

II.

Report on an Inquiry into the recent Epidemic of Influenza in the
County Borough of Leicester,By
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The facts recorded in this report were obtained during the visits made to Leicester County Borough and Leicester County at various dates from the beginning of November 1918 to March 1919. A note of the sources of information is appended (A).

LEICESTER COUNTY BOROUGH.

From the table of deaths appended (B) it will be seen that Leicester County Borough was affected in the summer wave of influenza in 1918, in the autumn wave in 1918 and in the wave in the early part of 1919, the weeks in each wave with the greatest number of deaths being those ending July 20th, November 2nd, and March 1st.

Definite facts as to the incidence and case mortality were lacking ; with the assistance of the Medical Officer of Health and his staff a house to house inquiry was undertaken. Five areas of the town were selected which were considered to include all types of housing in Leicester with the exception of the largest houses. The inquiry was made between the 4th and 17th March. The February-March wave was of course still active.

Several streets in each area were visited and information obtained so far as possible at every fifth house. The information asked for was—

- (a) Number of rooms in house.
- (&) Number of occupants with age, sex, and occupation of each.
- (c) Dates of attacks of influenza from May 1918.
- (d) With regard to each attack it was ascertained how long the patient had been in bed, how long ill, whether the patient had been seen by a doctor, whether there had been any complications, and how the illness had ended.

An attempt was also made to ascertain the previous health of the occupants, but this was found to be impracticable without a great increase in the time expended.

With regard to the figures it may be noticed that there are a few slight discrepancies in totals. This arises from the fact that certain data have occasionally not been noted. In no case are the results affected appreciably. A note on certain factors likely to have affected the constitution of the sample population concerned is appended (C).

The number of houses from which particulars were obtained was 1,061. The number of persons concerning whom particulars were obtained was 4,619.

A table is appended (D) showing the grouping into houses with 1, 2, 3, &c, persons per house.

The number of inhabited tenements in Leicester in July 1917 was 54,147, The population at the Census 1911 was 227,242, and the estimated population 1917 was 217,537. The sample is therefore probably about 2 per cent of the population. The number of influenzal attacks amongst these persons from May to the date of the inquiry was 1,387 ; 164 of these were in persons attacked twice, and six in persons attacked three times. The number of persons attacked was therefore 1,302.

The attacks were distributed in time as follows:—

	Incidence. Per cent.
Wave period May, June, July, August	295 = 6·3
Intervening period of September	30
Wave period of October, November, December	678 = 14·6
Intervening period of January	14
Wave period of February and part of March	370 = 8·0
Total	1,387 = 30·0

The figures for each month are given in Table (E). The dates for 1918 are, in many cases, probably not accurate, as in the absence of some event fixing the date of illness, I found many persons uncertain as to the month in which they had been ill.

It may be noted that if the incidence on the population of the sample population is taken as approximately correct for Leicester, it gives a striking example of the danger of accepting "impressions." During the height of the October-November wave I was given several estimates of the incidence on the population. None were as low as that found in the sample population, and some were several times higher.

The distribution of the population into age and sex groups with attacks and deaths is given in Table (F) appended.

It will be noted that the males of military age are comparatively few in number. This group tends to be a source of error in house to house inquiries at present. A considerable number of men of army ages have been at home for a fraction of the previous year, and many have returned during the past two months. More than 200 such were noted and were not included in the sample population, but I am not confident that some such were not included. Amongst the 200 there were some cases of influenza, and some deaths.

