THE VARIATION IN THE MORTALITY FROM CANCER OF DIFFERENT PARTS OF THE BODY IN GROUPS OF MEN OF DIFFERENT SOCIAL STATUS.

By MATTHEW YOUNG, M.D.

(*National Institute for Medical Research.*)

INTRODUCTION.

THOUGH it is generally believed that a difference in the incidence of cancer as a whole amongst people of different social position may exist, opinion as to its nature is not yet unanimous. Most of those who have studied the problem, including Stevenson (1923), Brown and Lal (1914), Maynard (1909) and Dublin (1924), have come to the conclusion that the incidence increases with descent in the social scale, but others, including Davies (1924), Roger Williams (1908) and Heron (1907), have brought forward evidence in support of the converse view. Even though the incidence of cancer as a whole may not show much variation in people of different social status, it seemed not improbable that there might be demonstrable in these some special susceptibility to cancer in particular parts of the body. The present investigation was undertaken with the view of determining whether such a differentiation in susceptibility occurs.

ANALYSIS OF DATA AND DISCUSSION.

The data necessary were obtained through the courtesy of the Registrar-General. They comprise the recorded deaths at the different ages from cancer in different sites or parts of the body in groups of men following different occupations in England and Wales in the three years' period 1910–1912. The social classes that were considered were the first five of the series of eight distinguished by the Registrar-General in the Supplement to his 75th Annual Report. They comprise the following groups:

1. The upper and middle classes.
2. Intermediate between groups 1 and 3 and comprising elements of both.
3. Skilled workmen.
4. Intermediate between groups 3 and 5.
5. Unskilled workmen.

This is a grading of a large section of the male working population into five social classes as determined by occupation. It is not entirely satisfactory, as has been pointed out by Dr Stevenson, chiefly because the occupational classification is largely industrial, *i.e.* all grades of workers are grouped to-

gether for each industry. The classes may, however, be considered to represent broadly groups of men in a descending social scale.

The cancer sites selected for investigation were the skin (including the lip) the tongue, the mouth and palate, the jaw, the throat and pharynx, the oesophagus, the stomach, the liver and gall bladder, the pancreas, the bowel, the rectum, the kidney, the bladder, the prostate, the larynx and the lung. The deaths from cancer in these 16 sites comprised in the aggregate 92 per cent. of the total mortality from the disease in the triennial period. For each of the five social classes already described, the deaths from cancer in the different age groups in each of the 16 different sites were obtained by summing together the corresponding data for the different occupations comprising them. From these deaths, standarised death-rates for the sites were calculated for each of the five social classes and for these classes in the aggregate. The standardised death-rates for cancer in the respective sites in each social class are given in Table I in association with the percentages which these death-rates are of those for the corresponding sites in all the five social classes taken together which are used as standards of comparison.

Of the five social groups, unskilled workmen, the lowest social class, shows the highest standardised death-rate for cancer as a whole. Next to this comes the group of skilled workmen and then the group comprising the upper and middle classes. From a study of the data for cancer in these social classes in the report already mentioned, Dr Stevenson formulated his conclusion that, generally speaking, there seems to be evidence of a moderate increase of cancer as a whole down the social scale.

In the present study, attention will be devoted mainly to Classes 1, 3 and 5, comprising the upper and middle classes, skilled workmen and unskilled workmen respectively. By excluding from consideration in the first instance the two so-called intermediate social classes in the series of five, the three remaining classes give a more clearly demarcated grading in social status.

The relative mortality from cancer in the several sites or parts of the body in these three classes can be readily seen by comparing the percentages in Table I. It is evident that ascent in the social scale is accompanied by a progressive decrease in the mortality from cancer in the following parts of the body: skin, tongue, mouth, jaw, throat, stomach, bladder and lung. In three other sites, namely, the larynx, the oesophagus and the liver including the gall bladder, the mortality-rate is still highest in the lowest social class, but that in the upper and middle classes shows a slight excess over that in the class of skilled workmen. Even when some allowance is made for a possible over-statement of the mortality in the class of unskilled workmen through some lack of correspondence between the census population of labourers and the registered deaths in this occupation, the death-rate from cancer would probably remain highest in this class for the parts of the body mentioned, that is in 11 out of 16 sites altogether. Of the remaining five

sites of malignant tumours considered, namely, the bowel, the rectum, the pancreas, the kidney and the prostate, in all except the rectum, the mortality from cancer is highest in the best social class. The mortality-rates for prostatic cancer in the three classes appear to decline progressively with descent

Table I.

