STUDIES ON AGE AND WASTAGE IN INDUSTRIAL POPULATIONS

I. AGE AND INCIDENCE

BY

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1. INTRODUCTION

The series which this paper initiates deals with labour wastage due to medical causes. *Inter alia*, valid comparison of the experiences in different populations presupposes the possibility of making due allowances for differences with respect to age composition. This communication deals with such differences in so far as they affect the number of cases of disability which occur in the total employed population. It is not concerned with the amount of time lost; and the population principally considered consists of all persons in receipt of National Health Insurance (N.H.I.) benefits in Scotland between 1931 and 1936, that is to say it is not restricted to an industrial population *sensu stricto*, but it does exclude self-employed persons.

That liability to die varies (though not in simple proportion) with age has been the rational basis of the insurance industry. The body of necessary accounting which this social need has evoked, together with the relative ease with which data could be collected through the office of the Registrar-General, has resulted during the past hundred years in a thorough mapping of the territory, in so far as the means for doing so are available. That liability to fall sick is also affected by age presents more complex problems, and data for their solution have been sparingly collected. Despite various attempts on the part of leaders of the sanitary movement in the mid-nineteenth century, there has been no official collection of morbidity data for the civilian population of Britain as a whole, other than that provided by compulsory notification for certain infectious diseases. There has, however, been a certain amount of information collected and published from the experience of nineteenth century Friendly Societies and from National Health Insurance which consolidated their work in the present century. Indeed, vital statistics and concern for cutting down by insurance schemes the uncertainties of life of the urban worker go hand in hand from the early days of the factory system. Farr (1854) records how :

“ A Bill, embodying a plan for enabling the labouring poor to provide support for themselves in sickness and old age, by small weekly savings from their wages, was introduced by Mr. Dowdeswell, and approved by the House of Commons, in 1773; but it met with the same fate as another Bill framed by the Commons in 1789, and founded on tables computed,

at the request of a committee, by Dr. Price. The Lords rejected both Bills; and thus deprived the labouring poor of the guidance of a legislative Act in the formation of friendly societies for half a century."

What the State would not provide until 1911, however, voluntary associations managed, somewhat inadequately, to offer throughout the nineteenth century. The resultant statistical experience relates in the main to the equivalent in morbidity accounting of the life tables of the life insurance companies. That is to say, it consists of aggregate figures of cases and days of incapacity, having no regard to differences of diagnosis. What has been published constitutes in fact the basic figures that were necessary for planning the national sickness benefit scheme. A comprehensive account of the best of these experiences and the way they were employed for the actuarial basis of N.H.I. administration is given by Watson (1927). The essential planning figures consist of the "rate of sickness," which Watson defines as the ratio of the total number of man-days for which benefit is drawn to the relevant populations at risk. As he points out, however, this may be more usefully regarded as "the product of two factors, the average amount of incapacity suffered by each person who is sick during the year and the proportion of the whole body of lives at risk on whom the contingency of sickness has fallen." When separate figures for these two factors are given, one striking difference is immediately visible. In all three of the cases Watson quotes, the number of cases per thousand persons insured falls slightly between the ages of 16 and 30 and then rises, until in the 60-64 group it is from 1.1 to 1.7 times as high as in the 16-19 group. The average duration of claim, however, rises steadily throughout life from 3-4 weeks in the 16-19's to something over 7 weeks among the 60-64's, a roughly two-fold increase.

This phenomenon must arise from either or both of two causes: from differential incidence at various ages of diseases taking intrinsically different periods of time to pursue their course in the human body, or because similar diseases bring about incapacitation for increasing periods as people grow older. The purpose of the first communication of this series is to examine the first of these causes and to educe what information is available concerning case incidence of different diseases at different ages. It is hoped to take up the question of time lost in a later paper. The Friendly Society and early N.H.I. experiences were, naturally, preoccupied with financial claims and the assessment of premiums, and remained outside the main stream of medical research. Thus, despite the fact that the importance of the data they could provide was recognized by Farr (1854), it was only in the years immediately preceding 1939 that figures analysed by proper diagnostic categories were published. These were contained in a series of reports published by the Department of Health for Scotland and referring to the years 1930-37. The figures contained therein provide the basic data for the majority of what follows.

In specifying diagnostic categories considerable care is necessary to elucidate what constitutes a clinical entity of reasonable singularity for examination in the light of the problem in hand, and what is a convenient label that can be applied,

with no pretence of scientific justification. The problem is not, of course, new. In the field of taxonomy, however, statistics can fairly be claimed as the midwife of medical semantics. Sauvage's *Nosologia Methodica Sistens Morborum* of 1763 is an ontological curiosity, the result of purely armchair speculation. The first edition of the Royal College of Physicians' Nomenclature of Diseases of 1869, published after the experience of the General Register Office in producing statistics of deaths on a basis of diagnostic certification became available, is the result of an administrative necessity. The need for accurate diagnosis for statistical work was realized early and inescapably. An anonymous writer to the medical press (possibly Farr), quoted by Gafaer (1934), put the point in 1841: "... not only must the diseases which we call by the same name be the same things, own the same causes, and have the same things in common, but the circumstances under which our patients are placed must be, as far as possible, the same."

Of the two principal methods whereby diagnoses can be classified, we are here concerned mainly with aetiology rather than with signs or symptoms. It is, for example, clear that the age incidence of a disease, such as Addison's, which may be one of the sequelae of a neoplasm or infection will inevitably give a confused picture compounded of the age distributions of such antecedent disorders and that of the idiopathic disease itself. On the other hand, where a particular diagnosis is found to have a clear-cut age distribution, that phenomenon of itself provides a *prima facie* case for supposing it a single entity in default of evidence to the contrary. Such a yardstick has at least as rational a basis as that of dividing micro-organisms by their behaviour under the application of particular staining reagents.

The complex philosophical issues behind the establishment of taxonomic systems reappear at a more mundane level in any statistical system where classification is carried out by a variety of persons, albeit trained professional men. Such a system is necessarily that of National Health Insurance, whose data originate in the form of certificates made out by individual panel doctors. Two main problems arise. First, it is by no means certain that all panel doctors either use the same terminology or are infallible diagnosticians. Secondly, the granting or withholding of certificates for minor sicknesses is affected by a variety of social circumstances; and, conversely, the insured worker does not necessarily absent himself from work for every sickness, nor, in the higher income groups, does he always make use of insurance facilities if he does. The mechanics of certification has been subjected to particular examination by the Department of Health for Scotland, to whose *First Report on Incapacitating Sickness* (1930-31) the reader is referred for further information.

There is no complete solution to these difficulties, nor to the difficulty of discriminating between the relation of age to onset and the relation of age to severity, in the absence of specification of *first occurrences* as such on medical documents used in the compilation of statistics. In spite of that, we are more likely to obtain biologically meaningful information by retaining our data in specific diagnostic categories than by accepting the timid compromise of grouping

diseases into loosely defined "systems." Furthermore, a partial solution does exist. In dealing with similar data in an Army population Hogben and Johnstone (1947) had to face an analogous problem in that total records of cases were defective as a result of the inevitable losses in transporting large numbers of individual documents across the world during wartime. As far as accuracy was concerned, their data are superior to any comparable figures from a civilian source in so far as: (a) all serious sickness in the Army resulted in admission to hospital; (b) all diagnoses were made by a specialist physician or surgeon. Nevertheless, there was a known deficiency in the aggregate, and even the most careful checks on diagnostic procedure cannot efficiently pigeon-hole every case of sickness under a clear-cut aetiological or clinical heading. To circumvent this difficulty, they adopted the practice which we shall here follow of examining *relative* rates alone. In conformity with the usage which they introduced we shall employ the following notation:

C_x = Number of cases of a given disease in the x th age group.

c_x = Proportion of cases of a given disease in the x th age group.

