A S T U D Y
OF THE
INFLUENCE OF WEATHER AND SEASON
UPON PUBLIC HEALTH ;

MADE UPON ABOVE 217,000 CASES OF SICKNESS NEWLY
OCCURRING AT VARIOUS INSTITUTIONS FOR THE
RELIEF OF THE SICK POOR IN ISLINGTON,
DURING THE NINE YEARS
1857—1865.

I. THE INFLUENCE OF ATMOSPHERIC TEMPERATURE.

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WITH the exception of a paper by Dr. Guy, published in vol. vi of the 'Statistical Journal,' I am not aware of any extensive numerical observations having been made with a view to determine the effect of weather upon public health, except as the latter is measured by the amount of mortality. The indications derivable from the mortality are fallacious, inasmuch as conditions of weather that may bring about a fatal termination of diseases already affecting a population, are not necessarily such as to occasion or favour attacks of illness in persons already in average health. I have frequently been struck, in the preparation of reports upon sickness and mortality, with the great discrepancy in this respect between the tables of sickness and the mortality tables for the same period of time. The inquiry I am about to enter upon, no

doubt, would have been prosecuted long ago, had any national registration of sickness been existent. Several years ago (in 1858) the medical officers of health in the metropolis, feeling how desirable a thing it was that they should be in possession of information as to variations in the amount and character of public sickness, undertook the collection of statistics of sickness, and, returns being made to them from most of the metropolitan districts, the results were published weekly. The aid which they received from the government, however, being withdrawn, this valuable publication ceased. As the medical officer of health in one of its largest parishes, I was a regular contributor to it while it lasted; and when it came to an end, from lack of funds to carry it on, I still continued to collect as before, extending rather than contracting the sources from which I derived information. By the close of 1865 I found myself in possession of a record of over 217,000 cases of sickness, certain acute and readily determined diseases being specially enumerated. In respect of all, I am in possession of a record of the month in which they occurred, and, as respects the greater number, of the week. They were all newly occurring cases of sickness seeking aid either at the hands of parochial surgeons, or at one or other of the dispensaries in Islington; and I have been permitted to include, by the kindness of the surgeon of the establishment, Mr. Bradley, the new cases of sickness happening in the Pentonville convict prison.

The materials at hand are such as to enable me to discuss, with some prospect of success, a considerable number of very important questions; but the first in importance has appeared to me to be the relation which existed between the amount of sickness prevalent at any time and the weather with which it was associated. In doing this I have availed myself of the meteorological tables published by Mr. Glaisher, in the returns of the Registrar General. Their public character, the readiness with which they may be consulted, and their great accuracy, far beyond that of any local tables I could have access to, led me to prefer their use.

Two methods of prosecuting the inquiry were open to me.

One of these was to compare the actual amount of sickness week by week, month by month, quarter by quarter, or year by year, with the meteorological conditions of each of these periods of time; the other, to note the fluctuations only of the sickness observed, and to compare them with the variations which occurred from time to time in atmospherical conditions. Both methods give valuable results and one may be used as confirmatory of the results of the other. But, of the two, the former is open to more fallacy than the latter, inasmuch as the absolute amount of sickness is dependent very much upon long antecedent conditions; so that very different amounts of sickness come to be recorded in seasons which in themselves differ very little in the character of their weather. The latter method is, to some extent it is true, liable to the same objection; but the influence of antecedent seasons is lost sight of where an extensive subdivision of time is had recourse to, and where such short periods with merely their fluctuations of sickness, as taken from very different years and seasons, are mixed together in the same table; note being taken, not of the actual numerical amount of the several meteorological conditions (such as the actual temperature, actual degree of humidity, &c.), but merely of their fluctuations from one short period of time to another. This latter method, then, I propose first of all to adopt, reserving to myself the use of the former where it appears likely to afford valuable information.

Of all the meteorological conditions ordinarily observed, none is more influential than atmospheric temperature; none more constant in its operation, nor more consistent in its mode of operation. I propose then to commence with this element of weather, and first of all to show how it operated in the course of 389 weeks, comparing the variation of mean temperature, week by week, with the fluctuations in general sickness which were associated with it. The materials for this comparison will be furnished by the records of sickness as supplied to me, week by week, in the years 1858 to 1865 from the following sources: viz. the Islington workhouse and infant poor house; the case-books of eight district parochial

surgeons; the books of the Central Holloway Dispensary and of the Islington Dispensary. During these eight years 158,721 new cases of sickness of all kinds came under observation. For a reason to be presently assigned, a few weeks at the close of each year have been excluded from the inquiry, as fallacious in their indications.

Table I represents the fluctuation in general sickness which took place in the course of 196 weeks of rise of mean temperature during the eight years 1858-1865.

Certain weeks immediately about Christmas in each year are excluded from the summary, inasmuch as the account of sickness in my record for those weeks is not to be relied upon as a fair representation of what actually occurred. At and about Christmas I have invariably found that the applications for medical relief at the institutions which supply the basis of my record were greatly and apparently capriciously reduced.

The normal tendency of rises of mean temperature is to occasion increase of sickness in the weeks in which they occur.

In the course of the 196 weeks during which rises of mean temperature of various extent took place, increases of sickness occurred to the total amount of 4246 cases, and decreases to the total amount of 2000 cases.

Thus, for every 1000 cases of increase of sickness there occurred only 471 cases of decrease.

For the purposes of the analyses I have found it convenient arbitrarily to divide both rises and falls of temperature into those which are "slight," or under 2 degrees in extent; "moderate," or to the extent of 2 and less than 5 degrees; and "considerable," to the extent of 5 degrees and upwards.

That this difference as to increase and decrease of sickness was not accidental, but more or less directly the result of the rises of temperature, appears from observing that the increases were greater in proportion to the decreases of sickness according as the extent of the associated rises was greater. Thus—

Tables showing the relation between fluctuations of mean weekly temperature and weekly fluctuations of general sickness.

TABLE I.—*Rises.*

	Increase of sickness.							Decrease of sickness.							Neither increase nor decrease of sickness.				
	Number of weeks.	Sum of rises.	Mean weekly rise.	Number of weeks.	Sum of rises.	Mean weekly rise.	Frequency of increase per cent. of weeks.	Amount of increased sickness.		Number of weeks.	Sum of rises.	Mean weekly rise.	Frequency of decrease per cent. of weeks.	Amount of decreased sickness.		Number of weeks.	Sum of rises.	Mean weekly rise.	Frequency per cent. of weeks.
									Sum. Mean.						Sum. Mean.				
Rises generally.....	196	733.5°	3.74°	121	497.5°	4.11°	61.73	4246	35.09	74	232.5°	3.14°	37.75	2000	27.0	1	3.5°	3.5°	0.52
Slight rises (under 2°)	70	70.7°	1.01°	40	39.0°	0.97°	57.14	1166	29.1	30	31.7°	1.05°	42.86	984	32.8				
Moderate rises (2° and under 5°).....	73	245.0°	3.35°	40	137.8°	3.44°	54.79	1295	32.3	32	103.7°	3.24°	43.84	761	23.7	1	3.5°	3.5°	1.3
Considerable rises (5° and upwards)	53	417.8°	7.88°	41	320.7°	7.82°	77.36	1785	43.5	12	97.1°	8.09°	22.64	255	21.2				

TABLE II.—*Falls.*

	Increase of sickness.							Decrease of sickness.							Neither increase nor decrease of sickness.						
	Number of weeks.	Sum of falls.	Mean weekly fall.	Number of weeks.	Sum of falls.	Mean weekly fall.	Frequency of increase per cent. of weeks.	Amount of increased sickness.	Sum.	Mean.	Number of weeks.	Sum of falls.	Mean weekly fall.	Frequency of decrease per cent. of weeks.	Amount of decreased sickness.	Sum.	Mean.	Number of weeks.	Sum of falls.	Mean weekly fall.	Frequency per cent. of weeks.
Falls generally	193	700.1°	3.62°	76	260.7°	3.43°	39.38	2253	29.6	113	436.3°	3.86°	58.55	4538	40.2	4	3.1°	0.7°	2.07		
Slight falls (under 2°)	58	60.1°	1.03°	26	27.9°	1.07°	44.83	1028	39.5	29	31.1°	1.07°	50.00	960	33.1	3	1.1°	0.3°	5.17		
Moderate falls (2° and under 5°).....	87	290.0°	3.33°	34	117.6°	3.45°	39.08	855	25.1	52	170.4°	3.27°	59.77	1823	35.1	1	2.0°	2.0°	1.15		
Considerable falls (5° and upwards)	48	350.0°	7.29°	16	115.2°	7.20°	33.33	370	23.1	32	234.8°	7.33°	66.67	1755	54.8						

In the course of the 70 weeks of slight rise of temperature, for every 1000 cases of increase of sickness there happened 843 cases of decrease.

In the course of the 73 weeks of moderate rise of temperature, for every 1000 cases of increase of sickness there happened 587 cases of decrease.

In the course of the 53 weeks of considerable rise of temperature, for every 1000 cases of increase of sickness there happened 142 cases of decrease.

Table II represents the fluctuation in general sickness which took place in the course of 193 weeks of fall of mean temperature during the same eight years.

The normal tendency of falls of mean weekly temperature is to occasion decrease of sickness in the weeks in which they occur.

In the course of the 193 weeks during which falls of mean temperature of various extent took place, decreases of sickness occurred to the total amount of 4538 cases, and increases to the total amount of 2253 cases.

Thus for every 1000 cases of decrease of sickness there occurred only 496 cases of increase.

That this difference again was not accidental, but more or less directly the result of the falls of temperature, appears from observing that the decreases were greater in proportion to the increases of sickness according as the extent of the associated falls was greater. Thus,—

In the course of the 58 weeks of slight fall of temperature, for every 1000 cases of decrease of sickness there happened 1070 cases of increase.

