

## DIPHTHERIA PREVALENCE IN HAMPSTEAD AND THE NEED FOR ITS PREVENTION<sup>1</sup>.

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(With 1 Map, 2 Graphs and 3 Charts.)

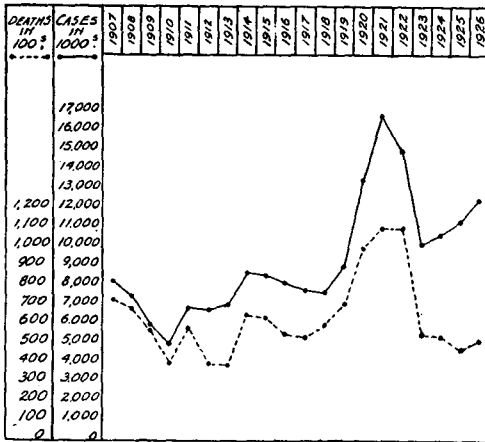
THERE could be no more suitable preface to emphasise the need for Diphtheria prevention than the following quotation from so high an authority as the Metropolitan Asylums Board's Report of 1924-25: "Notwithstanding the great improvement in diagnosis, standard of living, education in matters of hygiene and other public health measures, the fact remains that, for reasons not altogether clear, diphtheria appears to be strengthening its forces and gathering power unchecked by science." The gravity of this statement, drawing attention as it must to the constant menace of the disease, is manifest from the high figures shown by diphtheria of recent years and maintained in 1925 and 1926—when respectively 12,472 and 13,526 cases, and 493 and 547 deaths were recorded in London alone (see Graph I).

The ten year period 1917 to 1926 included three years (1920 to 1922) of unusually high diphtheria prevalence, which fell heavily throughout the metropolitan area, and particularly on Hampstead (see Graph II). During the past ten years, no less a total than 188,232 cases were notified and 7660 deaths occurred. That 83·5 per cent. of the cases (nearly 99,000) and 96·0 per cent. of the deaths (7345) were reported in children under the age of 15, is a fact which calls for the serious consideration of preventive action. In 1921 and 1922 the heaviest toll was taken of any years since the high wave of 1893 to 1902—with totals respectively of 16,293 and 15,247 cases, and 1150 and 1145 deaths at all ages. In those two years over 26,000 cases representing 11 per 1000 of the child population, and 2225 deaths (nearly 1 in 1000 of the child population) occurred in children under 15 years of age. During the two years, Hampstead suffered amongst the most severely infected boroughs, particularly in 1921, when there were 408 cases (an attack rate of 5·2 per 1000) and 35 deaths (a death rate of 0·4 per 1000 of all ages), and a case mortality of 8·5 per cent. Of these totals, the child population under the age of 15, provided 80 per cent. of the cases and 91·4 per cent. of the deaths, and a case mortality of 10 per cent. The only others of the 29 London boroughs with heavier incidence in 1921, were Bermondsey, Greenwich and Shoreditch, with attack rates of 6·1, 5·9 and 5·6 per 1000 population. Taking the averages of the all-age incidence for the past ten years, 1917-1926, it

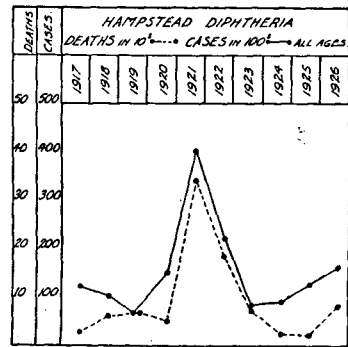
<sup>1</sup> Paper read at a meeting of the Hampstead Division of the British Medical Association on May 12th, 1927.

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may be stated that Hampstead has suffered considerably less than the majority of boroughs, with an average attack rate of 1.8 per 1000 (well below the corresponding mean for London of 2.65), coming 23rd on the list, with Bermondsey highest of all, 4.3, and Westminster lowest, 1.5 per 1000. This relatively favourable position has, however, as already indicated, been by no means uniform. In order of greater to less prevalence in the five years, 1921 to 1925, among the 29 boroughs, Hampstead was placed as follows on the list, 4th, 17th, 24th, 27th, 22nd, with attack rates of 5.2, 2.8, 1.2, 1.1 and 1.8 per 1000 for the respective years as compared with the London averages of 3.6, 3.4, 2.2, 2.3 and 2.7 per 1000 population. The years 1921, particularly, and 1922 gave cause for considerable anxiety in the borough; and the risk of such a repetition of high prevalence and mortality, especially among the child population of the borough cannot be ignored. Such a possibility may



Graph I. Diphtheria incidence and mortality in London, 1907 to 1926.