Showing: (a) the standardised death-rates from cancer in the several parts of the body in the different social groups per million males from age 25 and upwards, and (b) these death-rates as percentages of the standards for the corresponding sites.

Site of tumour		Social group 1 a. Clergymen, doctors, lawyers, bankers,	Social group 1 b. Residue of group 1 (excluding 1 a)	Social group 1. Upper and middle classes	Social group 2. Intermediate to 1 and 3 (excluding unoccupied)	Social group 3. Skilled workmen	Social group 4. Intermediate to 3 and 4	Social group 5. Unskilled workmen	All groups
Skin	(a)	27	42	40	73	63	76	135	77
	(b)	35	55	52	95	82	99	175	100
Tongue	(a)	54	85	80	86	118	100	172	113
	(b)	48	75	71	76	104	88	152	100
Mouth	(a)	14	19	19	19	33	25	47	31
	(b)	45	61	61	61	106	81	152	100
Jaw	(a)	9	22	20	23	42	44	70	40
	(b)	23	55	50	58	105	110	175	100
Throat	(a)	17	43	39	28	46	41	58	43
	(b)	40	100	91	65	107	95	135	100
Larynx	(a)	36	48	47	39	45	41	53	45
	(b)	80	107	104	87	100	91	118	100
Oesophagus	(a)	104	163	155	117	149	139	177	146
	(b)	71	112	106	80	102	95	121	100
Stomach	(a)	195	310	293	377	401	356	508	393
	(b)	50	79	75	96	102	91	129	100
Liver and gall bladder	(a)	179	215	210	199	207	196	224	207
	(b)	86	104	101	96	100	95	108	100
Pancreas	(a)	67	41	47	37	36	36	36	38
	(b)	176	108	124	97	95	95	95	100
Bowel	(a)	219	234	232	185	178	155	179	183
	(b)	120	128	127	101	97	85	98	100
Rectum	(a)	150	194	188	179	202	186	189	189
	(b)	79	103	99	95	107	98	100	100
Bowel and rectum	(a)	370	428	420	363	380	341	368	372
	(b)	99	115	113	98	102	92	99	100
Kidney	(a)	14	15	15	10	10	9	10	11
	(b)	127	136	136	91	91	83	91	100
Bladder	(a)	38	56	54	53	56	50	68	56
	(b)	68	100	96	95	100	89	121	100
Prostate	(a)	64	71	69	49	47	43	36	48
	(b)	133	148	144	102	98	90	75	100
Lung	(a)	24	16	17	19	19	15	20	18
	(b)	133	89	94	106	106	83	111	100
Total sites	(a)	1211	1574	1525	1493	1652	1512	1982	1638
	(b)	74	96	93	91	101	92	121	100

in the social scale; for cancer of the pancreas, cancer of the bowel, and cancer of the kidney, respectively, the mortality-rates in the two lower social classes are practically equal but are distinctly lower than the corresponding death-rates in the highest social class. The rectum is the only site in which the

skilled workmen show the highest mortality-rate from cancer. The mortality-rate from rectal cancer is, however, only slightly higher in this class than in the other two classes in which the rates are practically equal. For bowel and rectal cancer taken together the best social class shows the highest death-rate; the mortality-rates in the other two classes are somewhat lower and approximately equal. Though the differences that occur in the mortality-rates from cancer in the majority of sites in the three social classes seem to exceed such as might arise from random sampling, it seemed desirable to obtain some confirmation of their significance. This was done by calculating from the mortality-rates in the three classes the actual number of deaths from cancer in each particular site and the number of deaths that might be expected on the basis of the mortality in that site for the three classes together. From these figures, by a slight modification[1] of the usual formula, χ^2 was calculated for each site and taking n, the number of independent variates, as 2, the corresponding values of P, or the probability that such a deviation as, or a greater than that found might arise from random sampling, were determined. Amongst those sites in which an increased mortality from cancer seemed to coincide with a decline in social status, in the oesophagus, stomach, mouth, jaw, throat, skin, and tongue, the distribution found was quite significantly different from what might be expected (P being less than 1 in 100) and in the bladder probably significant (P being approximately 1 in 50). For cancer of the liver, lung and larynx, however, the deviations from the expected numbers of deaths in the series of three classes are probably not significant. Of the sites in which the cancer mortality seemed to increase with ascent in social position, in the bowel, the bowel and rectum together, and the prostate, the deviations from the expected were certainly significant (P being less than 1 in 100) and that in the pancreas probably significant (P being less than 1 in 20). On the other hand, the excess of mortality from renal cancer in the highest social class cannot be considered significant.