The incidence on certain age groups was as follows:—

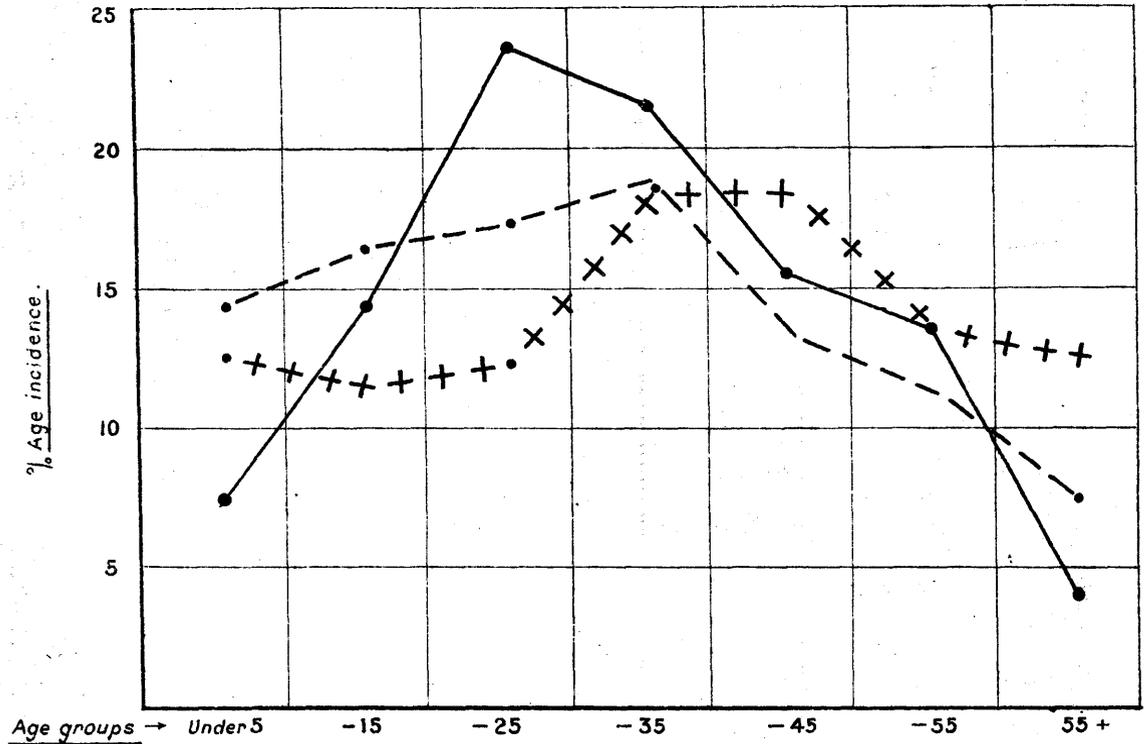
Age Group.	Persons.	Cases.	Incidence.
			Per cent.
Under 5	449	113	25·1
„ 15	1,089	338	31·0
„ 25	810	290	35·8
„ 35	625	243	38·8
„ 45	546	171	31·3
„ 55	526	135	25·6
55 and over	574	97	16·8
Total	4,619	1,387	30·0

The incidence in each wave was—

Age Group.	1st Wave.	2nd Wave.	3rd Wave.
	Per cent.	Per cent.	Per cent.
Under 5	3·1	14·6	7·3
„ 15	6·0	16·6	6·7
„ 25	10·1	17·2	6·9
„ 35	9·1	18·8	10·5
„ 45	6·5	13·3	10·6
„ 55	5·7	11·0	7·7
55 and over	1·7	7·3	7·3

INFLUENZA - LEICESTER RESULT OF BLOCK CENSUS.

This Chart is obtained by taking the total incidence in each wave as equal to 100 and distributing the age group incidences proportionately.



— = May to August wave 1918
 - - = Oct. Dec. wave 1918
 + + = February, March wave 1919

A chart is appended in which these incidences have been scaled to be proportionate in each wave to the total incidences. The chart suggests that there was a progressive tendency towards an equality of incidence on the various age groups in the successive waves.

Sex Incidence.—In a population of 1,894 males, there were 523 cases, or 27.6 per cent.

In a population of 2,725 females, there were 864 cases, or 31.7 per cent.

The incidence on the age groups was—

Age Group.	Incidence on Males.	Incidence on Females.
	Per cent.	Per cent.
Under 5 - - - - -	26.3	24.1
„ 15 - - - - -	30.9	31.1
„ 25 - - - - -	30.1	38.1
„ 35 - - - - -	35.9	39.9
„ 45 - - - - -	28.6	33.0
„ 55 - - - - -	25.6	25.7
55 and over - - - - -	14.3	18.8

Mortality.—There were 32 deaths from influenza in 1,387 cases, or 2.3 per cent mortality.

In the 295 cases in the summer wave there was no death; in the 678 cases in the October-November-December wave, 26 deaths, a case mortality of 3.8 per cent. In the 370 cases of the February-March wave there were 6 deaths, a case mortality of 1.6 per cent.