P_x = Number of persons in the x th age group.

p_x = Proportion of persons in the x th age group.

$I_x = C_x \div P_x$ Incidence of a given disease in the x th age group.

R_x = Relative age incidence. $100 I_x \div \sum I_x$.

$q_x = c_x \div p_x$.

$T_q = \sum q_x$.

$Q = 100 T_q^{-1}$.

As a computing check in working out R_x we have, also, $100 q_x \div T_q = R_x$. The relative age incidence, R_x , exhibits in a convenient way the alteration in liability to a disease as age advances, it is independent of the magnitude of the incidence and so can be derived from data which are known to enumerate the number of cases incompletely, provided that no cause operates to render this incompleteness relatively more or less likely in particular age groups. In the absence of complete and thorough examination of every member of the population at risk, such data must inevitably be the source of any studies, like the present, where we have recourse to measuring the frequency of biological occurrences, such as the presence of recognizable disease, by counting the number of persons who conform with a social or administrative procedure such as reporting sick in the Army, or drawing health insurance benefit. By its nature R_x is, of course, also particularly suited for comparing one disease with another.

The statistic Q , besides being necessary if we wish to examine q_x and to indicate whether a given age group contains a disproportionate number of cases of a disease, is of value in connexion with age-standardizing factors. As shown by Hogben and Johnstone *supra*, the factor F by which we must multiply the crude incidence of a disease to make it comparable with the incidence in a second, standard population is:

$$F_s = \frac{\sum R_x \cdot s p_x}{\sum R_x \cdot c p_x}$$

In this formula ${}_s p_x$ and ${}_c p_x$ are the proportion of individuals in the x th age group in the standard and actual populations respectively. If we now take as our standard population a hypothetical one, having the same number of persons in each year of life, and divide it into k equal age groups, ${}_s p_x = 1/k$, so that:

$$1/F_s = K \sum R_x \cdot {}_c p_x \quad \text{where } K = \frac{k}{100}$$

$$= 100 K \sum \frac{q_x}{T_q} \cdot {}_c p_x$$

$$= 100 K \sum \frac{c_x}{T_q}$$

$$= \frac{100 K}{T_q}$$

$$= K Q$$

$$F_s = 1/KQ$$

To convert to any standard population we have, as above,

$$\begin{aligned} F'_s &= \frac{\sum R_x \cdot {}_s p_x}{\sum R_x \cdot {}_c p_x} \\ &= F_s \cdot \frac{\sum R_x \cdot {}_s p_x}{\sum R_x \cdot {}_c p_x} \\ &= \frac{1}{K Q} \cdot \frac{k}{100} \sum R_x \cdot {}_s p_x \\ &= \frac{\sum R_x \cdot {}_s p_x}{Q} \end{aligned}$$

a formula which is more convenient for computing purposes. It should be observed, however, that all *indirect* methods of age standardization such as the present have, as their basic assumption, the supposition that R_x is independent of the population on whom it is originally assessed. Where the rates of sickness prevailing in two real populations are standardized in this way it carries as a corollary that R_x is a biological constant to both populations. How far this is so in the *short term* is the subject of further investigation below. Over the long term it is obvious that changes in social conditions and technical achievement may differentially affect liability to particular diseases at particular ages, but figures are, in the main, lacking to provide quantitative assessments of this.

2. RELATIVE CONTRIBUTIONS OF DISEASE AND INJURY

Virtually the only source of information for age distributions of diseases among the British civil population is, as stated above, the reports of the Department of Health for Scotland. As stated in the first report:

"The raw material is made available centrally by the periodical receipt, either daily or weekly, from each Approved Society operating in Scotland, of intimations relating to all first and final certificates issued by insurance practitioners for insured persons when incapacitated for work. For each case of incapacity, the facts of which account is taken, are as follows:

The reputed cause of illness, the dates of onset and termination, the final result (i.e. death or recovery); the year of birth of the patient (giving a reliable indication of age), sex, occupation and (for women only) marital status."

An administrative complication arises with regard to the last classification, in that married women who quit employment continue (if they have collected enough stamps on their cards) in their entitlement to benefit for two years after making the last contribution. As these *class K* beneficiaries are not distinguished in the figures from employed married women, and as they obviously constitute a differentially high proportion of certain age groups, it was not felt that married women as a whole constitute a sufficiently homogeneous class to permit any conclusions to be drawn from statistics about them. In what follows, therefore, examination is restricted to single employed women and all employed males.

Since relative age distributions take no account of absolute incidence, it is desirable to set them in perspective by consideration of the proportionate contribution which particular diseases make to the total cases under review. Table I demonstrates, for men and single women separately, the relative contributions of injury

TABLE I
RELATIVE CONTRIBUTIONS OF SICKNESS AND INJURY TO TOTAL CASUALTIES AMONG INSURED WORKERS,
BY AGE: SCOTLAND, 1936-37

Age	..	..	< 20	20-	25-	30-	35-	40-	45-	50-	55-	> 60	All ages
MEN													
All diseases	..	84.9	85.5	87.9	89.1	88.8	89.8	89.7	89.4	89.9	91.2	88.2	
All injuries	..	15.0	14.4	12.0	10.9	11.1	10.1	10.3	10.5	10.0	8.6	11.7	
Not specified	..	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	
Total	..	100	100	100	100	100	100	100	100	100	100	100	
Cases	..	38,172	44,835	39,759	37,461	31,982	27,295	25,550	23,529	22,083	19,634	310,300	
SINGLE WOMEN													
All diseases	..	94.5	95.6	95.8	95.7	95.5	95.5	94.3	93.4	92.5	92.8	95.1	
All injuries	..	5.4	4.3	4.1	4.1	4.3	4.3	5.5	6.5	7.2	7.0	4.8	
Not specified	..	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.3	0.2	0.1	
Total	..	100	100	100	100	100	100	100	100	100	100	100	
Cases	..	35,746	38,675	19,501	11,050	7,609	6,245	5,515	4,773	3,804	3,036	135,952	

and "disease" *sensu stricto*. An interesting disparity, to which we shall return later, is immediately visible in that, while injury is far more important as an overall source of wastage among men, its contribution falls slightly with age; with women, however, it increases steadily. In view of the striking character of this disparity, and the need to establish whether it arises from some selective social process affecting the distribution by occupation of single women in the different age groups

or whether it is common to all persons in the community, it is particularly unfortunate that American studies of overall morbidity, such as Collins (1935 a and b) are vitiated by failure to publish separate figures for men and women. Table II, which is adapted from Collins' data, shows the gross result obtained in a survey of 9,000 American families over a period of eighteen months and is clearly consistent with the later, Scottish enquiry. It should, of course, be borne in mind in comparing similar age groups that the category "under 20" in the Scottish data contains no person under 14, since this is an insured working population.