Whereas the mortality from cancer in most of the sites investigated seems to increase with descent in social status, thus supporting the conclusion that has been drawn by various observers from a study of cancer as a whole, one of the sites at least, namely the bowel, in which this relationship does not hold, is quite frequently attacked by cancer; the relative incidence in the three social classes of the mortality from cancer in this and in the other two sites, the pancreas and the prostate respectively which show a similar tendency, requires further consideration.

The explanation of the excessive incidence of cancer in these sites in the best social class, that immediately suggests itself as the most probable, is the circumstance that better facilities for medical supervision and the greater chance of an accurate diagnosis are found in this class than in the lower social classes. They are pre-eminently among the parts of the body in which improved medical methods and observation would lead to a correct diagnosis.

[1] See Appendix.

It should be recollected, however, that though improved medical skill and methods in the higher social class would result in fewer cases being missed, it would also result in fewer deaths being wrongly ascribed to cancer in these sites. More cases might be missed in the worst than in the best social class but more cases would also probably be ascribed to cancer in the one than in the other through errors of diagnosis. The net result would, however, probably be a relative gain, but one difficult to assess, to the best social class. In this class, the excess above the average mortality shown in all classes for cancer of the bowel is 27 per cent., in the pancreas 24 per cent. and in the prostate 44 per cent. For cancer of the kidney the excess above the average is 36 per cent., but this is based on small numbers and is probably not significant. In the lowest social class, the mortality from cancer of the bowel and pancreas is slightly under the average for all classes and that in the prostate is 25 per cent. below the average. It seems rather improbable, though not impossible, that differences of this magnitude might arise from better diagnosis in the best social class, the more so when it is recollected that the diagnoses in many cases amongst the lower classes are made or verified in hospitals and that the mortality-rates in the lowest class are probably overstated through the lack of correspondence that exists between the census population and the registered deaths in the labouring class.

It has recently been suggested that, as cancer of the liver is rarely primary but usually secondary to a tumour in the stomach, bowel or rectum, which has eluded discovery, the recorded death-rate from hepatic cancer in the members of a series of different districts or social groups might be used as an approximate index of the general accuracy of diagnosis of malignant disease therein. In the data under review, as is shown in Table I, the mortality-rate from hepatic cancer in unskilled workmen, the lowest social group (No. 5) is about 8 per cent. above the average incidence, but in the highest social group, the upper and middle classes (No. 1), it is also slightly above the average. As the difference between the mortality-rates from hepatic cancer in the two groups at the limits of the social scale is only 7 per cent. varying accuracy of diagnosis, in so far as it can be indicated by this index, does not appear to be a factor that has any special influence in producing the divergencies in the site-rates for cancer that are shown in the social groups 1, 3 and 5.

If the apparently excessive mortality from cancer in these parts of the body in men of the best social class is not wholly determined, as seems practically certain, by more skilful diagnosis there are not, so far as is known at present, any circumstances definitely associated with life under better social conditions that would conduce to a high mortality. It is true that habits of life, such as high feeding and easy living (Roger Williams), have been advanced as factors that determine a relatively high cancer incidence amongst people of good social position, but these might reasonably be expected to be as potent in predisposing to cancer of the stomach as to cancer of the bowel and yet

gastric cancer is apparently more common in the lower than the upper classes. A possible suggestion to account for the relatively excessive mortality from intestinal cancer in the upper and middle classes is that the sedentary life which is more frequently led by people of this social class results in constipation followed by auto-intoxication and impairment of vitality in the bowel. Lowered vitality from this sequence of events may also be advanced as the predisposing cause of the excessive mortality from cancer in the pancreas, prostate and possibly the kidney amongst people of the best social class, but this is rather improbable as the incidence of cancer of the rectum is not similarly affected. The causal relationship of auto-intoxication and predisposition to cancer cannot be regarded as proved. The excessive mortality from pancreatic cancer shown in men of the best social class is of special interest as the incidence of diabetes is known to be much higher in this social class than in the lower social classes and as a significant correlation has been shown to exist between the death-rates from cancer as a whole and from diabetes in data derived from American sources; for English data a positive but less intensive association between the mortalities from the two diseases has been described though it has not been found by other observers.

