional defects belonged to families of small size and the larger families represented in this investigation are equally surprisingly few in number. For example, of the 400 children, 32 children (8%) belonged to 'one child' families. As the 400 children came from a total of 349 families these 32 amounted to 9.1% of the families represented. Further, 100 cases came from families of one or two children, 32 as already noted from 'one child' families and the remaining 68 from families in which there were two children. Thus the smaller families of one or two children produced one quarter of the 400 nutrition C children. The case of families of three children is particularly interesting in that almost another quarter of the total examined, namely 92, were drawn from families of that size. In point of fact more subnormal children came from three child families than from those of any other size.

It would appear, therefore, that factors other than a poor economic state must exert a profound influence on the problem of malnutrition unless the income of these families is so meagre that the advent of one or two children places the family below the poverty level. As will be mentioned in a later section dealing with the scheme for the provision
of meals for necessitous cases, many of these families had an income which excluded them from participation in the free meals scheme as organised at that time.

The high incidence of defective nutrition among children belonging to the smaller families is not only a disquieting observation, but is, indeed, a little noticed feature of the problem. For some years there has been a tendency to attribute to size of family much of the ill-health and physical unfitness of children in the poorer areas. However true it may be that any increase in the size of a family does diminish the effective power of the wage-earner to supply his family with all that is necessary for full health and well-being, it cannot be gainsaid that, in this area at least, the bulk of the cases of malnutrition come from families of the smallest size.

Further light on this aspect of the problem is clearly required in view of the forecasted imminent fall in our population and the necessity to increase the birth rate to a level which will, at least, prevent serious depopulation. It is considered by some who have made a study of population statistics that, at the present stage of our national history, a minimum of four children per family is required for replacement and to cover annual loss in child life through disease and accident. It is interesting therefore to observe that in this investigation, families of four children contributed 75 (18.7%) cases of malnutrition. Further, when families consisting of four children or less are arranged together, as many as 267 (66.7%) of the 400 are accounted for.
As we progress in the scale of size of family there is a rapid falling off in the numbers of families affected. This is what one would expect in view of the smaller proportion of the larger sized families in the population. In addition to that, various other factors come into play and contrive to lessen the effects of poverty when the families reach the four and over level. For example, Health Visitors pay particular attention to the infants and toddlers in such families, and, in this area at least, parents are more eager to follow advice on dietary and child-care matters. Assistance in various forms is given on account of the size of the family and the low income level. Provision of meals at school; free milk for the infant and the school child; vitamin products at reduced price through the Infant Welfare and School Clinics; and attention to the health and nutritional requirements of the mother in the ante-natal period. This last includes in addition to ordinary ante-natal supervision, free or assisted attention to the teeth and the supply of free meals or milk in cases of necessity.

(b) PLACE IN THE FAMILY OF THE NUTRITION C. CASES.

A point which is of importance in the elucidation of the problem of the underlying causes of malnutrition is the place in the family occupied by the child affected. For example, is the fourth child more likely to suffer from malnutrition than the first, or is the danger equally great irrespective of the place of the child. The view most frequently expressed is that the smaller the family the less is the risk of malnutrition; and that, if the families of industrial workers and other low wage earners were kept small - that is were limited to two or three children - the
<table>
<thead>
<tr>
<th>Place of Child in Family</th>
<th>1st Place</th>
<th>2nd Place</th>
<th>3rd Place</th>
<th>4th Place</th>
<th>5th Place</th>
<th>6th Place</th>
<th>7th Place</th>
<th>8th Place</th>
<th>9th Place</th>
<th>10th Place</th>
<th>11th Place</th>
<th>12th Place</th>
<th>13th Place</th>
<th>14th Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Instances</td>
<td>118</td>
<td>89</td>
<td>65</td>
<td>48</td>
<td>27</td>
<td>19</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Percentage</td>
<td>24.5</td>
<td>22.25</td>
<td>16.25</td>
<td>12.0</td>
<td>6.75</td>
<td>4.75</td>
<td>2.25</td>
<td>1.5</td>
<td>0.35</td>
<td>0.25</td>
<td>0.25</td>
<td>0.25</td>
<td>0.75</td>
<td>0.25</td>
</tr>
</tbody>
</table>
nutritional problem would almost disappear because the family income would then be sufficient to cover the household needs.

The data presented here conflict with the above widely accepted view. In this investigation it was found that, in addition to a large proportion of the cases of malnutrition coming from families of small size, over 50% of the 400 nutrition C children occupied the first or second place in the family.

It will be remembered that in the preceding section mention was made of the fact that in 32 instances the child was an 'only child': that at the time of the inquiry he was the first and sole member of the family. In addition to these 32 first children there were other 36 children who were the first born in families of varying size. Together these two groups account for 118 (29.5%) of the 400 cases investigated. The complete figures are set out in Table VIII. It is worthy of special comment that children who occupy first or second place make up over half of the total, 207 (51.7%) to be exact.

It should not be overlooked that the significance of place in the family, in connection with the development of malnutrition is related to the size of the family; which point was considered in the preceding section. Obviously if there is a succession of children at short intervals the older members, though still at the toddler stage and in need of the closest care, receive a greatly decreased amount of attention. The baby absorbs a great deal of the mother's time and energy and the other children may suffer in respect of diet, hygiene and sleep and even nursing during illness. In the ordinary way of things a mother of average intelligence...
and efficiency is able to give adequate attention to all members of her family, if numbering four or less; and, provided her knowledge of mothercraft and of the dietary needs of growing children is not at fault she should be able to rear healthy children of sound constitution, unless the income of the family cannot meet the necessary expenditure. With larger families it is doubtful if the mother can, without domestic help, look after all the children properly even though the purchasing power of the family is adequate.

On the other hand, unless the income level is below the poverty level, can it be maintained that a mother of two or three children cannot give sufficient attention, with all that that implies, to the older members. In other words, is it the presence of the younger child and the resulting diminished care of the others, that has determined the onset of the malnutrition in the older members. Few women of experience would admit that this could be the case in families not greater than four, unless sheer neglect or some other factor, such as low purchasing power, were operative. Yet as was demonstrated in the previous section, families composed of one and two children provided one quarter of the cases of malnutrition, and 267 cases (66.7%) came from families of one to four children. The remaining 33.3% belonged to families larger than four. It is, however, obvious from the facts noted above that the incidence of malnutrition is high among families of small size, and among the children born first. This is contrary to what one would expect, inasmuch as the purchasing power of a family is greater while the family is still small and the mother has fewer demands on her time and energies. It
illustrates an aspect of the problem which has not been fully investigated, but which is worthy of attention by workers who have the opportunity to study the subject from the angle of pre-disposing domestic circumstances.

(c) INTERVAL BETWEEN BIRTH OF THE NUTRITION C CHILD AND THE BIRTH OF THE PREVIOUS CHILD.

Frequent pregnancy at short intervals is known to have a harmful effect on the health of the mother. Within limits the foetus benefits at the mother's expense and it may not show signs of deprivation of nutritional substances even though the mother's system may be weakened simultaneously. If further pregnancies supervene before the mother has recovered fully it is plain that the results on the mother are bound to be harmful to her, and, in the case of the later pregnancies, to the unborn child as well. It has been demonstrated that nutritional anaemia of childhood may originate from insufficient deposit of Iron in the foetal Liver; a sequel to the earlier depletion of the maternal iron reserves. It is probable, too, that an insufficiency of Vitamin D and of Calcium in the pre-natal stage, hinders calcification in the foetal bones and conduces to the development of Rickets after birth.

During the course of the Nutrition Survey the question arose as to the extent to which marked under-nutrition in childhood is preceded by a succession of births at frequent intervals. It is obvious that the operation of other factors, mainly economic and social, cannot be excluded in any group of cases taken from this area because to almost all of these people the birth of another child always means extra calls on the family income and increased demands on the mother's time and
energies, with their inevitable repercussions on the nutrition of the family. It may be remarked that the provision of adequate child allowances and of domestic help for mothers of families, would make it easier to determine the effects of the insufficient spacing of births on the younger members of the family, but at present we cannot do more than draw inferences as to the respective responsibility of the several factors involved.

The data summarised in this section were secured in the hope that some further light would be thrown on the problem: - a problem which had appeared to become still more complicated by the evidence already given, that first born children and children born in families of small size also were hardly less subject to the liability to suffer from under-nutrition than those in the larger families. However correct (or incorrect) that may be, it was thought that certain preliminary enquiries could, with advantage, be carried out. The point investigated was the length of time elapsing between the birth of the previous child and the birth of the child recorded as suffering from malnutrition. As families of small size were not of significance here, and because, as has been pointed out earlier (page 55), additional help in various forms which might influence the results, was available for mothers of children in large families, it was decided to enquire into the instances of 'four-child families' having a case of malnutrition, and to determine in how many of these cases the birth had been preceded by a previous gestation within a short interval.
### TABLE IX.

<table>
<thead>
<tr>
<th>TIME BETWEEN BIRTHS (IN YEARS)</th>
<th>1 YEAR TO 1½ YEARS</th>
<th>1½ YEARS TO 2 YEARS</th>
<th>2 YEARS TO 2½ YEARS</th>
<th>2½ YEARS TO 3 YEARS</th>
<th>3 YEARS TO 3½ YEARS</th>
<th>3½ YEARS TO 4 YEARS</th>
<th>OVER 4 YEARS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF INSTANCES</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>PERCENTAGES OF TOTAL CASES (%)</td>
<td>26.8%</td>
<td></td>
<td></td>
<td></td>
<td>74.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>40.7%</td>
<td></td>
<td></td>
<td>59.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CASES (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>59.2%</td>
<td>40.8%</td>
</tr>
</tbody>
</table>

**GRAPH III.**

![Bar graph](image)

Interval in years between birth of one child and that of previous child.
the enquiry would have been enlarged and the basis altered slightly to yield more information but the pressure of other work prevented its being continued.

The facts which did emerge are interesting, and, although the numbers involved are small, the information obtained - though not of much statistical value - may not, thereby, be completely invalidated. Of the group of four-child families represented by one or more members on the list of malnutrition cases, accurate information was obtained in only 31 instances; and of these 31, four are omitted because the case was the first born child. That leaves 27 cases only. Table IX records the number of families in which there was a birth within the periods specified prior to the date of birth of the malnutrition case. The same data are represented in diagramatic form, (Graph III)

Comment on Table IX.

As is seen from the table, in no case had a child been born less than one year prior to the birth of the child with malnutrition. In 7 (25.8%) of the 27 cases, one to one and a half years only had elapsed between the successive births, and in a further 4 instances the period was between 1½ and 2 years. Together these two groups account for 40.7% of the total cases.

If we include with these cases the five children born within two and two and a half years from the preceding child the percentage increases to 59.2. In other words 16 children suffering from malnutrition were born less than 2½ years after the earlier birth, and 7 of these sixteen, amounting to 43.7% were those in the 1/1½ years category.
DISCUSSION.

It emerges from the figures that quite an important proportion of the group of families had successive births at intervals which were too short, when consideration is given to the lack of opportunity for physical restoration which many of the mothers encounter; a difficulty which, in the main, follows from low family purchasing power, from insufficient and inappropriate food, from the burden of domestic responsibility and from the lack of assistance in the home together with the inability to obtain the benefit which a holiday and a change of environment would produce.

(d) EMPLOYMENT OF WOMEN IN INDUSTRY IN THE AREA.

The effects on home life and on the nutrition of children, of the employment of women in industry arises from the findings discussed in the previous section. It should therefore be noted that the number of women so employed, either part time or full time, in the area, was negligible. The main industries were not such as could absorb much female labour. Part time work as cleaners in schools and offices was the principle sphere open to married women desirous of employment; and such opportunities were very limited.

(e) FAMILIES HAVING MORE THAN ONE CASE OF MALNUTRITION.

Ninety three of the 400 children under investigation belonged to families of which more than one member was found to be suffering from malnutrition at the time of the Nutrition Survey. Altogether there were 42 such families. They were arranged as follows:
<table>
<thead>
<tr>
<th>Number of Children in Family</th>
<th>Number of Families Affected</th>
<th>Numbers of Families Having:</th>
<th>Total Children with Defective Members in Each Size of Family</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 cases each</td>
<td>3 cases each</td>
</tr>
<tr>
<td>2 Children</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3 Children</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4 Children</td>
<td>7</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>5 Children</td>
<td>8</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>6 Children</td>
<td>8</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>7 Children</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>8 Children</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9 Children</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>12 Children</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
35 families had 2 cases of malnutrition each.

\[ \begin{array}{ccc}
5 & 3 & 4 \\
62 & 35 & 4 \\
\end{array} \]

The question which is immediately aroused at this point is: what is the size of these families with multiple cases of malnutrition? The details illustrative of the position are set out in Table X and the particulars are arranged under size of family, numbers of families of each size affected and numbers of families having two, three or four cases of malnutrition.

**Comments on Table X**

From the table it is seen that one family of two children had both children affected; and the position with regard to families of larger size is clear from the table. By way of illustration the case of five-child families will be referred to more fully. Of the eight instances of five-child families, six had two children classified as subnormal; one had three children and one had four children placed in the categories of defective nutrition. The particulars relating to families of other sizes have been arranged in similar fashion. To consider the matter from a different angle - the thirty five families having two cases each, were of varying sizes as can be seen from the table. The majority of instances of two cases of malnutrition occurred in families with three children, but families with 4, 5 and 6 children produced a good proportion. When we consider families having three or four children with defective nutrition it is seen that they are restricted to families larger than four children. In the previous section (place of Nutrition C cases in families) it was inferred that in families larger than four, if the births occurred at fairly short intervals,
a mother might have difficulty in attending to the requirements of all of her children and that the older members might, in consequence, suffer in health and nutrition. This tendency, too, would be enhanced if the family income were insufficient to meet the basic nutritional needs. It would appear that the occurrence of three or four cases of malnutrition in families above the four child level might be connected with both of these possibilities - the adequate care factor, almost certainly; and insufficient income playing a part too. Orr and others - who have investigated nutrition from the angle of the ability of the different income groups to purchase the foods which are essential for full health and development - have shown that the financial resources of large sections of the population are insufficient to procure adequate quantities of such relatively expensive foodstuffs as milk, eggs, meat, vegetables and fruit. This inability to purchase these valuable foods is more apparent where there are several children in the family. (73) One point which should be borne in mind is that it is probable that a larger number of families would have been found to include several cases of malnutrition if pre-school members of the family or the children who had left school had been examined in conjunction with those attending school. In addition, follow-up at later periods would undoubtedly increase the numbers of subnormal cases because other members of the family who had been passed as unaffected but who were in reality suffering from a latent state of malnutrition, would, by that time, have become obvious.

(f) INSTANCES OF MALNUTRITION IN TWIN CHILDREN.

The advent of twins throws a greater strain on the
<table>
<thead>
<tr>
<th>AGE OF TWINS</th>
<th>SIZE OF FAMILY</th>
<th>PLACE IN FAMILY</th>
<th>SEX</th>
<th>WHETHER ONE OR BOTH TWINS Affected</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 YEARS</td>
<td>3 CHILDREN</td>
<td>3rd PLACE</td>
<td>MALE</td>
<td>ONE</td>
</tr>
<tr>
<td>8 YEARS</td>
<td>3 CHILDREN</td>
<td>2nd PLACE</td>
<td>FEMALE</td>
<td>ONE</td>
</tr>
<tr>
<td>9 YEARS</td>
<td>7 CHILDREN</td>
<td>3rd PLACE</td>
<td>FEMALE</td>
<td>BOTH</td>
</tr>
<tr>
<td>10 YEARS</td>
<td>4 CHILDREN</td>
<td>3rd PLACE</td>
<td>MALE</td>
<td>BOTH</td>
</tr>
<tr>
<td>10 YEARS</td>
<td>3 CHILDREN</td>
<td>2nd PLACE</td>
<td>FEMALE</td>
<td>ONE</td>
</tr>
<tr>
<td>10 YEARS</td>
<td>4 CHILDREN</td>
<td>2nd PLACE</td>
<td>FEMALE</td>
<td>ONE</td>
</tr>
</tbody>
</table>
financial resources of the parents and on the labour of the mother than would two children born at an interval as short even as 18 months. It is occasionally found that one of the twins - and very often the male if the twins are male and female - is smaller and weaker physically and does not progress as satisfactorily as the other child. It is interesting therefore to note that 8 of the 400 cases of defective nutrition under examination, were twins.

These eight children belonged to six different sets of twins. In four instances one child of the pair was found to be subnormal and both children in each of the other two sets of twins, were affected.

The accompanying table records the various facts connected with each including sex, size of family and the place in the family of the child or children in question. (Table XI).

(g) INQUIRY INTO THE INFANT FEEDING OF THE 400 NUTRITION CHILDREN.

So many factors may play a part in the causation of malnutrition that it is often difficult to single out any one as being solely responsible in a particular case; and very complete and painstaking inquiry is frequently necessary before even the relative responsibility of several agents can be determined. The type of infant feeding is one of these factors. After the stage of infancy has passed it may not be possible to assess the part played by infant feeding in the development of malnutrition in any one individual. Many children, in point of fact, suffer for years, if not permanently, from the effects of incorrect
infant feeding, but unless a satisfactory medical record were maintained from infancy to school days at least, the identification of the error which initiated the disturbance, and the appraisal of the relative importance of the other related factors, might be impossible. The connection between infant feeding and the incidence of infectious diseases and the development of Rickets will be dealt with in later sections.

The principal difficulty to be faced when classifying Infant Feeding lies in the considerable variation in the length of time during which breast feeding is often continued before it is found necessary to supplement it with cows' milk or to change over completely to artificial feeding. Over-subdivision would render the examination valueless, and, on the other hand, an injudicious grouping would detract from the validity of such deductions as might be made. The arrangement decided upon is in the nature of a compromise. Children receiving breast milk for a limited period were allocated to the Breast Fed group if breast feeding was carried on for four months or more; otherwise they were entered in the Bottle Fed section, with the exception of those children who were given breast and supplementary bottle feeding throughout the greater part of the suckling period. These were entered separately.

The rationale of this grouping is that any particular additional benefit which an infant may obtain from being breast fed, would not normally reach a maximum unless the child had been breast fed for a period of not less than four months. After the age of four months, a breast fed child has, in the majority of cases, so gained in strength
and developed in constitution that the likelihood of a setback through digestive or other debilitating disorder, (brought on by the injudicious bottle feeding methods which are unfortunately unnecessarily common among all social classes) would have been materially decreased. On this basis, therefore, the children were divided into Breast, Breast and Bottle, and Bottle groups.

That the information supplied by the mothers should be accurate and therefore reliable is a fundamental consideration. An indication that they are substantially correct is obtained from comparison with the records kept by Health Visitors of the Infant Feeding of children in their districts in this Borough. Almost all of the infant population comes under their supervision, and monthly visits are paid to the homes during the first year of life. Though only approximately 50% of mothers attend the Clinic, the others receive domiciliary supervision. These Health Visitor records, compiled as they are during visits to the homes, or during the attendance of child and mother at the Clinic, are accurate. A group of 500 of these cards was analysed and the data relating to the type of infant feeding is included in Table XII together with the figures for the 400 Nutrition C cases. It is seen that there is a surprisingly close agreement between the two sets of figures. The numbers under the heading 'Unknown' are fairly large in the case of the Nutrition C children. This is because when a mother was not quite sure of the facts an entry was made in that column.

The data obtained in respect of the children with malnutrition are set out in Table XII.
TABLE XII.

<table>
<thead>
<tr>
<th></th>
<th>BREAST FED</th>
<th>BOTTLE FED</th>
<th>COMBINED BREAST AND BOTTLE</th>
<th>NOT KNOWN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>%</td>
<td>Number %</td>
<td>Number %</td>
<td>Number %</td>
</tr>
<tr>
<td>182</td>
<td>45.5</td>
<td>248</td>
<td>49.6</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
<td>57</td>
<td>11.4</td>
<td>57</td>
</tr>
</tbody>
</table>
Comments on Table XII.

The first point which attracts attention is the high percentage of breast fed children in the Malnutrition Group. First hand experience of the difficulties many mothers have in coping with bottle feeding without digestive or intestinal disorders supervening, would have led me to expect that the proportion of bottle fed children would have been far in advance of the breast fed. This, as the table shows, is not the case. In point of fact, if we assume that the figures for infant feeding obtained from Health Visitors' records represent the position for the community as a whole (which includes all nutrition grades) then the fact that the corresponding data for the malnutrition children are substantially alike, suggests that the type of infant feeding has little influence on the development of malnutrition. On the other hand if bottle feeding were more conducive to nutritional defect in later life, the proportion of children fed by that particular method would have been higher in a group of Nutrition C children than in a cross section of the child population inclusive of all nutrition grades. As this is not the case it cannot be maintained, from the findings of this investigation at least, that any one form of infant feeding has an undue influence on subsequent defective nutrition.

(h) NOTE ON THE USE OF VITAMIN CONCENTRATES FOR INFANTS IN THE AREA.

After an attempt to obtain particulars from mothers regarding the use of Vitamin-rich substances by their babies, such as Cod Liver Oil or its substitutes and Vitamin C preparations, the line of enquiry was abandoned. A short trial showed that the parents could not recollect accurately either what had been given nor for how long. It will
suffice therefore to outline what had been the practice at the Infant Welfare Clinic until recently, because the advice given by Health Visitors to the parents was based on clinic practice. As long as the child was being Breast fed the parents were not advised to give Cod Liver Oil or any other substance rich in Vitamins A and D, nor was it thought necessary to recommend extra supplies of Vitamin C or of iron. Immediately Bottle feeding was commenced the administration of Cod Liver Oil or of Hailbut Liver Oil was insisted upon and the value of a daily allowance of Orange Juice was stressed. Many parents did not follow the advice given, and others did so irregularly. In general it may be said that at that time Bottle fed infants were given extra supplies of the Vitamins; Breast fed infants were not. This policy has however been revised and Health Visitors now recommend that all children should be given an additional Vitamin A and D preparation and additional Vitamin C, irrespective of the type of feeding. An innovation which it was hoped might correct the slight degrees of Anaemia from which many of the infants suffered (and prevent its onset in others) consisted in the advocation of an iron and copper mixture. This mixture and the extra Vitamins are now given in graded amounts from the end of the first month.

(i) CONSUMPTION OF MILK IN SCHOOL BY CHILDREN SUFFERING FROM MALNUTRITION.

One of the points investigated during the socio-economic investigation of the 400 malnutrition cases was the consumption of milk in school. It was found that the majority of these children had a one third pint
### TABLE XIII.

<table>
<thead>
<tr>
<th>Group</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having Milk Regularly</td>
<td>335</td>
<td>83.7</td>
</tr>
<tr>
<td>Irregular Consumption of Milk</td>
<td>12</td>
<td>3.0</td>
</tr>
<tr>
<td>Not Taking Milk at School</td>
<td>53</td>
<td>13.2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>400</strong></td>
<td><strong>—</strong></td>
</tr>
</tbody>
</table>

### TABLE XIV.

<table>
<thead>
<tr>
<th>Reasons for Non-participation in Milk Scheme</th>
<th>Number of Children</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disliked Milk</td>
<td>27</td>
<td>50.9</td>
</tr>
<tr>
<td>Cost of Milk</td>
<td>12</td>
<td>22.6</td>
</tr>
<tr>
<td>Disliked Cold Milk</td>
<td>4</td>
<td>7.5</td>
</tr>
<tr>
<td>&quot;Sickness&quot; Following Milk</td>
<td>1</td>
<td>1.9</td>
</tr>
<tr>
<td>Unclassified Reasons</td>
<td>9</td>
<td>17.0</td>
</tr>
</tbody>
</table>
bottle of milk at school each morning; and some whose subnormal nutritional state had been detected earlier at Routine Medical Inspection were receiving two such bottles daily.

The figures obtained are recorded in Table XIII. Comments on Table XIII.

The table shows that over 83% of the group of children had milk regularly at school while 12 out of the 400 children drank milk at school only occasionally. The principal reason for this irregularity appeared to be that the child spent the half-penny for the milk in ways other than that intended by the parent. In such cases the parents were recommended to pay the headmaster personally each week and thus ensure that the child obtained the milk without fail. It should be mentioned that many of the parents of these children of subnormal nutrition who were under investigation purchased the milk. There was no necessity for a free issue. In fact the question of financial stringency did not arise in many of these cases as will be seen when provision of meals in school is discussed. The reasons given by the 53 children who did not take milk at school were varied and interesting; and the difficulties they disclosed were not insuperable in most cases.

Table XIV contains the principal reasons advanced. It is interesting to note that only one child claimed that the milk disagreed with her. Under the heading 'unclassified' are included those children who bought sweets, etc. with the money intended for milk. In 12 instances the failure to take milk was attributed to cost.
This requires some explanation. In some of these cases several children from the one family were attending school and the total cost to the milk was between 1/- and 2/- each week at one half-penny per day per child. A number of the parents could not afford this additional outlay even though the return for the expenditure in the form of food values was far in excess of what could be procured in the open market.
SECTION IV

GENERAL OBSERVATIONS ON THE MILK IN SCHOOLS SCHEME IN THE AREA, TOGETHER WITH NOTES ON THE NUTRITIONAL VALUE OF MILK AND REFERENCE TO FEEDING EXPERIMENTS IN GREAT BRITAIN INVOLVING USE OF EXTRA MILK.
(a) MILK IN SCHOOL SCHEME.