TABLE II
RELATIVE CONTRIBUTIONS OF SICKNESS AND INJURY TO ANNUAL CASE RATES AMONG NINE THOUSAND
WHITE AMERICAN FAMILIES: EIGHTEEN AMERICAN STATES, 1929-30

Age	<5	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	>65	All Ages
All diseases	94.2	91.2	87.3	86.5	90.5	92.0	90.4	91.3	92.2	91.4	91.2
All injuries	5.8	8.8	12.6	13.5	9.5	8.0	9.6	8.7	7.8	8.6	8.8
Total	100	100	100	100	100	100	100	100	100	100	100
Total Cases	6,682	5,589	3,113	1,828	1,425	4,626	4,592	2,544	1,244	978	32,756

The relative contributions which the particular diagnoses selected for later study make to the broad category of "all diseases" is shown for the Scottish data in Tables III and IV. Table III deals with men and Table IV with single women. It is immediately apparent that, with morbidity as with mortality, the proportion of total sickness caused by particular diseases alters radically as age advances. Among the male population malignant neoplasms, which account for less than 0.05% of all cases at ages under 20, are responsible for nearly 1% at ages over 60. In ranking order, among the diseases listed, they rise from least in order of frequency in the former age group to seventh in the latter. Appendicitis falls from 2% and sixth in order of importance to under a half % and fifteenth over the same age groups. Similar changes in relative importance at different periods of life are observable, *mutatis mutandis*, in other diagnoses. The rise in the proportion accounted for by *other diseases* is ascribable at least in part to a variety of rheumatic conditions whose aetiology is insufficiently clear to merit separate study.

Two considerations immediately arise from these proportional age shifts in the composition of total sickness. In a society the age structure of whose population is shifting, such data must form the basis for budgeting specialist clinic services in a system of state medicine. In conjunction with similar figures showing time lost—temporarily or otherwise—from work, data of this sort also give a clear indication of priorities in research and preventive medicine aimed at diminishing man-power wastage. Secondly, it is evident that where preventive medicine operates effectively to diminish the overall incidence of individual diseases, this will affect any statistic

TABLE III
RELATIVE CONTRIBUTIONS OF INDIVIDUAL DISEASES TO MORBIDITY AMONG INSURED WORKERS:
SCOTLAND, 1936-37 (MEN)

Diagnosis	<20	20-	25-	30-	35-	40-	45-	50-	55-	>60	All ages
Adenitis ..	0.6	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.3
Appendicitis ..	2.0	2.3	2.0	1.5	1.3	0.9	0.6	0.6	0.4	0.4	1.4
Arteriosclerosis ..	—	—	0.0	0.0	0.0	0.0	0.1	0.2	0.5	0.8	0.1
Asthma ..	0.4	0.6	0.7	0.7	0.7	0.9	0.9	0.9	1.0	1.0	0.7
Bronchitis ..	4.9	4.2	4.2	4.9	6.0	7.0	8.2	9.6	9.7	11.7	6.4
Conjunctivitis ..	0.4	0.4	0.4	0.4	0.3	0.4	0.2	0.3	0.3	0.3	0.3
Cerebral haemorrhage	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.8	0.1
Diphtheria ..	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Erysipelas ..	0.0	0.1	0.1	0.2	0.3	0.4	0.4	0.6	0.5	0.5	0.3
Hernia ..	0.3	0.5	0.5	0.7	0.6	0.7	0.9	1.0	1.1	0.9	0.7
Haemorrhoids ..	0.1	0.3	0.5	0.8	1.1	1.1	1.0	0.8	0.7	0.6	0.6
Inflammation of skin and sub- cutaneous tissue	6.0	5.4	4.1	3.4	2.8	2.5	2.2	2.0	1.9	1.7	3.5
Influenza ..	40.1	33.1	33.1	33.8	33.5	34.1	33.4	28.6	26.8	25.1	32.8
Measles ..	0.4	0.3	0.2	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Mumps ..	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	0.2
Myocarditis ..	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.9	1.3	2.1	0.4
Neoplasms (Ben.)	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.2
Neoplasms (Mal.)	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.4	0.6	0.9	0.2
Peptic ulcers ..	0.2	0.7	1.5	1.8	2.2	2.0	1.9	1.8	1.3	1.0	1.4
Pharyngitis ..	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.2
Phlebitis ..	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.4	0.4	0.2
Pneumonia ..	0.9	0.7	0.5	0.6	0.7	0.7	0.7	0.6	0.5	0.6	0.7
Scarlet fever ..	0.5	0.3	0.2	0.2	0.1	0.1	0.0	0.0	0.0	—	0.2
Sinusitis ..	0.2	0.3	0.4	0.3	0.3	0.3	0.2	0.1	0.2	0.1	0.3
Tonsillitis ..	8.8	9.0	8.0	6.3	4.5	3.1	2.2	1.6	1.2	0.7	5.3
Tuberculosis (pulmonary) ..	0.2	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.3
Tuberculosis (other sites) ..	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Tuberculosis (not specified) ..	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1
Ulcers, carbuncles, etc. ..	5.2	6.0	5.8	4.9	4.5	4.0	3.8	2.3	2.9	2.0	4.5
Varicose veins ..	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1
Valvular disease of the heart ..	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.2	0.1
Exophthalmic goitre ..	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Goitre ..	—	0.0	0.0	0.0	0.0	0.0	0.0	—	0.0	—	0.0
Other ..	27.2	33.3	35.7	37.4	39.0	39.8	40.8	44.7	47.1	47.5	38.0
Total ..	100	100	100	100	100	100	100	100	100	100	100
Cases ..	32,413	38,346	34,928	33,366	28,406	24,503	22,905	21,034	19,845	17,911	273,657

based on *total* morbidity and aimed, as R_x is, at eliminating differences due to varying age composition in the population at risk at different times. In particular, the eminently successful efforts of nineteenth century sanitarians in cutting down infectious disease, which clearly bulk larger among the young, must have shifted the relative incidence of total morbidity towards the higher age groups.

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TABLE IV

RELATIVE CONTRIBUTIONS OF INDIVIDUAL DISEASES TO MORBIDITY AMONG INSURED WORKERS:
SCOTLAND, 1936-37 (SINGLE WOMEN)