Graph II. Chart of Diphtheria incidence and mortality in Hampstead, 1917 to 1926.

indeed be foreshadowed by the rise in cases and deaths which occurred in 1926 and is shown in the several tables. A rough survey of diphtheria prevalence in Hampstead is afforded by study of the map of the borough divided into its seven wards, and Table I gives the attack rates for all ages, the 0-15 year age group, the school rate, as well as the death rates and case mortality of the past ten years, and a comparison with the corresponding averages for the whole of London. (See also Graph II and Charts 1 and 2.)

It will be observed that, whereas the ten years' Hampstead mean attack rates per 1000 for all ages and for the 0-15 age group, viz. 1.8 and 7.4, were well below the corresponding London mean, 2.65 and 8.2, the disproportion in the year 1921 is very striking in the 0-15 years, and, particularly, the school population (whose diphtheria attack rates in Hampstead trebled the average for all the London schools), and reached 20.8 and 29.3 as compared with the London average rates, 11.3 and 9.3 per 1000 of the respective popu-

lations. The average death rates for the ten year period (Table II) show similar disparities, with 0.11 per 1000 all ages, and 0.58 in the 0-15 age group in Hampstead, distinctly lower than the London means of 0.17 and 0.62; whereas in 1921 the positions were reversed with rates of 0.4, all ages, and 2 (0-15 years) per 1000 population in Hampstead, as compared with the London averages of 0.25 and 0.85 per 1000 for the two groups respectively.

In the two heavy years 1921 and 1922 in London, no fewer than 2225 children under 15 died of diphtheria, representing over 97 per cent. of the two years' total diphtheria mortality, and representing nearly one-third of the total 7345 deaths at that age period in the past decade. In Hampstead



Chart 1. Total diphtheria cases. Average annual attack rate per 1000 population = 1.8 in Hampstead, 1917 to 1926.

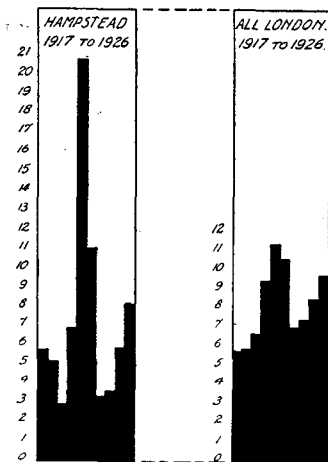


Chart 2. Attack rates per 1000 (0 to 15 years) comparison of attack rate among the 0-15 year age groups in Hampstead and London.

in those two years, 41 out of the 44 diphtheria deaths belonged to the 0-15 years group, or nearly half of the total diphtheria mortality during 1917 to 1926.

The child case mortality, averaged for the ten years, amounted to 7 per cent. in Hampstead, and 7.4 per cent. in London; but in 1921 and 1922 reached 10 and 11 per cent. in Hampstead, as compared with 8.5 and 8.9 per cent. for the whole of London.

Table III compares the diphtheria deaths in England and Wales, and in London with the mortality from measles, scarlet fever and whooping cough in 1926 and shows the prominent position which diphtheria has taken.

*Ward and School incidence of diphtheria in Hampstead.*

Following a comparison of the recent diphtheria prevalence and mortality in Hampstead and London generally, the distribution of diphtheria in Hampstead borough, as regards incidence in the various wards and schools, may be

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Table I.