As social class 1 includes a large proportion of commercial clerks, an effort was made to obtain the cancer mortality-rates in a group more representative of people of the highest social status. With this end in view, standardised death-rates were calculated for cancer in the different sites in a group comprising clergymen, barristers and solicitors, physicians and surgeons and bankers. The death-rates from cancer in the different sites were also calculated for the residue of group 1 after the exclusion of these professional men. These sub-classes form groups 1 *a* and 1 *b* respectively in Table I. This table shows that, though the death-rates from cancer in most parts of the body are definitely lower in the specially selected group 1 *a* than those experienced by group 1 *b* and group 1 as a whole thus supporting the inferences that have been drawn regarding social status and incidence of cancer in these sites from a comparison of the social groups 1, 3 and 5, the mortality-rates from cancer of the bowel, the kidney and the prostate in social class 1 *a* are only slightly lower than those from cancer in the corresponding sites in social group 1 *b* and the mortality-rates from pancreatic and pulmonary cancer are higher in the former than in the latter group. Little importance can perhaps be attached to the death-rates from cancer in the kidney and the lung in group 1 *a* as they are based on relatively small numbers of deaths, but cancer of the bowel still shows a mortality 20 per cent., cancer of the prostate 33 per cent., and cancer of the pancreas 76 per cent. above the average. The death-rates in the three last-named sites are based on at least 30 deaths and so may be accepted as fairly approximate. Though no actual increase of mortality from cancer in the bowel and prostate takes place with such an increase of social status as occurs in passing from group 1 *b* to group 1 *a*, the mortality-rates from cancer in these sites in group 1 *a* seem to exceed sub-

stantially the mortality-rates in social groups 3 and 5 and to differ from the general tendency shown in the social groups for the majority of the sites. It is possible that after the attainment of a certain level of social status, *e.g.* that shown in group 1 *b*, social status and the factors associated therewith that predispose to cancer in these sites have attained their maximum effect and further improvement of social status is not accompanied by an increased incidence of the disease. The results, in the sub-classes of group 1, would appear to support the view at least that improvement of diagnosis with better social status is not an adequate explanation of the relatively excessive mortality in these sites shown in group 1 as a whole as compared with that shown in groups 3 and 5.

The relative mortalities from cancer in the several parts of the body may also briefly be compared in the two social classes, 2 and 4, described as intermediate, the higher between the upper and middle classes and skilled workmen, and the lower between skilled workmen and unskilled workmen. Table I shows that the higher mortalities from cancer occur in an equal number of sites in each of these classes. The socially lower intermediate class has the higher mortality-rates from cancer of the skin, tongue, mouth, jaw, throat, larynx, oesophagus and rectum. As in some of the remaining sites, for example, the stomach and liver, the mortality-rates in the higher intermediate class are only slightly in excess of those in the lower intermediate class, the mortality in the latter class would probably exceed that in the former in more sites by such a transfer of deaths from the unskilled workmen to the lower intermediate class as would be necessary to correct the recorded data; an adjustment which Dr Stevenson describes as necessary. Even with such a transfer, the mortality from cancer of the bowel, prostate and perhaps the kidney, would, however, probably still remain greater in the higher social class than in the lower. The comparison of the two intermediate classes thus seems to lend some support to the inferences that have been drawn from a study of social classes 1, 3 and 5, namely, that though the mortality from cancer in most parts of the body is greater in men of lower than in men of higher social status, there is reasonable cause for the belief that for cancer in certain other parts of the body, namely, the bowel, the prostate and probably the pancreas, the converse tendency is present.

SUMMARY AND CONCLUSIONS.

This paper is the result of an attempt to determine if, in the different social classes obtained by a grading of a large section of the male working population of England and Wales for the triennial period 1910–12, as described by the Registrar-General in the Supplement to his 75th Annual Report, there was shown any special susceptibility to cancer in particular parts of the body. From a comparison of the standardised mortality-rates from cancer in 16 different sites in (1) men of three social grades, namely, the upper and middle classes, skilled workmen and unskilled workmen, (2) two

sub-groups of the upper and middle classes and (3) men of two social classes, a higher and a lower intermediate to classes 1 and 3 and 3 and 5 respectively, it seems reasonable to draw the following conclusions:

1. The mortality-rates from cancer in the majority of the parts of the body considered, including amongst others the tongue, oesophagus and stomach, which altogether account for 92 per cent. of the total deaths, are definitely higher in the men of lowest social status; the incidence decreases, though not always regularly, with ascent in the social scale.