The occurrence of 32 deaths in a population of 4,619 gives a mortality of 6.9 per 1,000. The estimated population of Leicester in 1917 was 217,537, and the census 1911 population 227,242. Taking the population at 220,000, the anticipated deaths from influenza and its complications would have been, on the ascertained proportion in the house to house inquiry, 1,518. The deaths actually registered from June to the week ending March 15th, as due to influenza or its complications, were 1,140. If the deaths registered from pneumonia in the same period are added the total would be 1,426. As the pneumonia deaths follow the influenza waves, this addition seems justified, and gives an index of how far the house to house inquiry made may be considered a fair sampling.

The case mortality in the age groups was as follows :-

Age Group.	Cases.	Deaths.	Case Mortality.
			Per cent.
Under 5 - - - - -	113	7	6.1
„ 15 - - - - -	338	5	1.4
„ 25 - - - - -	290	7	2.4
„ 35 - - - - -	243	9	3.7
„ 45 - - - - -	171	2	1.1
„ 55 - - - - -	135	2	1.4
55 and over - - - - -	97	0	0
Total - - - - -	1,387	32	2.3

Twenty-two of the deaths were in females and 10 in males. The case mortality is 2.5 per cent in females and 1.9 per cent in males. The

difference in age constitution of the male and female populations would nullify any argument from the last figures, and the numbers are too small to justify a further analysis.

All deaths occurred in first attacks.

Complications.—The only complications inquired for were pneumonia and bronchitis and pleurisy. 47 or 3.3 per cent of cases surviving had pneumonia and 86 or 62 per cent had bronchitis. The incidences of pneumonia and bronchitis in cases of influenza surviving were —

	Pneumonia.	Bronchitis.
	Per cent.	Per cent.
May to August wave - - -	2.0	5.0
October to December wave - -	4.5	4.7
February to March wave - - -	2.7	10.2

The age groups were affected as follows:—

Age Group.	Bronchitis Cases.	Percentage of Influenza Cases affected.
	Per cent.	Per cent.
Under 5 - - - - -	7	6.1
„ 15 - - - - -	9	2.6
„ 25 - - - - -	10	3.4
„ 35 - - - - -	16	6.5
„ 45 - - - - -	13	7.6
„ 55 - - - - -	15	11.1
55 and over - - - - -	16	16.4

If all influenzal pneumonia cases are included, *i.e.*, those that ended fatally as well as those that recovered, all the deaths but three have to be added.

The pneumonia rates then are:—

May to August wave - - - -	2	per cent. of cases.
October to August wave - - -	7.9	„ „
February to March wave - - -	4.3	„ „

The age grouping of all cases of pneumonia is:—

Age Group.	No. of Cases.	Percentage of Influenza Cases with Pneumonia.	
		All Cases.	Oct.-Dec. Wave.
		Per Cent.	Per Cent.
Under 5 - - - - -	12	10.6	12.1
„ 15 - - - - -	21	6.2	7.7
„ 25 - - - - -	17	5.8	10.0
„ 35 - - - - -	13	5.3	10.1
„ 45 - - - - -	7	4.0	4.1
„ 55 - - - - -	5	3.7	3.4
55 and over - - - - -	1	1.0	2.3
Total - - - - -	76	5.4	—

Immunity.— Of a population of 4,619, 295 or 6.3 percent were attacked in the May to August wave. There were no deaths in this wave in the houses visited.

In considering immunity, groups of cases in September and January have been omitted in order to obtain definite wave periods.

Of the population of 4,619 of May 1918, there were at the beginning of October, 295 who had been attacked in the summer wave and 30 who had been attacked in September, leaving a population of 4,294 persons. Amongst these there were 662 attacks during October, November and December, or 15.4 per cent. Amongst the 295 persons attacked in the summer wave there were 16 cases, or 5.4 per cent.

The population not previously attacked at the beginning of February was 4,619 less those attacked in the two previous waves, *i.e.*, 295 and 662, and those attacked in September and January (30 and 14*) 3,624. Of these 309 were attacked, or 8.5 per cent. There were also 295—16 persons previously attacked only in the May to August wave, and of these 22 were attacked, or 7.4 per cent.

