THE SIGNIFICANCE OF NUPTIALITY WITH RESPECT TO INTERPRETATION OF SEX DIFFERENCES

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1. INTRODUCTION

Existence of sex differentials with respect to disease in human populations is a matter which deserves investigation both from a practical and from a theoretical viewpoint. At the operational level, their interest scarcely calls for comment; but the biological significance we attach to them is an issue we are prone to dismiss too lightly by undue reliance on experience of laboratory stocks. In one way or another, most human societies are polarized with respect to the prevailing pattern of occupation in which one or other sex is engaged. Hence statistical regularities characteristic of the sex difference may well arise in virtue of hazards peculiar to different occupations in contradistinction to agencies ultimately traceable to the X-chromosome complement.

If a wholly decisive test for discrimination between these possibilities or for evaluation of their relative importance in a given situation is not available, there is at least one framework of comparison relevant to a balanced judgment. On the whole, single females, if adult, have gainful employment outside the home, as do the majority of men. To this extent, we are entitled to expect that sex differences, if attributable to differential occupational risk, will be less obtrusive if we restrict our comparison to unmarried women. This does not mean that a sex differential attributable wholly or largely to circumstances unconnected with constitutional differences will disappear if we confine our comparison to men as a whole and to single women only. We must not disregard the fact that single women and men, if gainfully employed, dominate different trades and professions. For instance, men dominate the heavy industries and single women predominate in domestic and cognate services, including the care of children and the sick.

It is none the less broadly true that the daily regime of the single woman conforms more to that of the male than does that of the married woman. In so far as the morbidity experience of the single woman conforms more to the male pattern we have

therefore good grounds for assuming that differences which distinguish women as a whole are appreciably attributable to occupational status. The converse is not true, inasmuch as a difference which distinguishes the sexes may be associated with an occupational hazard almost or wholly restricted to males.

Needless to say any comparison undertaken with this end in view is liable to lead us grossly astray if we do not pay attention to the differential incidence of disease with respect to age. Accordingly, comparisons of the mortality experience of men with that of women, or of single women with that of married women should take within their scope a breakdown with regard to age of the relevant populations at risk. This communication is an examination of what materials official statistics of disease supply.

2. SOURCES OF FIGURES

For the purpose of this investigation we have had recourse to mortality experience in different countries. Morbidity statistics, where they do exist, refer only to the section of the community insured for National Health purposes. A population represented by such a characteristic will exclude all children, the majority of married women, and all others who are either retired or of independent means. For this reason mortality in England and Wales during the three years round the last census that is, 1930-1932, was our first target. Canada is the only other country which provides mortality statistics for each conjugal group at different ages and other sources of mortality experience cited below were used to provide confirmation of sex differentials disclosed by the mortality statistics of England and Wales, and of Canada. As far as is compatible with the delimitation of the census year and with the size of the population, mortality rates during the same period have been chosen in each country. Statistics of Canadian mortality during the last war, however, were available and have been included. All crude figures have been related to the population given in the mid-year Census of the period reviewed in each country.

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TABLE I

DISEASES WITH A HIGHER MALE MORTALITY: AT AGES FIFTEEN YEARS AND OVER
(Female rates as percentage of male rate)

A. ENGLAND AND WALES, 1930-1932

Disease	Age groups								
	16-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Pneumonia (all)	63.9	53.3	58.1	46.3	37.5	51.4	61.7	72.6	81.4
Peptic ulcer (all)	5.0	2.4	20.4	18.4	25.3	29.3	37.9	31.8	45.1
Suicide	74.2	58.6	54.2	43.2	34.9	28.9	22.7	23.6	16.1
Bronchitis (all)	88.2	61.0	62.6	35.1	35.4	53.2	61.3	66.0	66.7

B. CZECHOSLOVAKIA, 1928-1930

Disease	Age groups				
	15-24	25-39	40-49	50-64	65—
Pneumonia (all)	82.3	94.2	74.0	80.2	88.1
Peptic ulcer (all)	10.3	27.1	32.4	36.2	52.2
Duodenal ulcer	—	20.1	19.4	35.7	75.1
Gastric ulcer	12.2	28.3	35.7	32.1	49.8
Appendicitis	64.7	72.7	57.2	72.7	71.6
Suicide	43.7	37.4	30.6	26.6	27.3
Bronchitis (all)	113.5	76.5	54.3	57.9	81.4
„ (acute)	100.0	152.5	122.7	63.1	99.8
„ (chronic)	114.8	70.7	49.5	57.5	79.4

C. NEW ZEALAND, 1930-1942

Disease	Age groups								
	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Pneumonia (all)	54.7	78.7	70.6	49.7	41.7	46.8	60.1	62.5	81.1
Peptic ulcer (all)	26.0	38.5	22.8	18.2	16.4	30.7	38.1	38.0	32.7
Duodenal ulcer	—	20.6	14.9	14.6	11.7	17.3	38.7	21.6	17.5
Gastric ulcer	26.0	68.6	29.0	21.6	22.4	37.9	30.4	44.6	43.4
Appendicitis	58.2	48.7	58.3	58.7	55.2	92.1	53.3	51.6	51.6
Bronchitis (all)	57.6	30.7	81.2	70.8	37.7	51.6	68.1	65.8	83.9

3. SEX DIFFERENTIALS

To bring into clearer focus sex differentials arising from differences in occupational status, the adult population has been considered separately. Tables I to V show only those diseases from which males suffered a mortality consistently higher or lower in each country for which statistics were available than that of females at ages 15 and over or less than 15 years. In all these Tables female mortality rates are presented as a percentage of male mortality rates in the same age group.