In the course of the 87 weeks of moderate fall of temperature, for every 1000 cases of decrease of sickness there happened 469 cases of increase.

In the course of the 48 weeks of considerable fall of temperature, for every 1000 cases of decrease of sickness there happened 210 cases of increase.

It is remarkable, and a point which will be again referred to, that the decreases of sickness in the weeks of slight fall

were altogether less than the increases which took place in these weeks.

Assuming that normally rises and falls of temperature to a similar extent act with a like force in producing fluctuations of sickness, although in opposite directions, we may estimate their normal force, under average conditions in regard to supplementary meteorological states of the atmosphere, so far as our tables are concerned, as follows :

We have upon our tables altogether 389 weeks in which rises of mean temperature took place to the total extent of 733·5 degrees, and in which falls took place to the total extent of 700·1 degrees, making together fluctuations, either by way of rise or fall of 1433·6 degrees.

During the 169 weeks of rise of temperature increases of sickness occurred to the amount of 4246 cases and decreases to the amount of 2000 cases, giving thus a clear gain by way of increase of sickness amounting to 2246 cases.

Again, during the 193 weeks of fall of temperature decreases of sickness occurred to the amount of 4538 cases, and increases to the amount of 2253 cases, giving thus a clear gain by way of decrease of sickness, amounting to 2285 cases.

Adding these normal gains together, we obtain as the total result of the 389 fluctuations of mean temperature corresponding fluctuations of sickness, the clear gain from which by way of increase or decrease amounts to 4531 cases. This is the final result of 1433 degrees of fluctuation of temperature, so that the mean result, under average conditions, of a change of temperature either by way of rise or fall, to the extent of one degree, may be taken to be an increase or a decrease of sickness to the amount of 3·16 cases ; all above or below which must be attributed to the operation of supplementary meteorological conditions co-operating with or antagonising the rises or falls of temperature. Such conditions may, as we shall see, be concurrent with or antecedent to the changes of temperature referred to.

We may now apply this standard of force to the results of the rises and falls as stated upon the tables. Thus,—

There were 196 rises, the sum of which was 733·5 degrees. The clear gain by way of increase of sickness which might have been anticipated under average supplementary conditions is therefore 2317 cases. But, deducting the decreases from the increases of sickness, we obtain the number 2246 cases of increase only, so that the gain of increase of sickness does not reach the estimated amount by 71 cases. I infer from this that in the course of these 196 weeks of rise of temperature in which various supplementary conditions, promotive some of increase and others of decrease of sickness, were operative, an excess of force was exercised by the antagonistic conditions (those promotive of decrease) which may be represented by saying that it was equal to what would, under average conditions, be exerted by 22·47 degrees of fall of mean temperature or by a mean weekly reduction of temperature to the extent of 0·11 degrees.

Applying the same standard to the results of slight, moderate, and considerable rises severally, we find—

1st. *As to slight rises.*—There were 70 such rises, the sum of which was 70·7 degrees, the clear gain by way of increase from which would, under average conditions, be 223 cases. But, deducting the decreases which occurred from the cases of increase, we obtain as the actual clear gain only 182 cases, so that the gain does not reach the estimated amount by 41 cases. Thus, as respects these 70 weeks of slight rise, we find that in their course an excess of force was exercised on the part of the supplementary antagonistic conditions, which may be represented by saying that it was equal to what, under average conditions, would be exerted by 12·97 degrees of fall of mean temperature, or by a mean weekly reduction of temperature to the extent of 0·18 degrees.

2nd. *As to moderate rises.*—There were 73 such rises, the sum of which was 245·0 degrees, the clear gain by way of increase of sickness from which would, under average conditions, be 774 cases. But, deducting the decreases which occurred from the cases of increase, we obtain as the actual clear gain only 534 cases, so that the gain does not reach the

estimated amount by 240 cases. Hence it is to be inferred as respects these 73 weeks of moderate rise that in their course an excess of force was exercised on the part of the supplementary antagonistic conditions equal to what under average conditions would be exerted by 75·95 degrees of fall of mean temperature, or a mean weekly reduction of temperature to the extent of 1·04 degrees.

3rd. *As to considerable rises.*—There were 53 such rises, the sum of which was 417·8 degrees, the clear gain by way of increase of sickness from which would, under average circumstances, be 1320 cases. But, deducting the cases of decrease of sickness from those of increase, we obtain as actual clear gain 1530 cases, so that the gain exceeds the estimated amount by 210 cases. Hence it may be inferred, as respects these 53 weeks of considerable rise, that in their course an excess of force was exercised on the part of the supplementary co-operative conditions (promotive of increase of sickness) equal to what, under average conditions, would be exerted by 66·46 degrees of rise of mean temperature, or by a further mean weekly rise of 1·25 degrees.

Again. There were 193 falls, the sum of which was 700·1 degrees, the clear gain by way of decrease of sickness from which would, under average circumstances, be 2212 cases. But, now deducting the cases of increase of sickness on the table from those of decrease, we obtain an actual clear gain of 2285 cases, so that the gain exceeds the estimated amount by 73 cases. Hence it may be inferred that in the course of these 193 weeks of fall of temperature, an excess of force was exercised on the part of the supplementary co-operative conditions (promotive of decrease of sickness) equal to what under average circumstances would be exerted by 23 degrees of fall of mean temperature, or by a further mean weekly fall to the extent of 0·12 degrees. Then—

1st. *As to slight falls.*—There were 58 such falls, the sum of which was 60·1 degrees, the clear gain by way of decrease of sickness from which would, under average circumstances, be 190 cases. But we observe on consulting Table 2 that so far from there being any such gain the cases of decrease of

sickness were less numerous than those of increase by 68 cases. Hence we must infer that in the course of these 58 weeks of slight fall an excess of force was exercised on the part of the supplementary antagonistic conditions (promotive of increase of sickness) sufficient not only to neutralize the normal decrease of 190 cases, *but to produce 68 cases of increase also*—a force thus capable of increasing sickness virtually by 258 cases, and therefore equal to what under average circumstances would be exerted by 81.65 degrees of rise of mean temperature, or by a mean weekly rise to the extent of 1.40 degrees.

2nd. *As to moderate falls.*—There were 87 such falls, the sum of which was 290 degrees, the clear gain by way of decrease of sickness from which would, under average circumstances, be 916 cases. But, deducting the cases of increase from those of decrease we obtain as actual clear gain a decrease of 968 cases, so that the gain exceeds the estimated amount by 52 cases. Hence it may be inferred, as respects these 87 weeks of moderate fall of temperature, that, in their course, an excess of force was exercised by the supplementary co-operative conditions (promotive of decrease) equal to what under average circumstances would be exerted by 16.45 degrees of fall of mean temperature, or by a further mean weekly fall to the extent of 0.18 degrees.

3rd. *As to considerable falls.*—There were 48 such falls, the sum of which was 350 degrees, the clear gain by way of decrease of sickness from which would, under average circumstances, be 1106 cases. But, deducting the cases of increase of sickness from those of decrease, we obtain as actual clear gain a decrease of 1385 cases, so that the gain exceeds the estimated amount by 279 cases. Hence it may be inferred as respects these 48 weeks of considerable fall that, in their course, an excess of force was exercised by the supplementary co-operative conditions equal to what, under average circumstances, would be exerted by 88.29 degrees of fall of mean temperature, or by a further mean weekly fall to the extent of 1.84 degrees.

A deduction, which there will be occasion to use presently, may here be drawn, viz., that in the weeks of rise generally, and in the weeks of fall generally, the supplementary causes of increase and decrease of sickness are balanced in the same manner. In both the supplementary causes of decrease of sickness operate in excess of those promotive of increase of sickness, and as nearly as possible with the same force.

RELATION OF RISES AND FALLS OF MEAN WEEKLY TEMPERATURE TO THE FREQUENCY OF OCCURRENCE OF INCREASE AND DECREASE OF SICKNESS.

1. *Rises.*

1st. Rises of mean weekly temperature were associated with increase of sickness much more frequently than with decrease of sickness.

Increase of sickness occurred in 61·73 per cent. of the weeks in which a rise of temperature took place ; decrease in 37·75 per cent.

2nd. That the rises themselves were influential in producing the greater frequency with which increase of sickness took place is shown by the observation that the frequency with which increase of sickness occurred was greater when the extent of the rises was great than when it was comparatively small.

The frequency of increase of sickness in the 53 weeks of considerable rise of mean temperature (mean 7·88 degrees) was 77·36 per cent. ; in the 143 weeks of slight and moderate rise of mean temperature (mean 2·2 degrees), 55·92 per cent. There was one week in which neither increase nor decrease of sickness occurred.

2. *Falls.*

1st. Falls of mean weekly temperature were associated with decrease of sickness much more frequently than with increase of sickness.

Decrease of sickness occurred in 58·54 per cent. of the

weeks in which a fall of temperature took place ; increase of sickness in 39·37 per cent.

2nd. That the falls themselves were influential in producing the greater frequency with which decrease of sickness took place is shown by the observation that the frequency with which decrease of sickness occurred was greater when the extent of the falls was great than when it was comparatively small.

The frequency of decrease of sickness in the 48 weeks of considerable fall of mean temperature (mean 7·29 degrees) was 66·66 per cent. ; in the 87 weeks of moderate fall of mean temperature (mean 3·33 degrees), 59·77 per cent. ; in the 58 weeks of slight fall of mean temperature (mean 1·03 degrees), 50 per cent.