All schools in the area participated in the scheme. The support given by parents and children in the early days following the inauguration of the scheme left much to be desired. No accurate figures are available of the number of children who took milk at school and such figures as had been prepared were only approximate. This is because many children (other than those who were supplied free) did not obtain milk regularly, and absence from school by reason of illness accentuated the irregularity of the daily figures. It may be mentioned at this point that an arrangement is now in force whereby a sick child is not deprived of the milk because of inability to attend school; upon presentation of a medical certificate the milk can be taken to the home.

A valuable indication of the position is, however, obtained from the records of the total bottles provided in the schools during the years 1939 and 1940. The relevant facts are contained in Table XV, which, with the exception of the data in the last column, was compiled from official records.

Comments on Table XV. (Page 72.)

The statistics for 1939 reveal the extent of the free distribution of milk. Over one quarter of the children on the school registers received milk free, and, more significant still, almost half of the milk bottles issued during the year were given to children in receipt of the free issue. There are two reasons for this: (1) the placing of a child on the free list, was, at that time, largely left to the discretion of the teacher, and (2) teachers, in some instances, distributed any extra bottles to children whose parents, though able, were unwilling to purchase. The column headed, 'Expected annual bottle issue' contains a tentative figure
<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Children Receiving Free Milk (Monthly)</th>
<th>Number of Bottles Issued Free</th>
<th>Total Bottles Issued (Free and Sold)</th>
<th>Total Bottles Bought</th>
<th>Average Daily Attendance</th>
<th>Estimated Possible Annual Issue (280 Days X Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1939</td>
<td>1,164</td>
<td>206,881</td>
<td>475,334</td>
<td>265,753</td>
<td>4,900</td>
<td>10,780,000</td>
</tr>
<tr>
<td>1940</td>
<td>1,253</td>
<td>224,268</td>
<td>644,486</td>
<td>390,218</td>
<td>4,528</td>
<td>9,146,560</td>
</tr>
</tbody>
</table>
of the number of bottles which would have been supplied had all children taken milk daily. It represents the product of the average daily attendance and the number of school days in the year. It is clearly seen that the number of bottles actually used during 1939 was very much below the ideal figure, but 1940 records very marked improvement. Though the percentage increase over 1939 in the number of bottles supplied free is substantial the corresponding figure for milk bought is correspondingly greater. This is as it should be and it is largely the result of persistent advocacy by school teachers and members of the school medical service. We are, however, still very far from the point at which it can be said that an almost universal milk drinking habit has been formed among school children in the area.

(b) **NUTRITIONAL VALUE OF MILK. FEEDING EXPERIMENTS INVOLVING USE OF EXTRA MILK.**

As milk is intended by nature to supply the nutritional requirements of the young throughout the period elapsing from birth to the stage when alternative sources of nutrients can be utilised it must be regarded as the closest possible approach to a perfect food. One main reservation must be made. The milk of each species is particularly adapted to its special needs. A simple illustration of this modification by nature consists in a comparison of the rate of growth of a calf and a baby and of the related difference in the quantity and nature of the protein content of cows' and human milk. The proportion of tissue-building proteins in cows' milk is about twice that found in the human variety and the calcium content is about four times as great.
Another point frequently overlooked is that in spite of its lower protein, human milk furnishes about twice as much lactalbumin, which, in addition to being more easily digested by the child, provides it with the particular amino acids which are most essential for growth. These differences are of importance when cows' milk is given to the infant in place of the mother's milk. The root of the difficulties experienced by mothers and those having the care of infants, when changing to bottle feeding, lies in these differences in the nature and constituents of the two milks, and the resulting need to modify cows' milk.

The disadvantages of cows' milk as a food for infants are of no significance after the stage of infancy has passed. Only advantages accrue from the inclusion of cows' milk as an essential part of a child's daily dietary provided that such extraneous matters as the liability of milk to be a vehicle for dissemination of certain diseases receive adequate attention. It is now generally recognised that an increase in the consumption of milk - up to one pint daily - by all children and adolescents would go far towards achieving improvements in health and nutrition. No other single article of food can supply the deficiencies in the diet of large numbers of growing children as efficiently or as cheaply as does milk.

The constituents of cows' milk vary with the season of the year, the feeding, the breed and to a certain extent, with the care in milking.

The constituents of 1 pint of whole milk (Cow's) have been given by Mottram and Radloff, (82) as follows:-
World wide interest in the benefits that follow from the inclusion of an adequate quantity of milk in the diet of adolescents was roused by the publication of the results of various feeding experiments such as those conducted by Corry Mann (69) and by Leighton and Clark. (61). In a carefully controlled experiment in which the effects of various foods on weight, height and general health were tested over a fairly long period it was found that the children who had received 1 pint of milk daily had made substantially greater progress than any of the groups receiving other additions to their diet. For example, children on the usual diet of the Institution (without the additional milk) made an annual increase of 3.35 lbs. and 1.34 inches. The children receiving 1 pint of milk increased in weight by 6.98 lbs. and in height by 2.63 inches. None of the other foods under examination effected such improvement and the extra butter-group was the only one whose response approached that of the milk-fed children. (61)

These results have been confirmed by other observers and additional beneficial effects from the regular consumption of milk were reported later, such as improvement in health, resistance to respiratory diseases, increased physical energy and vitality; and a more active and alert spirit. The
Scottish experiments of Leighton and Clark were particularly valuable and enlightening.

The evidence provided by these and other experiments together with the campaign of the National Milk Publicity Council lead to an encouraging increase in milk consumption by school children. It was not until 1934 however, that the Milk Marketing Board, under Government subsidy, made one-third pint of milk available daily to all school children, at a cost of one halfpenny. (13). The case of the necessitous and under-nourished child received special consideration by the Board of Education and there was great expansion in the free provision of milk meals under Sections 32 - 34 of the Education Act, 1921. By 1938 the last year for which national data are available, as many as 2½ million school children were receiving milk at school daily.

Criticism of the present position of the Milk Scheme is called for on two counts. First, the proportion of elementary school children participating in the Scheme, is much too low. In 1939 only 55.6% of children in the public Elementary Schools consumed milk, either free or for payment. This is the highest proportion yet attained.

Secondly, it has been pointed out several times that one-third pint is hardly sufficient to make up for the known deficiencies in the diet of many children. Two-thirds of a pint is regarded as the minimum and 1 pint daily as the probable optimum.

A recent recommendation of the Board of Education is not without significance in this connection. The Board has advised that all children of subnormal nutrition should receive two-thirds of a pint daily. (14) In face
of this official recognition that the usual quantity of milk is insufficient to meet the needs of the child with malnutrition, it is surely logical to hope that immediately the supplies of milk can meet the demand, all children should receive the double quantity in order that the adverse effects on nutrition of dietetic deficiencies may be prevented as far as possible.
SECTION V.

THE OPERATION OF THE PROVISION OF MEALS SCHEME IN THE AREA WITH PARTICULAR REFERENCE TO THE 400 NUTRITION C Co
The passing of the Education (Provision of Meals) Act, 1906 was one response to the report of the Inter-departmental Committee on Physical Deterioration which was published in 1904. It will be remembered that this Committee was set up to enquire into the difficulties regarding man-power for the army which the demands of the South African war revealed.

The Committee's investigations brought to light a state of affairs affecting the physique of the nation which rightly gave rise to alarm. Subsequent publicity, together with the concern exhibited by various interested state departments, provided the impetus to action of which the Act above referred to, embodied the measures decided upon. An indication of the precise method to attain the desired end of an improved national physical level is evident from the naming of the Act.

The later Education Act of 1921 included the provisions of the earlier measure in Sections 31 to 34. Powers were given to Education Authorities to prepare schemes and provide means whereby such children "who are unable by reason of lack of sufficient food to take full advantage of the Educational facilities provided" could receive meals; free, in cases of economic necessity, or for payment according to an income scale prepared by each separate Education Committee. Clearly this was a step of first class importance in the formulation of a national nutrition policy.

The principal weaknesses which were discovered after experience of the operation of the scheme were two in number. First, the measure catered for the correction of
<table>
<thead>
<tr>
<th>GROUP</th>
<th>NUMBER</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALREADY ATTENDING</td>
<td>50</td>
<td>12.5%</td>
</tr>
<tr>
<td>AGREED TO APPLY</td>
<td>55</td>
<td>13.75%</td>
</tr>
<tr>
<td>NOT DESIRE</td>
<td>2.95</td>
<td>73.75%</td>
</tr>
<tr>
<td>HAD ATTENDED BUT CEASED</td>
<td>5</td>
<td>1.25%</td>
</tr>
</tbody>
</table>
malnutrition and not for its prevention. Only children who were already affected could be provided for. The child exposed to danger of defective nutrition through economic circumstances was not eligible until physical deterioration had become obvious. Secondly, the income scales prepared by some Education Committees were excessively severe. The Board of Education complained of the unhappy effects on the nutrition and well-being of many children who were excluded from participation because of the strictness of the local financial arrangements. (12)

**It is of interest and value in this enquiry to consider the position of the 400 children under investigation in relation to the matter of the provision of meals; and, in addition, to enquire into the operation of the Provision of Meals Scheme in this particular area.**

Certain figures were obtained during the course of the Socio-economic enquiry which have been tabulated (Table XVII)

**Comments on Table XVII.**

The point which immediately attracts attention is the very small number of the group who were already being supplied with free solid meals at the time of the Nutrition Survey. They amounted to only 12.5% of the 400 children.

Of equal significance is the fact that the parents of only 55 children agreed to make formal application for the meals. The parents of the remaining 295 children stated that the family income was such that they did not require assistance. Five members of the latter group had attended the school dining centres during periods of unemployment. It should be pointed out that the official
attitude locally, to the meals scheme was sympathetic and appreciative; and that every effort was made to induce an increased attendance by children whose physical condition indicated necessity. It is scarcely credible to one with knowledge of the district that the financial circumstances of all of the families to which these 295 children belonged, were adequate for the provision at home of a dietary satisfactory in quantity, and suitable in proximate principles, for the physiological requirements of growing children. In the minds of many of the people a stigma attached to those who, because of financial stringency, had to send their children to the school dining centres. The attitude was almost unavoidable as all the children who did attend were poor and under-nourished. The statutory provisions relating to eligibility created the unfortunate impression that the Provision of Meals Scheme was a form of poor relief.

Another factor which interfered with the success of the original scheme in this area is worthy of special consideration. The quality of the meals prepared for the children was very poor. Many dishes were unpalatable and there was a lack of variety which must have been distinctly depressing. The meals were served in halls which were devoid of decoration, and which were dull, dark, barn-like and had uncovered wooden floors. The furniture consisted of trestle tables with oil-cloth covering; and long wooden forms were provided for seats.

The food was served from ordinary 'zinc' pails or from enamel basins by a woman standing at the head of the long table. The older children waited at the tables.
At the time of this survey hygienic arrangements were non-existent. Children with grubby hands ran in and sat down unceremoniously. In some cases no adequate discipline was maintained and occasionally pandemonium reigned.

Had the food provided been satisfactory such administrative inadequacy might not have materially interfered with the considerable benefit which these needy children could have obtained from the scheme. The culinary methods and the quality of the food call for criticism. The food was cooked in bulk by women with no training and whose limitations therefore in the way of menu-preparation need no emphasis. The principal article was a thin soup with very scanty vegetable content (always root vegetables only and potatoes) made from small amounts of bones and beef: practically no meat was to be seen in the soup. This was followed by a milk pudding or a steamed pudding or, occasionally, stewed fruit and custard. The other dishes most frequently prepared were fried sausage and a very watery stew made from mince served ready mixed with carrot and potato. The amount of meat was frequently not more than two teaspoonfuls per child. No green vegetables would be served for weeks on end. In the course of my investigations particular attention was paid to the quality and the quantity of the food, and as a result of the adverse reports placed before the appropriate committees, supervision was increased. The improvement effected was, however, inadequate, for two reasons.

(1) The fact that untrained women were in charge who were quite unable to cook proper meals for large numbers.
The system of contract then in force; private contractors undertook the supply and preparation of the food for so much per child per day. All the defects which were found in the food they received at home were present in the school meals and as the dietetic deficiencies were not corrected, the aim of the scheme - namely, the promotion of good nutrition - was in part defeated.

The subsequent decision of the Education Committee to establish, equip and operate its own cooking centre and to appoint a fully trained person with College of Domestic Science diploma to be in charge revolutionised the position; scientific food preparation to conserve maximum values, and attention to making the meals appetising, together with the introduction of a menu sheet sufficiently wide to allow of an attractive daily variation, made the children eager to attend, and, what was equally important, enjoy the meals. Personal hygiene was given its proper place and monitors were appointed from among the older children to examine the hands of each child on entry to the hall.

The question of proximate principles received close care with the intention that the school meal should, in so far as possible, make up for the deficiency of certain nutrients in the home diet, rather than that it should, in itself, be an example of a balanced meal. Therefore carbohydrate was reduced; protein, especially first-class protein, was increased; and the use of green vegetables and of wholemeal bread (prior to the introduction of national wheatmeal) was begun. Further, each child was given a capsule of Adexolin daily.
It was interesting to observe that quite a number of the children could not at first consume the portion of food allotted. The poor appetite so frequently noticed in children suffering from malnutrition was much in evidence. Within a few weeks, however, the women servers reported that, except in the case of new arrivals, appetites had improved and second helpings were being taken by these same children. There was, under the reorganised scheme, no difficulty with the quantity of food: the child's capacity was the standard.

A later observation interesting from the social point of view is that following the inauguration of communal feeding by the Ministry of Food (1941) and the setting up of school canteens at which all children were invited to attend, it was found that necessitous cases accepted free meals more easily than previously. At the school canteens which in the case of this area were based on the re-organised Education Committee dining centres, no distinction of any sort was made between children receiving meals free or for payment. The parents also appreciated the change because attendance at the dining centre no longer constituted an indication to the other school children and to neighbours that free meals were being received.
SECTION VI

OBSERVATIONS ON THE PHYSICAL CONDITION OF THE 400 CHILDREN WITH SPECIAL REFERENCE TO DEFECTS HAVING POSSIBLE ETIOLOGICAL SIGNIFICANCE.
INTRODUCTION.

When pursuing an investigation of this type, the principal object of which is the determination or discovery (if possible) of the cause of the malnutrition in each individual case, many possible factors come under review, some of which constitute the main etiological defect or deficiency in one case, others in another. The defects of etiological importance may be dietetic, pure and simple; or, on the other hand, an original dietary deficiency may have given rise to, and been superseded by a physical disorder which, in part at least, maintains the state of bad nutrition in spite of a correct dietary regime.

During the clinical examination of the 400 cases, these types were noted repeatedly, but many of the other defects or abnormalities recorded were recognised to be the result of former deficiencies and could not in themselves be looked upon as having any direct bearing, in a causative or contributory way, on the nutritional state. Their significance to the investigator lay solely in their use as a sign of an earlier deficiency; for instance, rachitic stigmata in children from whom active disease had long since disappeared. Throughout the examination of the 400 Nutrition C children observation was made of certain conditions which are closely associated with malnutrition but which are more the result of deficiency than being contributory to the poor nutritional state.

Particulars of four such conditions were kept and they are set out in Table XVIII.
Sub-Section (1)

PHYSICAL CHARACTERS FREQUENTLY NOTED IN CASES OF MALNUTRITION.

(a) Under-weight and over-fat types.

To be regarded in this light are the records of the general condition of the soft tissues of the body. For example, some of the children were thin, in the sense that adipose tissue was scanty, the skin loose and the ribs poorly covered. Other children were fat and flabby, as from excessive carbohydrate consumption.

Among any group of children suffering from Malnutrition, examples of the excessively thin and of the overweight types can be found. The former are usually underweight for height, often in excess of the 10% below the average which is regarded as the limit of the physiological normal. These thin children may be further subdivided into those who receive insufficient food and those whose thin condition is due to a metabolic demand on the food supplies which leaves no margin for the laying down of fat stores. In the case of the over-fat child (and again a 10% upper limit above normal can be taken - though it is difficult to say where healthy plumpness ends and obesity begins) if we exclude children with specific endocrine deficiency, the fat stores can be attributed to incorrect diet. An excess of the energy-giving foods together with a deficiency of the tissue building proteins is the essential characteristic of the diet of these overweight children. In terms of common foods the dietary of most overweight children consists
largely of cereals, bread and tea, and the amount of meat, eggs, cheese and vegetables is much below physiological requirements. As is so often found, these plump children though pleasing to the eye of the unenlightened (witness the pictorial advertisements for some proprietary Infant foods which contain excess carbohydrate and quite insufficient of the tissue building nutrients) are not only more susceptible to Bronchial infection, and are frequently found to be the victims of Rickets and Anaemia, but also if the dietetic error is not corrected, develop into the undersized C.3's. of adult life.

<table>
<thead>
<tr>
<th>CONDITION of CHILD</th>
<th>NUMBER</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thin</td>
<td>174</td>
<td>43.5%</td>
</tr>
<tr>
<td>Flabby</td>
<td>66</td>
<td>16.5%</td>
</tr>
<tr>
<td>Muscle Tone Poor</td>
<td>160</td>
<td>40.0%</td>
</tr>
<tr>
<td>Stoop</td>
<td>107</td>
<td>26.75%</td>
</tr>
</tbody>
</table>

TABLE XVIII

Comments on data obtained by me (Table XVIII)

Almost half of the children, 174 (43.5%) to be exact, were found to have less adipose tissue than what I considered to be correct for a well nourished child of that particular build, and 66 (16.5%) were definitely overfat and flabby. The remainder of the Nutrition C children, numbering 160, had an amount of adipose tissue which was considered to be satisfactory; they could not be called thin or overfat. It is apparent that a test of nutritional status based on whether a child is "fat" or "thin" is of no practical value in a nutrition survey. Had it been employed in this case, 240 children (40%), whose nutrition was obviously poor, would have been omitted from the subnormal groups. Yet many school teachers, including Domestic Science teachers, and
occasionally nurses in charge of Infant Welfare Centres regard a child who is fat, as being well nourished and not in need of any dietetic supervision. Parents also fall into this error and advice by Medical Officers and Health Visitors is sometimes disregarded on that account.

(b) **MUSCLE TONE.**

The muscles of a normal healthy individual are constantly maintained in a state of tonicity throughout the whole of life, waking or sleeping. "Every muscle in the body is in a condition of slight continued contraction which keeps it tense". (109) Apart from disease it varies considerably according to the state of health of the individual, and, further, it bears a relationship to physiological conditions. It is reduced by fatigue and increased by excitement or anything which induces tenseness of the mind, for example, anxiety. Normally it is at its lowest in the morning and it increases as the day advances. It is generally recognized that decreased muscle tone is associated with subnormal nutrition.

In almost half of the 400 cases examined by me the muscle tone was appreciably poor, when estimated by digital examination of the Pectorals and the muscles of the arm. As has been mentioned earlier, attempts to devise a satisfactory test for determination of muscle tone for use in the assessing of nutrition are being proceeded with and a modification of Romberg's Test and a test involving the use of a special dynamometer may be mentioned. The value of such a test as an aid to the detection of borderline or early states of malnutrition would be considerable. Before full use can be made of this phenomenon, a more
sensitive index than digital examination is required. It is interesting however to record the numbers of children who had markedly poor muscle tone as assessed by the digital method. The figures are set out in Table XVIII.

(c) POSTURE.

Posture is closely connected with muscle tone, but habit and body build are, undoubtedly, influential factors in the development of mal-posture; while skeletal deformity constitutes the primary defect in some cases. In a study of malnutrition, posture is of importance in two ways; first, it may arise because of defective nutrition of the child and, secondly, there is the further possibility that it may produce aggravation of the already poor state of health.

That build must be taken into consideration in a study of posture is plain when one notes how much more frequently malposture is found among the tall, narrow-chested types as compared with the broad stocky child. It would appear to be easier for the short child of broad build to maintain fairly satisfactory posture even in the presence of malnutrition than it is for the child who is tall, slender and narrow in the hips and chest. The factor which creates the need for the adoption of the stooping round-shouldered stance is the fatigue and lowered tone of the muscle groups which maintain the erect position. In these fatigue cases - the cases which are of most importance to us in this study of malnutrition - other muscles not connected with posture tire easily as well, and this should not be overlooked. Malposture of this origin, is an indication of a generalized physiological
state. The whole muscular system shares in this diminished efficiency. When a particular stress is placed on any group as for example, the Sacrospinalis and other muscles which assist in maintaining erect posture, these muscles tire and malposture arises.

Even a cursory glance at a child who is round shouldered, who stoops and carries the head too far forward, reveals the direct effect such a position has on the opportunities for free action of the organs. The effective capacity of the chest is less, and free expansion of the lungs cannot take place, both from the limitation of movement of the ribs and from the pressure of the abdominal organs on the Diaphragm. Interference with the free oxygenation of the blood in the lungs follows.

The stooping, further, gives rise to pressure on the abdominal organs and intestine. The cramping of all the abdominal organs has secondary effects on the local blood circulation and therefore on the physiological activity of these organs.

These points serve to indicate that malposture, which is a feature of many cases of malnutrition, may play a part in maintaining the state of lowered health and diminished functional activity.

With regard to the figures obtained by me during the Nutrition Survey it is interesting to record that only 107 of the 400 children of subnormal nutrition examined, were noted as having bad carriage. Others,
in all probability, stooped when not under observation but during the course of the examination they maintained a satisfactory posture. The data obtained together with those for muscle tone are included in Table XVIII.
Sub-section (2)
DEFECTS OF POSSIBLE ETIOLOGICAL IMPORTANCE.

A list of the principal defects found during the medical examination of the 400 Nutrition C children is set out in Table XIX, together with the numbers of each of the defects specified and the respective percentages.

<table>
<thead>
<tr>
<th>DEFECTS</th>
<th>ANAEMIA</th>
<th>CHRONIC TONSILLITIS</th>
<th>ENLARGED TONSILS AND CERVICAL GLANDS</th>
<th>ENLARGED CERVICAL GLANDS (DISEASE WITHOUT DRAINAGE)</th>
<th>GROSS DENTAL CAVITIES</th>
<th>SUB-ACUTE OR CHRONIC BRONCHITIS (AT EXAMINATION)</th>
<th>OTORRHOEA (AT EXAMINATION)</th>
<th>REHABILITATION (AT EXAMINATION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER OF CHILDREN</td>
<td>195</td>
<td>76</td>
<td>48</td>
<td>29</td>
<td>26</td>
<td>7</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>PERCENTAGE OF 400 CHILDREN</td>
<td>48.75%</td>
<td>19.0%</td>
<td>12.0%</td>
<td>7.25%</td>
<td>6.25%</td>
<td>1.75%</td>
<td>1.25%</td>
<td>0.75%</td>
</tr>
</tbody>
</table>

A few remarks on the defects most frequently met with are set out below.

(a) Anaemia. With regard to Anaemia which was detected in 195 (48.75%) of the 400 cases, this observation in itself constitutes important evidence of the unsatisfactory state of health of these children. As the presence or absence of Anaemia was determined solely by visual examination of the lips and conjunctivae, the presumption is that there would have been a much higher proportion of positives had a haemoglobin estimation been carried out. Spence (107) and others (64) have reported that many cases of Anaemia which were detected by blood analysis were missed when visual examination alone was relied upon. The question of the significance of anaemia, its causes in growing children, and its repercussions on health are discussed in the section on Anaemia in School children of all nutrition grades. (Section IX).
(b) Septic Tonsils. Seventy six children (19%) have grossly enlarged and obviously septic tonsils. In some cases pus could be observed exuding from the crypts. In these cases the tonsillar infection was sufficiently severe to constitute a threat to health from toxic absorption or by the tonsils acting as a nidus from which organismal invasion of the system (blood or lymphatic) could arise. It was noted that 72 additional children had Tonsils of lesser degrees of enlargement. These were not considered to be, at the time, potential sources of danger, or inimical to the health of the child on account of toxic absorption or bacterial spread. It should not be overlooked, however, that enlarged tonsils, though free from sepsis, may be detrimental to good health and the creation of sound nutrition. Apart from focal infection, enlarged tonsils, by obstructing free breathing and full aeration of the blood, may foster malnutrition through depriving the tissues of the free supply of oxygen which is so necessary for tissue metabolism.

It was observed also that 48 children who had diseased tonsils had an associated enlargement of the medial Superior Deep Cervical Lymph Glands. It is not uncommon to find that the upper glands are enlarged as a sequel to infection of the tonsils, but when there is extension of the process, with involvement of the neighbouring glands, cognisance should be taken of it on the grounds that the extension may betoken a poor resistance of the body or an infection with a more invasive and dangerous organism. In none of the cases examined had the stage of abscess formation been reached.
(c) **Enlarged Cervical Glands.** The presence of enlarged lymph glands of the medial Superior deep chain was noted in 29 children in whom no active disease or infection of the tonsils could be demonstrated. The significance of this is open to varying interpretations.