	Hampstead. Diphtheria cases				Attack rates per 1000 living population					
	All ages	0-15 years	Per-centage of total cases under 15	No. of cases in 13 ele-mentary schools	Hampstead			London		
					All ages	0-15 years	Ele-mentary schools	All ages	0-15 years	Ele-mentary schools
1917	131	91	69	18	1.5	5.8	2.8	2.0	5.7	4.0
1918	109	82	75	36	1.16	5.2	5.6	2.0	5.8	4.1
1919	76	48	63	18	0.87	3.0	2.8	2.1	6.6	4.8
1920	162	107	66	61	1.86	6.8	9.6	3.0	9.3	8.1
1921	<b>408</b>	<b>327</b>	<b>80</b>	<b>186</b>	<b>4.68</b>	<b>20.8</b>	<b>29.3</b>	<b>3.6</b>	<b>11.3</b>	<b>9.3</b>
1922	<b>227</b>	<b>172</b>	<b>75</b>	<b>60</b>	<b>2.60</b>	<b>11.0</b>	<b>9.4</b>	<b>3.4</b>	<b>10.6</b>	<b>8.0</b>
1923	85	53	62	35	0.97	3.3	5.5	2.2	7.0	5.8
1924	92	59	64	29	1.05	3.7	4.5	2.3	7.2	5.5
1925	136	94	69	49	1.56	6.0	7.7	2.7	8.5	7.5
1926	162	128	79	64	1.86	8.1	10.0	2.9	10.0	8.5
Total 10 years	1588	1161	73	556	1.81*	7.4	8.7	2.65	8.2	6.5
			% av.							
(Deducting 1921 and 1922)	953	662	69	310	1.37†	5.2	4.8	(118,232)	(98,878)	(45,685)
8 years' total			% av.					2.2	7.5	6.0
1921 and 1922 totals	635	499	77.5	246	3.65†	15.9	19.0	3.5	10.9	8.6
			% av.							
<i>Populations:</i>			All ages (1921 census)					On school rolls (average of 10 years)		
Hampstead			86,890		0-15 years			6,340		
London			4,484,523					695,000		
								† Av. 1921 and 1922.		
								* 10 years mean.		
								† 8 years mean, 1917-1920 and 1923-1926.		

Table II. *Diphtheria mortality.*

		1917-1926. Averages per 1000 living population.			
		1917-1926	1921	1922	1926
<i>Hampstead:</i>					
All ages.	Yearly average	0.11	0.4	0.2	0.1
	Total deaths	98	35	19	9
0-15 years	Yearly average	0.58	2.0	1.1	0.5
	Total deaths	91	32	19	8
<i>London:</i>					
All ages.	Yearly average	0.17	0.25	0.25	0.12
	Total deaths	7660	1150	1145	547
0-15 years.	Yearly average	0.62	0.85	0.86	0.61
	Total deaths	7345	1108	1117	531
		Case mortality per cent.			
		1917-1926 average	1921	1922	1926
<i>Hampstead:</i>	All ages	5.6	8.5	8.0	5.5
	0-15 years	7.0	10.0	11.0	8.8
<i>London:</i>	All ages	6.2	7.0	7.4	4.9
	0-15 years	7.4	8.5	8.9	6.2

considered. From Table IV and by reference to the Map and Chart 3, it will be seen that three of the seven wards, Kilburn, Belsize and West End, show a far heavier incidence than has prevailed in the other four, well in excess of the average for the whole borough, and in one ward, Kilburn, above the whole London average.

Table III. (1) *England and Wales and* (2) *London. Deaths from principal infectious diseases in 1926.*

	Proportion per 1000 deaths from all causes							
	Under 15 years		0-5		5-10		10-15	
	No. of deaths	Proportion per 1000 deaths from all causes	No. of deaths	Proportion per 1000 deaths from all causes	No. of deaths	Proportion per 1000 deaths from all causes	No. of deaths	Proportion per 1000 deaths from all causes
1. Measles	3427 (926)	40 (100)	3100 (886)	43 (113)	278 (40)	36 (49)	39 (0)	8 (0)
2. Scarlet fever	572 (76)	7 (8)	308 (47)	4 (6)	211 (25)	27 (31)	53 (4)	10 (7)
3. Whooping cough	4104 (231)	48 (25)	3970 (228)	55 (29)	133 (3)	17 (4)	1 (0)	0 (0)
4. Diphtheria	2842 (531)	34 (58)	1422 (322)	20 (41)	1195 (183)	154 (223)	225 (26)	43 (47)

(General Register Office, Somerset House.)

*England and Wales.* In 1926, whereas in the pre-school age period, 0-5 years, whooping cough claimed nearly three times and measles over twice as many deaths as diphtheria; during the later quinquennia, 5-10 and 10-15, diphtheria was responsible for nearly twice as many deaths as measles, scarlet fever and whooping cough combined, for each of the two age periods.

*London* (figures for 1926 shown in brackets).

Diphtheria yielded a relatively higher mortality than in all England and Wales as compared with the three other diseases, and during the second and third quinquennia, 5-10 and 10-15 years, caused well over twice as many deaths (73 per cent.) as measles, scarlet fever and whooping cough together, 27 per cent. of the total deaths due to the infectious diseases group.

During 1925 and 1926, diphtheria caused the deaths of nearly 5500 (5491) children under the age of 15, in England and Wales, and of 1013 under 15 in London alone. According to respective age periods, pre-school and school, these deaths were allocated as follows: (1) in England and Wales 2887 under 5, 2604 between 5 and 15 years. (2) in London—the 1000 deaths (1013) were divided in the proportion of three to two—612 under 5, and 395 between 5 and 15 years.