There were also 662 persons attacked in the October-December wave. Of these, 26 had died, leaving 636, and six of these had been attacked again in the interwave period of January, leaving 630, of whom 37 were attacked, or 5.9 per cent.

There were 16 persons who had been attacked previously, both in the summer and autumn waves, and of these, two were again attacked.

It is, however, clear that the age grouping of those previously attacked is very different from that of the population not previously attacked, so that the attacked and unattacked cannot be fairly compared in subsequent waves.

An analysis was made of the age groups of females, 20-40 years, with the following result:—

Of 929 women of these age groups, 86, or 9.2 per cent., were affected in the May-August wave.

At the beginning of the October wave the number of women at these ages not previously attacked was reduced to 838.

Among these, 162 attacks occurred in the October-December wave, of which three were in persons previously attacked in the May-August wave. There were, therefore, 159 attacks in 838 persons not previously affected, or 18.9 per cent, and three in 86 persons previously attacked, or 3.4 per cent.

At the beginning of February 1919, there were 838 persons, less 159 and less two (January cases), or 677 persons not previously attacked. Ninety-one cases occurred in the February-March wave, of which 18 were in persons previously attacked, leaving 73 attacks in 677 persons not previously attacked, or 10.7 per cent. Of the 83 persons previously attacked only in the May-August wave, seven were affected, or 8.4 per cent. Of the 159 persons previously attacked only in the October-December wave, eight had died, leaving 151 persons, and amongst these were 11 attacks, or 7.2 per cent. Amongst the three persons attacked both in the May-August and October-December waves there was no attack in the February-March wave.

* Of these 14, six were second attacks in persons already attacked in October, and therefore only eight are subtracted here.

No death from influenza was recorded in a second or third attack in this census. Deaths in this population from other causes than influenza were recorded so rarely as not to affect the percentages.

SUMMARY OF FIGURES RELATING TO IMMUNITY.

	All Ages.	Age Group 20-40, Females.
	Per Cent.	Per Cent.
Incidences in May-August wave - - -	6·3	9·2
Incidences in October-December wave on those—		
1. Not previously attacked - - -	15·4	18·9
2. Previously attacked in May-August wave.	5·4	3·4
Incidences in February-March wave on those—		
1. Not previously attacked - - -	8·5	10·7
2. Previously attacked only in May-August wave.	7·8	8·4
3. Previously attacked only in October-December wave.	5·8	7·2
4. Previously attacked in both May-August and October-December waves.	2 in 16	0 in 3

Ward Distribution.—There are 16 wards in Leicester. If these are grouped from the influenzal death rates into order of severity of incidence in the October-December wave, and again for the February-March wave, it does not appear that the wards most heavily hit in October-December suffered any less than the others in February-March.

Occupation.—The staple trades at Leicester are hosiery and boot and shoe making. Visits to two factories, which were said to be typical, showed the following possible means of transference of particles from one worker to another:—

- (1) Roller towels in both factories.
- (2) Enamel drinking cups in one factory.
- (3) "Washing of teacups together in one factory.

I was informed that there are canteens in some factories.

- (4) Passing of goods in various stages of manufacture from one worker to another. There may be an interval of a day or more between the completion of one process and the beginning of the next, but where there is an urgent demand for one type of finished article, goods may go immediately from one worker to the next.

The possibility of droplet infection through the air varies considerably in the various processes. Of those I saw, machining in the shoe factory seemed to offer the greatest opportunity. Workers sit on each side of a long bench and face one another. The distance across the bench is about 5 feet and the lateral distance between the workers about 3 feet.

No useful figures were available at the factories I visited.

The effect of occupation is difficult to determine as comparable age groups of house-workers and workers away from homes are not large enough.

Of women of the age group 15 to 55, 56 per cent went out to work. Amongst those going out to work there were about 34 per cent of attacks and amongst those not going out to work about 30.5 per cent. The difference might easily be accounted for by the fact that the ages in the out-worker group tend to be lower than in the house-worker group.

One employer told me that he had two factories on similar work. One in Leicester employing about 150 had not had more than 20 cases and never more six away at any one time. The other factory, a little way from Leicester, had had to close for a time owing to the numbers away with influenza. However infection may be spread it does not seem that it is by a method distinctively active in the Leicester factories.