Outstanding differentials disclosed in Tables I to IV and in Fig. 1 and confirmed by their existence in more than one country are:

1. A high mortality among males of all ages from *tuberculosis of bones and joints*, *pneumonia*, *bronchitis*, and *appendicitis*. The sex differential is greater for lobar than for bronchopneumonia.

2. A high mortality among adult males only from *peptic ulcer* and *suicide*. The peptic ulcer differential is as pronounced in the youngest years of adult life as in the later ones; but one may suspect that occupation has some influence on the course of this disease since single women suffer a rather higher mortality than married. Duodenal ulcers show a slightly higher differential than do gastric ulcers.

TABLE I—continued.

DISEASES WITH A HIGHER MALE MORTALITY: AT AGES FIFTEEN YEARS AND OVER
(Female rates as percentage of male rate)

D. U.S.A., 1929-1931

Disease	Age groups								
	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Pneumonia (all)	64.1	70.2	68.0	54.0	54.0	70.0	86.0	95.8	106.3
Lobar pneumonia	60.8	65.9	65.8	51.9	51.1	65.9	80.7	90.3	97.6
Bronchopneumonia	77.2	89.2	77.2	62.6	64.7	81.2	97.6	105.1	115.7
Peptic ulcer (all)	51.2	32.2	23.5	20.2	23.9	26.9	34.5	50.1	55.6
Duodenal ulcer	59.3	18.1	17.2	18.6	25.1	25.0	29.8	36.5	47.3
Gastric ulcer	46.4	43.9	27.5	21.1	23.2	27.7	36.7	55.9	58.3
Appendicitis	61.2	56.1	60.7	53.4	60.6	70.9	85.0	75.9	85.8
Osteomyelitis	23.9	37.9	26.7	22.1	48.5	51.1	45.2	51.5	50.6
T.B. vertebral col., bones and joints	61.4	40.2	55.2	71.1	70.1	71.0	84.1	103.0	130.4
Bronchitis (all)	113.3	104.0	72.5	59.1	52.8	65.8	95.3	101.5	122.3
„ (acute)	100.0	76.1	105.5	99.1	71.2	91.7	118.2	122.9	148.2
„ (chronic)	121.9	115.9	61.9	45.5	47.0	57.4	87.9	94.2	108.1

E. CANADA, 1929-1933

F. CANADA, 1929-1943

Disease	Age groups				Age groups			
	15-24	25-44	45-64	65—	15-24	25-44	45-64	65—
Pneumonia (all)	72.9	80.9	64.0	88.6	76.7	76.6	95.4	80.2
Lobar pneumonia	70.5	80.1	65.5	88.6	69.6	74.6	56.7	77.3
Bronchopneumonia	82.9	119.9	74.7	111.6	71.7	91.2	67.6	94.1
Peptic ulcer (all)	49.0	26.9	26.2	41.0	19.8	16.8	17.0	29.5
Duodenal ulcer	35.4	19.7	20.5	27.0	10.9	13.8	16.0	26.9
Gastric ulcer	60.6	32.2	29.9	48.7	24.0	19.4	17.8	28.1
Appendicitis	62.1	53.5	62.2	72.3	52.3	51.2	62.9	71.2
T.B., vertebral col., bones and joints ..	53.9	64.9	98.0	100.3	53.2	56.4	86.2	84.3
Bronchitis (all)	114.3	112.1	82.8	110.7	96.9	68.2	42.0	90.4
„ (acute)	310.0	112.2	84.0	164.9	26.0	80.6	66.8	125.9
„ (chronic)	64.2	98.7	77.0	87.5	126.1	68.5	37.2	74.1

3. Males of less than 15 years only have a higher mortality from *acute nephritis*. American vital statistics provide figures of mortality with respect to *osteomyelitis*, which also discloses a sex differential in favour of the female.

4. Adult males have a lower mortality from *diseases of the thyroid* and *parathyroid*, from *diabetes*, and from *pernicious anaemia*. Unfortunately available public statistics do not contain data with respect to the contribution of each specific disease to the first group total.