2. The mortality from cancer in other parts of the body, namely, the bowel, the prostate and probably the pancreas, is definitely highest, however, in men of the best social status.

3. Though the relatively high cancer mortality-rates in these sites in the best social class may probably be attributed in some measure, which it is difficult or impossible to assess, to improved facilities for, and methods of diagnosis in this class, as compared with those in the lowest classes, this cannot be the whole explanation as the differences are considerable and as no increased mortality from cancer is evident in any of the sites except the pancreas with such an ascent in the social scale as takes place in passing from social group 1 *b*, to social group 1 *a*, where the influence of more skilful diagnosis might also be expected to reveal itself. If we may accept the mortality from hepatic cancer in the different social classes as an approximate index of the general accuracy of diagnosis of malignant disease therein, then varying accuracy of diagnosis can have little influence in producing the divergencies in mortality from cancer in these special sites that are found in the social groups under review.

4. The excessive mortality from cancer of the bowel amongst males of the best social class cannot reasonably be ascribed to their habits of life such as high-feeding and easy-living or to their alleged greater liability to auto-intoxication. If this were so, cancer of the stomach and cancer of the rectum might also be expected to show a higher incidence in the same social class; the mortality-rates from cancer in these sites, however, are not higher in this class than in the lower social classes.

REFERENCES.

BROWN, J. W. and MOHAN LAL (1914). An Inquiry into the Relation between Social Status and Cancer Mortality. *J. Hyg.* XIV. 2.

DAVIES, S. (1924). A Note on Cancer Occurrence in Hampstead and Shoreditch. *Public Health,* XXXVII. 139.

DUBLIN, L., KOBER and HAYHURST (1924). *Industrial Health,* p. 957.

HERON, D. (1907). Note on Class Incidence of Cancer. *Brit. Med. Journ.* I. 621.

MAYNARD, G. D. (1909). A Statistical Study of Cancer Death-rates, *Biometrika,* VII. 278.

STEVENSON, T. H. C. (1923). The Social Distribution of Mortality from different causes in England and Wales in 1910–12. *Biometrika,* XV. 382.

WILLIAMS, W. ROGER (1908). *The Natural History of Cancer.*

APPENDIX.

By H. E. Soper, M.A.

Social classes 1 to 5 have different age distributions and the deaths in each class are modified by small adjustments of numbers and deaths at each age to make the numbers at age follow a given law. How may we adapt the χ^2 theory to these modified deaths?

Take any one class. Let m_1, m_2 ... be the expected numbers of deaths at ages 1, 2 ... in the age groups numerically given for this class, and let $m_1 + x_1$, $m_2 + x_2$ ... $m_s + x_s$ ... be the actual numbers found in the class; so clearly, mean $x_s = 0$, mean $x_s^2 = m_s$, in random sampling.

To adjust the ages let the numbers and the deaths at ages 1, 2 ... be multiplied by factors $1 + e_1$, $1 + e_2$ ..., then the "error" in the total deaths for this adjusted class is no longer $x_1 + x_2 + ...$, but is

$$(1 + e_1) x_1 + (1 + e_2) x_2 + ... (1 + e_s) x_s + ...$$

The mean "error" in random sampling is therefore 0 and the s.d.² is

$$(1 + e_1)^2 m_1 + (1 + e_2)^2 m_2 + ...,$$

which, if the e's are small, equals

$$(1 + 2e_1) m_1 + (1 + 2e_2) m_2 + ...,$$

i.e. $$2 (1 + e_1) m_1 + 2 (1 + e_2) m_2 + ... - m_1 - m_2 - ...,$$

i.e. $$2m' - m,$$

where m' = expected deaths in the adjusted class,

m = expected deaths in the unadjusted class.

Therefore

$$\chi^2 = \text{sum for classes} \ \frac{\left\{\begin{array}{l}\text{actual deaths for adjusted class} \\ - \text{expected deaths for adjusted class}\end{array}\right\}^2}{\left\{\begin{array}{l}\text{twice expected deaths for adjusted class} \\ - \text{expected deaths for unadjusted class}\end{array}\right\}}$$