Diagnosis	<20	20-	25-	30-	35-	40-	45-	50-	55-	>60	All ages
Adenitis ..	0.6	0.5	0.4	0.4	0.3	0.2	0.2	0.3	0.1	0.1	0.4
Appendicitis ..	3.2	3.0	2.4	2.0	1.5	1.0	0.7	0.8	0.5	0.4	2.4
Arteriosclerosis ..	0.0	0.0	—	0.0	0.0	0.0	0.1	0.1	0.3	0.4	0.0
Asthma ..	0.3	0.5	0.6	0.8	1.0	0.8	0.9	0.9	0.9	1.0	0.6
Bronchitis ..	4.0	4.6	4.7	5.5	5.8	6.3	7.1	7.8	9.2	10.7	5.1
Conjunctivitis ..	0.3	0.4	0.3	0.3	0.4	0.5	0.3	0.5	0.4	0.4	0.3
Cerebral haemorrhage	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.4	0.6	0.0
Diphtheria ..	0.6	0.5	0.4	0.2	0.2	0.2	0.2	0.0	0.0	—	0.4
Erysipelas ..	0.1	0.2	0.2	0.2	0.3	0.1	0.4	0.7	0.7	0.4	0.2
Hernia ..	0.1	0.1	0.1	0.2	0.1	0.2	0.0	0.2	0.3	0.1	0.2
Haemorrhoids ..	0.0	0.1	0.3	0.3	0.3	0.3	0.4	0.2	0.1	0.3	0.2
Inflammation of skin and sub- cutaneous tissue	4.6	3.0	2.3	1.8	1.6	1.4	1.7	1.4	1.2	1.2	3.0
Influenza ..	29.7	28.8	29.4	30.9	31.1	31.5	28.6	25.0	23.2	22.0	29.1
Measles ..	0.5	0.4	0.3	0.2	0.2	0.1	0.0	0.1	0.1	0.0	0.3
Mumps ..	0.4	0.4	0.4	0.4	0.2	0.2	0.1	0.1	—	0.1	0.3
Myocarditis ..	0.1	0.1	0.2	0.2	0.3	0.5	0.5	1.2	1.5	2.5	0.3
Neoplasms (Ben.)	0.3	0.3	0.3	0.2	0.4	0.3	0.4	0.1	0.2	0.3	0.3
Neoplasms (Mal.)	0.0	0.1	0.1	0.2	0.1	0.3	0.4	0.5	0.9	0.4	0.1
Peptic ulcers ..	0.1	0.2	0.3	0.4	0.5	0.7	0.6	0.6	1.1	0.6	0.3
Pharyngitis ..	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.2	0.4
Phlebitis ..	0.0	0.1	0.2	0.3	0.4	0.9	0.8	1.1	1.1	1.2	0.3
Pneumonia ..	0.2	0.3	0.2	0.2	0.3	0.2	0.4	0.4	0.5	0.4	0.3
Scarlet fever ..	0.8	0.5	0.4	0.3	0.2	0.1	0.1	0.0	0.1	—	0.5
Sinusitis ..	0.2	0.3	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3
Tonsillitis ..	12.8	10.6	9.5	7.4	6.4	5.0	4.0	3.4	2.2	1.5	9.3
Tuberculosis (pulmonary) ..	0.3	0.4	0.4	0.4	0.2	0.2	0.1	0.1	0.1	0.1	0.3
Tuberculosis (other sites) ..	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.0	0.1	0.1	0.1
Tuberculosis (not specified) ..	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	—	0.1
Ulcers, carbuncles, etc. ..	3.1	2.8	2.4	2.0	1.7	1.7	1.5	1.9	1.7	1.1	2.5
Varicose veins ..	0.0	0.1	0.1	0.2	0.3	0.2	0.4	0.5	0.4	0.5	0.2
Valvular disease of the heart ..	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.4	0.4	0.4	0.3
Exophthalmic goitre ..	0.1	0.1	0.2	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2
Goitre ..	0.1	0.1	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1
Other ..	36.7	40.9	42.8	43.2	44.7	45.4	48.4	50.6	52.6	52.6	41.8
Total ..	100	100	100	100	100	100	100	100	100	100	100
Cases ..	33,788	36,983	18,677	10,577	7,268	5,961	5,200	4,459	3,520	2,818	129,249

Such hypotheses are notoriously easy of enunciation and difficult of proof. *Pari passu* with this diminution in infectious disease has gone improved methods of diagnosis and, probably, a greater social concern for health, resulting in increased claims for minor sickness. A selection of figures covering the period 1823-1937,

taken from various insurance sources, are given in Table V. When due regard is paid to the necessary crudity of the earlier data, and to inaccuracies due to lumping age groups together in the interests of comparability, it is remarkable how uniform these overall relative incidences are. It is at least apparent that, irrespective of the level of incidence, the relative liability to sickness in the working age range is greatest at under twenty and over sixty and at a minimum probably about the age of thirty.

TABLE V
RELATIVE INCIDENCE OF TOTAL MORBIDITY^a AMONG INSURED WORKING POPULATIONS (MEN ONLY)

Source	16-19 ^b	20-29	30-39	40-49	50-59	60	Total
East India Co. Labourers 1823-33	17.8	16.5	14.0	14.3	15.3	22.3	100
Registered Friendly Societies 1876-80	15.4	14.1	14.5	16.3	18.6	21.1	100
Manchester Unity of Oddfellows 1893-97	18.4	14.3	14.3	15.4	17.5	20.0	100
Leipzig Local Sick Fund 1887-1905 (compulsory members)	13.6	12.9	14.4	16.5	18.9	23.7	100
N.H.I. 1921-23	14.4	13.6	14.0	15.1	18.9	24.0	100
Scottish N.H.I. 1930-31	19.8	14.8	15.6	16.4	17.6	15.8	100
Scottish N.H.I. 1936-37	16.4	14.7	17.0	15.9	15.8	20.1	100

The figures here cited are not consistent with the statement of Russel and others (1947) that "sickness rates are generally a function of age—they increase with increasing age of the workers. . . ."

3. CONSTANCY OF R_x FOR SPECIFIC DISEASES

While relative incidence of *total* morbidity may alter as age advances over the long term as a result of differential changes in the incidence of particular diseases which make up that total, there remains the problem of how far the relative incidence of any specific disease tends to biological constancy and how far it is changeable by prophylactic measures, different social environments, or secular alteration in the nature of the *materies morbi*. Data for the general solution of this problem are lacking, since there exist neither figures covering one population over a long period of time nor figures for communities which, though contemporaneous, exhibit gross differences of culture pattern. There is, however, considerable evidence to show a remarkable constancy over the short period among populations at roughly the same culture level, while, for some diseases, the age incidence is almost certainly affected by environmental conditions. A final solution must treat with each disease separately and will have to attend on the collection of suitable statistical data.

Data from Scottish N.H.I. statistics are available, for certain diseases only, for each of the six years July 1931–June 1932 to July 1936–June 1937, though prior to 1933–4 the basis on which the age distribution of the population at risk was

RELIABILITY OF R_x

APPENDICITIS ♂

Spread between highest and lowest value
of R_x in six successive years 1931-6.

Fig. 1.

assessed, while the best possible in the circumstances, does not inspire full confidence. The values of R_x , for men only, for each of these years are shown for six diseases, chosen for the different slopes of their relative incidence, in Table VI, and three of these are illustrated graphically in Figs. 1-3. The regularity of these figures needs no further comment. Further confidence is given by a comparison of relative incidences of a more extensive list of diseases on the basis of 1936-7 figures with the results obtained by Hogben and Johnstone (1947) in their similar study of the British Army. The extensive list forms the basis of Section 5 of this present paper for comparison with the figures of Hogben and Johnstone. Here it suffices to remark that the slope of the relative age incidence lies in the same direction in every case where comparable diseases were studied, with only such minor discrepancies as can be accounted for by the more limited range of the Army population.