5. Young males under the age of 15 years had a lower mortality from *whooping-cough*.

Mortality rates with respect to *respiratory tuberculosis* (Table V and Fig. 2) display the familiar picture of an excess of female to male deaths in early adult life and an excess of male to female deaths

in middle age and later life. The peak mortality among older men is probably associated with increased risk due to industrial hazards, as a result either of years of work in "dusty" industries, or of increasing strain endured by older men in heavy industry. Rich (1946) suggests that the comparatively high mortality among young women is to some extent influenced by pregnancy and child-bearing since they occur more frequently among women of less than 30. He produces a table giving for different States of the U.S.A. the sex differential in each age group in association with birth rates and with extent of urbanization. Rich concludes:

"In general, then, the states in which a higher female than male mortality extends into the fourth decade tend to be predominantly rural states with a relatively high birth rate among females in this age period; and the states in which the male mortality surpasses that of the female in the fourth decade

have, in general, a predominantly urban population, with a relatively low birth rate in females in the fourth decade. Certainly, these are by no means the only factors concerned in the local differences in the male-female tuberculosis mortality ratio. Indeed, they may be much less important than other as yet undetermined factors. The purpose in presenting the data . . . is not to pretend to a solution of the problem, but rather to illustrate the need for much more study in the attempt to determine just what the factors are which are responsible for the marked differences in the mortality from tuberculosis in males and females."

It is evident, however, from the figures in Table VII that other influences on tuberculosis mortality among women are sufficiently strong to offset any effect of childbirth to such an extent that single women have an even higher mortality from this disease than those who are married. It may be that there is some selective process in so far as women known to have tuberculosis tend to remain unmarried; but the long latent period of the disease is likely to prevent any selection of this kind from being unduly widespread.

Mortality from *tuberculosis of bones and joints* presents quite a different picture. It is higher among males of all age groups except the oldest when women have an excess mortality. In Canada, the only country for which figures are available, mortality from this disease is much higher among single women of all ages than among married ones.

In a private communication, Dr. Enid Charles, Director of the Statistical Office of the Birmingham City Corporation, has kindly drawn our attention to sex differentials with respect to mortality from various diseases, published by the Metropolitan Life Insurance Company of New York. Figures cited show differences similar to those appearing in this paper. Comparable statistics extracted from their Bulletin are shown below:

4. DIFFERENCES BETWEEN MARRIED AND SINGLE WOMEN

Relevant figures are displayed in Tables VI and VII in which mortality rates among married women are calculated as a percentage of those among single women in the same age groups. They disclose the following differentials:

1. At all ages married women suffer a higher mortality from *cancer of the uterus*. Separate statistics for cancer of the *cervix* and of the *corpus uteri* were not available.

2. From the age of about 45, married women suffer a higher mortality from *diabetes*. That the differential is greatest after the child-bearing period excludes the possibility of its being a direct effect of pregnancy. We are left with two possible explanations:

(a) that it is an indirect effect of repeated pregnancies in so far as the metabolism of the mother may be upset;

(b) that it is due to a difference in eating habits or in the general environment of married as opposed to single women.

3. Married women have a rather lower mortality from *bronchitis* and *pneumonia*.

4. Married women have a conspicuously lower mortality than single women from *tuberculosis*, *peptic ulcers*, *cancer of the breast*, *pernicious anaemia*, and *suicide*.

Australian vital statistics provide data with respect to the number of deaths due to cancer at different sites among single women, married women with children, and among childless married women. Surprisingly enough, the ratio of deaths from *cancer of the breast* to deaths from *cancer of the uterus* among childless married women is more

TREND OF MORTALITY FROM SPECIFIED CAUSES AMONG WHITE PERSONS, BY SEX. AGES 1 TO 74 YEARS. METROPOLITAN LIFE INSURANCE COMPANY, INDUSTRIAL DEPARTMENT, 1921-1923 TO 1941-1943

Cause of death	Average of annual death rates per 100,000*						Ratio male to female rate		
	White males			White females					
	1921-1923	1931-1933	1941-1943	1921-1923	1931-1933	1941-1943	1921-1923	1931-1933	1941-1943
Ulcer of the stomach ..	4.9	6.5	6.7	1.9	1.5	0.9	2.6	4.3	7.4
Ulcer of the duodenum ..	1.8	3.0	3.1	0.6	0.5	0.5	3.0	6.0	6.2
Tuberculosis (all forms) ..	121.1	73.0	44.2	94.0	50.1	22.6	1.3	1.5	2.0
Pneumonia (all forms) ..	81.9	64.9	31.4	63.9	43.1	16.1	1.3	1.5	2.0
Appendicitis ..	16.2	16.1	7.2	11.7	11.2	4.5	1.4	1.4	1.6
Diabetes mellitus ..	14.2	13.9	12.9	21.6	26.6	26.1	0.66	0.52	0.49

* Standardized for age on the basis of the Standard Million of England and Wales, 1901.

TALITY RATES

WALES : 1930-32

MARRIED WOMEN

Mortality rates per million population in each age group are shown as a percentage of the sum of all such male rates.