One striking fact at least shows that something else besides the change of temperature influenced the occurrence of increase or decrease of sickness in the weeks under examination, viz., that in the weeks of moderate rise, the frequency with which increase of sickness occurred was less than in the weeks of slight rise. If it were otherwise increase of sickness would always be associated with rises of temperature, and decrease with falls. That decrease of sickness ever occurs with a rise of temperature shows that sometimes supplementary causes are in operation capable of overpowering the influence of the rises ; and that increase of sickness ever occurs with falls of temperature shows that supplementary causes are sometimes in operation capable of overpowering the influence of the falls. In any selected week, beside the rise or fall of temperature, supplementary causes both of increase and of decrease of sickness must be believed to be existent, and according as those promotive of increase or those promotive of decrease are in excess or predominant, there will be a tendency either to increase of sickness or to decrease. In the one case the supplementary causes in excess will tend to co-operate with rises and assist them in increasing sickness, or else tend to antagonise the falls and prevent them from decreasing sickness ; and in the other case the supplementary causes in

excess will tend to co-operate with falls and assist them in decreasing sickness, or else tend to antagonise rises and prevent them from increasing sickness. Whether in any week sickness will be increased or decreased then will depend upon the manner in which all these influences are balanced as regards their force. The factors are the extent of the rise or fall of temperature (their force); the predominance of supplementary conditions tending to increase or decrease sickness; and the degree (force) of their excess or predominance.

We will now, therefore, endeavour to discover as respects the weeks of rise or fall of mean temperature how far the occurrence of increase of sickness with rises, and of decrease of sickness with falls, as recorded upon our tables, was dependent upon the rises or falls themselves, and how far upon the predominance, in each set of weeks, of supplementary causes of increase or decrease of sickness; and again how far these latter causes operated in producing decrease of sickness with rises of temperature, and increase with falls.

Certain assumptions will have to be made, the probability of which will govern the trust to be placed in the results of the inquiry.

The first is that, just as rises and falls of temperature are about equal in frequency in the course of 389 weeks, and as the distribution of force of the various supplementary causes of increase and decrease is altogether similar in the 196 weeks of rise and the 193 weeks of fall, so also may the frequency with which the supplementary causes of increase and decrease are severally in excess in the weeks of rise or fall of temperature be regarded as similar.

The second is that this assumption may be accepted as applying to rises and falls of all degrees of extent; that is to say, whatever may be determined upon as the frequency with which supplementary causes of increase and decrease of sickness are in excess in weeks of rise and fall of temperature generally, that shall be regarded as the frequency with which either predominates in the weeks of slight, moderate, or considerable rise or fall of temperature respectively.

Let us endeavour, then, to ascertain with what relative frequency the supplementary causes of increase and decrease of sickness predominated in the 389 weeks.

First, looking at Table 1, we see that there were 38·27 per cent. of weeks of rise, in which the supplementary causes of decrease of sickness predominated over all causes of increase of sickness, including rises of temperature.

Secondly, looking at Table 2, we see that there were 41·45 per cent. of weeks of fall, in which the supplementary causes of increase of sickness predominated over all causes of decrease of sickness, including falls of temperature.

There remain 20·28 per cent. of weeks in which it is probable that a similar predominance of one class of causes over the other existed, although not sufficient to neutralize the obvious operation of the rises and falls of temperature. Distributing the frequency of predominance of supplementary causes similarly in these weeks we have 9·74 per cent. additional of weeks in which causes of decrease predominated, and 10·54 per cent. in which causes of increase of sickness predominated.

Hence we may regard it as probable that in the 389 weeks, whether of rise or fall of temperature, supplementary causes of increase of sickness predominated in operation in 52 per cent., and of decrease in 48 per cent.

But we have seen that both in weeks of rise and fall of temperature, the sum of force of operation of the supplementary causes of decrease of sickness was greater than that of the supplementary causes of increase.

Hence a further deduction that the supplementary causes of increase of sickness operate more frequently but with less force than the supplementary causes of decrease, while the supplementary causes of decrease of sickness act with more force but less frequency than the supplementary causes of increase.

1. *As to rises of mean temperature.*

Had there been no rises of mean temperature in the course

of the 196 weeks we should still, upon our estimate of the frequency of predominance of the supplementary causes of increase of sickness, have met with increase of sickness in 52 per cent. of those weeks.

But the actual frequency of increase was 61·73 per cent., that is, there was an excess of frequency of increase in these weeks of rise to the extent of 9·73 per cent. This excess of frequency may be held to be due therefore to the superior influence of the rises of temperature overcoming all antagonistic influences opposed to them; while in 52 per cent. of the weeks of rise the rises merely co-operated with other predominating causes of increase, the increase of sickness that occurred being the joint result of the rises of temperature and these predominating supplementary influences.

Then we have 38·27 per cent. of weeks in which the causes of decrease predominated in force to such an extent as to neutralize the operation of the rises of temperature. In 37·75 of these weeks the force of these causes was sufficient not only to do this but also to occasion more or less manifest decrease of sickness.

Placing this analysis of force in a tabular form we may state it thus:—

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
61·73 per cent. increase of sickness.	In 52·00 per cent. of weeks, increase of sickness occurred from joint operation of rises and other supplementary causes of increase. In 9·73 per cent., increase of sickness occurred from operation of rises alone overcoming the obstacle afforded by predominance of supplementary cause of decrease. In 37·75 per cent., decrease of sickness occurred from predominant operation of supplementary causes of decrease overcoming the influence of the rises, and producing manifest decrease. In 0·52 per cent., merely no increase of sickness occurred from same cause, but not forcible enough to do more than neutralize the rise.
38·27 per cent. decrease of sickness, or no increase.	
100·00	100·00

Applying the same method to weeks of rise of temperature of different degrees of extent we may tabulate the results also as follows :—

Weeks of slight rise.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
57·14 per cent. increase.	48·00 {
42·86 per cent. decrease.	
100·00	100·00

In 52·00 per cent., increase of sickness occurred from joint operation of slight rises and other supplementary causes of increase.

In 5·14 per cent., increase of sickness occurred from operation of slight rises alone overcoming the obstacle afforded by predominance of supplementary causes of decrease.

In 42·86 per cent., decrease of sickness occurred from predominant operation of supplementary cause of decrease, overcoming the influence of the rises and producing manifest decrease of sickness.

Weeks of moderate rise.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
54·79 per cent. increase.	48·00 {
45·21 per cent. decrease or no increase.	
100·00	
100·00	100·00

In 52·00 per cent., increase of sickness occurred from joint operations of moderate rises and other supplementary causes of increase.

In 2·79 per cent., increase of sickness occurred from operation of moderate rises alone overcoming the obstacle afforded by predominance of supplementary causes of decrease.

In 43·84 per cent., decrease of sickness occurred from predominant operations of supplementary causes of decrease overcoming the influence of the rises and producing manifest decrease of sickness.

In 1·37 per cent., merely no increase of sickness occurred from same cause, but not forcible enough to do more than neutralize the rises.

Weeks of considerable rise.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
77.36 per cent. increase.	48.00 {
22.64 per cent. decrease.	
	In 52.00 per cent., increase of sickness occurred from joint operation of considerable rises and other supplementary causes of increase. In 25.36 per cent., increase of sickness occurred from operation of considerable rises alone overcoming the obstacles afforded by predominance of supplementary causes of decrease. In 22.64 per cent., decrease of sickness occurred from predominant operation of supplementary causes of decrease overcoming the influence of the considerable rises, and producing manifest decrease of sickness.
100.00	100.00

2. As to falls of mean temperature.

Had there been no falls of mean temperature in the course of the 193 weeks we should, upon our estimate of the frequency of predominance of the supplementary causes of decrease of sickness, have met with decrease of sickness in 48 per cent. of those weeks.

But the actual frequency of decrease was 58.55 per cent., that is, there was an excess of frequency of decrease in these weeks of fall to the extent of 10.55 per cent. This excess of frequency may be held to be due, therefore, to the superior influence of the falls of temperature, overcoming all antagonistic influences opposed to them; while in 48 per cent. of the weeks of fall, the falls merely co-operated with other predominating causes of decrease, the decrease of sickness that occurred being the joint result of the falls of temperature and these predominating supplementary influences.

Thus we have 41.45 per cent. of weeks in which the causes of increase of sickness predominated in force to such an extent as to neutralize the operation of the falls of temperature. In 39.38 of these weeks the force of these causes was sufficient not only to do this, but also to occasion more or less manifest increase of sickness.

Tabulating this statement we may place it thus :—

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
58·55 per cent. decrease of sickness.	In 48·00 per cent. of the weeks of fall, decrease of sickness occurred from the joint operation of falls and other supplementary causes of decrease. In 10·55 per cent., decrease of sickness occurred from operation of falls alone overcoming the obstacles afforded by the predominance of supplementary causes of increase. In 39·38 per cent., increase of sickness occurred from predominant operation of supplementary causes of increase overcoming the influence of the falls and producing manifest increase of sickness. In 2·07 per cent., no decrease of sickness merely took place from same cause, but not forcible enough to do more than neutralize the falls.
41·45 per cent. increase of sickness or no decrease.	
100·00	100·00

Applying the same method to weeks of fall of temperature of different degrees of extent we may tabulate the results as follows :

Weeks of slight fall.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
50·00 per cent. decrease of sickness.	In 48·00 per cent., increase of sickness occurred from joint operation of slight falls and other supplementary causes of decrease. In 2·00 per cent., decrease of sickness occurred from operation of slight falls alone overcoming the obstacle afforded by the predominance of supplementary causes of increase of sickness. In 44·83 per cent., increase of sickness occurred from predominant operation of supplementary causes of increase overcoming the influence of the falls and producing manifest increase. In 5·17 per cent., no decrease merely took place from same cause, but not forcible enough to do more than neutralize the falls.
50·00 per cent. increase of sickness or no decrease.	
100·00	100·00

Weeks of moderate fall.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
59.77 per cent. decrease of sickness.	52.00 { In 48.00 per cent., decrease of sickness occurred from joint operation of moderate falls and other supplementary causes of decrease. In 11.77 per cent., decrease of sickness occurred from operation of moderate falls alone overcoming the obstacle afforded by the predominance of supplementary causes of increase of sickness. In 39.08 per cent., increase of sickness occurred from predominant operation of supplementary causes of increase overcoming the influence of the falls and producing manifest increase. In 1.15 per cent., no decrease of sickness merely took place from same cause, but not forcible enough to do more than neutralize the falls.
40.23 per cent. increase or no decrease of sickness.	
100.00	100.00

Weeks of considerable fall.