An example of a disease whose age distribution may be affected by social conditions is provided by pulmonary tuberculosis. Fig. 4 exhibits in a convenient manner the striking difference in relative age incidence which exists between men and single women in the Scottish data for 1936-7. It will be seen that among women the distribution is sharply humped at the younger age groups—a type of

TABLE VI

RELIABILITY OF R_x : VALUES FOR SIX SUCCESSIVE YEARS FOR CERTAIN DISEASES (MALES ONLY)

		20	20-	25-	30-	35-	40-	45-	50-	55-	60	Total
APPENDICITIS												
1931-2	..	17.7	18.8	16.5	12.5	9.4	7.6	6.3	4.2	4.2	2.8	100
1932-3	..	15.0	18.4	16.8	14.8	10.0	6.7	5.3	5.5	3.9	3.7	100
1933-4	..	15.6	18.5	15.4	14.2	9.7	8.3	6.2	5.3	4.1	2.8	100
1934-5	..	15.4	18.4	15.1	13.1	10.9	8.5	6.4	5.1	3.9	3.0	100
1935-6	..	15.2	18.2	17.0	13.0	11.0	8.5	5.8	4.3	3.7	3.3	100
1936-7	..	16.3	17.6	15.2	13.0	11.6	8.0	5.4	5.3	3.6	3.9	100
CEREBRAL HAEMORRHAGE												
1931-2	..	1.2	1.9	0.5	1.4	1.2	4.0	7.2	10.1	23.1	49.5	100
1932-3	..	0.8	0.4	0.4	2.6	1.7	4.5	5.1	9.7	18.5	56.5	100
1933-4	..	0.7	1.6	0.7	0.9	2.7	2.7	6.9	11.1	18.9	53.6	100
1934-5	..	0.8	0.8	1.0	1.9	1.4	3.7	3.5	11.1	20.0	55.9	100
1935-6	..	0.4	0.7	0.7	0.7	2.0	2.4	6.4	8.4	17.6	60.6	100
1936-7	..	0.5	0.4	1.2	1.0	1.0	3.2	5.0	13.8	21.2	52.8	100
INFLUENZA												
1931-2	..	11.5	10.4	9.8	11.3	10.8	10.5	9.2	8.8	9.3	8.5	100
1932-3	..	9.1	9.6	10.8	13.2	12.2	11.6	9.9	8.5	8.3	6.8	100
1933-4	..	10.3	10.6	11.2	12.1	11.6	10.5	9.7	8.6	8.0	7.6	100
1934-5	..	10.3	10.3	10.2	11.7	11.9	11.8	9.5	8.4	8.2	7.7	100
1935-6	..	9.7	10.5	10.7	11.6	11.4	10.5	9.9	9.0	8.5	8.3	100
1936-7	..	12.0	9.0	9.2	11.0	11.0	10.6	10.2	8.6	8.3	9.9	100
MALIGNANT NEOPLASMS												
1931-2	..	0.8	0.7	1.5	1.8	2.0	4.0	6.3	15.4	28.6	39.0	100
1932-3	..	0.8	1.0	1.2	2.2	4.0	3.6	8.9	15.6	21.6	41.2	100
1933-4	..	1.0	1.3	1.4	3.6	3.2	4.8	8.3	15.3	21.9	39.2	100
1934-5	..	0.6	1.7	1.9	1.9	3.0	6.0	10.0	12.4	25.1	37.4	100
1935-6	..	0.6	1.6	1.0	2.3	3.3	5.2	8.6	14.6	24.1	38.8	100
1936-7	..	1.0	0.9	1.4	2.3	4.4	4.7	7.4	13.6	21.7	42.6	100
TONSILLITIS												
1931-2	..											
1932-3	..											
1933-4	..	18.4	18.7	16.2	14.6	10.8	7.7	5.5	3.4	2.8	1.9	100
1934-5	..	17.7	18.8	16.4	15.1	11.0	7.8	5.1	3.6	2.6	1.9	100
1935-6	..	18.5	18.7	16.9	14.3	11.1	7.7	5.3	3.3	2.4	2.0	100
1936-7	..	19.4	18.0	16.3	15.0	10.9	7.0	5.0	3.6	2.7	2.1	100

RELIABILITY OF R_x

INFLUENZA ♂

Spread between highest and lowest value
of R_x in six successive years, 1931-6.

N.B. If we omit 1936/7 which provides either a maximum or a minimum in 6 out of 10 age-groups, still closer margins obtain.

AGE
Fig. 2.

distribution, as we shall see later, that is generally typical of infectious diseases. In men, however, the distribution is spread out over youth and middle life; and, indeed, shows a secondary rise in the 50-55 age group. This is broadly consistent with mortality figures and with the findings of Hogben and Johnstone for discharges from the Army on medical grounds. There are good *prima facie* reasons for supposing that: (a) this disparity arises from industrial risks, such as silicosis among miners, to which men are uniquely exposed; (b) if these risks were removed, the male distribution might well shift to the female, infectious type.

There is no need to labour the point, since it is readily susceptible to proof or disproof when figures for morbidity split by occupation can be made available. One swallow does not make even an English summer, and where social effort results in changing the relative age incidence of a disease it will clearly operate in that way only over an extended period. Enough has been said to show that R_x is a statistic of remarkable constancy in the short term; and for planning state medicine in an ageing population, or in one that is regionally divided into sub-populations of different age compositions, we are concerned only with the short term. For purely research purposes, such as examining the timing of immunity mechanisms, it will, at least, lead us to a good first approximation, though separate validation for each diagnosis is ideally necessary to close any *ad hoc* case.

RELIABILITY OF R_x
MALIGNANT NEOPLASMS ♂

Fig. 3.

4. AGE AND INJURY

The disparity between men and women in the relative contributions which injuries and disease make to total morbidity, as disclosed in Table I, invites further examination. The relative incidence of all injuries at different ages is shown for men and single women separately in Table VII. In each of the six years for which necessary information is available the same difference manifests itself. Among men the liability to injury falls slightly as life advances, a finding in agreement with the conclusions of earlier studies such as that of Newbold (1926). Among single women, however, no such phenomenon obtains. Indeed, the relative liability falls slightly to a minimum in middle life (located variously in the different years studied between 25 and 45) after which it rises comparatively steeply. The

T.B.—PULMONARY

Fig. 4.

ALL INJURIES

Fig. 5.

point is demonstrated further in Fig. 5, based on the latest year available (1936-7) and which offers figures that are in no way atypical of the six years.

TABLE VII
RELATIVE INCIDENCE OF ALL INJURIES AMONG SCOTTISH INSURED WORKERS FOR SIX SUCCESSIVE YEARS

	20	20-	25-	30-	35-	40-	45-	50-	55-	60	Total
MEN											
1931-2	12.6	12.5	10.6	9.8	8.9	8.9	8.9	8.9	9.8	9.1	100
1932-3	12.1	12.5	10.6	10.5	8.8	8.8	8.8	9.0	9.6	9.5	100
1933-4	12.8	12.8	10.4	9.8	9.3	9.2	9.1	9.2	9.2	8.5	100
1934-5	12.4	12.4	10.4	10.4	9.0	8.8	9.4	9.5	9.1	8.7	100
1935-6	12.5	11.7	9.9	10.1	9.2	9.2	9.2	8.7	9.0	10.5	100
1936-7	13.4	11.6	9.7	10.1	10.3	8.9	8.9	9.0	8.7	9.5	100
SINGLE WOMEN											
1931-2	10.0	8.9	7.6	7.0	7.5	7.9	10.2	13.5	14.0	13.4	100
1932-3	8.9	9.1	7.5	7.5	7.6	7.4	10.8	12.9	13.6	14.6	100
1933-4	9.6	9.2	8.2	7.5	7.7	7.2	10.8	13.0	11.6	15.0	100
1934-5	10.3	9.6	7.7	7.6	7.1	8.2	9.9	12.7	14.9	12.0	100
1935-6	9.3	9.1	7.0	7.1	7.7	8.7	9.2	12.2	13.6	16.1	100
1936-7	10.5	8.7	7.3	7.4	7.5	7.9	10.3	13.0	13.3	14.2	100

To elucidate further this somewhat unexpected result, more detailed breakdown of the figures is required. For 1936-7, though not for earlier years, the Scottish figures give an analysis by age of cases of injury arising during the year divided into broad groups by type of trauma. Examination of the proportionate contributions of different types to total injuries in each age group yields the result shown in Figs. 6 and 7. From these charts one conclusion is immediately evident. Just as the relative liability to injury *vis-a-vis* disease increases with age among single insured women and does not do so in the male population, so does the liability to fracture *vis-a-vis* other injury increase. To see how far this increased liability to fracture is alone responsible for the increase in all injuries, we may turn to the relative age incidence of fractures and of all other injuries. This is given in Table VIII.