Housing.—597 houses or 55.8 per cent were invaded. 125 were invaded twice and 15 three times. The percentages of houses invaded in each wave were approximately 15 per cent in the May-August wave; 30 per cent in the October-December wave, and 22 per cent in the February-March wave.

The population was considered in two groups according to density of distribution of persons in individual houses. 2,122 persons lived in houses with one or more persons per room, and amongst these there were 655 cases, or 30.8 per cent. 2,480 persons lived in houses with less than one person per room, and amongst these there were 725 cases, or 29.2 per cent.

The presence of returned soldiers affects the precision of this calculation, but a second count, in which some returned soldiers were included, gave practically the same result.

Of 71 houses with eight or more inhabitants, 47 were invaded, and in 12 of these there was only one case. This is in striking contradiction to a widespread belief that the introduction of the disease into a household is almost always followed by a general infection of the household.

In a population of 627 persons living eight or more in a house there were 27.5 per cent attacks, amongst 407 persons living eight or more per house in houses which were invaded there were 42.9 per cent, attacks.

In a population of 318 persons living two or less in a house there were 26.7 per cent attacks.

It should be remembered that the attacks are those occurring from May 1918 to March 1919, and some are second attacks in persons already once attacked. Also it may be noted that the age groups in houses with eight or more per house and in houses with two or less per house differ from the age group constitution of the total population, there being a tendency for the ages to be lower in houses with many persons and higher in houses with few.

After making all allowances, however, it is difficult not to believe that the importance of aerial droplet connection from person to person has not been exaggerated.

Medical Attendance.—Of 931 cases, 609, or about 65 per cent., were said to have been seen by a doctor. The distinction is not so definite in practice as might be expected.

Some persons saw a doctor only when they had recovered sufficiently to go to his consulting-rooms. Others say they obtained medicine for secondary cases in the house, though the doctor saw only the first case. Many who did not call in a doctor refrained because of notices in the press explaining that medical men were working at great pressure and should be consulted only when the need was urgent. The proportion, however, of one-third of the cases not seen by a medical man is probably not excessive in epidemic

times of influenza; in fact, I assume that the proportion not so seen is probably rather greater, as many of the informants seemed to suspect an accusation in the question on this point, especially when the patients concerned were children.

I was told by a physician of a remarkable outbreak in the summer in a small military hospital in Leicestershire which he attended. Its total population was about 60. He visited it one afternoon and all were well. He was informed that night that there were 20 cases of influenza, and next morning everyone, excepting one member of the staff, had influenza. The source of infection was not traced.

There is with regard to influenza an undiscovered factor which occasions among certain groups of persons an infectivity of a remarkable quality. This factor is by no means always, or even usually, perceptibly in action. In many homes only one case occurs.

It seems either that—

- (a) persons suffering from influenza are markedly different from each other in their power of giving infection, or that
- (b) they vary markedly and rapidly in their infective power at stages of their illness, or else that
- (c) there is some link or perhaps a special degree of receptivity required for the consummation of infection which is present somewhat erratically, but which may be remarkably effective when present.

CONCLUSIONS.

1. The age groups 15 to 35 appear to have had both a greater incidence and, excepting those under 5, greater case mortality. The incidence was greater on females than on males.
2. Groupings into those occupied at home and those occupied away from home and groupings according to density of home populations did not show significant differences of influenza incidence.
3. Considerable immunity to the October-December wave was shown by those who had already suffered in the May-August wave.
In the February-March wave only slight immunity of those who had previously suffered is suggested by the figures.
4. The total number of persons in Leicester who had attacks of influenza during the period covered by the inquiry is probably considerably less than was generally believed.

8th May 1919.

ADDENDUM A.

I am much indebted to the following persons, amongst others, for information and assistance in this inquiry—

- Dr. C. Killick Millard, Medical Officer of Health for the County Borough of Leicester.
- Dr. T. Robinson, County Medical Officer of Health, Leicestershire.

Dr. J. E. O'Connor, Medical Officer of Health for the Leicestershire combined sanitary Districts.
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 The Superintendent of the Leicester County Borough Asylum.
 The Superintendent of the Leicester District Nursing Association.
 Dr. W. Mackarell, Pathologist to the Royal Infirmary, Leicester.
 And to members of the staffs of the Public Health Departments of the County Borough of Leicester and of the County of Leicester.