Weeks.	Proportion of predominance of supplementary causes of increase or decrease.
66.67 per cent. decrease of sickness.	52.00 { In 48.00 per cent., decrease of sickness occurred from joint operation of considerable falls and other supplementary causes of decrease. In 18.67 per cent., decrease of sickness occurred from operation of considerable falls alone overcoming the obstacle afforded by the predominance of supplementary causes of increase of sickness. In 33.33 per cent., increase of sickness occurred from predominant operation of supplementary causes of increase, overcoming the influence of the falls and producing manifest increase.
33.33 per cent. increase of sickness.	
100.00	100.00

RELATION OF RISES AND FALLS OF MEAN WEEKLY TEMPERATURE TO THE AMOUNT OF INCREASE AND DECREASE OF SICKNESS WHEN EITHER TOOK PLACE.

1. Rises.

The mean amount of increase of sickness in the weeks of rise of temperature in which increase took place was greater

than that of decrease in the weeks in which decrease of sickness took place.

Thus the total amount of increase of sickness in the 121 weeks in which it occurred was 4246 cases—mean, 35·09 cases per week ; and the total amount of decrease of sickness in the 74 weeks in which it occurred was 2,000 cases—mean, 27 cases per week.

The influence of the rise of temperature in producing the increase of sickness that was observed, and in checking the operation of the causes of decrease, is shown by the fact that the mean weekly amount of all the weekly increases of sickness that occurred in the course of the 389 weeks was 32·99 cases, and of all the decreases 34·96 cases.

In the case of the slight rises, however, it is observable that the mean amount of weekly decrease of sickness when it occurred was greater than that of increase of sickness when increase took place.

A. *As to the amount of increase of sickness.*

1st. The amount of increase of sickness when it occurred was very much governed by the extent of the rises of mean temperature with which it was associated.

This appears from observing that the mean weekly amount of increase of sickness was greater in those weeks in which the extent of the rise of temperature was great than those in which it was comparatively small. Thus, in the 40 weeks of slight rise in which increase of sickness occurred, the mean amount was 29·1 cases ; in the 40 weeks of moderate rise, 32·3 cases ; in the 41 weeks of considerable rise, 43·5 cases.

2nd. The amount of increase of sickness, when it occurred, was also to a certain degree dependent upon other supplementary meteorological conditions.

The mean extent of the 121 rises of mean weekly temperature with which increase of sickness was associated was 4·11 degrees—the sum of all the rises together being 497·5 degrees. Now, assuming, as we have previously, that a rise of mean temperature to the extent of one degree is in our table equivalent to an increase of sickness to the amount of

3·16 cases, the amount of increase of sickness which under average conditions would have occurred in these 121 weeks is only 1572 cases. But the actual increase that occurred was 4246 cases. Hence in these 121 weeks an amount of increase of sickness to the extent of 2674 cases took place which the extent of the rises of temperature will not account for, and which must therefore be regarded as due to the operation of those predominant supplementary causes of increase of sickness which we have already referred to as co-operating with the rises in most of these weeks. Of the 35·09 cases of mean weekly increase of sickness then only 12·99 can be held due to the operation of the rises, while the larger proportion of 22·10 cases must be otherwise accounted for. The combined force of operation of the supplementary causes of increase in these weeks was then equal to what, under average circumstances, would be exerted by 846·20 degrees of rise of mean temperature, or by a further mean weekly rise of 6·99 degrees.

As to slight rises.—The mean extent of the 40 slight rises of temperature with which increase of sickness was associated was 0·97 degrees, the sum of all these rises together being 39 degrees. Under average conditions the amount of increase of sickness which would have occurred in these 40 weeks is 123 cases only. But the actual increase was 1166 cases, leaving thus 1043 cases due to the predominant operation of supplementary causes of increase co-operating in the majority of weeks with the rises. Of the 29·1 mean weekly increase in these weeks then only 3·1 cases can be regarded as due to the rises of temperature, while 26 cases must be attributed to the operation of other predominant causes of increase of sickness. The combined force of operation of these supplementary causes was then equal to what, under average circumstances, would be exerted by 330·06 degrees of rise of mean temperature, or by a further mean weekly rise of 8·25 degrees.

As to moderate rises.—The mean extent of the 40 moderate rises of temperature with which increase of sickness was associated was 3·44 degrees, the sum of all these rises together

being 137·8 degrees. Under average conditions, the amount of increase of sickness which would have occurred in these 40 weeks is 435 cases. But the actual increase which occurred was 1,295 cases, leaving thus 860 cases due to the predominant operation of supplementary causes of increase of sickness. Of the 32·3 mean cases of weekly increase in these weeks then only 10·9 cases were due to the rise of temperature, leaving 21·4 cases attributable to the operation of the predominant supplementary causes of increase. The combined force of operation of these supplementary causes was then equal to what, under average circumstances, would be exerted by 272·15 degrees of rise of temperature, or by a further mean weekly rise of 6·80 degrees.

As to considerable rises.—The mean extent of the 41 considerable rises of temperature with which increase of sickness was associated was 7·82 degrees ; the sum of all these rises together being 320·7 degrees. Under average conditions, the amount of increase of sickness which would have occurred in these 41 weeks is 1013 cases. But the actual increase which occurred was 1785 cases, leaving thus 772 cases which must be attributed to the predominant operation of supplementary causes of increase of sickness. Of the 43·5 mean cases of weekly increase in these weeks, then, 24·7 only can be regarded as the result of the rises, while the remaining 18·8 cases must be attributed to the operation of supplementary causes. The combined force of operation of these supplementary causes was then equal to what, under average circumstances, would be exerted by 244·30 degrees of rise of temperature, or by a further mean weekly rise of 5·96 degrees.

B. *As to the amount of decrease of sickness.*

1st. The amount of decrease of sickness, when it occurred in association with rises of mean weekly temperature as the result of the predominating operation of antagonistic influences, was controlled by the influence of the rises of temperature.

This appears from observing that the mean amount of weekly decrease of sickness was greater in those weeks in which the rises of temperature were comparatively small than

in those in which they were more extensive. Thus, in the 30 weeks of slight rise in which decrease of sickness occurred the mean amount was 32·8 cases; in the 32 weeks of moderate rise, 23·7 cases; in the 12 weeks of considerable rise, 21·2 cases.

2nd. The amount of the decrease of sickness, when it took place in association with rises of mean weekly temperature, was mainly dependent upon the force exerted by the meteorological conditions antagonistic to the operation of the rises, part of which force was expended in nullifying the influence of the rises of temperature, and part in producing manifest decrease of sickness.

The mean extent of the 74 weekly rises of temperature with which decrease of sickness was associated was 3·14 degrees, the sum of all the rises together being 232·5 degrees. Under ordinary circumstances increase of sickness might have been looked for in the course of these weeks, amounting in the sum to 735 cases, or a mean number of 9·9 cases per week. But no such increase took place; it was nullified by the operation of other predominating antagonistic conditions. A further effect of these antagonistic conditions was to occasion actual manifest decrease of sickness to the amount altogether of 2000 cases, or a mean of 27 cases weekly. The virtual reduction of sickness then that took place in the course of these 74 weeks was 2735 cases, or a mean weekly reduction of 36·9 cases. The entire value of the force of the conditions thus reducing the sickness in these weeks may be expressed by saying that it was equal to what, under average conditions, would be exerted by 865·5 degrees of fall of temperature, or a mean weekly reduction of temperature to the extent of 11·7 degrees. Of this force, a force equal to 633 degrees, or a mean force equal to 8·56 degrees of fall per week, was expended in producing manifest decrease of sickness after the influence of the rises was nullified.

As to slight rises.—The mean extent of the 30 slight rises of temperature with which decrease of sickness was associated was 1·05 degrees, the sum of all the rises together being 31·7 degrees. Hence, under ordinary circumstances, an

increase of sickness, to the total amount of 100 cases, or a mean weekly increase of 3·3 cases, would have occurred. This increase was nullified, and a manifest decrease of sickness produced, to the amount altogether of 984 cases or 32·8 cases weekly. The virtual reduction of sickness, then, that took place in the course of these 30 weeks was 1084 cases, or a mean weekly reduction of 36·1 cases. The entire value of the force of the reducing conditions, was then equal to that of 343·03 degrees of fall of temperature, or of a mean weekly fall to the extent of 11·43 degrees. Of this force, after nullifying the rises, a force equal to 311·33 degrees, or a mean weekly force equal to 10·38 degrees of fall, was expended in producing manifest decrease of sickness.

As to moderate rises.—The mean extent of the 32 moderate rises of mean temperature with which decrease of sickness was associated was 3·24 degrees—the sum of all the rises together being 103·7 degrees. Hence, under average conditions, an increase of sickness to the total amount of 328 cases, or a mean weekly increase of 10·2 cases, would have occurred. This increase was nullified and a manifest decrease of sickness produced, amounting altogether to 761 cases, or 23·7 cases weekly. The virtual reduction of sickness then that took place in the course of these 32 weeks was 1089 cases, or a mean weekly reduction of 33·9 cases. The entire value of the force of the reducing conditions was then equal to that of a fall of 344·62 degrees, or of a mean weekly fall of 10·77 cases. Of this force, after nullifying the rises, a force equal to 240·92 degrees, or a mean weekly force of 7·53 degrees, was expended in producing manifest decrease of sickness.