Table IV. *The seven wards in order of diphtheria prevalence for all ages.*

Name of ward and population		Ten years' av. of diphtheria cases		1921 totals	1921 attack rate	Nine* years' average	Attack rate nine* years	1926 Total cases	1926 Attack rate
Kilburn	(15,000)	41.6	2.75	128	8.47	32	2.1	46	3.0
Belsize	(14,000)	36.9	2.56	66	4.70	20	2.4	39	2.8
West End	(13,000)	31.6	2.43	137	10.54	33.6	1.53	22	1.7
Town	(14,200)	18.6	1.3	36	2.5	16.6	1.17	11	0.77
Adelaide	(10,000)	13.0	1.3	11	1.1	13.2	1.32	26	2.6
Priory	(10,500)	9.7	0.92	16	1.5	9.0	0.85	8	0.76
Central	(10,090)	7.4	0.73	14	1.38	6.6	0.66	10	0.99
Total cases		—	—	408	—	—	—	162	—
Ward mean (12,413)		22.7	1.7	58.2	4.3	18.7	1.43	23	1.80

In 1926, it may be noted that the four wards in which the incidence was above the annual average for the past 10 years are Kilburn, Belsize, Adelaide (with a double rate) and Central.

\* 1917-1926 omitting 1921.

In 1921, the year of greatest prevalence, with a total of 408 cases in the borough, West End and Kilburn wards stand out as by far the most heavily infected areas, alone providing 265 cases of the 408. Whereas in the other wards an increase in attack rate was shown, amounting generally to double the annual rate for the whole decade, the attack rate for all ages in West End ward rose to 10.5, as compared with the ten years' average of 2.43, and in the Kilburn ward to 8.47, as compared with the average of 2.75 per 1000. In one ward only, Adelaide, was the rate lower (1.1) than the ten years' average of 1.3 per 1000. Belsize ward during the past ten years has shown a fairly consistent high incidence with an annual average of 37 cases, which in 1921 rose to 66, the average attack rate being 2.56 per 1000 for the ten years, and rising to 4.7 in 1921 (see Table IV).

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Dr F. E. Scrase, Medical Officer of Health for Hampstead, in his Report for 1921<sup>1</sup>, states as follows in reference to the diphtheria outbreak of that year:

The number of cases during the year was unusually high and a large proportion occurred in *Kilburn* and *West End* wards. Towards the end of the third quarter of the year the disease became very prevalent in the *Kilburn* area, and a number of deaths occurred. The outbreak in the district was sudden and was of unusual virulence with an unusually high case mortality (at one time 50 per cent.).



Map of Hampstead borough in wards, showing main streets and schools, and distribution of diphtheria prevalence (in dotted areas). The bracketed figures under each ward represent the average annual attack rate per 1000. Ward boundaries ----- Schools ●.

Everything that could be thought of was done to check the outbreak, which slowly subsided, but spread just as widely over the *West End* ward. In that district, however, the cases were of a much less severe type, and the mortality there much lower.

The large number of cases in the *Town* ward was due to an outbreak which occurred in an orphanage, situated in that ward, and the number of cases there amounted to 13.

<sup>1</sup> Med. Officer of Health, Hampstead Borough Council. *Annual Report for 1921*.



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has fallen on some dozen streets, which in the past seven years provided a total of 333 cases, and a street incidence ranging from as high as 55 and 53 (in Netherwood and Palmerston Streets) and 34 and 25 respectively in 1921 alone, to 10, or under, in those streets more remote from the most heavily

Table V. *School incidence of diphtheria, 1917-1926.*

Year	Hampstead 13 schools		...	All London Schools in 29 boroughs	
	Approx. No. on roll	av. per annum		6340	695,500
	Total cases	Attack rate per 1000		Total cases	Attack rate per 1000
1917	18	2.8		2919	4.0
1918	36	5.6		2910	4.1
1919	18	2.8		3365	4.8
1920	61	9.6*		5841	8.1*
1921	186	29.3*		6661	9.3*
1922	60	9.4*		5641	8.0*
1923	35	5.5		3985	5.8
1924	29	4.5		3696	5.5
1925	49	7.7		5033	7.5*
1926	64	10.0*		5634	8.5*
Totals	556	Av. 8.7		45685	Av. 6.5

\* Above the 10 years' mean.