(d) **Teeth.** Though only 26 children were recorded as having severe caries, all of the 400 children examined had caries to a greater or lesser degree. The 26 mentioned had such foul mouths that special note was made of it. The presence of dental abscesses is indubitably deleterious to health. In the case of children, action is usually taken immediately by the parents. Dental caries on the other hand is so universal a complaint among adults and among children of all nutrition grades in this country, that caution is required in allocating the condition to the list of causes, even subsidiary causes, of malnutrition. No objection could be taken, however, to the decision that caries of the advanced and extensive degree found in these 26 children could be other than harmful and productive of a lowered state of health. Even in the absence of direct toxic absorption through the gums (a not unlikely contingency when destruction of the teeth has extended to below the gum level) the amount of foul material swallowed by these children whose teeth were represented by two rows of roots, must have been considerable. It is well known that gastric complaints such as mild indigestion and anorexia may arise from such a source and it is believed that toxins may pass beyond the mucous membrane of the
The view has been put forward that in some cases a connection may exist between extensive Dental caries and the onset of Acute Bronchial infections; in other words, organisms harboured in the carious teeth may become implanted in the Bronchial mucosa and produce inflammation there.

Evidence that advanced dental caries may contribute to the development and continuation of subnormal nutrition is furnished by the observation that attention to oral hygiene in such cases quite frequently leads to improvement in the appetite, increased vitality and rapid gain in height and weight. An exposition of the national position in respect of carious teeth with particular reference to the connection of caries with nutritional factors, is appended later. (Section XI).

(e) Other Defects. Children with Bronchial Infection, Otorrhoea and Rheumatism at the time of examination numbered 7, 5, and 3 respectively.

Other conditions were observed in individual cases which are not recorded here and this list is to be regarded as a summary of the defects which were most frequently encountered and which were thought to have some significance (causative or contributory) to the development of malnutrition.

These defects may be of importance in two ways. They may be merely the result of dietetic deficiencies and not play any part in relation to the subnormal state of health noted, as for example, carious teeth;
or they may exert a further contributory influence on the health and physique of the child by acting as a focus from which toxic absorption could be maintained and thus militate against an improvement in nutrition which a corrected dietary regime could otherwise have achieved.

Conclusion. The main deduction from this section is that when searching for the causes of defective nutrition, each case must be adjudged individually. Many of the Nutrition C cases were free from all physical defects which could, with the broadest view, have been looked upon as possibly having an etiological bearing on the state of health of the child. In the same way the children who were graded Nutrition A and B were not without examples of these defects, though the incidence was much less than in the poorer nutrition grades.
SECTION VII

STUDY OF INFECTIOUS DISEASES AND RESPIRATORY INFECTIONS IN CHILDHOOD WITH PARTICULAR REFERENCE TO NUTRITION AND TO INFANT FEEDING.
Sub-section (1)

COMPARISON OF THE INCIDENCE OF CERTAIN INFECTIOUS DISEASES AND OF RESPIRATORY INFECTION AMONG 200 CHILDREN OF SUBNORMAL NUTRITION AND AMONG 400 CHILDREN OF EXCELLENT NUTRITION, ALL OF SCHOOL AGE; AND OF THE INCIDENCE OF THE SAME DISEASES AMONG 500 CHILDREN IN THE PERIOD FROM BIRTH TO AGE FIVE YEARS.

The possibility that a relationship existed between the incidence of Infectious Disease in childhood and malnutrition, was investigated and certain data were accumulated in respect of three groups of children. One group was composed of Nutrition C children, two hundred in all; in the second group were four hundred boys and girls who had, at this Survey, been classified as Nutrition A; and the third group comprised 500 children all of whom had attained the age of five years and who are referred to, in this section, as the child welfare group.

The data obtained have been tabulated according to the various diseases, the numbers contracting them in each of the three groups and the respective percentages.

METHODS BY WHICH THE DATA WERE SECURED.

DATA FROM NUTRITION C GROUP.

The Nutrition C group which was composed of 200 children, is the same as that mentioned in earlier sections. During the Medico-Social investigation already described, (Section III, Part II) inquiry was made of the parent as to the infectious diseases and other illnesses from which the child had suffered since birth. As a check on the accuracy of the parent's memory, the Routine Medical Inspection card was examined immediately. On this card are recorded the main facts connected with the medical history of the child, which had been collected during infancy by the Health Visitors and later entered on the School Card: and to this were added at each Routine
Medical Inspection such additional illnesses as had been contracted during the interval. A surprisingly high degree of accuracy was noted between the verbal account offered by the Mother and the Record Card. This is partly to be explained by the keen interest which the mothers themselves take in discussing the infectious diseases contracted by their children - an interest which enabled them to state correctly which of their children had or had not, suffered from a particular disease. No reliance could, however, be placed on their memory of the age of the child when the disease was contracted. In the case of Bronchial and other respiratory infections the parent's statement only was available.

**DATA FROM NUTRITION A GROUP.**

In the case of the Nutrition A children, most of the data presented in the table was obtained from the Routine Medical Inspection cards. The cards of 400 children who had been classified by me as Nutrition A, and who were attending the same schools as the Nutrition C children, were passed under review and a summary made of the entries thereon of the history of infectious disease. It should be explained that additional information to be added to these cards at routine medical inspection is obtained from the parent by the simple expedient of giving the child, on the day prior to the medical examination, a prepared form to be completed at home. Verbal confirmation is obtained by discussion with the parent at the Medical Examination. Ordinarily little attention had been paid to Respiratory or Bronchial infections other than Pneumonia, and the records
unfortunately are incomplete in respect of that group of diseases. Enquiry was made of a small group of Nutrition A children in this connection, and the data obtained were entered. In the case of the Nutrition C children, a special clinical examination was carried out in the presence of the parent as part of the Nutrition Survey and particular care was taken to enquire into Respiratory infections. No such special examination was made on the Nutrition A children. Parents were not present during the preliminary stages of the Survey when the classification into Nutrition groups was carried out.

DATA FROM CHILD WELFARE GROUP.

The figures of the incidence of the common infectious diseases and of Bronchial infections, of a group of 500 children, during the five years from birth to School entry, were obtained by examination of the individual cards on which Health Visitors enter the various particulars. The information is obtained by the Health Visitors during the attendance of the mother and child at the Clinic or during the course of the domiciliary supervision which is maintained by them over those mothers who do not respond to the invitation to bring the baby to the Welfare Clinic. This supervision is fairly thorough, and extends to monthly visits during the first year of life, quarterly visits during the second year and twice yearly thereafter until admission to school. This is regarded as the minimum; in practice, visits are much more frequent if the child is not thriving or if the mother is inefficient or careless. Under these circumstances, the records made by the nurses are reasonably accurate as no extended period of time
elapsed between any two visits. Further, though much of
the other notes on the cards displayed signs of the operation
of the personal factor in, for example, the interpretation
of clinical signs and symptoms, yet the recording of the
infectious diseases contracted and at what precise age
and the type of infant feeding used are facts the recording
of which was uninfluenced by personal predilections.

The plan to obtain the data from Health Visitors' Cards was adopted because regular attendance at the clinics
was limited to a proportion of approximately 50% of mothers,
and these were not fully representative of the area. The
over-worked mothers, the very poor mothers, and the
careless mothers, were irregular in their attendance, and
a noticeably higher proportion of the intelligent and
industrious mothers made use of the facilities offered.
As Health Visitors' Records included children who did not
attend at the Clinic, their records are in that respect
more comprehensive than the medical cards for such children
as did attend.

POSSIBLE INFLUENCES OF UNAVOIDABLE SELECTION OF CASES ON
THE RESULTS OBTAINED.

There was no planned selection of cases but certain
factors which might have affected the results, should be
mentioned. The most important of these was the difference
in the average age of the children in the three groups.
As explained earlier, the Nutrition A and the Nutrition C
cases all attended the same schools and many of both types
were drawn from the same school classes. The children of
parents who were better off financially, lived in roughly
the same districts, and attended the same schools as those of parents who were unemployed or who belonged to the more poorly paid trades. In so far as differences in social and economic status are concerned, the Child Welfare cases could be held to be selected, as they were from homes in which supervision by Health Visitors is ordinarily deemed necessary, but as few homes in the borough were excluded from this system of observation, the figures are not thereby materially affected in this particular instance.

When we consider age of the child in relation to varying length of time for exposure, a different state of affairs is revealed.

As the figures for the Nutrition Grades in the different age groups reveal, (Page 41) there is a higher proportion of Nutrition C cases in the middle age group than in the Leaver Group (age 12, 13, 14). The opposite is the case with Nutrition A children. Proportionately more of them are found among the older children. There is no doubt but that - in the aggregate - the Nutrition A children had a longer time to contract the diseases than the Nutrition C children. The degree to which this has influenced the results - if at all - is difficult to say. In the case of the Child Welfare group, all had reached the age of 5 years when facts relating to events in the birth-to-school-entry period were examined.
TABLE XX. NUMBERS AND PERCENTAGES OF CHILDREN IN THE
THREE GROUPS CONTRACTING DISEASES.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Nutrition C (200 cases)</th>
<th>Nutrition A (400 cases)</th>
<th>M. and C. W. cases (500 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Percentage</td>
<td>Number</td>
</tr>
<tr>
<td>Measles</td>
<td>160</td>
<td>80.0%</td>
<td>352</td>
</tr>
<tr>
<td>Whooping Cough</td>
<td>63</td>
<td>31.5%</td>
<td>192</td>
</tr>
<tr>
<td>Scarlet Fever</td>
<td>30</td>
<td>15.0%</td>
<td>79</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>6</td>
<td>3.0%</td>
<td>14</td>
</tr>
<tr>
<td>Acute Bronchial Infections</td>
<td>74</td>
<td>37.0%</td>
<td>11</td>
</tr>
</tbody>
</table>

Comments on Table XX.

The tabulated results show that in the case of Nutrition A children, as compared with those of C Nutrition, the differences in the incidence of Infectious Disease are all in favour of the latter group except in the case of Acute Respiratory Infections. With that exception there was a higher attack rate among the Nutrition A children in every disease recorded. When allowance is made for the greater average age of the A children - as there are more A children in proportion to C children in the higher age groups - and when cognisance is taken of the greater aggregate length of time to contract the diseases resulting from the age difference, there would still remain a proportionately higher incidence in the group of children who had been graded as A. In the case of Whooping Cough, the difference in the incidence
in the two groups is particularly high - 16.5% more of the A nutrition children contracting it. In the case of Measles, there was an 8% greater attack rate among the children classified as of excellent nutrition. The difference in the case of Scarlet Fever was also material and amounted to 4.7%; while the incidence of Diphtheria was approximately the same in both groups, with a slightly higher figure for Nutrition A children. In contrast, the recorded figures for the Child Welfare cases are surprisingly low. The differences in the percentage incidence of the various diseases between the M & C.W. children and the Nutrition C group, are high. They are recorded in tabular form for convenience: and in the same table (XXI) the corresponding figures for the Nutrition A and the Nutrition C groups, together with the differences already mentioned, are set out.

**TABLE XXI. DIFFERENCES IN THE PERCENTAGES CONTRACTING DISEASES IN THE THREE GROUPS.**

<table>
<thead>
<tr>
<th>DISEASE</th>
<th>NUTRITION C PERCENTAGE INCIDENCE</th>
<th>M. &amp; C.W. CASES PERCENTAGE INCIDENCE</th>
<th>DIFFERENCE BETWEEN NUTRITION C AND M.C.W. PERCENTAGES</th>
<th>NUTRITION A PERCENTAGE INCIDENCE</th>
<th>DIFFERENCE BETWEEN NUTRITION C AND A PERCENTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>80.0%</td>
<td>26.8%</td>
<td>53.2%</td>
<td>88.0%</td>
<td>8.0%</td>
</tr>
<tr>
<td>Whooping Cough</td>
<td>31.5%</td>
<td>19.4%</td>
<td>12.1%</td>
<td>48.0%</td>
<td>14.5%</td>
</tr>
<tr>
<td>Scarlet Fever</td>
<td>15.0%</td>
<td>4.0%</td>
<td>11.0%</td>
<td>19.7%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>3.0%</td>
<td>1.6%</td>
<td>1.4%</td>
<td>3.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Acute Bronchial Infections</td>
<td>37.0%</td>
<td>8.2%</td>
<td>28.8%</td>
<td>11.7%</td>
<td>25.3%</td>
</tr>
</tbody>
</table>
DISCUSSION.

It will be seen from the table (Table XX) that less than 27% of the 500 M & C.W. children contracted Measles before the age of 5 years and less than 20% suffered from Whooping Cough. As all of these children had reached the age of 5 years before the M & C.W. records regarding them were closed, there must be some explanation other than that of the absence of epidemics. Measles was prevalent each year of the five under consideration. The most important deductions, however, from these figures are: (a) that in the majority of cases, Measles is contracted after school life has commenced, and after the very important—from the point of view of physique—Toddler Stage has passed; and, (b) that a not inconsiderable number of the cases of Whooping Cough develop after the child has gone to school. This finding is in keeping with expectations. The later, rather than the earlier, contracting of infectious disease, is something that should be encouraged, as it has been demonstrated that the deleterious actions of Infectious Diseases and their after-effects are of less significance in the case of the older child.

As the relationship, if any, between infectious disease and subsequent malnutrition has not been established, it would be of considerable importance to investigate the subsequent history and nutritional state of those children who, in the very early years of life, suffered from such diseases as Measles and Whooping Cough which are not only fatal in large numbers of cases annually, but which are debilitating in many more.
Another finding which merits comment, is the small number of M & C.W. children who were reported as having had Broncho-Pneumonia or other acute Bronchial diseases. Only 8.2% of 500 children suffered from these respiratory diseases, but this, in my view, is a conservative figure. On the other hand 37% of the 200 Nutrition C cases of ages 5 to 14 years, are reported as having been the victims of Broncho-Pneumonia. In the case of Nutrition A children, 11 out of 94 children (11.7%) had had Acute Respiratory Infection during early youth. It should be remembered, however, that no Nutrition classification was carried out on the M & C.W. group, and doubtless the relative proportions of the nutrition grades in this almost unselected group of children would be not unlike that which has been found in the Entrants group in the Nutrition Survey. This is mentioned because there is some evidence that children of excellent nutritional state are less prone to contract Respiratory infections; and therefore the low incidence of Broncho-Pneumonia in these 500 children could be correlated with a larger proportion of the children being Nutrition A grade at that stage. The significance of this observation and the possibility that acute Respiratory Disease may have an etiological bearing on the subsequent development of malnutrition will be considered more fully at the end of this section.

Summary.

The main facts elicited from these figures are:

(1) that a surprisingly low incidence of the common infectious diseases, and of the acute Respiratory diseases, was observed among children below school age;
(2) that there is a higher attack rate for the common infectious diseases among Nutrition A children than among Nutrition C children. The difference between the two groups was fairly considerable in the case of some diseases, for example Whooping Cough.

(3) that a high rate of incidence of Broncho-Pneumonia and acute Respiratory infections was noted among children graded Nutrition C, and that this incidence is considerably in excess of that recorded from a small group of Nutrition A children.

Conclusion.

No evidence was obtained that the common infectious diseases, by themselves give rise to a defective nutritional state, unless other factors operate simultaneously. There is a possibility that children who suffer from Measles or Whooping Cough in the early years of life may subsequently show after-effects, of which one may be a lowered nutritional state. The further possibility of dietary deficiency occurring at the time of the disease, or immediately afterwards, will be considered later. The frequency with which Acute Respiratory infections have been reported among the Nutrition C children is of significance in two connections. Firstly, the disease may have been contracted because the child was of subnormal nutrition; or, secondly, a minor dietetic deficiency may have lowered the child's resistance, and infection of the Respiratory passages may have arisen the more easily because of this. In consequence the child's health and nutrition may have been adversely affected with results which caused him to be graded C.
Sub-section (2)
INQUIRY INTO THE NUMBERS OF CHILDREN IN THE THREE GROUPS WHO CONTRACTED SEVERAL DISEASES.

As it was considered that a succession of illnesses could be especially deleterious to the health of the growing child, this point was investigated also. The numbers of children who contracted one or more of the four principal infectious diseases - Measles, Whooping Cough, Scarlet Fever and Diphtheria - are set out in tabular form together with the numbers who had remained free from attack up to the time of examination. (Table XXII)

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>NUTRITION C</th>
<th></th>
<th>NUTRITION A</th>
<th></th>
<th>M. AND C.W. CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td>NUMBER</td>
</tr>
<tr>
<td>HAD ONE DISEASE ONLY</td>
<td>87</td>
<td>44.5%</td>
<td>163</td>
<td>9.7%</td>
<td>160</td>
</tr>
<tr>
<td>HAD TWO DISEASES ONLY</td>
<td>65</td>
<td>32.5%</td>
<td>170</td>
<td>40.7%</td>
<td>35</td>
</tr>
<tr>
<td>HAD THREE DISEASES ONLY</td>
<td>10</td>
<td>5.0%</td>
<td>36</td>
<td>42.2%</td>
<td>1</td>
</tr>
<tr>
<td>HAD FOUR DISEASES ONLY</td>
<td>0</td>
<td>0%</td>
<td>3</td>
<td>0.7%</td>
<td>0</td>
</tr>
<tr>
<td>HAD NONE OF THE DISEASES LISTED</td>
<td>18</td>
<td>9.0%</td>
<td>39</td>
<td>9.7%</td>
<td>251</td>
</tr>
</tbody>
</table>

Comments on Table XXII and Discussion.

To consider first the group which remained free from infection approximately half of the Child Welfare children come into that category, a much higher proportion than one would have expected in an urban community. The modern tendency to small families may have an influence on this by protecting the child from exposure to infection until later. In the case of Nutrition A and Nutrition C children, those who did not contract any of the four
diseases cited amounted to respectively 9.75% and 9% of the
groups.

Of those who had had only one disease there were
significant differences in the numbers affected in the
three groups. For example 44.5% of the Nutrition C
children had had one disease only; 32% of the Child
Welfare Group and only 9.75% of the Nutrition A group.
To put it differently, 83.7% of Nutrition A children had
had more than one disease, as compared with 37.5% of the
C cases. Not only has there been a higher attack rate
for each of the different diseases among the Nutrition A
children, as was pointed out earlier, but we now see that
a higher proportion of them had had several diseases.
Only 5% of the Nutrition C group are recorded as having
had three diseases, while over 42% of the Nutrition A
section come into this category. The explanation of
this difference is difficult to determine and the theory
which has been advanced to account for it - that it is
due to the Nutrition A children not developing immunity
by exposure to minimal infections because a large number
of them are members of small families - is not completely
satisfactory. (95) The children of both nutrition
grades, from whom the data were obtained, live in a
compact, fairly densely populated area: reside in the
same streets: attend the same schools: mix together
in and out of school, and would appear to be exposed to
an equal degree to the possibility of contracting
infections of minimal degree or greater. Further 8%
of the Nutrition C children were members of one-child
families and 25% were in families of one or two children.
If families of one to three children are taken together, then over 45% of the children are accounted for, while if families comprising four children are added, the figure rises to 67%. Though it is reasonable, and indeed correct, to assume that older children may convey infectious diseases to the younger members of a family, and that members of a small family or of one-child families do not have the same opportunity to develop immunity through obtaining repeated small doses of the infecting agent, yet the figures from this survey which show that a substantial number of the Nutrition C children belonged to one-child or small sized families, place the 'C' children on practically the same footing as the 'A' group in respect of the opportunity (or lack of opportunity) to become immune, assuming that a good proportion of 'A' children are also from small families.

To take the case of Measles - it has been shown by Stocks and Karn (III) and others that many susceptible children, exposed at home, do not contract Measles. These were said to have a latent immunity of a temporary nature: and within a relatively short period, many of them afterwards contract the disease. It is generally agreed that in almost all cases, life immunity follows a clinical attack of Measles. If the theory of exposure at home is used to account for the latent immunity of certain children, it is surprising that this intimate contact at home - carrying with it, as it does, the opportunity for more massive infection, such as one would expect would give rise to a clinical case - results only in the development of a temporary immunity in some cases. Further, it is scarcely logical to maintain that the less close contact with
infection at school or at play, such as one must assume happens in the case of members of one-child families, produces, not latent immunity, but clinical cases. In other words, it is implied that the less close the exposure to the disease, the more likely is it for a dose of the infective agent to be received, which is sufficiently massive to produce a clinical case.

An alternative theory would be, that, as natural immunity wanes after the first few months of life, or before it has completely disappeared, if exposure to infection occurs, there results either a complete abortion of the disease or its modification with the development of so-called attenuated Measles. In the former case, the immunity is probably short-lived. In the latter case, the immunity may be active and permanent. (96) On this basis, the children who pass through the whole of their school life without having had Measles, though exposed on many occasions, could be accounted for. The other possibility, of latent immunity being restored periodically by repeated infection, is scarcely feasible except in the case of large institutions or nurseries.
Sub-section (3)
INFANT FEEDING AND INFECTIOUS DISEASES IN CHILDHOOD.

PART I. TYPE OF INFANT FEEDING AND INCIDENCE OF INFECTIOUS DISEASES.

The records of the 500 Child Welfare children whose cards were analysed in respect of the incidence of infectious disease were further scrutinised to determine whether any relationship existed between natural and artificial infant feeding and the incidence of infectious disease.

Of the 500 children:--

248 (49.6%) were Breast Fed.
195 (39%) were Bottle Fed.
and 57 (11.4%) had combined Breast and Bottle feeding throughout the greater part of the nursing period.

Children who were Breast fed for periods of less than four months were entered under the Bottle Fed group, while those continuing on the Breast for longer than four months were classified as Breast Fed even though artificial feeding was resorted to later. The basis of four months was used here for the same reason as that given in the earlier section dealing with infant feeding and the incidence of Rickets - namely, that by the time age 4 months has been reached, any additional benefit, in enhanced strength and constitution which might accrue from Breast Feeding, will have been attained.

In table XXIII are set out the numbers and percentages of those of the 500 children who contracted the diseases specified - namely, Measles, Whooping Cough, Scarlet Fever and Diphtheria. In addition, the corresponding figures relating to Bronchial Infections are included.
These figures are subdivided according to the type of Infant feeding. Chicken Pox was omitted from consideration because, though it was prevalent, yet the systemic effects and sequelae are so slight in most cases that the subsequent health of the child would not ordinarily be prejudiced.

**TABLE XXIII.**

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Cases</th>
<th>Percent (of 500)</th>
<th>Breast Fed</th>
<th>Bottle Fed</th>
<th>Combined Breast and Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td>Measles</td>
<td>134</td>
<td>24.8%</td>
<td>68</td>
<td>27.4%</td>
<td>148</td>
</tr>
<tr>
<td>Whooping Cough</td>
<td>97</td>
<td>19.4%</td>
<td>49</td>
<td>19.7%</td>
<td>35</td>
</tr>
<tr>
<td>Scarlet Fever</td>
<td>20</td>
<td>4.0%</td>
<td>12</td>
<td>4.8%</td>
<td>7</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>8</td>
<td>1.6%</td>
<td>3</td>
<td>1.2%</td>
<td>4</td>
</tr>
<tr>
<td>Acute Bronchial Infections</td>
<td>41</td>
<td>8.2%</td>
<td>17</td>
<td>6.8%</td>
<td>18</td>
</tr>
<tr>
<td>Had None of the Listed Diseases</td>
<td>257</td>
<td>51.2%</td>
<td>135</td>
<td>63.4%</td>
<td>95</td>
</tr>
<tr>
<td>Totals</td>
<td>500</td>
<td></td>
<td>248</td>
<td></td>
<td>195</td>
</tr>
</tbody>
</table>

**Comment on Table XXIII**

It will be noted that 251 (50.2%) of the children had not suffered from any of the diseases listed, throughout the period of observation. As would be expected, Measles and Whooping Cough had the highest incidence, Bronchial Infections took third place. The figure for Scarlet Fever, namely 20 (4%), compares favourably with those recorded in other districts.

The figures for each of the diseases are discussed more fully but separately in Part II below, in which additional information is given as to the ages - between birth and age 5 years - at which the diseases were contracted.
PART II
ENQUIRY INTO THE POSSIBILITY THAT A CORRELATION EXISTS BETWEEN THE TYPE OF INFANT FEEDING AND THE AGE AT WHICH CERTAIN DISEASES ARE CONTRACTED.

(a) Measles.