♀ COMPARATIVE MORTALITY

----- MALE RATE =

FIG. 2.—Comparative mortality rates with respect to tuberculosis. For each site, mortality rates

RATES FROM TUBERCULOSIS

100% ----

RESPIRATORY
VERTEBRAL COLUMN,
BONES AND JOINTS

among women are shown as percentages of the corresponding rates among men of the same age group.

akin to that among other married women than to the corresponding ratio among single women.

The appropriate figures are shown below:

RATIO: BREAST TO UTERUS

Age groups	Never married	Married without children	Married with children
Under 35	0.77	0.57	0.69
35-39	2.78	0.50	1.00
40-44	2.18	0.97	1.31
45-49	2.16	1.00	1.15
50-54	2.24	1.09	1.12
55-59	2.27	1.19	1.03
60-64	1.80	1.15	1.18
65-69	1.75	1.23	1.17
70-74	1.90	1.64	1.26
Over 74	3.25	1.83	1.50

We are led to one of two conclusions: (a) that circumstances attendant on marriage as such, in contradistinction to procreation, exert some influence on cancer of the breast and of the uterus; (b) that some obscure form of selection favours nuptiality among persons less prone to malignant disease at one site and more prone to malignant disease at the other. Separation of cancers of the uterus into those affecting the cervix and those affecting the body of the uterus might be revealing; but such a separation is not possible from available published figures.

Waterhouse (1948)* gives figures of the proportions of parous and nulliparous women treated for cancer of the cervix and for cancer of the body of the uterus in the Birmingham United Hospital (B.U.H.). Among those treated for cancer of the cervix the average number of children was 3.8, which is significantly different from the corresponding mean of 2.0 for the body of the uterus. In the following Table he cites also figures published in the Eighteenth Annual Report of the British Empire Cancer Campaign (B.E.C.C.):

	Cervix		Body	
	B.U.H. (%)	B.E.C.C. (%)	B.U.H. (%)	B.E.C.C. (%)
Nulliparous ..	6	11	28	34
Parous ..	78	85	47	56
Unknown ..	16	4	25	10

After allowing for the different proportions of "unknowns" in the two sets of figures, they are remarkably similar and show that the proportion

* Private communication.

of nulliparous women with cancer of the cervix is much lower than the proportion with cancer of the corpus uteri.

5. SOCIAL CLASS DIFFERENTIALS

Further evidence with respect to the effect of occupation or of environment on mortality is available in the Decennial Supplements of the Registrar General for England and Wales which contain figures of deaths from different diseases among each social class. The Registrar General defines Social Class I as consisting mainly of professional men and women, Social Class III as consisting mainly of skilled artisans, and Social Class V as consisting of unskilled workers. All those who fall between these three main groups are in Social Classes II or IV. To facilitate comparison the mortality experience of Social Classes I, III, and V only was investigated for those diseases which displayed a striking sex differential or a pronounced difference between married and single women. Relevant figures are in Tables VIII (men), IX (single women), and X (married women). Figures for single women in Social Class I are of doubtful significance since (a) the population at risk is small, (b) the largest single occupation of women in Social Class I is that of nuns, who are scarcely comparable with married women or with men in the same social class. Among both men and women, mortality from the three respiratory diseases quoted is higher in Social Class V than in Social Class I. This differential is most striking for *bronchitis* and least striking for *pneumonia*. On the other hand, neither *peptic ulcer* nor *diabetes* displays a very clear-cut differential. Mortality from the two last diseases in the oldest age groups is highest among men and women of Social Class I. Among younger men and women, mortality from the two diseases is lowest in Social Class I.

Deaths from *cancer of the breast* and of the *uterus* show the familiar opposing pattern, viz. mortality from the former is highest in Social Class I and from the latter in Social Class V; this is true of both married and single women.

6. SUMMARY

The aim of this paper is less to present decisive conclusions than to indicate a new attack upon the problem of sex differences, one which will throw light on their significance *vis-à-vis* the nature-nurture issue. If it offers few conclusions which are in fact decisive, it indicates a new line of profitable research when more copious and more reliable sources of official statistics become available. At the present time, the advent of a new Health Service

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TABLE II

DISEASES WITH A HIGHER MALE MORTALITY: AT AGES UNDER FIFTEEN YEARS
(Female rates as percentage of male rates)