Table VI. *School incidence of diphtheria in Hampstead in order of greatest prevalence.*

Ward and No. on School rolls	School and average No. on roll	1917-1926		1921		1926		
		Total cases	Attack rate per 1000	Total cases	Attack rate per 1000	Total cases	Attack rate per 1000	
West End 1190	Broomsleigh Street	868	144	15.8	59	58	15	19.7
	Emmanuel	212	38	16.5	23	100	2	8.9
Kilburn 1920	Netherwood Street	1150	119	10.8	64	56	17	17.9
	Kingsgate Road	770	67	8.7	16	21.0	8	10.0
Belsize Town 1430	Fleet Road	1430	108	7.5	16	11	13	9.1
Priory 430	New End	350	21	6.0	1	2.7	3	11.2
	Christ Church	260	12	4.6	4	15.2	3	10.8
	Hampstead Parochial	300	13	4.3	0	0	0	0
Central 260	All Souls'	150	4	2.6	2	12.5	0	0
	St Mary's (West End Lane)	280	21	7.5	0	0	3	12.5
Adelaide 200	Holy Trinity	210	5	2.3	1	4.8	0	0
	North Court P.D.	50	1	2.0	0	0	0	0
Hampstead	St Paul's (Winchester Road)	200	3	1.5	0	0	0	0
Total schools (13) 6340 average No. on roll		556	8.7	186	29.3	64	10	
London schools 695,000 average No. on roll		45685	6.5	6661	10.6	5634	8.5	

infected focus about Netherwood Street School. From the street figures obtained, it would appear that at least 40 per cent. of the cases occurred in children living in the immediate vicinity and attending Netherwood Street School, the centre of a densely crowded area of 10 acres, whose population density was as high as 238 per acre. Similarly, in the case of the other school

in Kilburn (Kingsgate Road), 66 per cent. of the cases in the adjacent streets occurred among children attending the school.

In *West End Ward*, with a population density of 84 per acre and an all-age diphtheria attack rate averaging 2.43 per 1000, there were seven streets, each of which provided 10 cases, and over, between 1920 and 1926, the most heavily infected being Ravenshaw and Broomsleigh Streets, with 53 and 44 cases respectively in the seven years, and 28 and 29 cases in 1921 alone. These two streets bound a large elementary school of over 800 children, and it is estimated that over 60 per cent. of the children in the infected homes attended this school.

In *Belsize Ward* also the street incidence was most evident in the proximity of Fleet Road School, seven streets providing a total of 110 cases between 1920 and 1926, 90 per cent. being children in attendance at the school, where in the past 10 years a total of 108 cases have occurred, an attack rate of 7.5 per 1000. Fleet Road itself with 28 cases was more heavily infected than any other street. The diphtheria incidence in this ward has maintained a steady level averaging 36 to 37 cases annually in the past ten years, with an attack rate of 2.5 per 1000 and a net population density of 76 per acre.

The *Town Ward*, with 43 persons per inhabited acre, has the lowest net population density in the borough, after deduction of the uninhabited portion of Hampstead Heath which comes within the ward boundaries. However, it includes some areas where the density is considerably higher, four streets with over 10 cases of diphtheria each in the last seven years, provided a total of 68 cases. No fewer than 28 cases were notified in Rosslyn Hill alone. This was, however, mainly due to the outbreak of infection at the Soldiers' Daughters' Home, where 22 cases occurred in 1921 and 1922 among 150 inmates. But, following the adoption of active preventive measures by application of the Schick test and toxin antitoxin immunisation, which is still continued for the new admissions, there have been no further cases since December, 1922.

In contrast to the heavy diphtheria incidence in the five schools in Kilburn, West End and Belsize Wards, totalling 476 cases in the past ten years among an average annual number of 4540 children on the school rolls (*i.e.* an annual attack rate of over 10 per 1000), in the three schools in the Town Ward, with a total of only 46 cases among 910 annually on the school rolls, the morbidity rate was exactly halved, averaging only 5 per 1000.

In the remaining three wards, Priory, Adelaide and Central, with net population densities of 54, 45 and 44 persons per acre, the amount of diphtheria during the past decade, and even in the epidemic year of 1921, has been relatively negligible, with the exception of one focus (Stanley Gardens) near England's Lane in Adelaide Ward, which provided 13 cases in 1925.

The general street distribution of diphtheria in these wards has shown for the most part only scattered sporadic units. Similarly, the five schools of these less densely populated wards have enjoyed remarkable freedom from infection, with the one exception (St Mary's at the south end of West End



Lane, and at the junction of Priory and Kilburn Wards), where a total of 21 cases were notified in the ten years, seven having occurred in 1925, *i.e.* an attack rate of 7.5 per 1000.