ADDENDUM B.

Influenza and Pneumonia Deaths from June 1918 to March 22nd, 1919,
 Leicester.

(No Influenza Deaths in weeks omitted.)

Week ending		Influenza.	Pneumonia.
June	15 - - - -	1	4
July	6 - - - -	5	7
"	13 - - - -	22	11
"	20 - - - -	27	6
"	27 - - - -	7	5
August	3 - - - -	1	3
"	10 - - - -	2	5
"	17 - - - -	3	2
"	24 - - - -	1	2
September	7 - - - -	1	1
"	28 - - - -	1	1
October	12 - - - -	5	11
"	19 - - - -	54	19
"	26 - - - -	194	24
November	2 - - - -	262	31
"	9 - - - -	147	24
"	16 - - - -	65	13
"	23 - - - -	20	10
"	30 - - - -	18	4
December	7 - - - -	18	7
"	14 - - - -	9	5
"	21 - - - -	10	2
"	28 - - - -	3	3
January	4 - - - -	2	0
"	11 - - - -	3	1
"	18 - - - -	1	2
"	25 - - - -	0	4
February	1 - - - -	1	7
"	8 - - - -	2	8
"	15 - - - -	12	8
"	22 - - - -	60	20
March	1 - - - -	91	14
"	8 - - - -	50	24
"	15 - - - -	41	7
"	22 - - - -	19	6

ADDENDUM C.

On possible Causes of Deviation from the Normal of the Sample Population.

1. The military age groups of males resident in Leicester are much depleted.

The men in these age groups who have been on military service have returned to their homes at various times throughout the past 12 months and in considerable numbers since the armistice. It was frequently difficult to decide whether a returned soldier should be included, especially in relation to the density of the population in individual houses.

2. Houses which were found closed at the time of visit were ignored in this census. Houses in which there are young children are rarely found closed and this probably tended to affect the age grouping of the population recorded.

3. Families which had been severely affected in the epidemic, *i.e.*, in which there had been more than one death amongst wage earners were more likely to have left an industrial centre such as Leicester. In my own inquiries I was twice told that this had happened.

ADDENDUM D.

Number of houses with—

One occupant	-	-	-	-	27
Two occupants	-	-	-	-	155
Three	„	-	-	-	220
Four	„	-	-	-	217
Five	„	-	-	-	170
Six	„	-	-	-	130
Seven	„	-	-	-	71
Eight	„	-	-	-	39
Nine	„	-	-	-	12
Ten	„	-	-	-	14
Eleven	„	-	-	-	5
Twelve	„	-	-	-	1
					1,061

NOTE.—This grouping relates not to the actual number of occupants at the time of visit, but to the inhabitants who had been resident so far as could be ascertained since the beginning of the influenza epidemic.

It is only approximate.

ADDENDUM E.

Monthly incidence of influenza—

May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March (part of).
17	61	188	29	30	202	447	29	14	303	67

ADDENDUM F.

Age Groups.	Males.	Cases of Influenza.	Females.	Cases of Influenza.	Total Males and Females.	Total Cases.	Deaths.	Population re-grouped.	Cases.	Incidence.
- 2 - -	67	8	72	12	139	20	2	449	113	Per cent. 25·1
- 5 - -	142	47	168	46	310	93	5			
- 10 - -	300	97	253	81	553	178	4	1,089	338	31·0
- 15 - -	272	80	264	80	536	160	1			
- 20 - -	184	65	288	123	472	187	4	810	290	35·8
- 25 - -	55	7	283	96	338	103	3			
- 30 - -	66	17	239	87	305	104	3	625	243	38·8
- 35 - -	98	42	222	97	320	139	6			
- 40 - -	93	25	185	66	278	91	1	546	171	31·3
- 45 - -	120	36	148	44	268	80	1			
- 50 - -	130	39	160	46	290	85	2	526	135	25·6
- 55 - -	116	24	120	26	236	50	0			
- 60 - -	74	12	118	22	192	34	0	574	97	16·8
60+	177	24	205	39	382	63	0			
Totals	1,894	523	2,725	865	4,619	1,387	32	—	—	30·0