TABLE VIII
RELATIVE INCIDENCE OF FRACTURES AND OTHER INJURIES AMONG SCOTTISH INSURED WORKERS, 1936-7

		20	20-	25-	30-	35-	40-	45-	50-	55-	60	Total
Fractures, other than skull	Men	12.1	10.2	8.0	8.8	9.6	9.1	9.7	10.7	9.6	12.1	100
	Single women	3.6	3.4	3.5	3.8	6.1	6.0	11.0	18.4	20.6	23.7	100
Other injuries	Men	13.6	11.8	9.9	10.2	10.4	8.8	8.8	8.8	8.7	9.2	100
	Single women	11.8	9.8	8.0	8.1	7.7	8.3	10.2	11.9	11.9	12.3	100

INJURIES ♂ 1936/7

Fig. 6.

While men show an excess liability to injuries not involving fractures at ages below 45, it is comparatively slight. The increased relative liability to fracture among women over the age of 45, however, is dramatically large, and we are safe in postulating that the bulk of the discrepancy noted in the figures for total injuries is due to this phenomenon. The explanation of this may be local, and lie in increased risk among the older women due to selection of the types of occupation in which they find themselves, or it may be a generalized physiological sex difference.

It should be noted that insured persons are liable to claim in respect of lost time resulting from any injury, irrespective of cause. We have therefore no means of dividing these injuries into broad groups by location or mechanism of the accidents which caused them. Some evidence relevant to our present purpose, however, is to be found in the reports of the American National Health Survey, conducted by the Federal Government under the New Deal Administration. Britten and others (1940), reporting on material collected among 2,498,180 American citizens of known age, found the overall frequency of accidents among the total population at risk to be 16 per 1,000 per annum, of which 29% were home accidents, 24%

INJURIES ♀ 1936/7

Fig. 7.

occupational accidents, 20% automobile accidents, 21% other public accidents, and 6% were unspecified as to place of occurrence. This overall figure, however, gives little guidance, since the proportion of the overall population which can be considered at risk for each type of accident varies. One does not expect occupational accidents in children under 10, or in as high a proportion of adult women as men. They find, however, that 64% of urban domestic accidents are due to falls, while another report on the same population at risk (Klebba and Britten, 1941) gives the proportion of public accidents due to the same cause as 40%. Unfortunately, no comparable figures for industrial accidents are available, but it is worthy of note that only 14% of accidents in British industry, according to the Chief Inspector of Factories (1946), are due to persons falling, though the liability to this showed a steep gradient with increasing age. If one accepts the not unreasonable premise that falls constitute the principal cause of fractures, this would suggest that the disparity may well be accounted for by differential risk to various types of accident. It is, for example, not unreasonable to suppose that increasing proportions of the older groups of insured women in 1936 were employed in domestic service with the concomitant risk that work in the home entails. Support for this

FRACTURES OTHER THAN SKULL

Fig. 8.

view is to be found in the figures of Britten and others for accidents in the urban home, which show that, while liability to falls increases far more greatly with age among women than among men, there is little difference between the sexes in the proportion of falls which resulted in fractures. The figures for liability to falling are inconclusive, since the true population at risk to which the number of falls should be related ought to be measured not in numbers of persons but in man or woman-hours spent in the home environment, and this is not available.

While the phenomenon may be due to a differential spread of social risk which is concealed by the heterogeneity of the data, an examination of the actual timing of the increased fracture liability of women, shown by the Scottish data, as demonstrated in Fig. 8, is suggestive of another possible explanation. It will be seen that the increase in relative liability does not take place steadily with age. After a comparatively small increase after 35 years of age, it goes up abruptly in the 45–50 age group and still more sharply in the 50–55 group. Any phenomenon that shows an abrupt change in these age groups in women, not paralleled by a similar change in men, may legitimately be suspected of having a physiological cause in some effect of the menopause. The tempting suggestion that increased fragility of bone would account for the figures presented is almost certainly ruled out by

the American findings. That increased liability to falls is a true sex difference, not accounted for by social habits, remains a possibility and may well be connected with comparatively abrupt changes in body weight following on the menopause. Further investigation, however, must attend the production of data showing the incidence of accidents divided both by causative agent and by physical result for known populations at risk at different ages.

5. AGE AND DISEASE

Figures for the relative incidence at different ages for each of the specific diseases listed earlier in Section 2 are shown for men in Table IX. It will be seen that 21 of the 31 diagnoses selected for study show a clearly marked rise or fall in relative incidence as age advances. The general direction of the slope in all cases is in accordance with the results obtained by Hogben and Johnstone for the British Army, but the more extended age range of the insured population gives us, in some cases, a clearer picture of such developmental conditions as affect more particularly the older groups.

Three broad groups are distinguished in the table. Of diagnoses which show a declining incidence with advancing age all but two are zymotic conditions, for which the growth of an immune community of persons who have already had the disease provides a sufficient explanation (*vide* Hogben and Johnstone) of the slope of the relative incidence. Of the other two conditions, the behaviour of appendicitis is possibly amenable to an explanation arithmetically on all fours with immunity, since appendectomy withdraws the individual healed from the effective population at risk, while the falling incidence of adenitis may be explained by the occurrence of many, though not all, of the cases as sequelae of a number of infectious diseases which themselves fall off with age. Among the diagnoses listed it is not wholly clear what is the dividing line between a condition listed as "inflammation of the skin and subcutaneous tissue" and "ulcers, carbuncles, boils and abscesses." It is worthy of note, however, that the latter shows a far less steep falling off.

A number of disorders, mainly of the cardiovascular system, account for diagnoses showing a marked rise with age. In increasing order of steepness, these are: valvular disease of the heart, varicose veins, phlebitis, myocarditis, cerebral haemorrhage, and arteriosclerosis. The inclusion in this section of certain other conditions is also worthy of comment. On the present data, it is uncertain what precise interpretation should be placed on the rising relative incidence of asthma and bronchitis since it is not possible to tell whether this is due to a pool of asthmatics and bronchitics who are incommoded to an extent that they are incapacitated from work more and more frequently as they grow older, or whether it arises from a true increase in liability to first attack as an individual ages. Alone, of diseases due to infection, erysipelas appears in this section. In this it is in striking contrast to scarlet fever. A possible explanation is progressive desensitization to the toxins of β -haemolytic streptococci allied to increasing sensitivity, at least as far as infection