The four other schools in the past decade have provided in all only 13 cases, *i.e.* an annual attack rate of only 2.1 per 1000, but little above the average annual mean (1.8) for all ages in the whole borough (see Table VI, p. 56).

*The control of factors concerned in the spread of diphtheria.*

1. *The carrier.* An inquiry<sup>1</sup> into the prevalence of the carrier of diphtheria bacilli among the children of the London schools in 1921 and 1922 revealed a carrier rate respectively of 6.4 and 5.75 per cent. among close on 9000 children swabbed in 440 schools in the two years, the total carriers numbering 543.

In Hampstead the school carrier rate proved to be 7 per cent. in 1921 and 5.2 in 1922, among a total of 575 children swabbed in 27 schools, visited owing to the occurrence of diphtheria—the number of carriers found being 38.

The highest carrier rates found in London among children swabbed in those two years were 11 per cent. in Shoreditch schools in 1921, and 11.8 per cent. in Westminster schools in 1922. The lowest, in 1921, 3.6 per cent. in Westminster and Chelsea, in 1922, 1.8 per cent. in Kensington.

Of the 543 carriers of diphtheria bacilli in the two years, it was possible to isolate the organism and to obtain virulence tests in 294 or 54.5 per cent. of cases, which showed 67.6 per cent. virulent and 32.4 avirulent—or approximately two-thirds of the carriers virulent and one-third avirulent. The latter condition being regarded as harmless, the individual could be safely returned to school, but the carrier with virulent organisms was excluded from school till further swabbing yielded negative results.

So far as schools are concerned, therefore, the danger of the carrier can be eliminated, to a partial, though strictly limited, extent, because of the improbability of discovering *every* carrier who may be a source of infection to others, and, on account of the uncertain chances of throat swabbing yielding a positive diphtheria culture, of errors in technique of swabbing, as well as of the possible intermittence of the carrier state by temporary disappearance of the bacillus from the surface of the mucous membrane.

Outside the school, control of the carrier becomes a very difficult problem. Contact with others at play, in the home, the street, or in cinemas and other crowded places, is likely to prove a frequent source of spread of infection, not only as regards the carrier, but also the early unrecognised case of actual diphtheria.

Therefore, except in a residential institution, separation of the carrier in the early stage of an attack cannot be relied upon as a certain means of checking the spread of infection before harm has already been done.

<sup>1</sup> Forbes, J. G. *Public Health*, Sept. 1923, p. 340.

2. *Density of population and overcrowding.* To what extent these factors favour the spread of infection and how far they are directly correlated with or responsible for diphtheria prevalence, are points difficult to determine with accuracy. Calculation of the net population per inhabited acre has been arrived at from the known population in the whole acreage after deduction of the areas of unoccupied land and open spaces in each borough. The estimate can only be regarded as approximate, even after deduction for open spaces has been made, for population density and degrees of overcrowding may vary very considerably in different parts of the same ward and borough.

Table VII.

Boroughs	Net population per acre	Percentage overcrowding	Diphtheria incidence per 1000 population
<i>Group A:</i> City of London, Woolwich, Lewisham ... ..	24.9	6.4	1.99
<i>Group B:</i> Wandsworth, Hampstead, Hammersmith, Stoke Newington, Camberwell ... ..	58	9.6	2.18
<i>Group C:</i> Greenwich, Poplar, Deptford, Westminster, Lambeth, Kensington, Bermondsey, Hackney, St Marylebone, St Pancras, Battersea, Fulham, Chelsea ... ..	84.2	15.5	2.5
<i>Group D:</i> Islington, Paddington, Holborn, Finsbury ...	118.2	22.1	2.64
<i>Group E:</i> Stepney, Shoreditch, Southwark, Bethnal Green	161.7	28	3.58
Average for all London ... ..	70	16.2	2.57

Table VII is based upon a grouping of the boroughs into five classes, on an ascending scale, of the averages of population density, percentage overcrowding (*i.e.* percentage—of total population in private families—living more than two in one room<sup>1</sup>), and the average diphtheria incidence per 1000 population over the period of 10 years, 1916–1925<sup>2</sup>.

The 14 boroughs whose diphtheria incidence for 1916 to 1925 was *above* the London mean of 2.57 per 1000 population yielded an average population density of 109.3 persons per acre, and an overcrowding percentage of 21, whereas in the remaining 15 boroughs with a diphtheria incidence *below* the mean the density averaged 70.2 persons per acre, and the overcrowding 11.5 per cent. (of the total family population) living more than two in a room.