A. ENGLAND AND WALES, 1930-1932				D. U.S.A., 1929-1931			
Disease	Age groups			Disease	Age groups		
	0-4	5-9	10-14		0-4	5-9	10-14
Pneumonia (all)	79.0	93.3	89.5	Pneumonia (all)	82.2	85.2	97.9
Lobar pneumonia	78.7	90.5	89.6	Lobar pneumonia	81.1	78.1	97.1
Appendicitis	71.0	77.6	70.9	Bronchopneumonia	82.6	95.9	99.7
Bronchitis (all)	80.8	91.3	102.0	Appendicitis	76.3	89.4	77.1
B. CZECHOSLOVAKIA, 1928-1930				T.B. vertebral col., bones and joints	86.6	64.4	79.9
Disease	Age groups			Bronchitis (all)	85.7	71.3	135.6
	0-4	5-14		" (acute)	84.9	61.2	138.9
Appendicitis	66.1	98.0		" (chronic)	97.0	131.8	130.4
Acute nephritis	74.6	86.5		E. CANADA, F. CANADA, 1929-1933			
Bronchitis (all)	83.2	220.0		Disease	Age group		Age group
" (acute)	83.0	185.0			0-15	0-15	
" (chronic)	84.5	243.7		Pneumonia (all)	60.9	83.8	
C. NEW ZEALAND, 1930-1942				Lobar pneumonia	68.3	89.8	
Disease	Age groups			Bronchopneumonia	82.3	77.7	
	0-4	5-14		Appendicitis	88.4	79.4	
Pneumonia (all)	78.7	89.5		T.B. vertebral col., bones and joints	83.3	69.3	
T.B. vertebral col., bones and joints	—	69.4		Acute nephritis	88.4	73.4	
Bronchitis (all)	71.8	74.5		Bronchitis (all)	72.8	68.0	
				" (acute)	70.4	69.2	
				" (chronic)	161.6	88.6	

and of widespread recognition of what contribution statistical studies can make to the advancement of medicine offers a prospect which is encouraging from this point of view; but the extent to which the new situation will ensure more fruitful use of health statistics must depend on improvement of documentary design implemented with due regard to the potential outcome of comparison undertaken with a clearly-conceived biological objective. Pilot surveys of existing statistics may therefore be of value, if only by focusing attention on their deficiencies.

In viewing the outcome of the present study it will therefore be more profitable to draw attention to its deficiencies than to emphasize the positive findings which have emerged in the course of it. In any discussion of mortality statistics we should bear in mind that a relatively high mortality may be due to one or both of two circumstances: (a) a correspondingly high *morbidity* from the same disease; (b) a high *fatality*. In this context fatality

with respect to any disease signifies the risk of death among persons affected therewith. How far mortality differentials disclosed in this investigation are influenced by one or other of these two circumstances is impossible to determine in the absence of reliable statistics of the incidence of diseases. A differential morbidity with respect to *infectious* diseases can be caused by variations in exposure to risk, in the virulence of the infecting organism, or in degree of resistance offered by its host. It is unlikely that organisms invading one group of people are more virulent than those invading at the same time another group from the same community; nor have we any ground for believing that the physiological mechanism of resistance, that is, the ability of tissues to create antibodies, is affected by group differences such as sex or marital status. We may therefore suppose that groups of people distinguished by a differential incidence of clinical attacks of an infection are also distinguished by a differential exposure to risk or by variations in their

TABLE III
DISEASES WITH A LOWER MALE MORTALITY AT AGES FIFTEEN YEARS AND OVER
(Female rates as percentage of male rates)

CZECHOSLOVAKIA, 1928-1930

Disease	Age groups				
	15-24	25-39	40-49	50-64	65—
Pernicious anaemia	224·8	237·3	138·3	104·7	126·2
Diseases of the thyroid and parathyroid	228·3	421·7	444·7	272·9	238·4

U.S.A., 1929-1931

Disease	Age groups								
	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Pernicious anaemia	121·1	200·6	213·4	175·4	142·1	103·0	104·8	101·0	91·1
Diseases of the thyroid and parathyroid	371·4	339·6	396·2	426·7	469·2	500·6	770·4	811·0	789·2
Diabetes	103·1	86·1	350·0	71·7	146·0	231·8	165·6	151·0	123·1

CANADA, 1929-1933

CANADA, 1933-1943

Disease	Age groups				Age groups			
	15-24	25-44	45-64	65—	15-24	25-44	45-64	65—
Pernicious anaemia	149·1	290·0	123·3	61·4	164·9	234·2	122·8	116·1
Diseases of the thyroid and parathyroid	371·0	463·8	459·8	689·7	269·3	382·6	378·7	532·6
Diabetes	101·8	97·4	153·0	158·0	127·0	96·2	177·4	147·5

ENGLAND AND WALES, 1930-1932

Disease	Age groups								
	16-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Diabetes	106·6	89·1	87·0	110·2	126·5	141·3	128·3	104·6	88·5

NEW ZEALAND, 1930-1942

Disease	Age groups								
	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	75—
Diabetes	264·3	71·1	83·0	93·0	186·8	193·5	209·5	197·7	147·6

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TABLE IV

DISEASES WITH A LOWER MALE MORTALITY AT AGES LESS THAN FIFTEEN YEARS
(Female rates as percentage of male rates)

A. ENGLAND AND WALES, 1930-1932			B. CZECHO-SLOVAKIA, 1928-1930		C. NEW ZEALAND, 1930-1942		D. U.S.A., 1929-1931			E. CANADA, 1929-1933		F. CANADA, 1939-1943	
Disease	Age groups			Age groups		Age groups		Age groups			Age group	Age group	
	0-4	5-9	10-14	0-4	5-14	0-4	5-14	0-4	5-9	10-14	0-15	0-15	
Whooping-cough	128.0	156.9	128.0	111.1	125.2	147.4	229.6	121.0	130.9	116.3	112.9	113.4	

resistance in so far as the latter can be affected by environmental circumstances such as inadequate nutrition or long hours of work.