As to considerable rises.—The mean extent of the 12 considerable rises of temperature with which decrease of sickness was associated was 8·09 degrees, the sum of all the rises together being 97·1 degrees. Hence, under average conditions, an increase of sickness to the total amount of 307 cases, or a mean weekly increase of 25·6 cases, would have occurred. This increase was nullified, and a manifest decrease of sickness produced, amounting altogether to 255 cases, or 21·2 cases weekly. The virtual reduction of sickness then that took

place in the course of these 12 weeks was 562 cases, or a mean weekly decrease of 46·8 cases. The entire value of the force of the reducing conditions was then equal to that of a fall of 177·85 degrees, or of a mean weekly fall of 14·82 degrees. Of this force, after nullifying the rises, a force equal to 80·74 degrees, or a mean weekly force equal to 6·73 degrees of fall of temperature, was expended in producing manifest decrease of sickness.

There is upon the table one week in which neither increase nor decrease of sickness occurred. The mean rise of temperature in this week was 3·5 degrees, corresponding, under average circumstances, to an increase of 11 cases of sickness. The increase was simply nullified by the operation of predominating causes of decrease of sickness of similar force to the rise of temperature.

2. Falls.

The mean amount of decrease of sickness in the weeks of fall of mean temperature in which decrease took place was greater than that of increase of sickness in the weeks in which increase took place.

Thus the total amount of decrease of sickness in the 113 weeks in which it occurred was 4538 cases—mean, 40·2 cases; and the total amount of increase of sickness in the 76 weeks in which it occurred was 2253 cases—mean, 29·6 cases.

The influence of the falls of temperature in producing the decrease of sickness that was observed, and in checking the operation of the causes of increase was shown by the fact that the mean weekly amount of all the weekly decreases which occurred in the course of the 389 weeks was 34·96 cases; and of all the increases 32·99.

A. As to the amount of decrease of sickness.

1st. The amount of decrease of sickness when it occurred was very much governed by the extent of the falls of mean temperature with which it was associated.

This appears from observing that the mean weekly amount of decrease of sickness was greater in those weeks in which the extent of the falls of temperature was great than those in which it was comparatively small. Thus :

In the 29 weeks of slight fall in which decrease of sickness occurred the mean amount of the decrease was 33·1 cases ; in the 52 weeks of moderate fall, 35·1 cases ; in the 32 weeks of considerable fall, 54·8 cases.

2nd. The amount of decrease of sickness also was to a certain degree dependent upon other supplementary meteorological conditions.

The mean extent of the 113 falls of mean weekly temperature with which decrease of sickness was associated was 3·86 degrees, the sum of all the falls together being 436·3 degrees. Under average circumstances the amount of decrease of sickness that might have been anticipated from falls to this extent is 1379 cases. But the amount of decrease of sickness that actually occurred in these 113 weeks was 4538 cases, leaving thus 3159 cases of decrease to be accounted for by the predominant operation in these weeks of supplementary causes of decreased sickness. Of the 40·2 mean weekly cases of decrease then, only 12·2 cases can be regarded as due to the falls of temperature, the remainder, 28 cases, being attributable to supplementary conditions. The combined force of these supplementary conditions was then equal to what, under average circumstances, would be exerted by 999·68 degrees of fall of temperature, or by a further mean weekly fall of 8·85 degrees.

As to slight falls.—The mean extent of the 29 slight falls of mean weekly temperature with which decrease of sickness was associated was 1·07 degrees, the sum of all the falls together being 31·1 degrees. Such an extent of falls would correspond, under average circumstances, to a decrease of sickness amounting altogether to 98 cases. But the actual decrease that occurred in the course of these 29 weeks was 960 cases, leaving thus 862 cases to be accounted for by the predominant operation of supplementary causes of decrease. Of the 33·1 mean weekly cases of decrease then only 3·4

cases can be regarded as due to the slight falls of temperature, while the remainder, 29·7 cases, must be referred to the operation of supplementary conditions. The combined force of these supplementary conditions was then equal to what, under average circumstances, would be exerted by 272·78 degrees of fall of temperature, or by a further mean weekly fall of 9·40 degrees.

As to moderate falls.—The mean extent of the 52 moderate falls of temperature with which decrease of sickness was associated was 3·27 degrees—the sum of all the falls together being 170·4 degrees. Under average circumstances falls to this extent would correspond to a decrease of sickness to the total amount of 538 cases. But the actual sum of the decreases was 1823 cases, leaving thus 1285 cases to be accounted for by the predominant operation of supplementary causes of decrease of sickness. Of the 35·1 mean weekly cases of decrease then only 10·3 cases can be regarded as due to the moderate falls of temperature, while the remainder 24·8 cases must be referred to the operation of supplementary conditions. The combined force of these supplementary conditions then was equal to what, under average circumstances, would be exerted by 406·65 degrees of fall of temperature, or by a further mean weekly fall to the extent of 7·82 degrees.

As to considerable falls.—The mean extent of the 32 considerable falls with which decrease of sickness was associated was 7·33 degrees—the sum of all the falls together being 234·8 degrees. Under average circumstances falls to this extent would correspond to a decrease of sickness to the total amount of 742 cases. But the actual sum of the decreases was 1755 cases, leaving thus 1013 cases to be accounted for by the predominant operation of supplementary causes of decrease of sickness. Of the 54·8 mean weekly cases of decrease then only 23·2 cases can be regarded as due to the considerable falls of temperature, while the remaining 31·6 cases must be referred to the operation of supplementary conditions. The combined force of these supplementary conditions then was equal to what, under average circumstances, would be exerted

by 320·57 degrees of fall of temperature, or by a further mean weekly fall to the extent of 10·01 degrees.

B. As to the amount of increase of sickness.

1st. The amount of increase of sickness, when it occurred in association with falls of mean weekly temperature as the result of the predominant operation of antagonistic influences, was controlled by the influence of the falls of temperature.

This appears from observing that the mean amount of weekly increase of sickness was greater in those weeks in which the falls of temperature were comparatively small than in those in which they were more extensive. Thus :

In the 26 weeks of slight fall in which increase of sickness occurred the mean amount was 39·5 cases ; in the 34 weeks of moderate fall, 25·1 ; in the 16 weeks of considerable fall, 23·1.

2nd. The amount of the increase of sickness, when it took place in association with falls of mean weekly temperature, was mainly dependent upon the force exerted by the meteorological conditions antagonistic to the operation of the falls, part of which force was expended in nullifying the influence of the falls of temperature, and part in producing manifest increase of sickness.

The mean extent of the 76 weekly falls of temperature with which increase of sickness was associated was 3·43 degrees—the sum of all the falls together being 260·7 degrees. Under ordinary circumstances decrease of sickness might have been looked for in these weeks to the total amount of 824 cases, or a mean weekly decrease of 10·8 cases. But no such decrease took place ; it was nullified by the operation of other predominating antagonistic conditions. A further effect of these antagonistic conditions was to occasion manifest increase of sickness to the amount altogether of 2253 cases, or a mean of 29·6 cases weekly. The virtual increase of sickness then that took place in the course of these 76 weeks was 3077 cases, or a mean weekly increase of 40·5 cases. The entire value of the force of the conditions thus increasing the sickness in these weeks may be expressed by saying that it was equal to what, under average conditions, would be exerted by 973·73 degrees of rise of temperature, or a mean weekly rise

to the extent of 12·81 degrees. Of this force, after nullifying the falls, a force equal to 713·03 degrees of rise of temperature, or a mean weekly force equal to 9·38 degrees of rise was expended in producing manifest increase of sickness.

As to slight falls.—The mean extent of the 26 slight falls of temperature with which increase of sickness was associated was 1·07 degrees—the sum of all the falls together being 27·9 degrees. Hence, under ordinary circumstances, we might have looked for decrease of sickness in these weeks to the amount of 88 cases, or a mean weekly decrease of 3·4 cases. This decrease was nullified, and a manifest increase of sickness occasioned the sum of which was 1028 cases, or a weekly mean of 39·5 cases. The virtual increase of sickness then which took place in the course of these 26 weeks was 1116 cases, or a mean weekly increase of 42·9 cases. The entire value of the force of the conditions thus increasing sickness was therefore equal to what, under average circumstances, would be exerted by 353·16 degrees of rise of mean temperature, or a mean weekly rise of 13·58 degrees. Of this force, after nullifying the falls, a force equal to 325·26 degrees of rise of temperature, or a mean weekly force equal to 12·51 degrees, was expended in producing manifest increase of sickness.

As to moderate falls.—The mean extent of the 34 moderate falls of temperature with which increase of sickness was associated was 3·45 degrees—the sum of all the falls together being 117·6 degrees. Hence, under ordinary circumstances, we should have looked for decrease of sickness in these weeks to the amount of 372 cases, or a mean weekly decrease of 10·9 cases. The decrease was nullified, and a manifest increase of sickness occasioned, the sum of which was 855 cases, or a weekly mean of 25·1 cases. The virtual increase of sickness then which took place in the course of these 34 weeks was 1227 cases, or a mean weekly increase of 36 cases. The entire value of the force of the conditions thus increasing sickness was then equal to what, under average circumstances, would be exerted by 394·62 degrees of rise of mean temperature, or a mean weekly rise of 11·60 degrees. Of this force, after nullifying the falls, a force equal to 277·02

degrees of rise of temperature, or a mean weekly force equal to 8.15 degrees, was expended in producing manifest increase of sickness.