<table>
<thead>
<tr>
<th>AGE (IN YEARS)</th>
<th>TOTALS</th>
<th>PERCENTAGE (OF TOTAL MEASLES CASES)</th>
<th>BREAST</th>
<th>PERCENTAGE</th>
<th>BOTTLE</th>
<th>PERCENTAGE</th>
<th>COMBINED</th>
<th>BREAST AND BOTTLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1</td>
<td>27</td>
<td>20.1%</td>
<td>8</td>
<td>11.7%</td>
<td>13</td>
<td>27.0%</td>
<td>6</td>
<td>33.3%</td>
</tr>
<tr>
<td>1 to 2</td>
<td>44</td>
<td>32.9%</td>
<td>21</td>
<td>30.8%</td>
<td>15</td>
<td>34.1%</td>
<td>8</td>
<td>44.4%</td>
</tr>
<tr>
<td>2 to 3</td>
<td>34</td>
<td>25.3%</td>
<td>22</td>
<td>32.3%</td>
<td>8</td>
<td>16.6%</td>
<td>4</td>
<td>22.2%</td>
</tr>
<tr>
<td>3 to 4</td>
<td>16</td>
<td>11.9%</td>
<td>8</td>
<td>11.7%</td>
<td>8</td>
<td>16.6%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4 to 5</td>
<td>13</td>
<td>9.7%</td>
<td>9</td>
<td>18.2%</td>
<td>4</td>
<td>8.3%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTALS</td>
<td>134</td>
<td>-</td>
<td>68</td>
<td>-</td>
<td>48</td>
<td>-</td>
<td>18</td>
<td>-</td>
</tr>
</tbody>
</table>

Comment on Table XXIV

Of the 134 cases of Measles, 68 (50.8%) were in the Breast Fed group and 48 (35.8%) among the Bottle Fed children. A striking point is that only 11.7% of the Breast Fed children who suffered from Measles contracted it during the 1st year: whereas the much higher figure of 27.08% of the cases among Bottle Fed children occurred during the 1st year. In the 2nd year of life almost equal proportions of the two groups contracted the disease. This may be the result of a temporary protection conveyed by the mother's milk. On the other hand, the figures for the group of children receiving both Breast and Bottle, is even higher. At least 33.3% of the cases among these children occurred during the first year of life. Many of these children, on supplementary feeding, received, for a period, insufficient mother's milk prior to supplementary bottle feeding being begun; and the total amount of Breast milk which they received was frequently very little.
Discussion.

The possibility that Breast feeding is a factor of importance in the postponement of Measles arises from the data set out in the table (Table XXIV). A fairly substantial difference exists between the two groups in the incidence of Measles in the first year of life. It is believed by some that a certain degree of passive immunity is associated with Breast feeding. (45) The length of time it may continue after cessation of nursing is unknown.

If one of the beneficial effects of Breast feeding is more prolonged immunity and therefore later attack of the disease - and, considering that the mortality and the damaging after-effects are less frequent and severe the later the disease is contracted - breast feeding would appear to be a measure deserving of further investigation. In addition, if an attenuated attack and active immunity could be produced by the exposure of the children to the infection just before weaning and at the stage when a reduction in the quantity of Breast milk was taking place, then something not disadvantageous to the child and its future health would have been achieved.

Of the total 134 Measles cases, 105 contracted the disease in the first three years of life; the highest figure (32.8%) occurring among children aged one to two years. It has to be borne in mind that this may have been associated with a mild epidemic occurring at the time when these children were approximately two years of age. The second year of life is, in the case of almost all children, the period when most damage to the child's
health may arise. The dietary difficulties of the weaning period and the nutritional disturbances which result from improper feeding, together with the all too frequent diminished maternal care, render the child not necessarily more susceptible to Measles, but more likely to suffer from after-effects. If the occurrence of the disease could be postponed to the 4th or 5th year even, by which time the child has developed in constitution and become accustomed to the new conditions of life - dietetic and environmental - there is the expectation that recovery from the illness would be the more rapid and complete.

(b) WHOOPING COUGH.  

<table>
<thead>
<tr>
<th>AGE (in Years)</th>
<th>TOTALS</th>
<th>PERCENTAGE (of total whooping cough cases)</th>
<th>BREAST</th>
<th>PERCENTAGE</th>
<th>BREAST</th>
<th>PERCENTAGE</th>
<th>COMBINED BREAST AND BOTTLE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td></td>
</tr>
<tr>
<td>0 to 1</td>
<td>11</td>
<td></td>
<td>5</td>
<td>10.2%</td>
<td>3</td>
<td>8.5%</td>
<td>3</td>
</tr>
<tr>
<td>1 to 2</td>
<td>16</td>
<td></td>
<td>7</td>
<td>14.2%</td>
<td>7</td>
<td>20.0%</td>
<td>2</td>
</tr>
<tr>
<td>2 to 3</td>
<td>34</td>
<td></td>
<td>21</td>
<td>42.8%</td>
<td>10</td>
<td>28.5%</td>
<td>3</td>
</tr>
<tr>
<td>3 to 4</td>
<td>31</td>
<td></td>
<td>12</td>
<td>24.4%</td>
<td>15</td>
<td>42.8%</td>
<td>4</td>
</tr>
<tr>
<td>4 to 5</td>
<td>5</td>
<td></td>
<td>4</td>
<td>8.1%</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TOTALS</td>
<td>97</td>
<td></td>
<td>49</td>
<td>-</td>
<td>35</td>
<td>-</td>
<td>18</td>
</tr>
</tbody>
</table>

**Comment on Whooping Cough Data.**

Only 97 children (19.4%) contracted Whooping Cough prior to going to school. The highest incidence was among children aged two and three years. There were 65 cases (67%) among children of that age. Those who contracted the disease during the first year of life numbered 11 (11.3%). As can be seen from the table, there was no significant difference between the incidence among the Breast and Bottle fed groups.
(c) SCARLET FEVER.

A total of 20 (4%) children of the 500 under review were diagnosed as suffering from Scarlet Fever. No information was available regarding other Streptococcal infections of the fauces. None of the 20 cases occurred during the first year of life.

(d) DIPHTHERIA.

Comment is unnecessary in the case of this disease in respect of any difference in the incidence between the two groups of children.

(e) ACUTE BRONCHIAL INFECTIONS.

<table>
<thead>
<tr>
<th>AGE (IN YEARS)</th>
<th>TOTALS</th>
<th>PERCENTAGE (OF TOTAL BRONCHIAL INFECTION)</th>
<th>BREAST</th>
<th>BOTTLE</th>
<th>COMBINED BREAST AND BOTTLE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NUMBER</td>
<td>PERCENTAGE</td>
<td>NUMBER</td>
</tr>
<tr>
<td>0 to 1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1 to 2</td>
<td>3</td>
<td>15.0%</td>
<td>2</td>
<td>16.6%</td>
<td>1</td>
</tr>
<tr>
<td>2 to 3</td>
<td>7</td>
<td>35.0%</td>
<td>4</td>
<td>33.3%</td>
<td>2</td>
</tr>
<tr>
<td>3 to 4</td>
<td>4</td>
<td>20.0%</td>
<td>4</td>
<td>33.3%</td>
<td>0</td>
</tr>
<tr>
<td>4 to 5</td>
<td>6</td>
<td>30.0%</td>
<td>2</td>
<td>16.6%</td>
<td>4</td>
</tr>
<tr>
<td>TOTALS</td>
<td>20</td>
<td></td>
<td>12</td>
<td></td>
<td>7</td>
</tr>
</tbody>
</table>
Because of the relative frequency with which acute Bronchial infections in infants have an associated patchy pneumonic condition and, in view of the difficulty which exists in distinguishing accurately between the two on clinical grounds in the home, it was found better to combine both types of case for the purposes of the survey. Acute Bronchial infection is therefore an inclusive term.

The figures obtained are as set out in the table above. Of the 500 children 41 (8.2%) suffered from acute Bronchial infections. More than three quarters of these, 80.5% to be exact, occurred in the first three years of life. Of the cases among Breast fed children 17% occurred during the first year of life whereas the much higher proportion of 27% is the corresponding figure for the Bottle fed cases. In the second year on the other hand the position is reversed. Of the children who are known to have had Bronchial infections, more suffered from them during the stage when they were between one and two years of age, than any other year of the five, throughout which the records were compiled. It is interesting to observe that the position with regard to the relationship to the type of infant feeding has been reversed after the weaning stage. As mentioned above, during the course of Breast feeding the incidence of Bronchial disease among children so fed was lower than in the other two groups, but after mixed feeding was commenced the group of Breast fed children had a higher incidence than those who had been Bottle fed. The difference may have been fortuitous and in any case the numbers themselves are so small that deductions either way would not be valid.
(f) **Data of Group remaining free from all the infections under consideration.**

<table>
<thead>
<tr>
<th>Age (in Years)</th>
<th>Total (of 500)</th>
<th>Percentage</th>
<th>Breast</th>
<th>Bottle</th>
<th>Combined Breast and Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5</td>
<td>251</td>
<td>50.2%</td>
<td>135</td>
<td>51.4%</td>
<td>95</td>
</tr>
</tbody>
</table>

Of the whole group of 500 children, 251 (50.2%) remained free from the four Zymotic diseases considered above and from Acute Bronchial Infection, for the first five years of life. Breast fed children proved to be the most resistant and a much higher proportion of the 251 children belonged to that section than to the other two. 54.4% of them had been breast fed. In 48.7% Artificial feeding was used, and in the case of children receiving combined feeding the percentage of children who escaped these diseases amounted to only 36.6%.

**Summary of Part II.**

No significant statistical difference was detected between the Breast and the Bottle fed babies in connection with the relationship between the type of feeding and the incidence of infectious diseases except in the case of Measles and, possibly acute Bronchial infections.

**Subsection (h).**

**GENERAL DISCUSSION.**

**Infectious Disease and Nutrition.**

Considerable work has been undertaken and scientific research conducted with a view to determining the relationship, if any, between Infectious disease in childhood and subsequent malnutrition. The question of the effects of diet on susceptibility and resistance to Infectious disease has been investigated using both statistical and experimental methods.
With regard to the former premise, that is, the connection, if any, between Infectious disease and Malnutrition - no decision has as yet been arrived at, but a large body of evidence, for and against, has been collected. As H.E. Magee (68) stated recently with reference to this problem "Some maintain that most infectious diseases are essentially nutritional in origin." On the other hand it has been shown by various investigators that children of good nutrition are as prone to contract the common infectious diseases as are those of subnormal nutrition. Figures put forward as a result of this survey are in support of this latter contention.

Relation to Diet.

When the matter is limited to certain specific diseases most would agree with Aykroyd (2) that "Malnutrition paves the way for certain world wide diseases which are associated with a specific organism such as Tuberculosis and Pneumonia. Lassen (58) also found that susceptibility to some infections is influenced by diet: for example he showed that well fed rats are less susceptible to Bact. typhi-murium than comparable animals on an incomplete laboratory diet. In experiments with mice and the same organisms Topley, Greenwood and Wilson (115) found that an excessively rich diet was also deleterious. MacGowan (74) throws doubt on the claims made by some workers that diet had a material influence on certain immunological reactions in animal experiments: in effect, the claim that antibody production is greater in well fed animals than in poorly fed. Though the question of increased susceptibility to specific infections as a result of dietetic insufficiency
and malnutrition is still under dispute, yet it is generally agreed that resistance to disease may decrease, - in the sense that the severity of the illness is greater and the mortality higher - as a result of defective diet. In the well known survey of conditions in Stockton-on-Tees an increased death rate of 9.2% among children from birth to 10 years of age was attributed by McGonigle (73) to the effects of prolonged dietary deficiencies. Hutchison also has given it as his opinion that underfeeding gives rise to lowered resistance to disease, (52) and Clausen (27) has said that "resistance to infection may be greatly reduced by deficient diet" though "susceptibility is not, as a rule, affected." The essential fact would appear to be, not the contracting of Infectious Disease, but the neglect to obtain full and proper treatment and particularly after-care. The absence of convalescent treatment, with all that that implies in things dietetic, environmental and psychological, must undoubtedly have a profound influence on the developing child.

When, however, it is realized that the absence of desirable things implies that undesirable and unsuitable conditions take their place, the significance and the seriousness of the position can be gauged. A child not yet fully recovered from an acute infectious disease may have its health and physique damaged by insufficient rest and sleep; by lack of appropriate nourishing food and by the inability of the parents to provide climatic change either in the country or at the seaside, as the case may be.
Infectious Disease and Subsequent Health.

In the Annual Report of the Board of Education for 1926 it is stated that the debility of large numbers of children is the result of previous Infectious disease (5) and the further observation is made that "the common infections of childhood are protean in their debilitating effect, far more so than is generally supposed, and particularly in children who have enjoyed no convalescent treatment."

If the supposition is correct that infectious disease plays an important part in determining the development of malnutrition in children one would have expected that children found to be of Nutrition A grade would have had, individually and as a group, a lower attack rate for the common infectious diseases than children of poor nutrition. The figures tabulated above show that proportionately more children of Nutrition A suffered from the four common Infectious Diseases than Nutrition C children; and, furthermore, a higher proportion of them had had several diseases.

Similar findings have been reported from other areas. An investigation in 1935 by Watkins in Rhondda demonstrated that children of good nutrition in that industrial area had a considerably higher attack rate of Measles, Whooping Cough, and Scarlet Fever than those of poor nutrition (119) while in 1938 Roberts et al (95) working from the Bristol Public Health Dept. and the Bristol University Department of Preventive Medicine found that there was a higher percentage incidence of the same diseases among Nutrition
A boys and girls than among those of Nutrition C or D except in the case of Measles among Nutrition A boys. In all other cases there was a higher morbidity rate among children of good nutrition. The conclusion arrived at by the authors of the Bristol report was that A children "come off worst in respect of infectious disease because many of them are from one-child families. The C and D nutrition group developed immunity through subclinical attacks contracted under conditions of overcrowding." The latter question has already been touched upon in the subsection on Measles and Breast Feeding.

The figures cited are remarkable and very significant from the point of view of the etiological importance of infectious disease in relation to malnutrition. Whatever be the true reason for the higher figures among A nutrition children, the crucial point - namely, the connection, if any, between infectious disease and malnutrition - remains to be decided. Either the occurrence of infectious disease does not have a deleterious action - as one would suppose from the results reported here - or it does, and if so, some other closely related factor must operate. This factor may be the age of the child when the disease is contracted - a very important consideration related as it is to the strength and physical resources of the child to fight disease and, in the case of infants, perhaps not unconnected with the type of infant feeding, whether natural or artificial.
Thus, it might be contended that infectious disease is of definite etiological importance only in certain cases and under a particular set of conditions which weakened the natural resistance of the body. The sequence might be dietetic deficiency leading to lower resistance, but not necessarily greater susceptibility. The lower resistance resulting in more severe attacks of disease with consequent greater damage to the system and, with the continuing defective diet, giving rise, subsequently, to the end-result, of the child of subnormal nutrition.

**Significance of Age.**

The connection between the age at which infection is contracted and the higher mortality and debility which result at the earlier ages, has been fully established in the case of the common infectious diseases of childhood. That a state of malnutrition not arising as an immediate sequel to infectious disease may have its roots in an antecedent infection of that type, has not however been demonstrated though it is a possible sequence of events. To decide what is the relationship between age at the time when the infectious diseases were contracted and subsequent malnutrition, it would be necessary to follow up and keep careful records of a group of children over a period of years, as for example from birth to school-leaving age. A study of this type already attempted achieved only partial success in that from the incompleteness of the records little of value could be deduced. (48)

**Value of Breast Feeding.**

In connection with the influence of Breast feeding on susceptibility to infectious disease, the figures
obtained in this investigation indicate that in the case of Measles breast fed children are less prone to infection during the first year of life. For later years the figures for breast fed children mounted and by the time age 5 years was reached, of the 134 cases of Measles recorded, 68 (50.8%) were breast fed children and 48 (35.8%) only were of the bottle fed group. Similar results for the first year of life were obtained in the case of Bronchitis which will be considered more fully below.

If it could be shown that Breast (or artificial) feeding can be correlated with a lower or a later incidence of these infectious diseases and if, further, late attacks are related to less subsequent malnutrition, then a case would have been made for the value of Breast feeding as a factor in the prevention of malnutrition in later years.

Some light was thrown on this matter in the Rhondda survey (Page 119) already cited. It was found that 50% of the good nutrition cases had been Breast fed as compared with 43.5% of the poor nutrition children, and, as already pointed out, these children of poor nutrition had suffered less from infectious disease than the others, a finding similar to mine. Work done in the United States (50) supports my observation that there is a lower incidence of measles and Bronchitis among breast fed children during the first year. It should be remembered that 45.5% of the 400 Nutrition C cases examined in this survey had been Breast Fed and further, it was noted that these Nutrition C children had been less frequently attacked by Infectious
Disease than Nutrition A children. The proportion of Breast fed children in my Nutrition A group was not recorded.

**Importance of Respiratory Diseases.**

In the table relating to the diseases from which the Nutrition C children had suffered (Table XX) it is shown that 37% of 200 children had had Bronchitis or Pneumonia, and of a small group of Nutrition A children, 11.7% had a history of acute Respiratory Disease.

Comparable data put forward by other investigators is of interest. For example Watkins found in Rhondda that children of poor nutrition were attacked by Bronchitis and Pneumonia more easily than were those of good nutrition even though, as already stated, the opposite was the case in respect of the common infectious diseases. Similar results were obtained in Cardiff by the same investigator (119) who found that as many as 48.6% of the children of poor nutrition, as compared with 31.7% of those of good nutrition, suffered from acute respiratory infections. Helen Mackay (64) reported that in her series of cases, babies who were in a poor nutritional state and who had a low haemoglobin figure had double the incidence of respiratory infections as those whose iron deficiency had been corrected by pre-medication. It was found also by Spence in Newcastle (107) that Bronchitis and Pneumonia were over eight times as common among the children of the poor as among those of the well-to-do, and Orr and Gilks (87) reported a much higher incidence of Bronchitis among the cereal eating Kikuyu than among the Masai, whose diet contained a high proportion of animal protein and who were of much better physique.
It has for long been recognized, as was pointed out in the Annual Report of the Board of Education for 1926, that "catarrhal conditions and their after effects exist more commonly and severely in the poorer and badly housed areas," (5) but it has not been generally realized that much of the disability and subnormal health and physique from which children in these areas suffer, is, in part at least, to be laid at the door of Respiratory infections. Not only is it true that "in children who are prone to catarrhal conditions the acute specific fevers of childhood are more than usually damaging," (81) but it has been shown that a definite correlation exists between susceptibility to Bronchial infection and a poor nutritional state as revealed by the presence of Rickets. (49) In effect it would appear that susceptibility to Respiratory disease is not only enhanced by defective environmental and dietetic conditions, but it, in turn, further lowers the health and resistance of the child.

An illuminating analysis by the Board of Education of reports on 1074 children of ages 3 and 4 years whose records were submitted by School Medical Officers reveals "the outstanding part played by diseases of the Respiratory System" in the medical history of these children. (6) At the time of examination 116 (12.2%) of these children were found to be suffering from Bronchitis and it was shown that nearly 30% of the children had had Pneumonia, Broncho-Pneumonia or Bronchitis during the first 3 or 4 years of life.
In another analysis embodied in the 1931 Annual Report of the Board of Education it was stated that "children with poor or indifferent nutrition are most in evidence in the catarrhal group of children." (7) Also included in the same Report there is an account of an inquiry by the Board into the health of 3000 children age 2 to 6 years, inclusive, in three areas in England. In one of these areas - an industrial one in the North - 29% had physical signs of Bronchitis and 51% of the Bronchitis cases presented signs of Rickets as compared with 40.7% of the free-from-Bronchitis group. The opinion was expressed that "the prevalence of Bronchitis and Broncho-Pneumonia is perhaps the most significant of the disabilities from which young children suffer." (7)

In this connection it is important to note that Respiratory disease accounts for a large proportion of deaths at ages under 15 years. In 1936 about 20% of deaths of children up to the age of 15 years was due to diseases of the Respiratory system, and of these deaths over 90% occurred among children less than five years old. (93) With regard to the other children who suffered from similar infections and recovered, it is highly probable that many of them were seriously ill and that their physical health and nutritional state were materially affected as a consequence. It has been shown that in fatal cases of Broncho-Pneumonia a variety of organism may be incriminated and that the predominating organism may vary from case to case and from outbreak to outbreak. The principal organisms involved are Pneumococci (all types), Haemolytic and Non-haemolytic Streptococci, Staphylococcus Aureus and H. influenzae, (116)
In tables XX and XXVII it is recorded that 41 of the M & C.W. children whose records were analysed by me had had Bronchitis or Pneumonia, and that 30.4% of them occurred before the age of 3 years. These figures do not take into account the cases of Bronchitis which were not considered by the parents to warrant the attendance of a doctor. I found in my Infant Welfare Clinics that the total morbidity from respiratory diseases among young children was fairly considerable and that parents regarded such illnesses lightly. Children who should have been in bed were allowed to run about with complete disregard of the infection and this carelessness was more frequent among the poorer families and in over-crowded homes. In other cases, very often one-child families, parental authority over the child was not sufficiently strong for correct treatment to be carried out in the home.

Apart from the deleterious action on the system, of acute Respiratory Diseases, and the aggravation of the severity of the disease which results from physical exhaustion and dietary deficiencies, it would be scarcely surprising to find that children who suffered from comparatively mild attacks of such diseases, but which were neglected by the parents, bore evidence of the harmful effects of these debilitating illnesses for long afterwards. Observation to detect a failure to maintain the previous rate of growth (height and weight increase) would be valuable.

The Role of Vitamins.

The role of vitamins in the prevention of and recovery from infections is still under investigation, but it is becoming increasingly evident that certain vitamin
deficiencies pave the way for organismal invasion of the system; that these deficiencies may be further increased throughout the course of the illness and because of the illness; and that failure to restore the loss and to make good the previous deficiency militate against full and rapid recovery.

Vitamin A is of particular significance in the case of infections of the Nasal and Respiratory passages; and it is considered that a relationship exists between Vitamin C and Immunity, a deficiency of the vitamin leading to a lowering of resistance to infectious diseases.

Conclusion.

The figures obtained in this investigation and the data relating to similar investigations elsewhere, show that children of poor nutrition differ from those of good nutrition in two important respects:

(1) The incidence of Respiratory Infections is higher.
(2) They contract the common infectious diseases to a lesser extent.

The prevention of a state of subnormal health and defective nutrition cannot be fully achieved in many cases by dietetic reforms and action to improve the economic status of the people, unless due regard is paid to the part played by acute Respiratory infections in the etiology of this condition.
SECTION VIII

EXAMINATION OF 783 SENIOR SCHOOL CHILDREN OF VARIOUS NUTRITION GRADES FOR RACHITIC STIGMATA TOGETHER WITH CORRELATION WITH TYPE OF INFANT FEEDING.
Salient features of the Pathology of Rickets.

Rickets is characterised by deficient deposition of Calcium salts in the bones resulting in softness and subsequent deformities. The process of ossification at the epiphyseal lines takes place in an abnormal manner. Normally the cartilage cells at these points degenerate, leaving spaces into which blood vessels and osteoblasts from the shaft penetrate and the process of ossification proceeds. In the rachitic case there is a failure of the essential preliminary degeneration of the cartilage cells: the cartilaginous area increases in extent and ossification is hindered. (126) It is found that the Serum Calcium or Serum Phosphate or both, is lowered. There is defective absorption of Calcium and Phosphorous from the intestine as a result of insufficient Vitamin D supplies, and therefore there is excessive loss of these substances in the faeces. Increased absorption from the intestine can be effected by the administration of Vitamin D or by the formation of the Vitamin in the skin from an active sterol (7 dehydrocholesterol) by exposure to ultraviolet radiation. Vitamin D is also believed to exert direct action on the process of ossification in the growing bone, for example, by initiating the degeneration of the Cartilage cells mentioned above. Further, Calcium or Phosphorus imbalance in the dietary may lead to the formation of insoluble compounds and also therefore to insufficient absorption from the intestine. This does not occur except under experimental conditions. The excessive ingestion of Cereals and other carbohydrates
may in the event of D-hypovitaminosis, give rise to rachitic manifestations through the inhibitory action of a "toxamin" — probably Sodium or Potassium Phytate — on ossification. (77) Evidence has been advanced that Calcium and Phosphorus deficiency in the diet of the pregnant woman predisposes to a tendency to Rickets in the child, which may not be effectively inhibited by post-natal prophylactic measures; and, in fact, Rickets may even be present at birth (70; 117) Mellanby and others have recorded the same phenomenon in their studies of Rickets in animals.

Constituents of Human and Bovine Milk in relation to the Development of Rickets.

The accompanying table (Table XXIX) shows the relative Vitamin D and Mineral content of Human and Cows' Milk.

**TABLE XXIX.**

<table>
<thead>
<tr>
<th>TYPE OF MILK</th>
<th>VITAMIN D CONTENT (INTERNATIONAL UNITS)</th>
<th>100 Parts Milk Contain (Milk Heubner)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MINERALS (PAS)</td>
</tr>
<tr>
<td>HUMAN MILK</td>
<td>0 TO 50 PER PINT</td>
<td>0.2</td>
</tr>
<tr>
<td>COWS' MILK</td>
<td>0 TO 50 PER PINT (BOVINE UNITS)</td>
<td>0.7</td>
</tr>
</tbody>
</table>

The important factor is obviously the provision of adequate Vitamin D for the growing child. Calcium and Phosphorus are present in sufficient amounts in the infant diet to satisfy the needs of the body, provided that satisfactory absorption from the intestine is obtained by Vitamin D. On the basis of a daily requirement of 785
milligrammes at six months (52) and a daily consumption of 1\(\frac{1}{2}\) pints of cows' milk containing 850 milligrammes it is clear that adequate quantities of the mineral are ingested. In this connection it is obvious from the figures tabulated above that though babies fed on raw cows milk do develop Rickets, this cannot be due to an insufficiency of the necessary minerals in the diet. As the six months old bottle-fed baby consumes on an average 1\(\frac{1}{2}\) pints milk per day containing only 63 International Units Vitamin D, there is a serious shortage of the Vitamin on the basis of an optimum of at least 500 International Units daily. (52) It has however been shown that where a mother's diet is deficient in Calcium, the percentage present in the milk falls below normal and, as a consequence, the total ingested by the infant per day may be less than the optimum. (22) Variations of from 18 to 31 milligrammes per cent have been recorded in the Calcium content of mothers' milk and a figure of 42 milligrammes per cent has been obtained when the diet was rich in Calcium (22)

**Pregnancy and Lactation.**

With regard to the deficiencies of the diet of pregnant women, it is becoming recognised increasingly that pregnancy creates the need for extra supplies of Vitamin D and, possibly, Calcium. During lactation a regular daily intake of 500 to 1000 units by the mother should provide ample amounts for herself and for the growing child. In order to maintain a child's Vitamin D at optimum level the view is taken that infants should be given additional Vitamin D, irrespective of that obtained through the Breast milk. It is known that Breast-fed babies do develop Rickets and that the
administration of Vitamin D to the child cures the condition and effectively prevents recurrence. This proves that the child is receiving minerals in satisfactory amounts from the mother; and it shows that the mother could, with advantage, pass on more Vitamin D to the child.