Table VII shows that Hampstead occupies a relatively favourable position, coming second in Group B.

Compared with the other 28 boroughs in the ten years (1916 to 1925) which have been averaged, Hampstead comes 23rd on the list in order of descending diphtheria incidence, with an attack rate of 1.94 per 1000, 25th in order of diminishing population density, with 48.8 people per acre, and

<sup>1</sup> London County Council. *London Statistics*, vol. xxx. p. 144, 1924–1925.

<sup>2</sup> Forbes, J. G. *The Prevention of Diphtheria. Med. Res. Council, Special Report series, No. 115.*

28th in overcrowding with 6.5 per cent. of families living more than two in one room.

Bermondsey showed highest diphtheria prevalence with 4.29 per 1000 population, but was 15th in order of population density with 83.5 persons per acre, and 6th in order of overcrowding, 23.2 per cent. Bethnal Green had the highest population density, 178 per acre, second highest diphtheria prevalence, 4.22 per 1000, and 4th in order of overcrowding, with a percentage of 27.8 of families living more than two in one room.

*Population density in relation to diphtheria incidence in Hampstead.*

As a similar survey of population density and diphtheria incidence in the various wards in Hampstead borough promised to afford some information of local interest, particulars of the extent of the uninhabited areas in each ward have been obtained and, by deduction from the known ward acreage, the net population densities have been arrived at. (See Table VIII.)

*Population density and areas of inhabited and uninhabited land.*

I. *Hampstead Borough.*

*Population* (1921 census) 86,890.

*Area* = 2265 acres.

*Gross population density per acre* = 38.4.

Percentage of area occupied by open space, parks, playing fields, roads, railways, etc. = 38.8 (858 acres).

*Net area inhabited* = 1407 acres.

*Net population per inhabited acre* = 61.8.

*Area of parks and open spaces* maintained by Government, County and Borough councils = 335 acres, *i.e.* 14.8 per cent. of total area—placing Hampstead 6th in order of boroughs with from highest to lowest amount of public open space, as compared with 9.3 per cent. for the whole of London (metropolitan area).

*Population per acre of open space* = 265 (*i.e.* lowest but two (Westminster and Greenwich) of all the metropolitan boroughs) as compared with 645 persons per acre of open space in all London.

II. *Hampstead Wards.*

Table VIII.

Ward	Population	Gross acreage	Gross population per acre	Inhabited acreage	Net population per acre
Town	14,200	687	20.7	330	43
Central	10,090	320	32.4	230	44
Adelaide	10,000	319	30.8	222	45
Priory	10,500	239	44	193	54.5
Belsize	14,000	272	61.7	184	76
West End	13,000	248	52.7	155	84
Kilburn	15,100	180	84	93	162.5
Hampstead borough	86,890	2265	38.4	1407	61.8
London	4,484,523	74,850	25	52,395	70
Metropolitan area	1921 census				

Table IX. *Diphtheria rates per 1000.*

Ward	Population per acre	Average for years 1917-1926	Average nine years 1917-1926 excluding		Annual school diphtheria rate	
			1921	1921	1917-1926	1921
Kilburn	162.5	2.75 (1*)	2.1 (2)	8.47 (2)	9.68 (2)	38.5 (2)
West End	84.0	2.43 (3)	1.53 (3)	10.54 (1)	15.3 (1)	79.0 (1)
Belsize	76.0	2.56 (2)	2.4 (1)	4.7 (3)	7.5 (2)	11.0 (3)
Priory	54.5	0.92 (6)	0.85 (6)	1.5 (5)	5.8 (6)	6.6 (4)
Adelaide	45.0	1.3 (4)	1.32 (4)	1.1 (7)	1.5 (4)	0 (7)
Central	44.0	0.73 (7)	0.66 (7)	1.38 (6)	2.3	2.4 (6)
Town	43.0	1.3 (5)	1.17 (5)	2.5 (4)	5.05 (5)	5.9 (5)
Hampstead mean 1917-1926	61.8	1.8	1.5	4.7	8.7	29.3
London mean 1916-1925	70	2.65	2.5	3.6	6.5	10.6

\* The position of each ward, in order from highest to lowest in the several columns, appears in brackets.

Grouping the wards in the arrangement applied to London boroughs, the seven wards fall into the following classes, in ascending scale of population density and diphtheria incidence (Table X).