As to considerable falls.—The mean extent of the 16 considerable falls of temperature with which increase of sickness was associated was 7.20 degrees—the sum of all the falls together being 115.2 degrees. Hence, under ordinary circumstances, we should have looked for decrease of sickness in these weeks to the amount of 364 cases, or a mean weekly decrease of 22.7 cases. This decrease was nullified and a manifest increase of sickness occasioned, the sum of which was 370 cases, or a weekly mean of 23.1 cases. The virtual increase of sickness then which took place in the course of these 16 weeks was 734 cases, or a mean weekly increase of 45.9 cases. The entire force of the conditions thus increasing sickness was equal to what, under average circumstances, would be exerted by 232.28 degrees of rise of mean temperature, or a mean weekly rise of 14.54 degrees. Of this force, after nullifying the falls, a force equal to 117.08 degrees of rise of temperature, or a mean weekly force equal to 7.34 degrees, was expended in producing manifest increase of sickness.

There are upon Table 2 four weeks in which neither decrease nor increase of sickness occurred. The mean extent of the falls in these four weeks was 0.7 degrees—the sum of all together being 3.1 degrees. In these weeks the decrease of sickness was simply nullified by the predominant influence of supplementary antagonistic conditions. Had this not been the case decrease of sickness to the amount of 9 cases might have been looked for, or a mean weekly decrease of sickness of 2.4 cases.

Three of these were weeks of slight fall in which the mean extent of the falls was 0.3 degrees—the sum of all together being 1.1 degrees. The decrease was nullified by antagonistic conditions of equal force: otherwise decrease of sickness to the amount of 3 cases, or a weekly decrease of 1.1 cases, might have been looked for.

The remaining week was one of moderate fall to the extent of 2 degrees, the amount of decrease nullified in this week being therefore 6 cases.

The results of the foregoing discussion will be rendered more distinct by placing them in a tabular form, thus:—

Average result of a change of 1 degree mean weekly temperature=a fluctuation of sickness to the amount of 3·16 degrees.

RISES.

General results of the 196 rises.

	Number of rises.	Total extent in degrees.	Estimated clear gain by way of increase of sickness.	Actual clear increase of sickness.	Number of cases of increase above or below estimate.	Number of degrees of temperature represented by the difference of estimated and actual increase.	
			Cases.	Cases.	Cases.	Weekly mean.	Sum.
Generally	196	733·5°	2317	2246	— 71	— 22·47°	— 0·11°
Slight rises	70	70·7°	223	182	— 41	— 12·97°	— 0·18°
Moderate rises ...	73	245·0°	774	534	— 240	— 75·95°	— 1·04°
Considerable rises	53	417·8°	1320	1530	+ 210	+ 66·46°	+ 1·25°

Assumed frequency with which increase and decrease of sickness occurred as the result of the operation of rises and of supplementary conditions.

	Weeks of increase of sickness, 61·73 per cent.				Weeks of decrease or no increase of sickness, 38·27 per cent.			
	Increase due to joint operation of rises and supplementary causes of increase.		Increase due to rises alone overcoming antagonistic supplementary causes.		Decrease due to antagonistic supplementary causes.		Increase nullified by antagonistic supplementary causes.	
	Number of weeks.	Per cent. of weeks of rise.	Number of weeks.	Per cent. of weeks of rise.	Number of weeks.	Per cent. of weeks of rise.	Number of weeks.	Per cent. of weeks of rise.
Rises generally...	102	52·00	19	9·73	74	37·75	1	0·52
Slight rises	36	52·00	4	5·14	30	42·86		
Moderate rises ...	38	52·00	2	2·79	32	43·84	1	1·37
Considerable rises	28	52·00	13	25·36	12	22·64		

Amount of Increase of Sickness when Increase occurred.

Rises.	Number of weeks of increased sickness.	Extent of rises.		Value in degrees of rise of temperature of supplementary causes of increase in predominant operation.		Value in degrees of rise of temperature of united causes of increase of sickness.		Estimated increase of sickness.		Amount of increase due to supplementary causes.		Joint results of rises of temperature and supplementary causes of increase.	
		Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.
Generally	121	497.5°	4.11°	846.20°	6.99°	1343.70°	11.10°	1572	12.99	2674	22.10	4246	35.09
Slight	40	39.0°	0.97°	330.06°	8.25°	369.06°	9.22°	123	3.1	1043	26.0	1166	29.1
Moderate	40	137.8°	3.44°	272.15°	6.80°	409.95°	10.24°	435	10.9	860	21.4	1295	32.3
Considerable ...	41	320.7°	7.82°	244.30°	5.96°	565.00°	13.78°	1013	24.7	772	18.8	1785	43.5

Amount of Decrease of Sickness when Decrease occurred.

Rises.	Number of weeks of decreased sickness.	Extent of rises.		Value in degrees of fall of temperature of supplementary causes of decrease in predominant operation producing manifest decrease of sickness.		Value in degrees of fall of temperature of supplementary causes of decrease in predominant operation producing manifest decrease of sickness.		Estimated normal increase of sickness nullified.		Manifest decrease of sickness produced.		Virtual decrease of sickness.	
		Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.
Generally	74	232.5°	3.14°	633.0°	8.56°	865.50°	11.70°	735	9.9	2000	27.0	2735	36.9
Slight	30	31.7°	1.05°	311.33°	10.38°	343.03°	11.43°	100	3.3	984	32.8	1084	36.1
Moderate	32	103.7°	3.24°	240.92°	7.53°	344.62°	10.77°	328	10.2	761	23.7	1089	33.9
Considerable...	12	97.1°	8.09°	80.75°	6.73°	177.85°	14.82°	307	25.6	255	21.2	562	46.8

Summary.—1. In the majority of the 196 weeks in which a rise of mean temperature above that of the previous week occurred, the rise of temperature was associated with an increase of general sickness. The general result of the inquiry is that increase of sickness is the normal effect of a rise of temperature.

2. In the remaining weeks (with one exception) decrease of sickness took place. In the exceptional week no alteration in the amount of sickness was noted. Decrease of sickness or the non-occurrence of increase of sickness in association with a rise of temperature must be regarded as due to the predominant operation of antagonistic meteorological conditions either antecedent to or concurrent with the rises; their force of operation may be expressed in a number of degrees of fall of mean temperature to which they are equivalent in operation.

3. Increase of sickness was, on the whole, observed to occur more frequently in the weeks in which the extent of the rise of temperature was great than when it was comparatively small.

4. The occurrence of increase or decrease of sickness in any individual week of rise of mean temperature depends partly upon the efficient force of the rise (its extent) overcoming or being overcome by antagonistic influences, and partly upon the predominance of operation and force of operation of other influences (supplementary causes of increase or decrease of sickness) co-operating with the rises or antagonising them.

5. Notwithstanding the probable co-operation of other causes of increased sickness in 102 out of the 196 weeks of rise of temperature, the clear gain by way of increase of sickness, in the course of these 196 weeks, did not quite reach the amount which might have been anticipated from a comparison of the extent of change of temperature generally in the 389 weeks tabulated, and the amount of clear gain by way of increase or decrease of sickness which those weeks furnished.

6. Dividing the weeks according as the rise of temperature was slight, moderate, or considerable, it was found that the

deficiency of increase of sickness referred to was only observed in the weeks in which the rises were slight or moderate, and that in the latter especially the clear increase of sickness was most deficient in amount. In the weeks of considerable rise, on the contrary, the clear gain by way of increase of sickness was in excess of what might have been anticipated.

7. The excess or deficiency of the final gain by way of increase of sickness in the weeks of rises of temperature must be held to be dependent upon the force of operation of those supplementary meteorological conditions which assist or antagonise the operations of rises of temperature. Hence it may be inferred that, in the weeks of rise of temperature taken altogether, the force of the antagonistic conditions was such as to reduce the increase of sickness below what would have resulted had not these antagonistic influences predominated in the course of the 196 weeks: that in the 70 weeks of slight rise of temperature the antagonistic conditions predominated sufficiently to reduce the final gain of increased sickness to what it might have been expected to be if the mean extent of the rises had been 0.18 degrees less than the actual extent: that in the 73 weeks of moderate rise the predominance of the antagonistic influences referred to was much more marked, the result being a lessened gain by way of increase such as would have been looked for had the mean weekly extent of the rise been 1.04 degrees less than the actual extent: that on the contrary in the 53 weeks of considerable rise the co-operating influences predominated in force in such a manner as to augment the increase beyond what might have been anticipated, and making the clear gain of increase of sickness equal to that which might have been looked for had the mean extent of the rises been 1.25 degrees greater than the actual extent.

8. The mean amount of increase of sickness in those weeks in which increase of sickness took place was greater than that of decrease of sickness in the weeks in which decrease took place.

9. The mean amount of increase of sickness in the weeks in which it occurred was greater the greater the extent of the

rises of temperature with which it was associated. Thus, it was greater in the weeks of moderate than of slight rise of temperature, and greater in the weeks of considerable than of moderate rise.

10. In those weeks in which increase of sickness took place in association with rise of temperature of all degrees of extent, the greater part of the increase (2674 out of 4246 cases) was due to the influence exerted by other predominating supplementary causes assisting the operation of the rises.

11. In those weeks of slight rise of temperature in which increase of sickness took place, this operation of supplementary causes of increase of sickness was most marked. Out of 1166 cases by which sickness was increased, 1043 cases resulted from the predominating influence of these supplementary conditions.

12. In those weeks of moderate rise of temperature in which increase of sickness took place, the amount of increase attributable to the supplementary conditions promotive of increase of sickness was still disproportionately large. Out of 1295 cases by which sickness was increased in these weeks, 860 cases resulted from the predominant operation of these conditions.