Fatality *per se* may be influenced by the virulence of an infecting organism or by the degree of resistance of the host. For reasons given in the preceding paragraph, differential fatality will be associated mainly with variations with respect to resistance offered to infecting organisms by different groups of people. *Whooping-cough*, *tuberculosis*, *acute nephritis*, *pneumonia*, and *bronchitis* are noteworthy among infectious diseases responsible for differential mortality between the two sexes. Of these diseases, the last three are consistently higher among males, as is *tuberculosis of bones and joints* in all but the

oldest age groups. *Whooping-cough* on the other hand, causes a consistently lower mortality among male children (Fig. 3). Of all males and females, those under the age of fifteen are most likely to share the same risk of exposure to infection, since they are both going to school, often to the same school. We therefore have reason to suspect that girls have a lower resistance to *B. pertussis* than do boys.

It is of interest that *pneumonia*, *bronchitis*, and *tuberculosis of bones and joints*, all of which cause a higher mortality among males, do so also among single women. They also cause a higher mortality in Social Class V than in Social Class I. We may suppose that occupational status has some bearing

MORTALITY FROM WHOOPING COUGH

(Children under 15 years)

FIG. 3.—Mortality rates per 1,000,000 population with respect to whooping-cough, among boys and girls of less than 15 years.

TABLE V
TUBERCULOSIS MORTALITY
(Female rates as percentage of male rates)

A. ENGLAND AND WALES, 1930-1932

Disease	Age groups											
	0-4	5-9	10-14	16-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis	85.6	115.6	225.9	155.2	113.7	91.8	54.6	33.2	33.6	62.5	48.6	75.2

B. CZECHOSLOVAKIA, 1928-1930

Disease	Age groups							
	0-4	5-14	15-24	25-39	40-49	50-64	> 64	
Respiratory tuberculosis	83.4	144.7	119.4	91.4	57.8	55.6	72.9	
T.B., vertebral col., bones and joints	84.6	66.6	54.0	77.2	109.5	145.4	177.0	

C. NEW ZEALAND, 1930-1942

Disease	Age groups										
	0-4	5-14	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis	33.6	141.9	252.6	191.9	136.0	66.4	44.1	36.2	33.3	45.5	66.5
T.B., vertebral col., bones and joints	—	69.4	51.9	55.4	61.4	45.7	45.4	114.9	179.5	17.8	498.9

D. U.S.A., 1929-1931

Disease	Age groups											
	0-4	5-9	10-14	15-19	20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis	90.2	107.0	200.0	202.5	157.4	106.1	61.3	47.7	52.8	65.9	79.1	92.0
T.B., vertebral col., bones and joints	86.6	64.4	79.9	61.4	40.2	55.2	71.1	70.1	71.0	84.1	103.0	130.4

E. CANADA, 1929-1933

F. CANADA, 1939-1943

Disease	Age groups					Age groups				
	0-14	15-24	25-44	45-64	> 64	0-14	15-24	25-44	45-64	> 64
Respiratory tuberculosis	126.4	172.8	124.0	67.7	87.0	125.5	162.4	108.1	53.0	74.1
T.B., vertebral col., bones and joints	83.3	53.9	64.9	98.0	100.3	69.3	53.2	56.4	86.2	84.3

TABLE VI
DISEASES WITH A HIGHER MORTALITY AMONG MARRIED WOMEN
(Married women as percentage of single women)

ENGLAND AND WALES, 1930-1932

Disease	Age groups						
	25-34	35-44	45-54	55-64	65-69	70-74	75—
Cancer of uterus	307·9	247·4	201·2	151·0	151·1	142·8	145·9
Diabetes	73·3	75·6	133·6	214·8	260·6	260·4	172·0

CANADA, 1929-1933

CANADA, 1939-1943

Disease	Age groups			Age groups		
	24-44	45-64	65—	24-44	45-64	65—
Cancer, female genital organs	286·8	103·8	95·5	187·6	102·5	103·2
Diabetes	161·8	164·4	203·7	66·5	116·8	226·4

TABLE VII
DISEASES WITH A LOWER MORTALITY AMONG MARRIED WOMEN
(Married women as percentage of single women)

ENGLAND AND WALES, 1930-1932

Disease	Age groups						
	25-34	35-44	45-54	55-64	65-69	70-74	75—
Respiratory tuberculosis	70·6	79·4	85·7	94·7	82·3	87·1	93·8
Peptic ulcer	89·1	72·0	79·9	78·0	79·4	90·4	68·9
Cancer of the breast	149·2	88·1	72·6	72·8	73·4	67·7	67·7
Bronchitis	70·9	76·0	95·0	104·1	125·6	108·2	87·5
Pneumonia (all)	113·2	95·1	72·6	79·7	98·1	107·9	73·2
Suicide	74·3	71·0	71·5	75·5	83·8	88·5	71·2