Rachitic Stigmata.

In this country all degrees of severity of Rickets are found from the mild subclinical forms, detectable principally by X-rays or by biochemical tests, to the gross types now fortunately very uncommon. The well known stigmata of this disease are the result of strains or stresses applied to bones which are too soft to bear them, and which give way, producing deformities. The skull may show the earliest bony change in the form of bossing or flattening. Deformities of the chest wall take place as a sequel to strains of respiratory origin. Attacks of Bronchitis or any prolonged intermittent obstruction to the breathing - such as occurs in Whooping Cough, for example - may cause alterations in the shape of the chest wall of varying form. The underlying rachitic disease is the essential etiological factor. The main limb deformities, Genu Varum and Genu Valgum, require no comment.

In recent surveys of School children, conducted with a view to determining the numbers who show evidence of preceding active Rickets, it has been customary to use the following plan as a basis. It is condensed from the Board of Education Report on the Association of Rickets and Dental Disease with Tonsils and Enlarged Adenoids. (15) The skull is examined for bossing of
the Frontal and Parietal bones; the upper limbs, to detect enlargement of the Radial Epiphyses; and the lower limbs, for evidence of Bow Legs, Knock Knees or bowing of the lower third of the Tibia. In the case of the chest the presence of a sulcus is considered and whether there is eversion or beading of the Ribs. This plan was followed by me but it was modified slightly later by the omission of less informative tests. After having examined large numbers of children, it became clear to me that some of the deformities, for example those of the chest and lower limbs, were of more practical value in a survey of this type than the others, in that in the determination of their presence or absence, the personal factor hardly operates.

**Results of other surveys.**

In his official Report for 1927, Sir George Newman stated that about 50% of the children examined in specially conducted surveys in various parts of England, bore evidence of Rickets. An investigation in Stockton-on-Tees in 1928 showed that 43% of children attending the Child Welfare Clinic were rachitic. (73) The Board of Education Committee on Adenoids and Enlarged Tonsils considered the question of Rickets among children attending elementary schools in the London County Council area, and in their second Interim Report they classified 87.5% of a group of 1638 children as being definitely rachitic. Earlier, Lawson Dick had estimated that 80% of pupils in L.C.C. Schools had had rickets, but the latest figures for London reveal marked improvement. In Birmingham, of
a group of elementary school children, 42.7% were found to have deformity of the chest and 56.3% had knock knees. (124) A large group of some 1602 children examined by Herd in Manchester in 1938, were found to be affected to a lesser degree. 17.6% were recorded as having one defect of definite rachitic origin. (47) These figures, and others which could be cited, constitute evidence of deficiency of a widespread nature, and they were the subject of comment by the authors of the P.E.N. Report (114) who considered that they should be regarded as an indication of extensive malnutrition in Britain.

That similar conditions exist in some parts of the United States of America is proved by comparable investigations undertaken there. For example Elliot (34) found that 86% of a group of 600 infants in New Haven, Connecticut, had stigmata of Rickets, and De Buys (33) reported that a very high percentage of children attending his clinic had clinical signs of this disease.

Present Investigation with Results.

In the investigation conducted by me a group of 783 children of both sexes and of ages varying from 7 to 14 years, were examined for signs of Rickets.

The method employed was that noted above which had been used in previous surveys, but in this instance modified by the omission of the Skull examination. In some surveys, two additional tests were employed, namely, enlargement of Radial Epiphyses, and beading of the Ribs. These also were not included in my investigations as they were not considered to be as capable of the degree of standardisation possible in the case of the signs adopted.
This view was also expressed officially, following the publication of the Report of the Board of Education Committee. The chest was examined in each case, visually and by palpation. The degree of deformity of the lower limbs was assessed by making the child stand with the back to a wall and, with the limbs kept close together making the child press the knees as far back as possible. This eliminated the postural effects which easily create difficulty. At least one inch space between the knees when the ankles were in contact or the same between the ankles when the knees were touching, was required before a positive result was recorded. The figures obtained are set out in Table XXX.

**TABLE XXX.**

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>NUMBER OF CHILDREN</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAVING DEFORMITY</td>
<td>370</td>
<td>47.2 %</td>
</tr>
<tr>
<td>HAVING NO DEFORMITY</td>
<td>413</td>
<td>52.7 %</td>
</tr>
<tr>
<td>Type of Deformity</td>
<td>Percentage</td>
<td></td>
</tr>
<tr>
<td>CHEST DEFORMITY</td>
<td>204</td>
<td>26.0 %</td>
</tr>
<tr>
<td>LOWER LIMB DEFORMITY</td>
<td>236</td>
<td>30.1 %</td>
</tr>
<tr>
<td>HAVING BOTH CHEST AND LOWER LIMB DEFORMITY</td>
<td>70</td>
<td>8.8 %</td>
</tr>
<tr>
<td>Total examined</td>
<td>783</td>
<td></td>
</tr>
</tbody>
</table>

**Short comment on data in Table XXX.**

Of the 783 children examined over half (52.7%) were free from deformities of the chest or lower limbs. Children found to have alterations in the normal shape of the chest were slightly less in number than those having knock knees or bow legs. 26% of the whole group had chest deformity and 30.1% deformity of the lower limbs. The number presenting signs in both chest and lower limbs was 70 (8.8%).
These figures in general correspond with findings in other parts of the country, especially in other industrial areas, and they approximate closely to statistics relating to the country as a whole. Over 50% of the children were free from clinical signs of having had Rickets of a degree sufficient to produce alteration in the shape of the chest or limbs.

An interesting finding is the high proportion of children having deformity of the chest wall. Wilkins, commenting on a 1938 survey in Birmingham (124) said that "the ribs are a specially sensitive index in infancy" on account of their tendency to give way under the strain of Respiratory Catarrh or obstruction. In a group of private school children examined by him 25.4% had chest deformity and only 9% had knock knees. Where there is D-hypovitaminosis, sufficient only to produce a suboptimal state, the ribs are more prone to suffer than are the legs as they are subjected to strains at an earlier age and more continuously than are the limbs. The limbs of many a rachitic child are saved from injury by the disinclination or even the inability of the child to attempt to walk. No such means of escape is available for the equally soft ribs.

On the basis of these findings it is clear that about half of the group of children who were examined for signs of Rickets had had Vitamin D in insufficient amounts to render the growing bones sufficiently resistant to the normal strains which they were called on to bear. It is the opinion of Hutchison that "in the temperate zone it is
difficult to supply Vitamin D to infants and young children through the medium of sunshine and ordinary foodstuffs. They need extra Vitamin D in some form, for example Cod Liver Oil." (52)

Further, in the same connection, Mottram has said, "Vitamin D on account of its cost is the crux of infant nutrition under present social conditions."

The poor housing conditions of many of the people in the district in which this investigation was carried out, the absence of gardens already noted, and the prevalence of misty or hazy weather even in the summer time, accentuate a deficiency already marked through dietetic defects.

**Relation between type of Infant feeding and Incidence of Rickets**

As a part of this inquiry into the prevalence of Rickets, a record was made of the type of infant feeding of the children who were examined for rachitic stigmata. The figures obtained are not complete in that nearly 40% of the group could not provide reliable information. The data were arranged as shown in the accompanying table XXXI according to the type of feeding, whether Breast, Bottle, or Breast and Bottle. The basis of 3 months was again taken to distinguish between children who were Breast fed for less than that period before Bottle feeding was begun, and those who had had Breast milk for more than three months before changing to Cow's milk.
In table XXXII above, the numbers and percentages of children in each of the three types-of-feeding groups who had rachitic signs, or those who were free from them, are set out.

These figures reveal that the Breast-fed child came off worse than the Bottle fed. A higher percentage of them suffered from Rickets - 57.3% as against 52.5%.

Discussion.

It is evident that there is insufficient Vitamin D in Breast Milk. This is probably the result of deficiencies in the diet of the mother. There may also be an additional factor, in that lack of sufficient insolation may determine sub-optimal formation of the Vitamin in the mother's or child's system. This vitamin deficiency can be corrected easily by the administration of a potent Vitamin D preparation to the child. The practice
in the area investigated by me had been to advise the giving of Vitamin D to bottle fed babies only. It was formerly assumed, erroneously, that mother's milk contained sufficient of the anti-rachitic vitamin. Now, both Breast and Bottle fed babies get Vitamin D and lactating mothers are advised to take a daily dose themselves.

The better figures for the bottle fed group should, in part at least, be attributed to the custom of giving Cod Liver Oil to artificially-fed infants. Dried Milks have almost completely superseded liquid cow's milk in this district, as the alternative to natural feeding; and the Nurses and Health Visitors have consistently advised the giving of Cod Liver Oil and Orange Juice to all babies fed on a milk powder. Yet, under these circumstances, one would have expected that the figures for bottle fed babies would have been much better than they are. There are several reasons why this is not so.

Many mothers did not give Cod Liver Oil regularly to the child; others ceased altogether after having given it for a period; and in almost every instance none at all was given after the age of nine months was reached. There was an abrupt withdrawal of Cod Liver Oil immediately weaning to mixed diet had taken place. All too often Bread and Jam constituted the foundation of this diet; and milk, on account of its expense, was regarded as a luxury. (This was prior to the extension of the Government's Milk Scheme to the "under fives.") With this poor diet and without the extra source of Vitamin D, it is not surprising that at ages two to three years
there should be disturbance of Calcium/Phosphorus/Vitamin D metabolism, with development of Rickets, even in children who had successfully passed through the nursing period. "The consequences of a sub-optimal intake of Vitamin D might not be obvious until quite late in the nursing period, or indeed it might not cause trouble until the child began to live on the defective diet of his parents."

It has been suggested that some Cod Liver Oil preparations favoured by the mothers are not potent, or have a low Vitamin D figure. Some Mothers prefer Cod Liver Oil and Malt, on the ground that children take it more easily. As there may be only 15% of Cod Liver Oil in this mixture the child would require to take excessively large amounts to provide the minimum of 500 International Units daily, which is at present regarded as a fairly satisfactory figure. The average Vitamin D strength of an active Cod Liver Oil is 100 International Units per cubic centimeter. (52)
SECTION IX

EXAMINATION OF 781 CHILDREN ATTENDING SENIOR SCHOOLS FOR EVIDENCE OF ANAEMIA. CORRELATION WITH PREVIOUSLY ASSESSED NUTRITION GRADES.
Prevalence of Anaemia.

Various observers have remarked on the prevalence of Iron-deficiency anaemia among the poorer sections of the population and on the particularly high association between anaemia of this type and malnutrition in children. Spence recorded that 81% of a group of children in Newcastle had a haemoglobin percentage below 75%. The state of anaemia which existed was in many cases quite severe. Among the children of the well-to-do in the same town only 16% had a haemoglobin level below 75. (107) Helen MacKay found in her investigations into the prevalence of anaemia in infants, that 51% of bottle fed and 45% of Breast fed babies suffered from anaemia. (64) In a Warrington inquiry conducted among malnourished school children, 48.9% had a haemoglobin figure below 70%. Of the other school children only 26% had a comparable haemoglobin level. (56) A similar condition of the blood has been discovered among adult women. (66; 29) Considerable evidence has been accumulated which shows that a low haemoglobin level is more frequently met with among certain groups of adults and adolescents in this country than was formerly realised. (67; 44)

Haemoglobin Levels.

The question as to what is the normal haemoglobin level for an individual is still under discussion, but recently, the experiments of Widdowson, (121) Fowler and Barer, (40) and others, on the rise and fall of haemoglobin as a sequel to the administration or withdrawal of Iron, indicate that there is no fixed level for any particular individual, but that there exists a broad zone comprising
individual, sex and age variations. Whitby and Britton (120) consider the average haemoglobin content of the blood of the adult male to be 15.6 grams per cent and 13.7 grams per cent for the female. The corresponding figures on the Haldane scale are 113% and 98% respectively. In the case of infants there is considerable fluctuation from 145 (Haldane) at birth to about 75 at the third month of life, followed later by a steady rise during the succeeding months (65). Conclusive evidence has been presented that lower levels are obtained in artificially fed children which are, in part at least, of dietetic origin. (53; 64) In this connection, but with particular reference to adults, it has been pointed out that the fact that the haemoglobin level can be raised by iron medication does not prove that the higher level is beneficial to the system nor that the original level - provided clinical anaemia does not exist - indicates an iron deficiency.

Detection of Anaemia.

The difficulty of carrying out a haemoglobin estimation on large numbers of children, for example in schools, involving as it does the withdrawal of blood from each child, has tended to prevent active interest being taken in the state of the blood of apparently healthy children. The alternative method of visual examination of the lips and conjunctivae has supplanted the more thorough and exact procedures in the routine inspection of school children. As a rough test which is capable of separating children into broad groups, visual examination of the membranes has much to commend
it provided its limitations are recognised. Helen MacKay (64) considers that "the colour of the lips is the best clinical indication, but unless anaemia is severe it is seldom possible to be dogmatic about its presence or absence without examination of the blood."

Data obtained in present Inquiry.

The figures recorded in the table below were obtained by me during the course of the Nutrition Survey. The degree of colour of the conjunctivae and lips was assessed in each of 781 children of both sexes, in two senior schools. According to whether the membranes were pale or were of satisfactory colour, the child was marked anaemic or not anaemic. It is admitted that classification based on subjective estimation is open to criticism on account of the undue influence of the personal factor. While recognising this danger, I consider that the data obtained by me are of some value and interest. As will be demonstrated later, there is a fair degree of correlation between the condition of the membranes and the nutrition grade, as determined by other standards; and further, there is close correspondence between my figures and those produced as a result of investigations carried out in other comparable districts. The nutrition grade of each of the children had been determined and recorded beforehand and it is on the basis of these grades that the table has been compiled.
### TABLE XXXIII. PRESENCE OF ANAEMIA IN RELATION TO NUTRITION GRADES

<table>
<thead>
<tr>
<th>CONDITION OF CHILD</th>
<th>NUMBERS AFFECTED</th>
<th>NUTRITION A</th>
<th>NUTRITION B</th>
<th>NUTRITION C</th>
<th>NUTRITION D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBERS</td>
<td>PERCENT</td>
<td>NUMBERS</td>
<td>PERCENT</td>
<td>NUMBERS</td>
</tr>
<tr>
<td>ANAEMIC</td>
<td>241</td>
<td>30.9%</td>
<td>22</td>
<td>17.2%</td>
<td>155</td>
</tr>
<tr>
<td>NOT ANAEMIC</td>
<td>540</td>
<td>69.1%</td>
<td>106</td>
<td>82.8%</td>
<td>402</td>
</tr>
<tr>
<td>TOTALS</td>
<td>781</td>
<td></td>
<td>128</td>
<td></td>
<td>557</td>
</tr>
</tbody>
</table>

**Analysis of the data in Table XXXIII**

When boys and girls of the four nutrition grades are taken together it is seen that 540 (69.1%) were not anaemic and that 241 (30.9%) were anaemic. It was noted that 22 children (17.2%) of apparently excellent nutrition - Nutrition A - were anaemic by visual standards, while as many as 63 (66.3%) of the Grade C children had distinct pallor of the membranes. The proportion of children in the two nutrition grades A and C who were not anaemic was 82.3% and 33.7% respectively. It would appear then that children who suffer from malnutrition are more prone to anaemia than those of excellent nutrition; and, in addition, it is shown that a relatively high percentage of children found to be Nutrition A (17.2%) had pallor of the lips and conjunctivae of sufficient degree to excite comment. In this connection the findings of Spence that five children of a small group of children of excellent nutrition were markedly anaemic is of more than passing interest. (107)

Proportion of cases in the two sexes.

Consideration of sex variation disclosed that a higher percentage of boys had pallor of the lips and conjunctivae than girls. There was a difference of 5.5% in favour of the girls. It has already been recorded
that boys are more frequently found to suffer from malnutrition than girls, and it is not without significance that an anaemic state also was more often detected in boys.

The figures and percentages are set out in Table XXXIV.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Condition</th>
<th>Numbers</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boys</td>
<td>Anaemic</td>
<td>133</td>
<td>33.8%</td>
</tr>
<tr>
<td></td>
<td>Not Anaemic</td>
<td>260</td>
<td>66.1%</td>
</tr>
<tr>
<td>Girls</td>
<td>Anaemic</td>
<td>110</td>
<td>28.3%</td>
</tr>
<tr>
<td></td>
<td>Not Anaemic</td>
<td>278</td>
<td>71.7%</td>
</tr>
</tbody>
</table>

Discussion of various aspects of the problem.

Until recent years, comparatively little attention had been paid to the possible effects on health of the lesser degrees of anaemia, especially on the health of the growing child. Helen MacKay in the report cited above records that she found many breast fed babies with a haemoglobin level of 70% and bottle fed babies with haemoglobin as low as 40%. There was a high morbidity rate, particularly in respect of Bronchial Catarrh and Gastro-intestinal disturbances, among babies with a low haemoglobin level. It is significant that the correction of the anaemia by iron medication led to a marked improvement in the health of these children as compared with that of the controls. It was noted also that the treated children put on weight more rapidly than the untreated.

The frequent occurrence of anaemia of nutritional origin in women of child-bearing age has been reported from various parts of the country. It has
been estimated that the need for Iron in pregnancy is from two to three times normal. (4) There is evidence that if the mother is anaemic the baby's iron stores may be low at birth, and though the haemoglobin level at the time of birth may not be below average, yet, because of the deficiency in the pre-natal stores in the infant's liver, the ultimate haemoglobin level some months later is less than it should be, with effects on health similar to those mentioned by Helen MacKay. If the baby's pre-natal store is low, the iron content of the milk is insufficient to make up for the deficiency and it may not be until the third or fourth year, when mixed diet containing vegetables and fruits can be consumed in substantial amounts, that the level rises to normal. The importance for the health of the child of preventing the expectant mother from having a deficient iron intake is evident. The therapeutic administration of Iron from early infancy not only prevents the development of nutritional anaemia but has remarkable beneficial effects on vitality and on resistance to bronchial infection.

It has been shown by Perkins (129) that the symptomatic anaemias which occur among children of school age are of two types, those resulting from recognised morbid processes such as Chorea and recurrent Tonsillitis, and those that are associated with malnutrition and debility. Tonsillar and Dental sepsis, especially if severe, may contribute to the development of subnormal nutrition by producing an anaemic state. Whitby and Britton (90) regard insufficient rest as an extremely important factor in the etiology of anaemia in growing children.
Optimum Iron requirements and some common sources of supply.

The optimum iron intake has been variously estimated, but the figure advanced by Sherman (101) of 15 milligrammes daily for the adult of both sexes, and that suggested by Widdowson and others (123) for the pregnant female, namely 20 milligrammes, have received widespread support. Professor L.S.P. Davidson (30) however considers 10 milligrammes daily to be adequate for the needs of the majority of women in the absence of excessive menstrual loss and the concensus of informed opinion appears to favour the lower figure. For example, the Technical Commission on Nutrition of the League of Nations (60) accepted the 10 milligrammes level as being generally satisfactory. Recent information on the availability of iron from different natural sources has thrown light on the problem of why certain foods with a known high iron content are relatively inefficient as a source of iron in the treatment of anaemia. Haemoglobin is a case in point. The problem is related to the state in which the iron occurs, whether ionised or not. Iron combined with pyrrole derivatives is not available. (35)

In general, as has been shown, iron of vegetable origin is much better absorbed than that from animal sources. It has been pointed out (122) that almost 90% of the total iron in a mixed diet of plant foods, eggs and milk is available, while in the case of a diet with a high meat content only approximately 50% of the total iron is absorbed. Cognisance should be taken of this fact by those who control the diet of children and the especial value of wholemeal, of certain green vegetables
and of certain fruits as sources of available iron for the growing child, should be emphasised. Vegetables with high available iron are Cabbage, Celery and Asparagus; and in the case of common fruits, Blackberries, Currants and Raspberries are worthy of special mention.

The recognition by the Medical Research Council that anaemia, due to lack of iron in the diet, is common in this country led the Council to consider the advisability of adding Iron salts to flour. This innovation was not recommended ultimately, on the ground that the addition of iron might react harmfully on some of the other nutrients present. (76)

Summary of Main Facts connected with the Nutritional aspects of Iron.

The following is a summary of the present position with regard to the place of Iron in the list of substances essential for good nutrition.

(1) Anaemia of the pregnant woman may have serious effects on the health of the child after birth, by hindering the accumulation of iron in the pre-natal stage.

(2) The normal Iron content of human and cows' milk cannot - in the presence of deficient pre-natal stores of iron - meet the nutritional demands of the growing child.

(3) As the iron content of milk cannot be raised above the normal level by increased maternal consumption, an iron preparation must be given to infants lacking adequate reserves.

(4) The administration of Iron in an inorganic form to the child prevents the onset of anaemia; and the liability of the child to suffer from the various complaints to which anaemic children are prone, is avoided.
(5) After weaning, the mixed diet the child receives should allow a total available iron allowance of not less than 10 milligrammes per day. Wholemeal Bread, eggs, vegetables and fruit should figure largely in the diet of all adolescents and pregnant women.

(6) Prophylactic Iron therapy in infancy and childhood should be carried out in the event of acute infections supervening. It is recognised that anaemia may arise and that blood regeneration may be retarded as a result of even mild infections.
SECTION X

CONSUMPTION OF WHOLEMEAL BREAD BY SCHOOLCHILDREN (506 OF THE CHILDREN EXAMINED FOR ANAEMIA (SEE SECTION IX). CORRELATION WITH THE PRESENCE OR ABSENCE OF ANAEMIA.
INTRODUCTION.

In connection with the prevalence of anaemia, the question of the consumption of Wholemeal bread was raised, in view of its known value as a source of Iron in a form which makes it readily available to the body. It is a matter of general knowledge that in the North East of England much of the bread consumed is home-baked. Inquiry showed that in a number of cases, stone-ground wholemeal was regularly added to the white flour and that frequently a proportion of the bread was prepared from whole-meal only. This appeared to be a well-established custom dating back for many years and therefore not in any way connected with the efforts of the Ministry of Food, following the outbreak of war, to popularise Wheatmeal Bread. It should not be overlooked that the data recorded here relate to the period prior to the introduction of the National Wheatmeal loaf and the figures therefore indicate what was the custom in the pre-war years in respect of the consumption of whole-meal by school children in this industrial urban area.

Three different sets of figures were secured and they are recorded in tabular form below. They relate to children using Wholemeal Bread only; to those whose consumption was adequate; and to children who never ate it. The particular children from whom the data were obtained are those from whom the data on anaemia were obtained, which were discussed in the previous section. A total of 506 children were reviewed.
Sub-section (1)
NUMBERS OF CHILDREN CONSUMING OR NOT CONSUMING WHOLEMEAL BREAD.

<table>
<thead>
<tr>
<th>WHOLEMEAL BREAD CONSUMPTION</th>
<th>NUMBERS OF CHILDREN</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSUMPTION ADEQUATE (DAILY OR ALMOST EVERY DAY)</td>
<td>148</td>
<td>29.2%</td>
</tr>
<tr>
<td>USED WHOLEMEAL BREAD ONLY</td>
<td>43</td>
<td>8.5%</td>
</tr>
<tr>
<td>NONE CONSUMED (OR INFREQUENTLY)</td>
<td>358</td>
<td>70.8%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>506</td>
<td>-</td>
</tr>
</tbody>
</table>

Analysis of the data in Table XXXV

Of the 506 children, only 148 (29.2%) claimed that they had Wholemeal Bread daily or almost every day, while 358 (70.8%) ate none or ate a little so infrequently that no account could be taken of it. Only 43 consumed wholemeal bread daily to the exclusion of the white variety. Nutrition Grades of children taking Wholemeal Bread.