13. In those weeks of considerable rise of temperature in which increase of sickness took place, although the operation of the supplementary causes of increase was still marked, yet it was not in excess of the operation of the rises themselves. Out of 1785 cases by which sickness was increased in these weeks, 772 resulted from the predominant operation of these conditions, while 1013 were due to the influence of the rises.

14. Thus, according as the extent of the rises with which increase of sickness was associated was greater, so the share taken by the rises in producing the increase was also greater, and the share taken by the other supplementary conditions promotive of increase was less.

15. The mean amount of decrease of sickness when it occurred in association with rises of temperature was less in the weeks in which the rises of temperature were more extensive, and greater in those weeks in which they were less

extensive. Thus, it was greatest in weeks when it was associated with slight rises, less when associated with moderate rises, and least when associated with considerable rises.

16. In estimating the force of the conditions producing decrease of sickness in spite of the tendency to increase imparted by a rise of temperature, it is necessary to take into account not only the manifest decrease produced, but the neutralisation of the influence of the associated rises also.

17. In the 74 weeks in which decrease of sickness occurred with rises of temperature of various degrees of extent, the amount of free and predominant antagonistic force expended in producing manifest decrease of sickness was much greater than that expended in neutralising the rises, the proportion of the former to the latter being as 633° to $232^{\circ}5$.

18. In the 30 weeks in which decrease of sickness occurred with slight rises of temperature, the disproportion referred to was most marked, the amount of antagonistic force expended in producing manifest decrease being to that expended in neutralising the rises as $311^{\circ}33$ to $31^{\circ}7$.

19. In the 32 weeks in which decrease of sickness occurred with moderate rises of temperature, the amount of antagonistic force expended in producing manifest decrease of sickness was to that expended in neutralising the rises as $240^{\circ}92$ to $103^{\circ}7$.

20. In the 12 weeks in which decrease of sickness occurred with considerable rises of temperature, the amount of antagonistic force expended in neutralising the rises was on the contrary rather greater than that expended in producing manifest decrease of sickness, the latter being to the former as $80^{\circ}75$ to $97^{\circ}1$.

21. Thus, the greater the extent of the rises with which decrease of sickness was associated, the greater was the proportion of the antagonistic force expended in neutralising the rises, and the less that expended in producing manifest decrease of sickness.

22. On the whole, the mean weekly amount of antagonistic force expended in neutralising the rises and producing manifest decrease of sickness was greater in the weeks of considerable rise in which decrease occurred than in those of

slight or moderate rise, and rather greater in the weeks of slight than in those of moderate rise.

23. Comparing now the weeks of rise of temperature in which sickness was increased with those in which it was decreased we find that the mean weekly value of the forces of decrease neutralising the rises and producing manifest decrease in the latter set of weeks was very slightly greater (by $\cdot 6$ degrees) than that of all the forces of increase combined and operating in the former set of weeks. A similar observation applies to the weeks of slight, moderate, and considerable rise respectively, in which increase and decrease of sickness took place, the difference being most marked in the weeks of slight rise.

24. Comparing the force of the predominating supplementary conditions promoting increase of sickness in the 121 weeks in which sickness was increased with the force of the predominating supplementary conditions neutralising the rises and producing decrease of sickness in the 74 weeks of decreased sickness, we find that the sum of the forces of the supplementary conditions of promoting decrease of sickness was rather greater than that of the supplementary conditions promoting increase of sickness (viz., as $865^{\circ}5$ to $846^{\circ}2$), and that the mean weekly force of the former was to that of the latter as $11^{\circ}7$ to $6^{\circ}99$. In the 30 weeks of slight rise in which sickness was decreased the sum of the force of the supplementary causes of decrease was to that of the supplementary causes of increase in the 40 weeks in which sickness was increased as $343^{\circ}03$ to $330^{\circ}06$, the difference in the two sums not being great; the mean weekly force of the former was, however, to that of the latter as $11^{\circ}43$ to $8^{\circ}25$. In the 32 weeks of moderate rise in which sickness was decreased the sum of the forces of the supplementary causes of decrease was much greater than that of the supplementary causes of increase in the 40 weeks of moderate rise on which sickness was increased (viz., as $344^{\circ}62$ to $272^{\circ}15$) the mean weekly force of the former being also to that of the latter as $10^{\circ}77$ to $6^{\circ}8$. In the 12 weeks of considerable rise, however, in which sickness was decreased, the sum of the force of the supplementary causes of decrease in operation was much

less than that of the supplementary causes of increase of sickness in the 41 weeks of considerable rise in which sickness was increased (viz., as $177^{\circ}85$ to $244^{\circ}3$); but taking the number of weeks into account, the mean weekly force of the former was to that of the latter as $14^{\circ}82$ to $5^{\circ}96$.

FALLS.

General results of the 193 falls.

	Number of falls.	Total extent in degrees.	Estimated clear gain by way of decrease of sickness.	Actual clear decrease of sickness.	Number of cases of decrease above or below estimate.	Number of degrees of temperature represented by the difference of estimated and actual decrease.	
			Cases.		Cases.	Sum.	Weekly mean.
Generally	193	700.1°	2212	2285	+ 73	+ 23.00°	+ 0.12°
Slight	58	60.1°	190	—	— 258	— 81.65°	— 1.40°
Moderate	87	290.0°	916	968	52	+ 16.45°	+ 0.18°
Considerable	48	350.0°	1106	1385	+ 279	+ 88.29°	+ 1.84°

Assumed frequency with which decrease and increase of sickness occurred, as the result of the operation of falls and of the supplementary conditions.

	Weeks of decrease of sickness, 58.65 per cent.				Weeks of increase of sickness or no decrease, 41.45 per cent.			
	Decrease due to joint operation of falls and supplementary causes of decrease.		Decrease due to falls alone overcoming antagonistic supplementary causes.		Increase due to antagonistic supplementary causes.		Decrease nullified by antagonistic supplementary causes.	
	Number of weeks.	Per cent. of weeks of fall.	Number of weeks.	Per cent. of weeks of fall.	Number of weeks.	Per cent. of weeks of fall.	Number of weeks.	Per cent. of weeks of fall.
Falls generally . .	93	48.00	20	10.55	76	39.38	4	2.07
Slight falls	28	48.00	1	2.00	26	44.83	3	5.17
Moderate falls ...	42	48.00	10	11.77	34	39.08	1	1.15
Considerable falls	23	48.00	9	18.67	16	33.33		

Amount of decrease of sickness when decrease occurred.

Falls.	Number of weeks of decreased sickness.	Extent of falls.		Value in degrees of fall of temperature of supplementary causes of decrease in pre-dominant operation.		Value in degrees of fall of temperature of united causes of decrease of sickness.		Estimated decrease of sickness.		Amount of decrease due to supplementary causes.		Joint result of falls of temperature of supplementary causes of decrease.	
		Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.	Sum.	Mean.
Generally	113	436·3°	3·86°	999·68°	8·85°	1435·98°	12·71°	1379	12·2	3159	28·0	4538	40·2
Slight	29	31·1°	1·07°	272·78°	9·40°	303·88°	10·47°	98	3·4	862	29·7	960	33·1
Moderate	52	170·4°	3·27°	406·65°	7·82°	577·05°	11·09°	538	10·3	1285	24·8	1823	35·1
Considerable ...	32	234·8°	7·33°	320·57°	10·01°	555·37°	17·34°	742	23·2	1013	31·6	1755	54·8

Summary.—1. In the majority of the 193 weeks in which a fall of mean temperature below that of the previous week occurred, the fall was associated with a decrease of general sickness. The general result of the inquiry is, that decrease of sickness is the normal effect of a fall of temperature.

2. In the remaining weeks (with four exceptions) increase of sickness took place. In the exceptional weeks no alteration in the amount of general sickness was noted. Increase of sickness or the non-occurrence of decrease of sickness in association with a fall of temperature must be regarded as due to the predominant operation of antagonistic meteorological conditions either antecedent to or concurrent with the falls; their force of operation may be expressed in a number of degrees of rise of mean temperature to which they are equivalent in operation.

3. Decrease of sickness on the whole was observed to occur more frequently in the weeks in which the extent of the fall of temperature was great than when it was comparatively small.

4. The occurrence of decrease or increase of sickness in any individual week of fall of mean temperature depends partly upon the efficient force of the fall (its extent) overcoming or being overcome by antagonistic influences, and partly upon the predominance of operation and force of operation of other influences (supplementary causes of decrease or increase of sickness) co-operating with the falls or antagonising them.

5. The clear gain by way of decrease of sickness in the course of the 193 weeks of fall exceeded the amount which might have been anticipated from a comparison of the extent of changes of temperature generally in the 389 weeks tabulated, and the amount of clear gain by way of increase or decrease of sickness which those weeks furnished. This excess was nearly to the same amount as the defect in the case of the rises, and it was observed notwithstanding that the co-operation of supplementary causes was probably less frequent than in the case of the rises tabulated.

6. Dividing the weeks according as the fall of temperature was slight, moderate, or considerable, it was found that while there was an excess of decrease of sickness in the weeks of moderate and considerable fall, especially marked in the latter, it was quite otherwise in the weeks of slight fall of temperature. In the weeks of slight fall, taken altogether, it was found that the cases of increase of sickness that took place in the course of them were really more numerous than the cases of decrease of sickness, so that the final result was that in these weeks the balance of fluctuation of sickness was in favour of increase and not of decrease of sickness.