TABLE IX

RELATIVE INCIDENCE OF SPECIFIC DISEASES AMONG THE INSURED POPULATION OF SCOTLAND, MALES, 1937

Disease	20	20-	25-	30-	35-	40-	45-	50-	55-	60	Total	No. of cases
<i>(i) Falling with Age</i>												
Adenitis, enlarged glands (not tubercular)	24.7	15.3	12.2	11.8	7.9	6.4	5.5	4.6	4.8	6.8	100	783
Appendicitis	16.3	17.3	15.2	13.0	11.6	8.0	5.4	5.3	3.6	3.9	100	3,717
Diphtheria	36.9	18.5	18.7	8.6	7.2	4.6	1.5	1.1	2.3	0.8	100	305
Inflammation of skin and subcutaneous tissue	18.7	15.2	11.9	11.3	8.6	7.9	7.1	6.2	6.2	6.8	100	9,558
Measles	29.5	24.1	13.0	12.0	7.7	4.6	3.4	4.4	0.9	0.6	100	397
Mumps	26.0	14.9	14.9	11.1	13.6	7.9	5.0	2.1	1.9	2.7	100	506
Pharyngitis	14.4	12.0	12.3	12.9	11.3	7.7	9.9	6.8	7.2	5.6	100	647
Scarlet fever	29.6	19.2	14.7	15.5	10.4	5.3	2.1	1.6	1.7	—	100	499
Tonsillitis	19.4	18.0	16.3	15.0	10.9	7.0	5.0	3.6	2.7	2.0	100	14,465
Ulcers, carbuncles, boils, abscesses ..	12.1	12.7	12.4	12.4	11.3	9.5	9.0	7.6	6.9	6.2	100	12,425
<i>(ii) Rising with Age</i>												
Arteriosclerosis ..	0.2	0.0	1.0	0.3	1.2	1.3	2.8	12.3	23.9	57.0	100	323
Asthma	4.6	7.1	7.7	9.2	9.3	11.1	11.6	11.3	12.9	15.4	100	2,033
Bronchitis	6.6	5.1	5.2	7.0	8.8	9.7	11.1	12.8	13.3	20.5	100	17,590
Cerebral haemorrhage	0.5	0.4	1.2	1.0	1.0	3.2	5.0	13.8	21.2	52.8	100	341
Erysipelas	1.3	2.9	2.7	7.2	9.4	12.0	12.1	17.0	16.4	19.1	100	761
Hernia	3.4	6.0	6.3	9.9	9.0	10.2	11.8	12.8	14.6	16.0	100	1,786
Myocarditis	1.0	1.3	1.1	2.6	3.3	4.7	7.9	13.5	21.7	43.1	100	1,184
Neoplasms (Mal.) ..	1.0	0.9	1.4	2.3	4.4	4.7	7.4	13.6	21.7	42.6	100	520
Phlebitis	0.9	3.2	3.2	6.6	7.3	9.6	12.2	16.2	18.1	22.6	100	525
Valvular disease of the heart	5.1	5.0	5.3	6.2	8.5	7.5	7.9	17.6	17.9	19.2	100	364
Varicose veins	4.6	7.1	9.2	8.9	6.1	6.3	7.8	11.4	16.5	22.1	100	373
<i>(iii) Other and uncertain Trend</i>												
Conjunctivitis	11.7	10.7	10.0	12.3	9.3	11.2	7.4	8.2	9.1	10.2	100	896
Haemorrhoids	1.0	3.3	6.5	11.6	16.2	15.4	14.2	11.4	9.9	10.7	100	1,747
Influenza	12.0	9.0	9.2	11.0	11.0	10.6	10.2	8.6	8.3	9.9	100	89,826
Neoplasms (Ben.) ..	11.1	12.3	11.1	10.0	9.5	8.7	11.8	8.3	8.0	9.3	100	619
Peptic ulcers (gastric and duodenal) ..	1.3	4.4	9.2	13.4	15.7	14.0	12.6	11.9	8.8	8.7	100	3,810
Pneumonia	13.4	9.3	7.0	9.5	11.0	10.1	10.9	8.7	7.6	12.6	100	1,768
Sinusitis	9.4	10.9	13.5	14.1	13.1	12.3	8.8	5.0	6.1	6.9	100	733
Tuberculosis (pulmonary) ..	7.0	11.8	11.7	11.3	11.4	10.7	9.6	10.4	8.3	7.8	100	783
Tuberculosis (other sites)	12.6	12.8	12.8	7.6	11.1	10.4	12.3	9.7	5.3	5.4	100	196
Tuberculosis (site not specified)	9.8	9.3	13.2	13.4	14.5	9.5	9.5	6.2	5.0	9.6	100	236
<i>(iv) Totals</i>												
All injuries	13.4	11.6	9.7	10.1	10.3	8.9	8.9	9.0	8.7	9.5	100	36,305
All diseases	9.6	8.7	8.9	10.4	10.5	9.9	9.8	9.6	9.9	12.7	100	273,657

through the subcutaneous small lymphatics is concerned, to the streptococcus itself.

The remaining section admits of further dichotomy, since it is composed in part of diseases whose incidence remains relatively stable throughout life, and in part of those showing a peak in middle life. Of the latter conditions the peak incidence of haemorrhoids in the 35-40 age group followed by a slow, but steady, subsequent fall is conceivably consistent with the supposition that true liability to the condition increases but that operative procedures result in a sub-population either no longer liable to risk or one which does not suffer to such an extent as to be incapacitated from work. The validification of this supposition, however, must await reliable statistics of the incidence of operative procedures. Peptic ulcers, with a peak in the 40-45 age range, confirm the findings of Hogben and Johnstone, who found a peak for hospital admissions in the Army in the 43-45 age range for duodenal ulcers and in the over 45 group (at their extreme age range) for the much less common gastric type. Pneumonia, in the absence of more refined sub-division of the diagnosis, inevitably presents a confused picture. Sinusitis would not be expected to behave like infectious disease of childhood, since it cannot make its initial appearance before a certain stage of growth of the anatomical site of infection; but a peak so late as the 30-35 age group calls for an explanation *sui generis*. The diagnosis is not, in any case, sufficiently clear-cut in these data to merit extensive deduction from the figures presented. Of other diseases in this section it is worthy of note that influenza shows a fairly level relative incidence throughout life, as does conjunctivitis. There is, in these figures, no indication of a developing immunity against influenza, as might be expected for a disease whose diagnosis, in general practice, is uncertain and whose aetiology may be various.

Table X shows comparable figures for unmarried women, for all diseases where a sufficiency of cases was recorded, together with two other conditions, goitre and exophthalmic goitre, of particular interest in women. Of these it will be noticed that the relative incidence of exophthalmic goitre reaches an early peak in the 30-35 age group and thereafter remains at a relatively high level until 55, when it falls again. Unspecified goitre, including presumably the hypothyroid type, on the other hand rises steadily to a maximum in the 45-50 age group and thereafter declines.

Noteworthy differences between age incidence in men and women occur in one or two cases, though in the main there is very good agreement in the figures presented. A possible explanation of the tuberculosis figures has been discussed above. Peptic ulcers in women do not reach a peak until the 55-60 age group, after which they appear to decline. This finding is again consistent with the findings of Hogben and Johnstone, in that gastric ulcers tend to increase among older age groups to a higher age than duodenal, but that males have greater liability to the duodenal type. Haemorrhoids have their maximum relative incidence in the 45-50 age range among single women as opposed to 35-40 among men.