<table>
<thead>
<tr>
<th>NUTRITION A</th>
<th>NUTRITION B</th>
<th>NUTRITION C</th>
<th>NUTRITION D</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUMBER IN GROUP</td>
<td>NUMBER TAKING WHOLEMEAL BREAD</td>
<td>PERCENT</td>
<td>NUMBER IN GROUP</td>
</tr>
<tr>
<td>79</td>
<td>30</td>
<td>38.0%</td>
<td>381</td>
</tr>
</tbody>
</table>

This table (Table XXXVI) is included merely as a matter of interest. It will be seen that a substantially higher proportion of the Nutrition A children took Wholemeal Bread regularly than did those in the poorer grades. Further, more than half of those Nutrition A children (62%) did not consume wholemeal. Even though a still larger proportion
of the Nutrition C children (74.7%) did not use wholemeal bread, no deductions as to the relationship - if any - between wholemeal consumption and nutrition grade can be made in view of the very small numbers consuming Wholemeal Bread in each or the two nutrition grades specified.
Sub-section (2)
RELATIONSHIP BETWEEN ANAEMIA AND WHOLEMEAL BREAD CONSUMPTION.

| TABLE XXXVII |
|------------------------|--------|--------|--------|
| CONSUMPTION OF WHOLEMEAL BREAD | NUMBER | PERCENTAGE | NUMBER | PERCENTAGE |
| CONSUMPTION ADOPTED (119 CHILDREN) | 95 | 79.8% | 24 | 20.2% |
| NONE CONSUMED (340 CHILDREN) | 226 | 66.5% | 114 | 33.5% |

Analysis of data in Table XXXVII.

Consideration was given to the possibility that correlation might exist between the presence or absence of Anaemia and the consumption or non-consumption of Wholemeal Bread. A group of 459 children was passed under review of which 138 were in an anaemic state as determined by the inspection of lips and conjunctivae. It was found that 119 of the 459 children took wholemeal bread regularly and that 340 did not. The number and percentages of those having Anaemia and those free from it in each of the two divisions (those taking or not taking wholemeal bread) are set out in the table. In view of the fact that there is such a considerable difference in the numbers of children in the two divisions, statistics based on them of the relationship between freedom from Anaemia and Wholemeal Bread consumption are of correspondingly less value. But as could be expected from the known high Iron content of Wholemeal, and the high availability of this Iron, there is a much smaller proportion of anaemic children in the 'taking-Wholemeal-Bread' section than in the other. In point of fact, of those taking Wholemeal Bread, 95 children (79.8%) were free from clinical signs of Anaemia, while
the remaining 24 (19.2%) were anaemic. On the other hand, only 226 (66.5%) of the children in the group not taking Wholemeal Bread were free from Anaemia, while 114 (33.5%) had Anaemia. In other words, more children, to the extent of 13.3% were anaemic in the group not taking Wholemeal Bread than in the smaller group of those taking it regularly. It should not be overlooked that many other factors, mainly dietetic and domestic, could have played, and probably did play a part, in the prevention of anaemia in the case of certain children; nevertheless as all of the children lived under similar environmental conditions and as the standard of life in practically all of the homes was comparable - except in those cases in which the size of the family was disproportionately high or low - and as the culinary arrangements did not appear to vary much from home to home, the assumption that the Wholemeal Bread intake constituted the principal anaemia-preventing measure, was accepted.
Sub-section (3)  
GENERAL NUTRITIONAL CONSIDERATIONS.

(a) Nutritive Value of Wholemeal Bread.

The whole question of the consumption of Wholemeal Flour has recently been reviewed and several of the more important facts, from the point of view of human nutrition, are mentioned below. It has been noted already in the previous section that Wholemeal is a valuable source of iron. Calculation shows that the consumption of 1 lb. of Wholemeal flour daily would easily provide the total daily iron requirements of an adult, that is, approximately 10 milligrammes. At 2.7 milligrammes per 100 grammes Wholemeal (McCance) one pound would yield 12.2 milligrammes. The loss of other nutrients in the preparation of the usual white flour (73% extraction) is equally serious from the point of view of the health of the people. In the milling process the rejection of the germ entails the loss of valuable protein and fat; and in the case of the rejection of the bran, valuable mineral matter and the protein of the Aleurone cells. This protein has a higher nutritive value than the protein normally present in white flour, and the value of the flour containing this layer is considerably enhanced. Further benefit to the health would accrue from the increased intake of Riboflavine, Nicotinic Acid and Vitamin B1.

(b) Biological Experiments with the three Principal types of Wheat Flour.

It has been shown that the growth and development of young rats proceeds better when they are fed on the National Wheatmeal Flour (85% extraction) than on white flour, and still better when flour from the complete grain
(100% extraction), is used. (125; 26) The principal constituents of these three varieties of flour are set out in Table XXXVII.

<p>| TABLE XXXVII |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>FLOUR</th>
<th>FIBRE %</th>
<th>ASH %</th>
<th>PROTEIN %</th>
<th>VITAMIN BI, INT. UNITS PER GM (THIOLUORENE METHOD)</th>
<th>CALCIUM MGM/100GM</th>
<th>PHOSPHORUS MGM MA (100GM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NATIONAL WHEAT MEAL (85% EXTRACTION)</td>
<td>0.60</td>
<td>0.90</td>
<td>11.4</td>
<td>1.2</td>
<td>27</td>
<td>203</td>
</tr>
<tr>
<td>WHITE FLOUR (78% EXTRACTION)</td>
<td>0.0</td>
<td>0.46</td>
<td>10.6</td>
<td>0.35</td>
<td>15</td>
<td>101</td>
</tr>
<tr>
<td>WHOLEMEAL FLOUR (100% EXTRACTION)</td>
<td>1.8</td>
<td>1.51</td>
<td>11.9</td>
<td>1.4</td>
<td>36</td>
<td>34.3</td>
</tr>
</tbody>
</table>

(c) **Principal Disadvantage of Higher Extraction Flours.**

The anticalcifying factor - Phytic (Inositol hexaphosphoric) Acid - present in the germ and branny envelope, will be ingested in greater amounts, in proportion to the increased consumption of wholemeal flour. Extra supplies of Vitamin D. should therefore be taken by growing children.

At the time of writing plans are almost complete for the addition of prepared chalk to National Wheatmeal flour in the proportion of seven ounces of Calcium Carbonate to each two hundred and eighty pounds sack of flour.
SECTION XI

ENQUIRY INTO THE CONSUMPTION OF VEGETABLES BY 400 NUTRITION C CHILDREN TOGETHER WITH CONSIDERATION OF THE NUTRITIONAL VALUE OF VEGETABLES.
INTRODUCTION.

It is a well known fact that many children dislike vegetables. This dislike may be carried to such an extent that it is bound to have an effect on the health and nutritional state of the children. Though frank scurvy is practically unknown in Britain, yet the proportion of children in a subscorbutic state may be higher than is generally realised. There is significant evidence that an unsatisfactory consumption of vegetables and fruits by large sections of our population is very common, and especially by those particular sections which have the highest birth-rate. (85; 41) It has been said that it is the daily consumption of potatoes which prevents large numbers of people in the British Isles from developing scurvy. (52) In spite of the large imports of fruit and the remarkable reduction in prices in the immediate pre-war years the proportion consumed by the children of the lower paid workers is all too meagre. (85)
The consumption of vegetables by the group of Nutrition C children examined by me was enquired into on the basis of frequency only. No account was, nor could be taken, of the quantity of vegetables because of the limitations of the investigation. Also it was considered that if, in addition to potatoes, children consumed some vegetables every day or almost every day, and if some were taken in the fresh raw state, the danger of incipient scurvy was slight.

The data obtained are set out in the Table XXXIX.

<table>
<thead>
<tr>
<th>Vegetable Consumption</th>
<th>Number of Children</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Having Vegetables Frequent</td>
<td>116</td>
<td>29.0%</td>
</tr>
<tr>
<td>Having Vegetables Occasionally</td>
<td>236</td>
<td>67.0%</td>
</tr>
<tr>
<td>No Vegetables Consumed</td>
<td>48</td>
<td>12.0%</td>
</tr>
<tr>
<td>Vegetables Disliked</td>
<td>8</td>
<td>21.5%</td>
</tr>
</tbody>
</table>

Only 116 (29%) of the children had vegetables almost every day and 236 (59%) partook of vegetables occasionally. Those who gave the information that they used vegetables only occasionally, stated that this was about once per week and at the Sunday dinner usually. 48 (12%) mothers said that no vegetables (other than potatoes) were cooked by them for the children, and various reasons were advanced by them to account for this. It was said that the children disliked vegetables and refused to eat them; that they had no garden and that the cost of purchasing vegetables was too great; or
that the vegetables were not worth the money and that it was better to buy other food stuffs.

Out of the 400 cases only 86 (21.5%) were said to dislike vegetables. Some of these children refused vegetables absolutely while others were sufficiently under parental control to take some at least. Mothers who had difficulty in persuading the children to take cooked vegetables quite often found that raw turnip or carrot was enjoyed by them, especially taken between normal meals at a time when the appetite was sharpened by hunger.
There is evidence that vegetables are consumed in quite insufficient amounts by children generally in this country, and that the two factors of cost and taste are to be held accountable. There is reason to believe too that if parents, particularly mothers, realised the important part vegetables can play in the life of a child, in the building up of a healthy sturdy frame - by assisting, through the Vitamin C content, in the promotion of quick recovery from certain diseases, shortening convalescence and aiding the healing of injured tissues; by acting as a convenient and cheap source of certain essential minerals, and by facilitating correct bowel action - there would be an immediate increase in their use. Indications of an unsatisfactory knowledge of the value of vegetables by the people of this country are available through the research of various investigators. Sir John Orr (85) in "Food, Health and Income" states that "Vegetables other than potatoes contribute less than sugar to the total expenditure" (of the working class housewife) "though they are more important to health." In a London report it was revealed that "of one hundred children suffering from non-pulmonary tuberculosis, 60 had an aversion to green vegetables" and 23 out of 30 children suffering from Pulmonary Tuberculosis had a marked dislike for green vegetables. It was also recorded that 53 of a hundred women between the ages of 15 and 20 years similarly disliked vegetables. (41) Sir John Orr emphasised cost as a main factor; and Galpin, taste. That both are very important cannot be gainsaid,
but after discussion with a large number of mothers I have been forced to conclude that sheer ignorance of the nutritive value of vegetables is the principal reason in very many cases.
NOTES ON THE NUTRITIONAL VALUE OF VEGETABLES

A few notes on the main constituents of vegetables from the standpoint of human nutrition will illustrate what the insufficient use of vegetables by the child entails for him in deprivation of valuable and essential materials.

Carbohydrates.

Vegetable foods are rich in Carbohydrates and comparatively poor as sources of Protein and Fats. In this they contrast with foods of animal origin. Though the Carbohydrate is mainly in the form of Starch and though it is enclosed by a Cellulose envelope on which human digestive juice has little action (71) yet, by rupturing the cellulose, the process of cooking renders the starch readily accessible to the digestive ferments. All of the common vegetables contain Carbohydrate in amounts which make them useful additional sources. Potatoes, Carrots and Parsnips are particularly rich.

Protein.

Vegetable Protein can be used to supply up to approximately three quarters of the total daily requirements of the body. (52) As it is of a lower biological value than animal protein it is of less use in the growth and repair of the body tissues, so a higher proportion than this is not advisable on nutritional grounds. In comparison with animal foods, vegetable protein is comparatively cheap, and more recourse should be had to vegetables as a ready source of Protein. Particularly rich in Protein are Brussels Sprouts, Asparagus and Peas. The bulkiness of vegetables limits the proportion of them that can be included advantageously in human diet. This
bulkiness interferes with digestion in two ways; first, by hindering ready access of the digestive juices, and secondly, by the stimulating action of mere bulk on peristalsis with consequent reduction of the time available for absorption to take place.

Fats.

As noted above the common vegetables are an inferior source of fats, but what is present is of equal nutritive value to those of animal origin. On account of the preponderance of Oleic Acid together with some Linoleic, these fats have the consistency of oils and are therefore more easily digested.

Minerals.

The high mineral content of vegetables would make them on that account alone, a particularly valuable foodstuff. The principal minerals are Sodium, Potassium, Calcium, Magnesium, Iron, Copper, Phosphorus and Chlorine.

The Calcium requirements of the growing child make the provision of cheap and convenient sources a major dietetic necessity, and various vegetables could be recommended, with benefit, as additional sources of supply to those who have the care of children. By way of illustration, boiled cabbage yields 58.2 milligrammes per 100 grammes, boiled Celery 52, Raw Carrots 48, and boiled Brussels Sprouts 27 milligrammes. (82)

The estimated daily Calcium requirements of the body vary from 680 milligrammes (101) to 825 milligrammes. (52) In spite of recent evidence that only a small proportion of the Calcium is absorbed by the body in the case of some vegetables, for example Spinach, this
cannot be said of the Cabbage and its allies. The Calcium in the green leaves of Cabbage is absorbed to almost 100% (52) 

**Vitamins.**

The principal vitamins to be obtained through vegetables are A (provitamin A), Vitamin C, small amounts of Vitamin B1 and to a lesser degree some other fractions of the Vitamin B complex, 

**Vitamin C.** Systematic investigation has shown that Brussels Sprouts (boiled) will yield 600 International Units of Vitamin C per 100 grammes, boiled Asparagus 540 units, and boiled old potatoes 220. 

**Vitamin A.** Vegetables particularly rich in Vitamin A are Carrots, Lettuce, Spinach and Cabbage. 

**Vitamin B1.** Vitamin B1 can be obtained in fair amounts in Spinach, Cauliflower, Lettuce and Cress. Their yields in International Units per 100 grammes are respectively 360, 110, 90 and 50.
Sub-section (4)

**BENEFIT WHICH WOULD ACCRUE FROM SLIGHT ALTERATION IN THE DIETARY HABITS IN THE AREA.**

In the district in which this investigation was conducted the main vegetables grown and consumed are those mentioned in table XL below, in which are set out their various constituents of dietary importance. The table is based on Hutchison and compiled from various sources particularly Plimmer and McCance. The data apply to the vegetables in the boiled state.

**TABLE XL.**

<table>
<thead>
<tr>
<th>VEGETABLE</th>
<th>GRAMMES PER 100 GRAMMES</th>
<th>MILLIGRAMMES PER 100 GRAMMES</th>
<th>PER 100 GRAMMES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Carbohydrate</td>
<td>Protein</td>
<td>Calcium</td>
</tr>
<tr>
<td>POTATO (raw)</td>
<td>19.7</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>CABBAGE</td>
<td>1.3</td>
<td>0.8</td>
<td>68.2</td>
</tr>
<tr>
<td>BRUSSELS SPROUTS</td>
<td>1.7</td>
<td>2.4</td>
<td>27.1</td>
</tr>
<tr>
<td>TURNIP</td>
<td>2.3</td>
<td>0.7</td>
<td>55.0</td>
</tr>
<tr>
<td>RUNNER BEANS</td>
<td>0.9</td>
<td>0.8</td>
<td>25.4</td>
</tr>
<tr>
<td>CARROT (raw)</td>
<td>1.3</td>
<td>0.6</td>
<td>34.9</td>
</tr>
</tbody>
</table>

A reasonable deduction from the figures incorporated in the table is that the regular daily consumption of Potato, with Cabbage or Brussels Sprouts on alternate days, or very frequently, and Turnip, Carrot or Runner Beans to give variety, would go far towards providing the child with Vitamins A and C, together with minerals - including Calcium, Phosphorus and Iron - in amounts which should be
regarded as indispensable in view of the difficulty of obtaining sufficient of them from the other articles of diet which are in common use in this country. An average helping at a meal would approximate to 100 grammes or $3 \frac{1}{2}$ ounces.

Such an alteration in the dietetic habits of the working people, namely, the habitual consumption of two vegetables (potatoes and one other as above) could, if adopted, be described correctly as revolutionary. It is recognised that in the case of the infant or the toddler, the amounts of vegetable which can be consumed are negligible, but this difficulty does not arise with children of school age; indeed the view is taken that if these vegetables are eaten regularly, and if regard is had to conservation of maximum nutritional values during cooking, then the quantity which need be taken on any one day is sufficiently small to allow of partial concealment by mixing with other articles of food, for example, gravy, before serving.
SECTION XII

EXAMINATION FOR CARIES BY MIRROR AND PROBE OF THE DECIDUOUS
TEETH OF 330 CHILDREN, AGE FIVE YEARS.
Sub-section (1)
INVESTIGATION OF THE TEETH OF 330 CHILDREN ON ENTRANCE TO SCHOOL.

INTRODUCTION.

It is well known that Dental Caries affects, to a greater or lesser degree, the permanent teeth of almost all school children, but it is not generally realised that caries also attacks the temporary or deciduous teeth with equal readiness. In fact in the case of many children, even before the age of school attendance, almost every tooth is damaged or completely decayed. It is plain that the onset of dental decay so early after the eruption of the teeth, must be of profound nutritional significance in so far as the etiology is concerned.

METHOD.

In order to obtain accurate data on the extent of the defect in the temporary teeth of children in the area, it was arranged that Entrants (age five years only) should have a dental examination soon after admission to school, and in all cases before the appearance of the permanent teeth. In all 330 children were thus examined and the mirror and probe were used, as results obtained by this method are much more accurate than those secured by mere visual examination.

The data are set out in tabular form below. (Table XLI).
### TABLE XLI

<table>
<thead>
<tr>
<th>State of the Teeth</th>
<th>Number of Children</th>
<th>Percentage of Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Carious Teeth</td>
<td>26</td>
<td>7.5%</td>
</tr>
<tr>
<td>Having complete set (20 deciduous teeth) free from caries</td>
<td>18</td>
<td>5.4%</td>
</tr>
<tr>
<td>Having one carious tooth</td>
<td>19</td>
<td>5.7%</td>
</tr>
<tr>
<td>Having two carious teeth</td>
<td>36</td>
<td>10.9%</td>
</tr>
<tr>
<td>Having three carious teeth</td>
<td>35</td>
<td>10.6%</td>
</tr>
<tr>
<td>Having four carious teeth</td>
<td>36</td>
<td>10.9%</td>
</tr>
<tr>
<td>Having five carious teeth</td>
<td>20</td>
<td>9.9%</td>
</tr>
<tr>
<td>Having more than five carious teeth</td>
<td>149</td>
<td>45.1%</td>
</tr>
</tbody>
</table>

Analysis of the results:

1. There were only 25 children (7.5%) with no caries. Of these 18 (5.4%) had complete sets of 20 teeth undamaged by caries. The remaining 7 had teeth missing which may have been touched by caries.

2. All of the other children examined suffered from caries, a major proportion having 3 or more decayed teeth.

3. As many as 179 (55%) had 5 or more teeth carious and in a large number almost all of the teeth were affected. Some mouths were in an appalling condition. The teeth were decayed down to the roots so that the children had an almost edentulous appearance.
Sub-section (2)
GENERAL DISCUSSION OF THE PROBLEM OF DENTAL CARIES.

(a) Widespread occurrence of Dental Caries.

In Great Britain dental caries is an almost universal affliction attacking all sections of the population, and at all ages from the period of eruption of the teeth onwards. Even from the Outer Hebrides - in which until recent years complete sets of undamaged teeth in adults could be met with relatively frequently - the same story of widespread caries has been reported. Whenever surveys have been undertaken, or in ordinary School Routine Medical inspections and Dental inspections, or in the examination of Recruits for the Forces, or of applicants for admission to certain trades and professions, it has for long been the rule to find signs of active caries or evidence indicative of previous dental disease in a very high percentage. Notwithstanding improvement in the standard of living and the newer knowledge relating to diet, particularly infant diet, and in spite of the measure of control of infant life exercised by the M. & C.W. services, there has not, so far, been an improvement proportional with the labour expended or the facilities provided.

It can be inferred from these facts relating to the widespread extent of the trouble and from the varied ameliorative measures advocated, that no single agency has been proved to be at fault and, indeed, as the evidence at present stands it is unlikely that any single factor will be incriminated. The concensus of opinion is that a combination of several factors acting in the pre-natal or post-natal period, or in both, ultimately
produce a condition of the teeth which lowers its resistance to the forces which initiate decay.

(b) Caries in School Children.

The condition of the teeth of school children and of adults is so well known that little need be said by way of illustration. It will suffice to quote a few figures. In England and Wales in 1933 - 3,303,983 children were examined by the School Medical Service and of these it was found that 2,263,135 or 68.5% were recorded as requiring dental treatment. (8) As children of all ages were included, a certain proportion, probably large, of the remaining children would have had dental treatment at another period. In 1937, out of 3½ million children examined by School dentists, approximately 2½ millions required treatment. (11) In 1938, the last year for which statistics are available at time of writing, almost identical figures were recorded. (12) The Annual Report of the Department of Health for Scotland for the year 1936 recorded that 70% of children examined had caries. It was not claimed, however, that the remaining 30% had never had dental caries nor that they had complete sound sets.

(c) Condition of Deciduous Teeth.

When we consider the dental state of children aged 5 years a better idea can be obtained of the extent to which the malady affects the youth of the nation. At age 5 years the eruption of the permanent teeth commences and though some of the deciduous teeth may have been lost earlier by natural processes connected with this developmental stage, yet in practice it is seldom that this is found. The majority of children of that age
have the twenty teeth of the temporary set still unless some have been extracted for dental reasons. A large proportion of them, however, display signs of the ravages of caries.

For example, Mrs. Mellanby in an inquiry into the state of the teeth of five year old children in London, found that only 4.7% of an unselected group of 1293 children were free from caries, while 83.6% had severe caries. These children were examined by means of the mirror and probe. (15) The data obtained at dental inspection of 5 year old children in Stockton-on-Tees has been reported thus. Those with entirely sound and complete deciduous dentitions amounted to only 5.6% in 1931, 6.4% in 1932, 7% in 1933 and 8.2% in 1934. (73) These results are approximately the same as those obtained by me. The remainder of the children in the Entrants Group had dental caries in varying degree. A New York investigation showed that the temporary teeth of children in the slum areas and from among the wealthy were almost equally prone to be attacked by caries. It was revealed that 90% of the children examined were found to suffer from caries in some degree. (104)

These figures and those recorded by me above as having been found during my 1940 survey, disclose a state of affairs which cannot be regarded with equanimity. The statements which have been made by some, which are designed to show that the position is not as serious as would appear from the statistics because of the absence of any disastrous effects on the health of the sufferers
from gross caries apart from exceptional cases, surely constitute no reason for refusal to embark on any practicable measures which might prevent this deplorable state.

A necessary preliminary to any successful preventative measures is the discovery of the cause or causes of the trouble. Considerable labour and thought have already been expended on the elucidation of this problem, and the salient features of the analysed results are as follows.

(d) Dental Hypoplasia as a Precursor of Caries.

It is generally agreed that Dental hypoplasia involving both Enamel and Dentine is the essential defect, almost a sine qua non of caries. A direct relationship has been traced between imperfect dental structure and subsequent decay. (78) This defective formation of the teeth is found to be very common. In one investigation it was discovered that over 80% of some 800 children's teeth (extracted or shed naturally) which were subjected to careful microscopic examination were defective in structure. (32) School dentists have commented on the wide prevalence of dental malformation, much of it of a gross type which can be detected by naked eye examination.

The fissures and pits which are present in these defectively formed teeth have been shown to have enamel which is thin or even absent in the depth of the crevice. These irregularities harbour organisms and collect carbohydrates and other food materials. (32) Acids are formed by the action of bacteria and as neither the
alkaline saliva nor the cleansing action of the toothbrush reach these danger areas, decay ensues; the underlying dentine is soon reached and as it is poorly resistant, quick extension follows.

In the past it has been customary to stress oral hygiene to the exclusion of all else in the etiology of dental caries. It was believed that healthy teeth could be attached and damaged by acids from the fermentation of carbohydrates, and that scrupulous attention to brushing would eliminate the possibility of caries. This belief has persisted, in spite of the known freedom from caries of certain native tribes, for example West Indians, who not only consume carbohydrates in the form of sugar, but pay no attention to the cleansing of the teeth. So firmly rooted has this belief been - which is at best only half a truth - that the author of a recent volume on the care of the teeth thought fit to point out that no amount of cleansing of the teeth could of itself preclude the possibility of dental decay. (18) Interesting work, but inconclusive from the point of view of the etiology of caries, has been carried out on the pH of the Saliva and on the association of L. Acidophilus with caries. (1)

(e) Causes of Dental Hypoplasia.

The causes of Dental hypoplasia have been listed by the Dental Board of Great Britain as follows: (32)

(1) Certain acute illnesses.

(2) Chronic conditions of illhealth and lowered vitality during infancy.

(3) Defective diet (a) of child.
(b) of mother.
That acute illnesses have been chosen by the Dental Board to head the list, is a fact which should not be overlooked. The deleterious action of acute illness on developing teeth has for long been recognised. Mebane (75) stated that in the control of caries in childhood and adolescence the prevention of general infections constitutes a measure of considerable importance. "It is well known" he says "that the teeth often decay rapidly during and after febrile diseases." The illnesses of children act upon the enamel in a way similar to that of local inflammation, but instead of a local effect, the portion of the enamel of all teeth developing at the period of the illness, is damaged. Thus if a child soon after birth is seriously ill the tips of the Incisor teeth and the cusps of the first permanent molars which are forming at that period will have soft brownish enamel, deficient in amount and covered with pits. If the illness be later, the enamel tips may be more or less perfect, but below this there will be a band of badly formed enamel corresponding to that forming at the date of the illness. (32)

Chronic conditions of illhealth and lowered vitality during infancy react on the whole system. There is a general retardation of growth and development of the body and the teeth are also affected. Those who are called on to attend to children in clinics and hospitals recognise that debilitated children exhibit the evidence of illhealth in many ways and not least in the structure of the teeth and in their resistance to decay.
The question of the effects of the diet of the mother resolves itself into the provision of certain food factors and nutrients to the child during the prenatal and lactating stages; while the effects of the child's diet are dependent upon the presence or absence of the same factors. Some information on what may be of importance has been obtained by field investigations and by animal experiment, and further additions to our knowledge will accrue from the controlled feeding experiments on children and expectant mothers, which are being conducted in certain industrial areas.