Table X. *Average diphtheria rates.*

	Average population per acre	Ten years 1917-1926	Nine years 1917-1926 excluding		Schools	
			1921	1921	1917-1926	1921
Group B:						
Town	46.6	1.06	1.00	1.6	3.6	3.2
Central						
Adelaide						
Priory						
Group C:						
Belsize	80	2.5	1.96	7.6	11.4	45.0
West End						
Group E:						
Kilburn	162.5	2.75	2.1	8.47	9.68	38.5

Details of overcrowding, which were available for individual metropolitan boroughs, could not be ascertained for the separate wards, but the subject is one to which special reference has been made in Dr Scrase's Report for 1925. On p. 110 of the Report<sup>1</sup> is given a table presenting an analysis of the room accommodation of 1946 members of 430 families; which showed that 154 families, with a total of 849 persons, were living more than two in one room, *i.e.* a percentage of overcrowding of over 43 per cent., or seven times as much as the rate of overcrowding for the whole borough (6.5 per cent.), a higher figure than is shown by any one metropolitan borough. Finsbury provides the highest borough rate of overcrowding, *viz.* 34 per cent., as compared with 16.2 per cent., the average for the whole of London (*i.e.* the percentage (of total population in private families) living more than two in one room)<sup>2</sup>. Elsewhere (p. 42) the report states: "Assuming that all the

<sup>1</sup> M.O.H. Hampstead *Annual Report*, 1921, pp. 110 and 42.

<sup>2</sup> London County Council. *London Statistics*, vol. xxx, p. 144, 1924-1925.

persons living more than two in a room are overcrowded, then at least 6000 persons or 2000 families are living in overcrowded conditions.”

As example of the density of population, is also quoted the group of four streets covering 10 acres, known as the “Netherwood area,” and containing 172 premises occupied by a total population of 2380, adults and children, averaging 14 persons per house—a population density of 238 per acre.

The net population densities for each ward calculated after deduction of open, unoccupied space, are given on Table IX, in order of highest to lowest, and the respective diphtheria rates are introduced for comparison. The agreement, though not exact, between density and diphtheria show an approximate relationship of the two conditions.

Kilburn, a ward containing areas of greater overcrowding than any other part of the borough (*e.g.* Netherwood Street, 238 persons per acre), therefore stands in a group by itself, on the same scale of population density and diphtheria prevalence as the four boroughs, Stepney, Shoreditch, Southwark and Bethnal Green.

There are, however, probably other factors and conditions than density of population, which have to be taken into account as influencing diphtheria prevalence in one or the other direction.

In the poorer parts of London where tenement dwellings are occupied by families living close quartered in one or two rooms, and so creating an unduly high population per acre with overcrowding, diphtheria prevalence may be held in check by the degree of herd immunity maintained by repeated exposure to small doses of infection. On the other hand, the more crowded the rooms, the greater the risk of close contact with massive infection capable of overcoming acquired partial immunity<sup>1</sup>.

#### *Preventive Measures.*

The prevention of diphtheria by means of the Schick test and immunisation with toxin, antitoxin, or more lately the improved modification, toxoid, has but recently been the subject of a full report, quoted above<sup>1</sup>, describing the extent of the adoption of those measures, and the evidence of their undoubted value, in Great Britain and the United States, as well as in many other parts of the world.

Consequently the facts there set forth need not be repeated here. From calculation as to the cost of protecting the London school population, dealt with in that report, it may be stated that in Hampstead the sum required for the purpose would amount, roughly, to £1000. In comparison with this, it is estimated, that in the past ten years the actual expense resulting from diphtheria in this one borough alone, came to about £50,000 or approximately £5000 per annum, further, that for the cost of a single case of diphtheria (£30), 200 children could be tested and immunised.

<sup>1</sup> Forbes, J. G. The Prevention of Diphtheria. *Med. Res. Council, Special Report series*, No. 115, p. 30.

## CONCLUSION.

The question to be faced is in the main one of popular education and enlightenment as to the real danger to child life and health, and the means at our disposal to combat it by immunisation. Co-operation between all branches of the medical profession is essential, to be followed by careful continuous propaganda in the education of the lay administration, health as well as school authorities, and, needless to say, the parents of the children, by using such organisations as are available through health visitors, child welfare centres and school nurses and teachers.

Much could be achieved by the formation in each borough of a committee, including appointed representatives of the local medical practitioners, public health and educational authorities, child welfare workers and health visitors, under the chairmanship of the medical officer of health, to decide upon the best means of setting on foot a scheme to attempt the eradication of diphtheria.

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