CANADA, 1929-1933

CANADA, 1939-1943

Disease	Age groups			Age groups		
	25-44	45-64	65—	25-44	45-64	65—
Respiratory tuberculosis	52·0	59·0	77·8	46·7	55·0	70·6
Tuberculosis (all)	50·9	56·9	75·5	47·3	50·0	68·3
T.B. meninges and C.N.S.	50·1	32·3	27·0	41·4	45·1	14·0
T.B., vertebral col., bones and joints	35·4	38·0	47·3	19·3	22·4	48·0
Peptic ulcer	91·1	58·6	88·7	84·3	89·3	67·5
Cancer of the breast	121·7	66·0	57·4	103·0	70·0	62·5
Bronchitis	68·7	57·5	68·2	54·6	79·1	75·9
Pneumonia (all)	125·3	71·2	60·9	82·5	67·8	56·1
Pernicious anaemia	88·5	74·6	80·2	74·5	67·7	67·4

TABLE VIII
MEAN ANNUAL MORTALITY RATES PER 1,000,000 AMONG MEN OF ENGLAND AND WALES, 1930-1932

Disease	Social Class	Age groups							
		20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis ..	I	551	625	869	805	879	703	472	474
	III	1,042	1,100	1,251	1,524	1,285	908	600	268
	V	1,196	1,210	1,626	2,015	1,727	1,327	900	458
Bronchitis	I	—	6	25	122	287	687	1,488	5,693
	III	22	29	116	342	815	2,050	4,382	13,070
	V	39	52	227	647	1,272	3,139	6,440	17,399
Pneumonia	I	107	183	405	807	988	1,599	2,526	5,377
	III	179	224	500	839	1,229	1,873	2,609	4,394
	V	241	350	807	1,359	1,738	2,677	3,384	5,574
Peptic ulcer	I	15	50	64	292	391	608	723	896
	III	44	75	192	378	461	497	560	517
	V	36	113	284	453	451	404	506	385
Diabetes	I	—	22	15	137	442	991	1,700	2,926
	III	18	28	43	91	315	705	1,000	1,085
	V	22	40	44	62	177	341	667	688

TABLE IX
MEAN ANNUAL MORTALITY RATES PER 1,000,000 AMONG SINGLE WOMEN OF ENGLAND AND WALES, 1930-1932

Disease	Social Class	Age groups							
		20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis ..	I	1,122	665	1,516	887	1,044	470	1,270	1,930
	III	1,071	1,158	818	585	559	507	353	432
	V	1,479	1,154	996	908	700	474	—	1,142
Bronchitis	I	—	—	—	111	447	1,410	1,904	11,582
	III	11	17	48	141	518	1,403	4,506	15,667
	V	19	52	238	260	744	2,053	7,705	29,107
Pneumonia	I	—	133	178	776	745	1,880	1,270	5,791
	III	79	118	225	442	940	1,598	2,739	6,478
	V	88	165	522	487	1,367	3,317	5,694	11,414
Peptic ulcer	I	—	—	—	222	447	470	—	—
	III	6	18	51	141	212	273	230	336
	V	13	10	143	97	44	158	670	—
Diabetes	I	—	67	—	441	—	470	635	2,574
	III	13	18	28	63	82	250	604	672
	V	13	21	95	227	569	158	1,340	—
Cancer of the uterus ..	I	—	—	—	554	149	470	—	1,287
	III	—	14	93	234	472	624	972	1,200
	V	—	10	142	422	657	1,264	670	1,712
Cancer of the breast ..	I	—	—	89	1,219	1,491	1,880	4,444	8,365
	III	—	20	235	718	1,275	1,685	2,244	3,479
	V	—	41	285	649	569	2,685	1,675	2,854

TABLE X

MEAN ANNUAL MORTALITY RATES PER 1,000,000 AMONG MARRIED WOMEN OF ENGLAND AND WALES, 1930-1932

Disease	Social Class	Age groups							
		20-24	25-34	35-44	45-54	55-64	65-69	70-74	> 74
Respiratory tuberculosis ..	I	538	412	305	281	285	213	283	410
	III	1,031	857	652	485	425	368	206	224
	V	1,262	1,139	903	658	535	462	318	213
Bronchitis	I	—	7	16	39	117	426	737	3,692
	III	6	22	43	133	454	1,369	3,151	8,111
	V	11	30	74	199	724	1,983	4,221	10,915
Pneumonia	I	134	99	176	209	528	883	1,304	2,871
	III	133	146	236	321	627	1,225	1,990	3,220
	V	186	242	338	428	800	1,558	2,194	3,271
Peptic ulcer	I	67	14	26	22	92	122	227	410
	III	11	18	36	90	118	209	182	243
	V	8	20	45	102	145	130	166	36
Diabetes	I	—	14	21	55	318	852	1,513	2,564
	III	28	25	43	125	549	1,125	1,438	1,410
	V	4	32	44	143	531	1,031	1,332	996
Cancer of the uterus ..	I	—	—	119	264	469	670	624	410
	III	6	33	197	438	635	750	859	1,083
	V	4	65	294	591	754	779	984	960
Cancer of the breast ..	I	—	7	269	715	1,164	1,613	1,190	1,743
	III	1	30	203	546	842	1,026	1,180	1,680
	V	—	32	162	420	685	772	984	1,387