(f) Significance of certain Vitamins and Mineral Substances.

As the teeth begin to form and harden very early in life (in the case of the milk teeth several months before birth) the health of the pregnant mother is as important as that of the child, and particular care should be taken to ensure that her diet is not deficient in any of the nutrients or known food factors. A summary of these essential requirements in the light of present knowledge is as follows:

Vitamin D. The action of Vitamin D on the developing tooth is similar to that played by this food factor in the formation of bone. The enamel consists of hexagonal prisms set vertically on the dentine. These prisms are fibrous but later become impregnated with phosphate and carbonate of lime. When Vitamin D is deficient during the period when the tooth is being formed and the enamel laid down, defects arise which pave the way for caries. Research work to determine the effect of adding this factor to the diet of children to see
whether the incidence of dental disease was affected, (78) produced results which confirmed the previous work of Mrs. Mellanby and the Dental Committee of the Medical Research Council (77) in so far as Vitamin D was concerned. It was found that the dental decay that developed in the children receiving Vitamin D was definitely less than in the control children. To quote from the Report "the beneficial effect of Vitamin D in inhibiting the initiation and spread of caries was particularly impressive when the improved diet was given during the period of development and before full eruption of the tooth."

The authors of this Report stressed the importance of the substance in cereals, particularly in the bran and germ, which tends to hinder calcification of the tooth as well as ossification of bone. They remarked that this inhibitory effect is especially active in the absence of Vitamin D or when excess carbohydrates are consumed. Edward Mellanby referred to this antagonising factor as "toxamin", (80) and he has since suggested that it is Sodium or Potassium Phytate. *

**Calcium and Phosphorus.**

It need hardly be said that Calcium and Phosphorus in optimum amounts and in correct ratio of 1:1 or 1:1½ are as essential in the correct development of the teeth as they are in the ossification of bone. (52) As was indicated in a previous section, (Section VIII) there is little likelihood of these minerals not being present in adequate quantities in the diet of the suckling or bottle fed child; but after weaning and the change to mixed diet there is a grave danger of serious deficiency

* Vide earlier comment on page 155.
of Calcium in the diet, unless regular allowance of milk, of at least one pint, is ingested daily. The administration of Vitamin D will ensure sufficient absorption from the intestine. In cases where there is a low intake of these minerals by the expectant mother, the reduction of her own stores in the interest of the foetus is the physiological expedient resorted to by nature.

**Vitamin C.** Without implying that any statements have been made which claimed for Vitamin D the status of a dental panacea, it is probably correct to say that dissatisfaction has been experienced by those who expected that the use of Vitamin D by the expectant mother and by the infant would quickly produce improvement in the dental state of the youth of the nation. This dissatisfaction was the result of failure to appreciate the role played by other factors in this process. Hutchinson's view is that though the administration of Vitamin D from early infancy decreases the incidence of trouble with the teeth, it by no means obviates it. The absence of some necessary element or the presence of a harmful substance had to be considered. One of these essentials may be Vitamin C, in cases in which there is definite deficiency.

As a result of dietary surveys and of animal experiments, increasing emphasis is being laid on the necessity for adequate quantities of Vitamin C during the prenatal period and later. No definite conclusions have been arrived at as to how sensitive is bone development to a shortage of Vitamin C but there is good reason to believe that Vitamins C and D may be co-equal with regard to their indispensability during tooth
formation. When Vitamin C is withhold from Guinea Pigs, changes arise in the odontoblasts which vary with the degree of C-hypovitaminosis. In mild cases they degenerate and there is irregular formation of dentine. In a severe state of deprivation the odontoblasts degenerate completely and no new dentine or enamel is formed. (126)

Vitamin A. With regard to Vitamin A, May Mellanby was of the opinion that infection of the subgingival epithelium is prone to develop when there is a deficiency of Vitamin A in the diet; and it has since been suggested that there is a simultaneous malformation of dentine and enamel. (g) Resistance to Caries of Teeth of certain Individuals.

In spite of the advances in our knowledge, the position is still somewhat obscure and the question of the fundamental reason for caries and that of its control after initiation have yet to be satisfactorily settled. A difficult point has been raised by the observation that a small percentage of children remain consistently free from caries without special attention to diet, or to oral hygiene. With regard to the possibility of a state of immunity, school dentists were asked by the Board of Education to make records - sufficiently complete and accurate to be of scientific value - of children of 12 years of age whose mouths had remained completely free from Dental Caries from the period of eruption of the teeth. The response was disappointing, and consideration of the reports submitted yielded little of value in the elucidation of the problem. The dietetic habits of the children with complete sets of sound teeth were so varied and contrary to what one would have expected that the
Report described them as "bewildering." (9) The one generalisation made with any degree of certainty was that "the regular use of a tooth brush is not always essential for the maintenance of freedom from caries." It was further considered that some children may possess a true immunity to caries which may persist "in spite of, rather than because of their way of life." In connection with the state of freedom from caries possessed by some people, an interesting report (99) on the dental condition of the inhabitants of Tristan de Cunha, who were examined early in the year 1932, revealed that all persons under the age of 21 years (78 in number) were entirely free from caries, and of the 32 persons between the ages of 21 and 32 years, 30 had perfect mouths. The diet consisted of fish, potatoes, eggs and milk. Very little cereal foods and practically no sugar was consumed. It was noted too that the teeth were never cleaned and that they had generally a dirty appearance.

That a daily ration of milk is a valuable asset in the protection of the teeth from caries has been demonstrated repeatedly, especially in the investigation of the response made by children of school age to the inclusion of ½ or ¾ pint in the diet. Of even greater importance is the degree of success achieved in the case of a test commenced during infancy. Forty children of an average age of 4½ months were given milk regularly and when age 4 years was reached all of them were entirely free from caries. (108) Later follow-up examination of these children will produce instructive data. Other completely different lines of research are being explored. The presence of some substance - as yet unidentified - in
the saliva which protects the teeth, has been postulated to account for freedom from caries, particularly in the case of certain West Indian tribes whose cereal consumption is high. Recently evidence has been brought forward that Fluorine may play a part in the resistance of the teeth to caries. (105)

(h) Summary of Principal Factors.

As far as the present state of our knowledge entitles us to go, the dietary and hygiene regime most likely to result in a child having well formed teeth should, in addition to other factors, embody the following:-

(A) For the Expectant Mother.

(1) Adequate Vitamin D. Between 800 and 1200, International Units per day throughout pregnancy and lactation.

(2) An increased intake of Calcium (total intake figures vary from 600 to 900 mgs daily) through ordinary diet if possible. If Calcium in the usual diet is adequate there will also be sufficient Phosphorus.

(3) Liberal quantities of fruit, and leafy vegetables with a total Vitamin C intake of between 150 and 300 mg daily.

(4) One pint Milk daily. Wholemeal Bread.

(B) For the Infant.

(a) During Infancy and irrespective of the type of feeding (Breast or Bottle)

(1) Vitamin D. At least 500 International Units daily.

(2) Vitamin C. Preferably from natural sources. Daily optimum 50/100 mgs.

(3) Prevention of acute infections and care during illness with considerable increase in the Vitamin C intake.
(b) After weaning to Mixed Diet.

(1) Prevention of illness and extra care during illness with coincident increase of Vitamin intake.

(2) Additional Vitamin D to at least six years of age; 500 to 1000 I.U. daily.

(3) Milk, fruits, leafy vegetables. Wholemeal Bread.

(4) Attention to oral hygiene.
SECTION XIII.

INQUIRY INTO THE SLEEP HABITS OF 400 NUTRITION C CHILDREN
TOGETHER WITH NOTES ON THE EFFECTS OF CHRONIC OVER-FATIGUE
AND INSUFFICIENCY OF SLEEP ON THE HEALTH OF CHILDREN
Sub-section (1)
(a) Introduction.

There is considerable evidence in support of the belief that chronic over-fatigue is very common among children of all ages in Britain. This problem of over-fatigue is closely connected with that of inadequate sleep and is, in fact, inter-related so both conditions will therefore be considered together in this inquiry into the parts played by over-fatigue and insufficient sleep on the health of the developing child.

It has been recognised for many years that school children and those of pre-school age as well, and in the cities in particular, all too frequently show signs of tiredness and listlessness which could not be attributed to any pathological defect or physiological error other than that of a long-standing insufficiency of sleep.

(b) Principal causes and effects of Chronic Over-fatigue.

Recapitulation of some of the salient features of the effects of chronic insufficiency of sleep and of over-fatigue in children will serve to illustrate the complexity of the problem and the difficulties of coping with it adequately. It is necessary in the first place to distinguish between natural fatigue which is the result of normal exercise, and a state of over-fatigue that has serious repercussions on health and nutrition. As mentioned above, the prime factor in the causation of over-fatigue consists in inadequate sleep continued night after night. Inadequacy of sleep may be of two forms. It may be a simple insufficiency as a result of the child
being too late in going to bed. Secondly, the quality of the sleep may be interfered with by extraneous factors such as noise, within the house or from the street; by defective hygienic arrangements - for example insufficient ventilation or over-crowded beds or rooms; and, in some cases, by ill-advised dietary habits, especially in towns in which fried fish shop facilities are well developed. Other factors, which must be taken into consideration in individual cases of over-fatigue are listed below, but no opinion can be expressed as to their respective importance because their significance varies according to the situation of the district, the social class of the parents, and the provision of counter-attractions for the children outside the home. They are:

(1) Habitual late hours of parents and later listening to wireless programmes.

(2) Unhappy home conditions; domestic friction or disputes giving rise to nervous strain on the child, leading to nocturnal wakefulness and poor quality of sleep.

(3) Attendance at Film Shows, Boys’ Clubs or Communal play until too late in the evening. The excitement curtails the period of restful repose in addition to making bed-time too late.

(4) Overstudy at school and in the evenings, and anxiety about school work in a few cases.

(5) Over-indulgence of children by parents. In the case of the well-to-do and the poor the child of even tender age is accorded considerable freedom of decision. Its refusal to go to bed at correct hours is too frequently treated with complacency or met by feeble protest by the parents. It is a question of domestic mismanagement and of parental incompetence.
The physiological processes of the child who suffers from chronic over-fatigue are interfered with in various ways. The relaxation of muscular tension which normally takes place during sleep is not fully obtained and the reduction in the Basal Metabolic Rate, which experiments have demonstrated coincides with the period of sleep, is partially interfered with. It has been shown that in a 6 year old boy, the heat production was 3 times higher when awake than when asleep. (126) Even a partial loss of this natural and beneficial decrease in the activity of the body processes, throws a strain on a developing child and, when there is added to that loss the normal high energy output of the child during exercise and play, and the energy requirements for growth it is clear that the constitution of such an unfortunate child is in danger of being weakened.

Unfortunately, one of the unwise dietary habits of many of our poorer children which is fostered by an unsatisfactory domestic economy, consists in the consumption of, or the excessive consumption of, tea. All too frequently in the cases examined by me, tea was the beverage favoured by the children at each of the three principal meals of the day. The effects of moderate doses of the active principle of tea are a quickening of the Respiration and pulse; a slight elevation of Blood Pressure; and an increased activity of the kidneys and - the point which I wish to stress - a mild excitation of the brain and a tendency to do away with a feeling of fatigue or depression. The evil of the excessive consumption of tea by children is plain -
nature's warning that rest is required is dulled or inhibited and the child continues its activities, spurred on by the excitation of the drug. Dullness and sleepiness in the morning are again countered by tea before setting out for school and the day's round of play and work further depletes the stores of energy.

Coupled with these general observations it should be borne in mind that over-fatigue and strain may interfere with the processes of digestion.

(1) By inhibition of the flow of Saliva and Gastric juices and
(2) By diminished activity of the Gastric musculature.

Anorexia and indigestion originating in this way are frequently present in children who are over-active or who receive insufficient rest. It has been suggested that anaemia may arise as a result of insufficient rest not only because of digestive disorders but through interference with tissue repair and growth. (120)
Sub-section (2)

(a) Importance of Standard.

In any inquiry into the sleep habits of children, it is necessary to have a Scale based on the number of hours of sleep required at each year of age. Though adherence to the Scale is the only foundation by which accurate data can be obtained, it is not without its faults. For example the actual hours of sleep may not extend from bedtime to the rising hour. Some children habitually lie awake for an hour or more before dropping off to sleep. Then, again, the poor quality of sleep of the restless tossing child who has been over-excited, or the disturbed sleep of the child in a noisy home or street, or the uneasy nights in the overcrowded bedrooms of the poor, frequently too hot and airless in the Summer and cold and cheerless in Winter, lead to the child's rising from bed unrefreshed, in spite of having retired at the approved hour.

(b) Present Investigation.

The hour of rising of all children was fixed at 7 a.m. because, in an industrial area, such as the one under examination, most households are roused at that time if not earlier. The variation in the number of hours of rest is therefore almost completely dependent upon the time of going to bed. For ease of reference, the bedtime hour in each case is included in the table (XLII)
TABLE XLII

<table>
<thead>
<tr>
<th>AGE</th>
<th>RECOMMENDED DURATION OF SLEEP</th>
<th>BEDTIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 5 Years</td>
<td>12½ Hours (Upper Limit Sleep)</td>
<td>6:30 P.M.</td>
</tr>
<tr>
<td>6 to 7 Years</td>
<td>12 Hours</td>
<td>7 P.M.</td>
</tr>
<tr>
<td>8 to 9 Years</td>
<td>1½ Hours</td>
<td>7:30 P.M.</td>
</tr>
<tr>
<td>10 to 12 Years</td>
<td>11 Hours</td>
<td>8 P.M.</td>
</tr>
<tr>
<td>13 to 14 Years</td>
<td>10 Hours</td>
<td>9 P.M.</td>
</tr>
</tbody>
</table>

Data obtained.

The results of the inquiry into the sleep habits of the 400 Nutrition C children reveal that half of them went to bed at too late an hour. Some of the replies given by the mothers during the course of the inquiry may not have been quite accurate and the total figures for children having insufficient sleep may, as a consequence, be lower. Parents were aware of the official attitude because of the efforts of School Medical Service and School teachers to encourage earlier bed-time for children. The subsequent direct questioning of the parents on this point may have produced a higher proportion of favourable replies than those who are familiar with conditions in the area would have expected. In spite of that, it is significant that 50% of these 400 children did not go to bed at a time which could have allowed them to have the minimum amount of sleep consonant with health. The figures obtained are set out in Table XLIII.

TABLE XLIII

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>NUMBER</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Had Sufficient Sleep</td>
<td>194</td>
<td>49.0</td>
</tr>
<tr>
<td>Had Insufficient Sleep</td>
<td>194</td>
<td>48.5</td>
</tr>
<tr>
<td>Not Recorded</td>
<td>10</td>
<td>2.6</td>
</tr>
</tbody>
</table>
SECTION XIV

INQUIRY INTO THE POSSIBILITY OF RELATIONSHIP BETWEEN DEFECTS OF VISION IN CHILDREN AND LOW NUTRITION GRADE.

(1740 CHILDREN AGE 8 YEARS AND OVER)
Sub-section (1)
Notes on the high incidence of Defective Vision in School Children.

Defective vision in school children may have profound consequences on the career, either scholastic or industrial, of those affected. It is a subject which is receiving increasing attention by the responsible authorities, but which is still regarded as being among the less important disabilities.

Reference to the Annual Reports of the Chief Medical Officer to the Board of Education for recent years shows that, of defects found to require treatment at Routine Medical Inspections in Schools defective vision occupies the principal place each year, and that by a substantial amount. In order to illustrate the position Table XLIV has been prepared. It has been modified from that embodied in the Health of the School Child for the year 1938. (12) In it the main defects found by School Medical Officers at these school inspections, and the incidence per 1000 inspections during the years 1934 to 1938 - the last year for which complete returns are at present available - are set forth.

<table>
<thead>
<tr>
<th>DEFECT FOUND AT MEDICAL INSPECTION</th>
<th>1935</th>
<th>1936</th>
<th>1937</th>
<th>1938</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFECTIVE VISION (EXCLUDING ENTERIC)</td>
<td>8-1 %</td>
<td>7-6 %</td>
<td>7-5 %</td>
<td>7-4 %</td>
</tr>
<tr>
<td>CHRONIC TONSILLITIS</td>
<td>1-9 %</td>
<td>2-0 %</td>
<td>2-1 %</td>
<td>2-0 %</td>
</tr>
<tr>
<td>ADENOID AND CHRONIC TONSILLITIS</td>
<td>1-9 %</td>
<td>2-0 %</td>
<td>2-1 %</td>
<td>2-0 %</td>
</tr>
<tr>
<td>SKIN DISEASES</td>
<td>0-9 %</td>
<td>0-9 %</td>
<td>0-9 %</td>
<td>1-0 %</td>
</tr>
<tr>
<td>STRABISMUS</td>
<td>0-7 %</td>
<td>0-7 %</td>
<td>0-7 %</td>
<td>0-8 %</td>
</tr>
<tr>
<td>NUTRITION C</td>
<td>10-4 %</td>
<td>10-5 %</td>
<td>10-6 %</td>
<td>10-8 %</td>
</tr>
</tbody>
</table>
The data recorded in the table indicate the proportion by which defective vision retains its place, year by year, as the main disability - excluding Malnutrition - from which school children suffer. Conditions affecting nose and throat and skin diseases are next in order of importance, but the numbers recorded are very much less than in the case of visual defects. Furthermore, in each annual return, figures for Strabismus approximate in size to those for skin disease and succeed it in the scale of incidence. It is plain therefore that Visual Defects, even excluding Squint, rank first in order of importance after subnormal nutrition, as a source of disability to the school child. This is a matter which calls for further investigations as the importance of vision, in all its aspects (during school life and afterwards) can hardly be over-emphasised.

The line of approach to the problem of which this paper is a short account, originated in the observation of Dr. H.M. Traquair (in a personal communication) that many of the children referred to him for ophthalmic inquiry required, primarily, nutritional investigation and dietetic treatment. In addition, as defective vision (excluding Corneal Ulceration and Blindness arising as a complication of Measles) has been known to become apparent after acute illnesses - especially the contagious illnesses of childhood - and as the debility from these diseases is frequently severe and prolonged, association of the two conditions - debility and visual defects - was natural. It seemed that additional statistical information on the subject was called for.
Accordingly the opportunity of a Nutrition Survey was utilised to provide a basis and data for a short statistical inquiry into the question.
Sub-section (2)  
PLAN OF PRESENT INVESTIGATION.  
(a) Method of Vision Testing.

Snellen's long distance chart was employed in testing the vision of the School Children. The test is ordinarily performed before or during the Routine Medical Inspection and the results for each eye are recorded in the appropriate section of the Medical Record Card. Care is taken that the illumination of the chart is adequate and that the distance of the child from the chart is 20 feet. The employment of the Snellen's chart method presupposes a knowledge of the alphabet and, as is the routine practice, only children aged eight years and over had had the vision tested in school. Therefore the data presented here relate to children above eight years of age.

The standard adopted was that if a child could read no further than the 6/12 line, with either eye, he is referred for full ophthalmic examination.

(b) Assessment of Nutrition and arrangement of Data on Vision.

The nutrition grade of all children had been assessed by the method outlined in an earlier section (Section III). For the purposes of this enquiry the Medical Inspection cards of 1740 children from nine Junior and Senior Schools in the district were examined without selection. They were arranged according to the nutrition Grade, and the numbers of children who had been referred for ophthalmic investigation in each nutrition grade were counted, and percentages prepared. These are set out in Table XLV.

In addition the numbers of children with Strabismus were arranged similarly.
TABLE XLV.

<table>
<thead>
<tr>
<th>Nutrition Grade</th>
<th>Total Children in Nutrition Groups</th>
<th>Defective Vision</th>
<th>Strabismus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Percentage</td>
</tr>
<tr>
<td>Grade A</td>
<td>304</td>
<td>29</td>
<td>9.5%</td>
</tr>
<tr>
<td>Grade B</td>
<td>1262</td>
<td>164</td>
<td>13%</td>
</tr>
<tr>
<td>Grade C</td>
<td>171</td>
<td>33</td>
<td>19.5%</td>
</tr>
<tr>
<td>Grade D</td>
<td>3</td>
<td>2</td>
<td>66.6%</td>
</tr>
<tr>
<td>Totals</td>
<td>1740</td>
<td>228</td>
<td>—</td>
</tr>
</tbody>
</table>

Comments on the Data in Table XLV.

Of the 1740 children included in the inquiry, 1262 had been graded Nutrition B and 304 and 171 Nutrition A and C respectively. Three children were found to be Grade D.

With regard to vision, 228 cases had been referred to the Ophthalmic Clinic on account of failure to pass the Snellen Test standard. When these 228 children were arranged according to the previously determined Nutrition Grade, it was found that of the 304 Nutrition A children, 29 could not read beyond the 6/12 line. In the case of the Nutrition B children, 164 did not comply with the pass standard and the corresponding figures in the C and D groups were 33 and 2 respectively. The relationship between the different grades is more clearly seen in the percentage columns which shows that 9.5% of the Nutrition A children, 13% of the Nutrition B, and 19.5% of the Nutrition C children required further ophthalmic investigation. Of the small number of Nutrition D children 2 cases (66.6%) had defective vision. These figures suggest that an association exists between Nutrition Grade and visual acuity.
POSSIBLE BEARING OF DEFECTIVE NUTRITION ON THE ETIOLOGY OF MYOPIA.

As Myopia - which is only occasionally encountered in infants - is of frequent occurrence among school children and throughout adolescence, it is convenient to enquire into the etiology of that particular form of visual defect in order to discover if it is possible for malnutrition to play a part in its development.

Many theories have been advanced and the number and variety of the hypotheses provide an indication of the obscurity surrounding the problem and of the difficulties confronting its elucidation.

Some of these theories are of particular significance in relation to the present inquiry into the possibility of a connection existing between malnutrition and defective vision. In the first place there is the theory associated with the name of Levinsohn which places the responsibility for acquired myopia on a weakening of the Sclera and distortion of the eyeball by forces occasioned by the weight of the eyeball and of the blood in the orbital veins. The offending action which brings these forces into play is looking downwards constantly, particularly during reading or when doing close work. In the case of a child who suffers from malnutrition and whose tissues are therefore already weakened, it is probable that a lesser degree of strain could have harmful results.

Ochi supports the Ocular-Muscles-Pressure theory. He takes the view that if the strength and resistance of the Sclera are less than normal, even the
compression of the ocular muscles alone could increase the antero-posterior diameter of the eye; and he ascribes juvenile progressive myopia to this. He contends, however, that this is possible only in the case of a lowered resistance of the Sclera. Healthy tissues do not yield. Obviously, in the presence of malnutrition conditions are favourable to the operation of the process described. It is interesting to note that Keith (57) takes the view that myopia should be ranked among the disorders of growth, and that he thinks that the factors which produce myopia are operative in the growing eye and give rise to disorganisation of the growth-controlling mechanism of the Sclera. Other workers, for example Sonder, (106) are of the opinion that the origin of myopia should be attributed to the acute infectious diseases of childhood. This theory could not account for all nor even for the majority of cases because although the incidence of Infectious Diseases is higher among children of excellent nutrition (Grade A) - as has already been shown - (Section VII) yet the occurrence of defective vision is considerably lower among these children than among those who were placed in the lower nutrition grades. A proportion of cases do arise as a sequel to Infectious Disease, but it is probable that they are the result, not of the Infectious Disease, but of the subsequent debility from which some children suffer.

In each of these theories the conditions requisite for the production of myopia are found, par excellence, in children who suffer from defective nutrition.
Various other theories have been propounded to account for certain types of case. In some the defect is attributed to hereditary causes; or a simple mechanical cause is advanced, such as that in which the growth of the eyeball is stated to be under the influence of the Ciliary muscle - increased activity of the latter resulting in overgrowth of the eyeball.

Irrespective of the validity of any of the various theories, it is evident that the physical integrity of the tissues of the eyeball has been accorded considerable importance. If the physical state of these tissues is impaired by malnutrition, in which there is a weakening of all of the tissues of the body, then an alteration in the anatomical shape of the eyeball can arise the more easily.

**SUMMARY.**

There is reason to believe that malnutrition may play an important part in the etiology of visual defects in childhood. Visual defects of even minor degree are deserving of careful attention as they constitute a hindrance to scholastic work, having a psychological effect on some children (which might have repercussions in later life) and require treatment which necessitates considerable expenditure of time and money. Though it is doubtful if correction of malnutrition after the development of organic changes in the eyeball could restore the organ to normal, yet arrangements for a full clinical examination, and for a socio-economic enquiry into the domestic circumstances of all cases of defective vision
when first detected, would enable the nutritional position to be ascertained and appropriate action taken. Particular care - including examination by Refraction - of all school entrants who, on admission, are found to be in one of the lower nutrition grades, might prevent the development of a number of cases.
SECTION XV.