Values of Q for these distributions are given in Table XI. It should be pointed

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TABLE X

RELATIVE INCIDENCE OF SPECIFIC DISEASES AMONG THE INSURED POPULATION OF SCOTLAND, FEMALES (UNMARRIED)—1937

Disease	20	20-	25-	30-	35-	40-	45-	50-	55-	60	Total	Cases
(i) Falling with Age												
Adenitis, enlarged glands (not tubercular)	21.3	18.5	11.8	13.7	9.0	6.6	5.2	8.7	2.8	2.5	100	564
Appendicitis	21.0	21.5	14.9	12.6	9.0	6.3	4.3	5.1	2.8	2.4	100	3,128
Diphtheria	28.1	24.8	15.0	7.4	6.1	7.1	8.3	2.0	1.2	—	100	527
Inflammation of skin and subcutaneous tissue	23.2	16.1	10.6	8.3	7.2	6.7	8.4	7.4	5.7	6.5	100	3,684
Measles	25.2	23.6	14.5	12.0	7.4	5.2	2.0	3.7	4.3	2.0	100	411
Mumps	18.2	19.3	16.8	16.1	7.4	8.8	4.3	4.2	—	5.1	100	431
Scarlet fever	31.3	21.9	16.1	12.0	6.5	2.6	3.7	1.8	4.3	—	100	595
Tonsillitis	21.0	18.5	14.3	11.3	9.4	7.8	6.3	5.6	3.4	2.5	100	12,027
Ulcers, carbuncles, boils, abscesses ..	16.2	15.4	11.3	9.5	7.8	8.5	7.3	9.7	8.3	6.1	100	3,229
*Tuberculosis (pulmonary) ..	12.2	18.1	17.2	17.8	10.0	8.3	5.3	5.4	2.5	3.5	100	380
*Tuberculosis (site not specified)	13.6	19.1	15.4	17.8	15.0	6.5	2.5	3.1	7.2	—	100	137
(ii) Rising with Age												
Arteriosclerosis						Insufficient cases						
Asthma	4.0	7.1	7.8	9.9	11.7	10.1	11.8	12.9	11.1	13.8	100	747
Bronchitis	6.3	7.6	6.7	7.9	8.2	9.4	10.7	12.3	13.5	17.4	100	6,635
Cerebral haemorrhage ..						Insufficient cases						
Erysipelas	3.8	5.7	5.0	6.3	8.5	3.1	11.6	21.7	20.9	13.3	100	262
Hernia												
Myocarditis	1.3	2.1	3.1	2.9	3.5	7.2	6.9	17.7	19.6	35.9	100	403
Neoplasms (Mal.)	1.2	2.3	2.5	5.1	3.0	10.9	14.0	18.6	29.9	12.5	100	183
Phlebitis	0.8	1.9	2.6	4.1	5.5	14.7	13.4	18.3	18.2	20.7	100	354
Valvular disease of the heart	4.7	7.7	6.9	8.6	11.7	10.7	14.2	11.1	12.2	12.3	100	338
Varicose veins	1.4	4.7	3.4	7.3	8.9	6.6	13.4	19.8	15.1	19.5	100	196
*Haemorrhoids	1.0	4.1	10.9	11.0	12.3	13.1	18.5	8.9	5.8	14.3	100	209
*Peptic ulcers	1.9	4.5	5.0	8.1	9.0	13.3	12.4	12.2	21.1	12.6	100	375
(iii) Other and uncertain Trends												
Conjunctivitis	8.2	11.1	8.3	8.4	9.0	12.9	7.3	14.0	9.7	11.3	100	445
Exophthalmic goitre ..	4.5	5.5	8.4	14.1	13.4	11.7	13.7	13.8	6.9	8.0	100	239
Goitre	9.7	7.6	8.8	8.2	13.9	11.9	15.7	6.4	7.5	10.3	100	130
Influenza	10.9	11.5	10.0	10.5	10.3	11.0	10.2	9.3	8.0	8.4	100	37,604
Neoplasms (Ben.)	10.3	11.5	10.0	8.0	13.6	9.4	15.0	4.2	5.8	12.1	100	372
*Pharyngitis	11.9	12.6	11.0	12.1	10.4	9.6	11.7	7.0	7.2	6.6	100	496
Pneumonia	7.8	9.3	7.2	7.1	8.4	6.4	11.9	13.0	15.2	13.6	100	337
Sinusitis	8.9	11.2	13.5	12.2	11.1	12.3	6.8	7.4	7.6	9.0	100	341
Tuberculosis (other sites)	11.9	11.3	10.1	11.7	11.4	13.1	15.3	2.3	5.4	7.5	100	140
(iv) Totals												
All injuries	10.5	8.7	7.3	7.4	7.5	7.9	10.3	13.0	13.3	14.2	100	6,527
All diseases	10.3	11.0	9.5	9.6	9.3	9.8	10.0	10.4	9.6	10.6	100	129,249

*Cases for women in different section from men.

out that since, as shown above, Q is in fact a form of age-standardizing factor, it is not independent of the initial population at risk. This being so, we cannot legitimately compare Q values calculated on initially different populations, except in the trivial case where the distribution of R_x is rectangular. For one and the same population it does, however, give us a useful measure of how sharp is the departure from the rectangular shape, besides its computing value in recovering other desirable information requisite for later communications of this series.

TABLE XI
VALUES OF " Q "—INSURED WORKERS IN SCOTLAND, 1936-7

Disease	Men	Single Women
<i>(i) Incidence Falling with Age</i>		
Adenitis, enlarged glands (not tubercular) ..	11.26	14.95
Appendicitis	11.50	15.87
Diphtheria	12.45	17.96
Inflammation of skin and subcutaneous tissues	10.99	14.29
Measles	12.37	17.14
Mumps	11.68	15.12
Pharyngitis	10.72	11.25
Scarlet fever	12.29	18.27
Tonsillitis	11.83	15.08
Ulcers, carbuncles, boils and abscesses ..	10.67	12.72
<i>(ii) Incidence Rising with Age</i>		
Arteriosclerosis	6.22	
Asthma	9.21	7.70
Bronchitis	8.69	7.94
Cerebral haemorrhage	6.45	
Erysipelas	8.24	6.59
Hernia	8.97	
Myocarditis	6.93	4.37
Neoplasms (Mal.)	6.95	4.78
Phlebitis	8.09	4.63
Valvular disease of the heart	8.59	7.89
Varicose veins	8.95	5.68
<i>(iii) Other and Uncertain Trend</i>		
Conjunctivitis	10.20	9.52
Exophthalmic goitre	—	7.94
Goitre	—	9.32
Haemorrhoids	9.11	6.93
Influenza	10.04	10.60
Neoplasms (Ben.)	10.35	10.45
Peptic ulcers (gastric and duodenal) ..	9.48	6.15
Pneumonia	9.80	8.70
Sinusitis	10.59	10.64
Tuberculosis (pulmonary)	10.27	13.70
Tuberculosis (other sites)	10.61	11.00
Tuberculosis (type not specified) ..	10.38	14.14
<i>(iv) Totals</i>		
All injuries	10.27	9.16
All diseases	9.77	10.18

6. SUMMARY

1. This communication deals with the relation of age to the risk of incurring specific diseases and to morbidity as a whole in an employed population. It is based principally on data concerning insured persons collected by the Department of Health for Scotland.

2. The relative age incidence of a number of diagnoses is given and possible implications of the figures discussed. Comparison with similar results obtained for an Army population by Hogben and Johnstone (1947) shows very close agreement.

3. Women tend to incur accidents relatively more often as they grow older. The incidence among men, on the other hand, tends to decline with age. The great part of this differential is accounted for by accidents resulting in *fractures*. Present data are inadequate to determine how far this is ascribable to differences of social habit, and how far to differences of physique. It is *not* due to differential fragility of bone.

4. All indirect methods of age standardization assume the relative age incidence of the condition studied to be a constant. This is not necessarily true for total morbidity, since preventive medicine has so far been successful principally in eradicating zymotic disease that predominantly affect the younger age groups. In the short term, however, a remarkable constancy of relative age incidence both for total morbidity and for individual diagnoses is found to obtain.

5. The social organization necessary to the production of morbidity statistics is discussed.

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