TABLE XI

INFERTILITY OF DECEASED MARRIED WOMEN DISTINGUISHING CERTAIN CAUSES OF DEATH
(Infertile per 1,000 stated)

Age of woman at death	All causes of death	Tuberculosis	Cancer of uterus	Cancer of breast	Diabetes
Under 25	455	496	—	—	—
25-34	296	317	193	240	—
35-44	214	222	136	168	258
45-54	188	177	179	213	180
55-64	160	167	153	204	92
65-74	142	96	141	167	87
75 and over	150	—	162	241	117

either on exposure to infection or on the ability of the individual to resist invading organisms; but so little is known of the influence of environment on an individual's resistance to disease that it would be dangerous to speculate on the basis of such inconclusive data. A knowledge of the contributions of morbidity and fatality to the mortality differentials of these groups would undoubtedly throw some light on their causation.

Whereas variations in exposure to and in individual resistance to infection provide a fairly clear-cut explanation of mortality differentials with respect to diseases due to infection, we have no such basis of scientific knowledge on which to build theories about the cause of mortality differentials with respect to other diseases. We may postulate that differences of temperament as well as of environment play a part not only in the course of a disease but also in its causation. The susceptibility of London bus drivers to *peptic ulcers* is well known. Unfortunately, we have no means of telling how far this is due to circumstances other than an occupation at present peculiar to the male sex, until the London Passenger Transport Board begin to employ women drivers. A sufficient body of information exists to convince us that the incidence of peptic ulceration as well as mortality from it is two or three times higher among men than among women. If certain occupations do predispose to peptic ulcers, marriage appears to be one of the least hazardous in this respect; and inasmuch as it carries with it no great risk of unemployment and does not demand adherence to a rigid time-schedule, this may well be so.

On the other hand, marriage does appear to predispose to *diabetes* and Table XI provides some evidence that the high mortality from this disease among married women is associated to some extent with childbearing. This Table, which was extracted from the Registrar General's Statistical Review of England and Wales for 1945, shows the proportion of childless to all married women who died during 1945 from various causes. Proportions based on between 50 and 250 cases are shown in italics, and those based on less than 50 cases are omitted. Other figures are therefore fairly reliable. In the two decades 55-64 and 65-74, the proportion of childless married women was very much lower among those dying from diabetes than among those dying from any other cause specified, or from all causes. Repeated adjustments to metabolism of the mother demanded by successive pregnancies presumably

have some adverse influence on the ability of her pancreas or liver to function efficiently.

On the whole, however, marriage appears to be a healthy occupation, since married women suffer a higher mortality than single women and men from only two diseases—diabetes and cancer of the uterus. With the exception of appendicitis, every disease which causes a higher mortality among men than among women also causes a higher mortality among single women than among those who are married. Since any agency traceable to the X-chromosome complement is certainly unaltered by marriage, occupation must play no little part in determining a differential risk of these diseases to men and women. Reliable statistics with respect to the incidence of disease, when they become available, can throw more light on this problem by providing a means of assessing (a) the contributions of morbidity and fatality to differential mortality, (b) existing differentials between men, single women, and married women with respect to diseases which are rarely fatal.

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REFERENCES

- Metropolitan Life Insurance Company (1945). *Statistical Bulletin*, Volume 26, number 9. New York.
- Rich, Arnold R. (1946). "The Pathogenesis of Tuberculosis." Springfield, Illinois.
- Commonwealth Bureau of Census and Statistics. *Australian Demography. Bulletins* nos. 49-53. 1931-1935. Canberra.
- Dominion Bureau of Statistics, Canada. *Vital Statistics, 1929-1933, 1939-1943. Annual Reports.* Ottawa.
- Office de Statistique (1936). "Mouvement de la Population en Tchécoslovaquie au cours des années 1928-1930." Prague.
- The Registrar General's Decennial Supplement. England and Wales, 1931. Part IIa. Occupational Mortality. H.M.S.O. 1938.
- The Registrar General's Statistical Review of England and Wales for the years 1930-1932 (New Annual Series Nos. 10-12). Tables Part I Medical. H.M.S.O. 1931-1933.
- The Registrar General's Statistical Review of England and Wales for the year 1945 (New Annual Series No. 25). Tables Part II Civil. H.M.S.O. 1948.
- Census and Statistics Office. Report on the Vital Statistics of the Dominion of New Zealand for the years 1930-1942. Annual reports. Wellington.
- Department of Commerce. *Vital Statistics of the United States. 1929-1931. Annual reports.* Washington, D.C.