INQUIRY INTO THE SCHOLASTIC ATTAINMENT OF 712 CHILDREN AGE 7 YEARS AND OVER, AND INTO POSSIBLE RELATIONSHIP WITH NUTRITION GRADE.
METHOD BY WHICH DATA WERE OBTAINED.

During the course of the Nutrition Survey the head teacher of each school was asked to provide a list of the names of boys and girls who were exceptionally bright and those who were particularly slow according to normal educational standards. There was no suggestion of backwardness, in the sense of inherent mental defect, in the case of these slow children. It was stipulated by me that the names of children aged eight years and over only should be submitted. The age of eight years was decided upon as the minimum age because, in the view of several teachers of experience who had given consideration to the matter and with whom I discussed the position, some children who appeared to be slow and dull on entry to school improved after they had become familiar with their new surroundings and had gained confidence. This age restriction does not in itself affect the validity of any deductions which may be drawn from the results.

The aim of the investigation was to determine what, if any, correlation could be established between mental alertness or slowness on the one hand - as estimated by the teacher - and, on the other hand, the nutritional grade of the child - as assessed by the medical officer.

The nutritional status of the children had been determined by me some weeks earlier and the findings recorded on the Routine Medical Inspection cards. When the names of the bright and slow children had been obtained from the teachers, these medical cards were referred to and the grade recorded thereon noted. Subsequently, the data were classified and tabulated. Reference to the
tables below shows that the classification is based on
the Nutrition Grades and that boys and girls are considered
together and separately.

Sub-section (1)
TOTAL FIGURES (SEXES COMBINED)

In Table XLVI the numbers of Bright and Slow children in each of the four nutrition grades and the respective percentages are set out.

<table>
<thead>
<tr>
<th>CLASSIFICATION</th>
<th>NUTRITION A</th>
<th>NUTRITION B</th>
<th>NUTRITION C</th>
<th>NUTRITION D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NUMBER</td>
<td>%</td>
<td>NUMBER</td>
<td>%</td>
</tr>
<tr>
<td>BRIGHT CHILDREN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(355)</td>
<td>100</td>
<td>28.2</td>
<td>235</td>
<td>66.2</td>
</tr>
<tr>
<td>SLOW CHILDREN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(357)</td>
<td>24</td>
<td>67</td>
<td>251</td>
<td>70.3</td>
</tr>
</tbody>
</table>

Comments on Table XLVI.

A total of 712 children (355 Bright and 357 Slow) had their names put forward by the teachers.

Taking the Bright children first - out of 355 children 100 (28.2%) were Nutrition A and 20 (5.6%) were Nutrition C. The remaining 235 children were classified as Nutrition Grade B.

In the case of the slow children the number whose nutrition status could be passed as excellent (Grade A) was 24. This was 6.7% of the group. On the other hand 22.1% (79 children) of these 357 slow children were of definitely subnormal nutrition and were rated Grade C.
In addition all of the three cases of bad nutrition (Grade D) were among the mentally slow children. The remainder of the group, that is, 215 children (70.3%) were of average nutrition and were classified as B.

It is of interest to note that the relative proportion of A and of C children in the groups of Bright and Slow children are to all intents and purposes reversed. Over 20% of the bright children and some 6% of the dull children were Nutrition A, whereas Nutrition C cases among the slow children amounted to over 20% of the whole group and the much smaller figure of 5.6% represents the Nutrition C cases among children found to be bright at school. It is obvious from these figures that a condition of subnormal nutrition constitutes a serious handicap on the educational advancement of the child.

Data for Boys and Girls separately.

Figures relating to sexes separately were prepared and some interesting results were obtained. The data are set out in Table XLVII. A total of 583 children (280 boys and 303 girls) were considered.

<table>
<thead>
<tr>
<th>TABLE XLVII</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEX</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>BOYS</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>GIRLS</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Comments on Table XLVII.

Of the bright children graded Nutrition A, 26% were boys and 30% were girls; that is, there was a 4% difference in favour of the girls. On the other hand slow children graded Nutrition C, amounted to 18.6% of the boys and to as many as 26.6% of the group of girls.

It would appear from these figures that the mental activity of girls is even more closely related to their general physical state than is that of boys.
FINDINGS IN OTHER INVESTIGATIONS.

References in the literature to the effects of malnutrition on educational status are not numerous but almost without exception they stress the importance of malnutrition as a cause of scholastic retardation. For example Baldwin (3) deduced from his investigations into the physical and mental growth of children that on the average the well-grown, well-nourished child is generally superior to the smaller child of the same age in its school record. Another investigation in which 423 children were examined by Group Intelligence Tests and graded physically as well, showed that 52% of the group with the highest intelligence scores had no physical defects whereas all of the children with the lowest scores had physical defects. (100) When a considerably larger group of 4558 children was surveyed a definite correlation was established between "intelligence" and the state of the health. (90) A more recent statistical study of the physique of elementary school children with special reference to their mental ability was recorded by Habakkuk. (43) He examined the records of 3914 boys and girls of ages 7 to 12 years in South Wales and he came to the conclusion that the most backward were the shortest and the most advanced the tallest. A similar attempt to correlate physical development and intelligence was undertaken in Glasgow. (31) The evidence obtained was such that it could be maintained that the taller children were definitely more active mentally. In this
connection it should be stressed that there is general agreement among experts on nutrition that height is a much better index of the nutritional state than is weight.

The investigations of the authors of Genetic Studies of Genius (113) make it clear that genius and exceptional brilliance are associated with, and are probably dependent upon a sound physique and, to a certain extent also, upon the superabundant energy which good health promotes.

Though malnutrition does not cause mental deficiency, it does give rise to mental retardation. (36) Various observers have commented upon this and recently Orr stated (86) that "the power to use intelligence depends upon the state of the health." To anyone who examines children suffering from malnutrition it is obvious that many of them are dull, listless and slow to grasp and understand the import of simple questions to which better nourished children of the same age respond with alertness.

In a Scots experiment involving 1425 children of from 5 to 13 years of age it was remarked that children who had been given a regular extra ration of milk were noticeably more alert and boisterous than the control group which had not had extra milk. (61) Leighton and Clark who conducted the experiment, stated that teachers remarked on the altered demeanour and behaviour of the boys. A somewhat similar response to an extra ration of milk was described by Corry Mann. (69) The test boys were obviously more fit and were much more high spirited.

The inference is - and there is some evidence to support
it - that the malnourished child who has been labelled "slow" may, as a result of corrected and improved dietetics, attain to an ability to use his mental powers equivalent to that enjoyed by his better nourished school mate.

The question of the application of Intelligence Quotient Test methods - which are designed to detect an inherent mental defect - to cases of mental retardation of nutritional origin, has received consideration. The view is taken that, in this particular type of case, dependence on the observation and judgment of a school teacher is of more practical value than is reliance on I.Q. methods. It will be generally admitted that a teacher who has had considerable experience in the handling of children is usually in a position to make valuable comment on a child who has been observed in class for months or more. Emerson put the matter concisely when he said that "mental development closely parallels physical development and any failure on the part of a child to show the interests and activities usual in children of his age should challenge attention."

(36) Consistent and sympathetic observation should therefore enable a teacher to detect even slight deviations from the normal, and at a comparatively early age.

CONCLUSION.

The data show that a strong correlation exists between nutrition and scholastic attainment. A preponderance of slow children is found in the poorer nutrition grades and alternatively a higher proportion of bright children belong to the Nutrition A than to the Nutrition C group.
Though other factors - especially domestic and environmental factors - operating outwith school hours are certain to play a part (for example the length and quality of sleep) it is my view that they are of lesser significance in this investigation, because the broad social and residential conditions are identical in each case apart from minor individual differences.
SECTION XVI.

PRINCIPAL CONCLUSIONS DRAWN FROM THE VARIOUS INVESTIGATIONS CARRIED OUT UNDER THE SURVEY WITH EMPHASIS ON THE MAIN FACTORS CONSIDERED TO BE RESPONSIBLE FOR THE DEFECTIVE NUTRITION. FIELDS FOR REMEDIAL AND PREVENTITIVE ACTION.
The investigations described show that a substantial number of children in the area are affected by malnutrition and that many other children present evidence which betokens serious deficiencies in certain nutrients which: (a) have affected the child at an earlier stage (e.g. insufficient Vitamin D (Section VII); or (b) others, such as insufficient Iron, Vitamin C, (Sections IX, X) which continue to affect the child's health adversely from infancy and throughout school life.

It has been shown that defective nutrition constitutes a serious hindrance to the child's educational progress (Section XIV); and that it may play a part in the causation of visual defects which may further handicap the child (Section XIV). In addition the burden of illhealth - as shown in his liability to Bronchial and Respiratory infection (Section VII) - and general physical unfitness, illustrated by the dental and naso-pharyngical and other defects (Sections VI and XII), which the child of subnormal nutrition has to bear, is clearly brought out; and it is demonstrated that this further diminishes his educational capabilities during childhood and his productive capacity.

These facts provide evidence that the primary aim of the work described in this thesis has been achieved; namely the demonstration of defective nutrition of a serious degree among the school children of the area.

The second aim of the work - the determination of the cause or causes of the malnutrition in each individual case in order that remedial measures (and preventative measures in respect of other members of the same family), might be taken - was carried out as completely as
circumstances permitted. In this connection particular stress was placed on the medico-social examination which included in appropriate cases rapid determination of the family income (on the basis of the then existing Provision of Meals Scheme) and discussion with the mother of the domestic culinary and dietary habits. It transpired from these investigations (see Section III, Part II; VII; XI; and XIII) that so many inter-related factors of possible etiological significance were operative in the majority of cases that it was difficult to point out confidently to one as being the principal error; and recourse was therefore had to a more general plan involving the correction of all defects which could in any way affect the child's nutrition and general health.

**IMPORTANT OBSERVATION.**

A significant fact relating to dietary habits which was elicited is worthy of special mention. It is that in many of the homes no cooked meal was prepared except on Sundays. In the opinion of Health Visitors who knew the home circumstances intimately this could, in the majority of cases, be accounted for by a lack of domestic ambition and by incompetence arising from insufficient training; added to which there was, in a number of cases, a shortage of culinary equipment. This aspect of social custom obtaining in the area led to the development by the Local Authority, of a 'cash and carry' dinner scheme to meet the needs of mothers and pre-school children.

**FACTS SUGGESTIVE OF OPERATION OF CAUSES OTHER THAN THE PURELY ECONOMIC.**

In recent years wide publicity has been given to the purely economic causes of malnutrition and stress has
has been laid particularly on the necessity for increasing the financial resources of families having young children. While not disputing the validity of the arguments used or questioning the necessity for some form of financial assistance to parents, it is clear from the facts discovered in this investigation that quite insufficient attention is being paid to other causes and that therefore the granting of money alone cannot, under the circumstances, achieve the benefit hoped for. Several observations from this study support the view that cases of malnutrition frequently occur apart altogether from lack of sufficient financial resources, and these are:

(1) The high proportion of the malnutrition cases who were members of small families.
(2) The surprisingly large number of 'only' children or first children who were in a low nutritional grade.
(3) The fact that other children living under the same environmental and economic conditions were not subnormal in nutrition.
(4) That some of the cases of malnutrition came from homes of the quite well-to-do in the district.
(5) That some of the defects observed (e.g. Rickets and Anaemia) could have been prevented by the parents at quite insignificant cost had they been fully conscious of the need; and
(6) The failure to take full advantage of the Milk in Schools scheme which made a valuable foodstuff available at reduced cost or free. (Section IV).
These facts suggest that even were the financial position of the family improved, other action requires to be taken if full benefit is to result.

**PRINCIPAL CAUSATIVE FACTORS OPERATING IN THE AREA.**

The experience obtained in this survey has led to the view that the *fundamental causes* for much of the malnutrition observed, other than the purely economic, are:-

1. **Lack of knowledge** by parents of:-
   - (a) Food Values,
   - (b) The need for balanced diet,
   - (c) Domestic cookery (simple and entailing conservation of food value).

2. **Domestic Mismanagement** involving faulty methods of rearing children in respect of:-
   - (a) Hygiene and Home Routine e.g. irregularity of meals, absence of proper bed-time arrangements, insufficient attention to personal cleanliness, etc.
   - (b) The psychological approach to the child resulting in children all too frequently deciding diet, bed-time, etc. thereby leading to ill-health, unhappiness and domestic discord.
   - (c) Home Nursing. Insufficient care during illness, especially in the case of Respiratory infections.

3. **Inadequate care of the expectant and nursing mother.** For example insufficient attention to:-
   - (a) Prevention of overwork and worry and the ill-health and mental depression which arise from bad housing conditions;
   - (b) Proper care and rest during even slight illness;
   - (c) Optimum spacing of births, etc.

**PROPOSED ACTION.**

Remedial action should be, broadly, directed into two channels:-

1. Education in mothercraft and Household Economy
including instruction in Diet and in Home Nursing. This could be given in the later years of school life or through the recently developed Youth organisations. It is advisable that boys should also be taught the main facts of the laws of health, as many fathers are not at all receptive of new ideas on diet, etc.

(2) Assistance in the home to the mothers of several children. For example by:

(a) an extension of the central cooking of mid-day dinners;
(b) Provision of home helps to be made available not only during confinements but during illness of child or mother;
(c) more close attention by Health Visitor or Nurse during the illness of the child.

Additional recommendations arising from observations in the survey.

(1) That children age 7 and 8 and 10 and 11 years should be accorded more attention than under the present Board of Education arrangements which concentrates on entrants and those aged 8 and 9. This should be directed particularly towards the detection of defective nutrition. It has been shown that more of the subnormal nutrition cases examined in this investigation were 7 years and 11 years of age than the numbers found to be other ages.

(2) That special care be taken of Entrants involving:-

(a) Concentration on Nutrition assessment clinically with re-examination in 6 months.
(b) Ophthalmic investigation with a full medical examination and a medico-social inquiry in all cases of visual defects.
(c) In view of the difficulty of detecting malnutrition clinically in the early stages, there should be 2 examinations at six-monthly intervals for all age 5 years, failing the introduction of a more precise device than clinical assessment for the estimation of nutritional condition.

I should like to emphasise, in conclusion that much of the work at present being carried on in schools would be superfluous, and much defect would be prevented, if there were more effective care and supervision of children in the pre-school toddler stage. The establishment of Nursery classes points the way.
SUMMARY OF THE WHOLE INVESTIGATION.
(1) A concise account is given of landmarks in the historical development of the science of nutrition.

(2) As a preliminary to the detailed account of the findings of the Nutrition Survey and of the other inquiries, various particulars illustrative of the sanitary and social conditions in the area under survey are given. Certain terms used in the text are defined; and the wider aspects of the problem of malnutrition discussed. The classification of Nutrition according to the Board of Education's Scheme is explained and the relative value of assessment by clinical standards and by the use of indices is discussed. The important part played by the League of Nations in encouraging the study of nutritional problems is mentioned; and short notes were given on some of the better known diet scales.

(3) A Nutrition Survey was carried out on the whole of the children attending school in an industrial town in the Tyneside area. 4,628 children of School age were examined and the Nutrition Grades assessed clinically. Of this number, 10.6% were of slightly subnormal nutrition (Grade C) and the nutrition of 0.15% was bad (Grade D). The percentage graded A (excellent nutrition) was 16.6.

(4) The proportion of boys graded C and D was slightly higher than that of the girls. 10.9% and 0.17% for the boys as compared with 10.3% and 0.15% for the girls. A considerably higher percentage of girls was placed in Grade A; 19.3% as against 13.7%. The data show that the nutrition of the girls in the area is distinctly better than that of boys.

(5) When the children are arranged into age groups according to the Board of Education Scheme those age 8 and 9 years present the worst figures and those age
the best. Of the former 12.1% were graded C and 8% of the latter. It is pointed out that this arrangement is not altogether satisfactory because when the C cases are placed in separate groups for each year of age the numbers of children age 7 years and 10 years are in excess of those age 8 and 9, a fact which is not apparent when the Board of Education Age grouping is used. In other words, in the area under investigation the nutritional state of children age 7 and 10 years is worse than that of those age 8 and 9. It has been generally recognised throughout the Country that the highest incidence of malnutrition is found among children age 8 and 9 when the Board's classification is used.

Data are provided showing that a correlation would appear to exist between Unemployment at the time of the birth of the child and the later demonstration in him during school life of a condition of sub-normal nutrition. This is based on a study of unemployment figures in relation to the ages of the children graded C.

Details are given of the method employed during the medico-social examination of 400 of the children graded C; and particulars of the principal facts relating to advice given and treatment recommended are set out.

Consideration of the size of the families to which the Nutrition C cases belonged revealed that a disquietingly high proportion belonged to families of small size (2, 3 and 4 child families) and as many as 8% of the 400 children were the sole child, (i.e. one child families).

With regard to the place of the Nutrition C child in the family it was found that 29.5% of the 400 cases
were firstborn children and that over 22% were second children. One would have expected that a far higher proportion would have been the younger members of large families. Reasons are advanced for this unexpected finding.

(10) The interval elapsing between the birth of the Nutrition C child and the birth of the preceding child was determined in the case of a small number of children who were members of 4-child families. It was found that in over 40% of the cases, the interval was less than 2 years and that in 25% less than 1½ years had elapsed between the successive births.

(11) Special consideration is given to the cases of the 93 children who belonged to families found to have more than one child at school suffering from Subnormal Nutrition. Particulars are given of the sizes of the families affected. Additional data are provided on the instances of malnutrition in twin children; and a note is added on the employment of women in industry in the area.

(12) The type of infant feeding used in the case of the 400 Nutrition C children is given together with the same particulars obtained from 500 children on the lists of the Child Welfare Department. It was found that the 400 cases of Subnormal nutrition were drawn from the ranks of the Breast fed and the Bottle fed in the same proportion as the strength of these groups in the general population of the area. It would appear that malnutrition developed with about equal readiness among the Breast and Bottle fed children in this area. In this connection notes are given on the use made of Vitamin concentrations by the mothers in the area.
Inquiry revealed that 13.25% of the 400 children with subnormal nutrition did not take milk through the Milk in Schools scheme and that a further 3% took milk irregularly. The reasons given by these children for not taking milk are set out together with data on the functioning of the 'Milk in Schools' scheme in the area. Notes are appended on the nutritional value of milk and on the published results of feeding experiments in Great Britain involving the giving of additional milk. Criticism is made of the amount of milk allowed for each child.

Particulars are given of the number of children among the 400 cases of subnormal nutrition who were attending or who agreed to attend the Education Committee's School Dining Centres under the Provision of Meals Scheme. Reasons are given for the poor support accorded to the scheme by the parents of necessitous children and criticism is made of the internal administration of the Dining Centres as operated at the time of the Nutrition Survey, and of the quality of food provided. The view is expressed that under the reorganized scheme considerable benefit will accrue to children attending; and mention is made of the immediate increase in popularity.

Certain observations were made on the physical condition of the 400 Nutrition C children. It was found that 43.5% were thin; and 16.5% were fat and flabby. In 40% muscle tone was poor, and over 26% stooped. Particulars are given of defects of possible etiological importance which were noted and the significance of each is considered.
The incidence of certain Infectious Diseases and of Respiratory Infections in childhood is considered with particular reference to varying attack rates for the different nutrition grades. It was found that except in the case of Acute Respiratory Infection, children who had been classified as Nutrition A had had a higher incidence than the children with subnormal nutrition. This difference amounted to 16.6% in the case of Whooping Cough, 8% for Measles and 4.7% in the case of Scarlet Fever. With Respiratory Infection on the other hand the proportion of Nutrition C children who contracted it was higher to the extent of 25.3% than in the case of Nutrition A children. Possible explanations of this are given and reference is made to the deleterious effect of Respiratory Infections on the health and physique of growing children. It is suggested that attacks of Respiratory disease may be a determining factor in the development of malnutrition in many cases by accentuating deficiencies of certain nutritional substances of which the intake by these children is admittedly low. Particulars obtained from the records of 500 children kept throughout the period from birth to school age are analysed with a view to determining if the age at which the common Infectious Diseases of childhood are contracted is in any way related to the type of infant feeding. It was found that in the first year of life there is a much lower incidence of Measles (16% difference) and of acute Bronchial infections (10% difference) among Breast fed than among bottle fed. Data for the other diseases are set out. Reference is made to the published findings of other investigators.
Of a group of 783 Senior School children who were examined for rachitic stigmata of the chest and lower limbs, it was found that 52.7% had no deformity, while 26% and 30.1% had deformities of the chest and lower limbs respectively. Inquiry into the type of infant feeding of these children revealed that 57.3% of the Breast fed and 52.5% of the Bottle fed had typical rachitic stigmata while 50% of the small group who had had combined feeding had similar deformities. The need for the routine administration of adequate amounts of Vitamin D to all infants irrespective of the type of feeding is stressed. The salient features of the pathology of Rickets are set out and the significance of various deformities are discussed in the light of the published findings of various recent inquiries.

Examination of the conjunctiva of 781 children of both sexes in 2 Senior Schools for signs of anaemia revealed that 30.9% of the total had distinct pallor. When boys and girls were taken separately it was found that a slightly higher proportion of boys than girls were anaemic, namely 33.8% of the boys and 28.3% of the girls. A relationship was established between the presence of Anaemia and a low nutrition grade (66.3% of the Nutrition C children were anaemic; while 27.8% of the B Grade and who 17.2% of the children/had been graded Nutrition A were considered to be anaemic). Reference is made to reports of the prevalence of Anaemia throughout the country and the problem is discussed shortly from the point of view of the health of the infant school child and the expectant mother. Iron requirements and some common dietary sources of supply are commented upon.
Enquiry was made of the consumption of Wholemeal Bread (prior to the introduction of National Wheatmeal) by 506 children of the group examined for the presence of anaemia. It was found that none was consumed by 70.8% of these children, while 29.2% used wholemeal bread daily. The data were correlated with the findings of the Anaemia inquiry. Though 20.2% of those consuming Wholemeal Bread regularly were anaemic a much higher proportion (32.5%) of anaemic children was found in the group who did not use this type of Bread to any extent. The nutritional value of Wholemeal Bread is discussed and mention is made of the principal constituents of the National Wheatmeal flour, White flour, and Wholemeal flour together with a note on the principal disadvantage from the point of view of the nutrition of children of the higher extraction flours.

Enquiry showed that the consumption of Vegetables by the 400 Nutrition C children was satisfactory in 29% of cases only. No vegetables were consumed by 12% and only occasionally by 59%. It was found that 21.5% of these children disliked vegetables. The problem of the insufficient consumption of vegetables by large sections of the population is discussed. Comment is made on the nutritional value of vegetables with particular reference to the varieties most popular in the area; and reference is made to the benefits to health which would accrue from a slight alteration in dietary habits of the people in the district.

The deciduous teeth of 330 five year old children were examined for caries by mirror and probe. Only 5.4% of those children had complete sets of 20 teeth untouched.
by caries; and children who, though some teeth were missing, were at that time free from caries amounted to only 7.5%. On the other hand 45.1% had more than 5 teeth damaged. The widespread incidence of caries among adults, school children and pre-school children is discussed together with reference to the occurrence (and origin) of Dental hypoplasia as a precursor of caries. The resistance to caries of the teeth of some individuals is considered and the part played by certain vitamins and mineral substances is emphasised. The dietary and hygienic regime for the expectant mother and the child most likely to produce caries-resistant teeth is given in summary form.

(22) Particulars are given of the sleep habits of the 400 Nutrition C children. On the basis of standard employed by me at least 48.5% of the group had insufficient sleep. Comment is made on difficulties of observing proper bedtime resulting from modern social habits; and reference is made to the effects of chronic fatigue on the development and functioning of the body.

(23) Inquiry was made into the possibility that a connection may exist between Defects of Vision and low Nutrition grade. This inquiry concerned 1740 children age 8 years and over. It was found that 228 of the group had defects of vision.

Arrangement of the children according to Nutrition grade revealed that a much higher proportion of the poor nutrition children had defective vision. The figures obtained are: - 9.6% of the Nutrition A children, 13% of the grade B, and 19.5% of the Grade C children had defective vision. Of the small number of Nutrition D cases, 2 (66.6%) had defective vision.
It is shown that the incidence of defective vision increases with a lowering of nutrition status.

Comment is made on certain theories of the origin of Myopia which throw some light on the problem.

(24) Inquiry into the scholastic attainment of 712 children of 7 years and over, with particular reference to connection between this and nutrition, revealed that 28.2% of the bright children and only 6.7% of the slow children had been graded Nutrition A. Further, only 5.6% of the bright children were Nutrition C, while 22.1% of the slow children were placed in this low nutrition category.

Certain interesting differences existed in the data for boys and girls, in the different nutrition grades. 26% of the bright children who were graded Nutrition A were boys and 30% were girls. On the other hand 18.6% of the dull children who were graded C were boys while a very much higher proportion, namely 26.6%, were girls. It is evident from the data that mental activity of school children is related to the state of nutrition and it would appear that this is even more marked in the case of girls than boys.

Reference is made to the findings of the investigators.

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