7. The excess or deficiency of the final gain, by way of decrease of sickness in the weeks of fall of temperature, must be held to be dependent upon the force of operation of those supplementary meteorological conditions which assist or antagonise the operation of falls of temperature. Hence it may be inferred that in the weeks of fall of temperature taken altogether, the force of the co-operating conditions was such as to raise the amount of decrease of sickness above what would have resulted, had not these co-operating influences predominated in the course of the 193 weeks: that in the 58 weeks of slight fall of temperature, supplementary antagonistic conditions predominated to such an extent as to produce a final result of increase of sickness similar to what might have been anticipated under average circumstances, had no falls of temperature at all taken place, but in lieu thereof a weekly rise to the mean extent of $0^{\circ}\cdot12$: that in the 87 weeks of moderate fall of temperature co-operating supplementary influences predominated to such an extent as to augment the decrease of sickness in a manner similar to that which would have resulted from a further mean weekly fall of $0^{\circ}\cdot18$: and that in the 48 weeks of considerable fall co-operating supplementary influences predominated to such an extent as to augment the decrease in a manner similar to what might have been anticipated from a further mean weekly fall of $1^{\circ}\cdot84$.

8. The mean amount of decrease of sickness in those weeks in which decrease of sickness took place was greater than

that of increase in the weeks in which increase of sickness took place.

9. The mean amount of decrease of sickness in the weeks in which it occurred was greater the greater the extent of the falls of temperature with which it was associated. Thus it was greater in the weeks of moderate than in those of slight fall of temperature, and greater in the weeks of considerable than in those of moderate fall.

10. In those weeks in which decrease of sickness took place in association with falls of temperature of all degrees of extent, by far the greater part of the decrease (3159 out of 4538 cases) was due to the influence exerted by other predominating supplementary causes assisting the operation of the falls.

11. In those weeks of slight fall of temperature in which decrease of sickness took place, the operation of supplementary causes of decrease was most marked. Out of 960 cases by which sickness was decreased, 862 cases resulted from the predominating influence of these supplementary conditions.

12. In those weeks of moderate fall of temperature in which decrease of sickness took place, the amount of decrease attributable to the supplementary conditions productive of decrease of sickness was still disproportionately large. Out of 1823 cases by which sickness was decreased in these weeks, 1285 resulted from the predominant operation of these conditions.

13. In those weeks of considerable fall of temperature in which decrease of sickness took place, the amount of decrease attributable to the supplementary conditions productive of decrease of sickness was still disproportionately large. Out of 1755 cases by which sickness was decreased in these weeks, 1013 resulted from the predominant operation of these conditions.

14. Thus, according as the extent of the falls with which decrease of sickness associated was greater, so the share taken by the falls in producing the decrease was also greater, and the share taken by the other supplementary conditions promotive of decrease was less.

15. The mean amount of increase of sickness when it occurred in association with falls of temperature was less in the weeks in which the falls of temperature were more extensive and greater in those weeks in which they were less extensive. Thus, it was greatest in the weeks in which it was associated with slight falls, less when associated with moderate falls, and least when associated with considerable falls.

16. In estimating the force of the conditions producing increase of sickness in spite of the tendency to decrease imparted by a fall of temperature, it is necessary to take into account not only the manifest increase produced, but the neutralisation of the influence of the associated falls also.

17. In the 76 weeks in which increase of sickness occurred with falls of temperature of various degrees of extent, the amount of free and predominant antagonistic force expended in producing manifest increase of sickness was much greater than that expended in neutralising the falls—the proportion of the former to the latter being as $713^{\circ}03$ to $260^{\circ}7$.

18. In the 26 weeks in which increase of sickness occurred with slight falls of temperature, the disproportion referred to was most marked, the amount of antagonistic force expended in producing manifest increase being to that expended in neutralising the falls as $325^{\circ}26$ to $27^{\circ}9$.

19. In the 34 weeks in which increase of sickness occurred with moderate falls of temperature, the amount of antagonistic force expended in producing manifest increase of sickness, was to that expended in neutralising the falls $277^{\circ}02^{\circ}$ to $117^{\circ}6^{\circ}$.

20. In the 16 weeks in which the increase of sickness occurred with considerable falls of temperature, the amount of antagonising force expended in producing manifest increase of sickness, was nearly equal to that expended in neutralising the falls, the former being to the latter as $117^{\circ}08$ to $115^{\circ}2$

21. Thus, the greater the extent of the falls with which increase of sickness was associated, the greater was the proportion of antagonistic force expended in neutralising the

falls, and the less that expended in producing manifest increase of sickness.

22. On the whole, the mean weekly amount of antagonistic force expended in neutralising the falls and producing manifest increase of sickness, was greater in the weeks of considerable fall in which increase occurred, than in those of slight or moderate fall, and greater in the weeks of slight than of moderate fall.

23. Comparing now the weeks of fall of temperature in which sickness was decreased with those in which it was increased, we find that the mean weekly value of the forces of increase neutralising the falls and producing manifest increase in the latter set of weeks was nearly the same as that of all the forces of increase combined, and operating in the former set of weeks: that in the weeks of slight fall the mean weekly force of the causes of increase when it occurred was much greater than that of the causes of decrease when decrease occurred: that in the weeks of moderate fall the force of the causes of increase when it occurred was slightly greater only than that of the causes of decrease when decrease occurred; but, on the contrary, that in the weeks of considerable fall in which decrease occurred the mean weekly force of the causes of decrease combined was much greater than that of the causes of increase when increase occurred.

24. Comparing the force of the predominating supplementary condition promoting decrease of sickness in the 113 weeks in which sickness was decreased with the force of the predominating supplementary conditions neutralising the falls and producing increase of sickness in the 76 weeks of decreased sickness, we find that the sum of the force of the supplementary conditions promoting decrease of sickness was rather greater than that of the supplementary conditions promoting increase of sickness, viz., as $999^{\circ}68$ to $973^{\circ}73$; but on the other hand, that the mean weekly force of the latter was to that of the former as $12^{\circ}81$ to $8^{\circ}85$. In the 26 weeks of slight fall in which sickness was increased the sum of the forces of the supplementary conditions promoting increase was to that of the supplementary conditions promoting

decrease in the 29 weeks in which sickness was decreased, as $353^{\circ}16$ to $272^{\circ}78$; and also the mean weekly force of the former was greater than that of the latter, viz., as $13^{\circ}58$ to $9^{\circ}40$. In the 52 weeks of moderate fall in which sickness was decreased the sum of the force of the supplementary conditions promoting decrease was to that of the supplementary conditions promoting increase as $406^{\circ}65$ to $394^{\circ}62$; but the mean weekly force of the latter was very much greater than of the former, viz., as $11^{\circ}60$ to $7^{\circ}82$. In the 32 weeks of considerable fall in which sickness was decreased the sum of the forces of the supplementary conditions promoting decrease was to that of the supplementary conditions promoting increase as $302^{\circ}57$ to $232^{\circ}28$; but again, the mean weekly force of the latter was very much greater than of the former, viz., as $14^{\circ}54$ to $10^{\circ}01$.

ON THE SUPPLEMENTARY CONDITIONS GENERALLY CO-OPERATING WITH, OR ANTAGONISING THE INFLUENCE OF THE RISES AND FALLS OF MEAN WEEKLY TEMPERATURE.

It may not be out of place here to gather up a few further deductions arising out of the preceding inquiry, respecting the frequency and force of operation of the supplementary meteorological conditions so often mentioned as modifying the results of the rises and falls of mean temperature in the 389 weeks which have been submitted to discussion. I propose to group them all together, leaving to a future time the inquiry into the influence exerted by each severally.

The principal of these conditions are, the temperature of the night, the daily range of temperature, variations in the amount of atmospheric humidity, the frequency and amount of rainfall, the direction and force of the wind, and the antecedent occurrence of increase or decrease of sickness depending either upon changes of temperature or other causes. These that I have enumerated have appeared to me to be the most important conditions affecting public health. I do not absolutely exclude the operation of changes of barometric pressure, but I am disposed to think that their connection

with fluctuations of sickness is less direct and independent, nor yet that of electrical states of the atmosphere, the amount of sunlight, and of atmospheric ozone, but the operation of these is less readily defined, and will therefore form no part of my present inquiry.

We may continue to express the force of operation of these supplementary conditions (as I term them for the present) in the number of degrees of rise and fall of mean temperature with which they correspond.

1. *As respects all the 389 weeks of change of temperature upon the tables.*

Supplementary conditions promoting increase and opposing decrease of sickness operated on the whole in the course of these weeks, more frequently than those which tend to promote decrease and oppose increase of sickness. That is to say, putting changes of mean temperature out of the question, the supplementary causes of increase of sickness predominated in force over those of decrease of sickness in a larger proportion of the weeks under analysis than did those of decrease over those of increase of sickness.

The supplementary causes of increase predominated in 52·00 per cent., and decrease 48·00 per cent.

Then as regards the force of their operation when either the one or the other set of causes predominated—

	Sum in deg. of rise.	Weekly mean.
The entire force of operation of the supplementary causes of increase of sickness when co-operating with the 121 rises of temperature	= 846·20°	— 6·99°
When antagonising 80 falls of temperature.....	= 976·83°	— 12·21°
Sum in 201 weeks.....	= 1823·03°	— 9·07°
	Degs. of fall.	
The entire force of operation of the supplementary causes of decrease of sickness when antagonising 75 rises of temperature	= 869·00°	— 11·59°
When co-operating with 113 falls of temperature	= 999·68°	— 8·85°
Sum in 188 weeks.....	= 1868·68°	— 9·94°

Thus, while the supplementary forces of increase predominated more frequently than those of decrease, the *sum of the forces of decrease was greater* than that of the forces of increase, and their *mean weekly force* when they did predominate was *greater also*.

Comparing the *force* of operation of the *supplementary causes* of increase and decrease of sickness as exhibited in the *weeks of rise with that exhibited in the weeks of fall* of temperature, we find—

1st. That the sum of the force of the causes of *increase* of sickness predominant and operating in antagonism of the 80 falls of temperature was decidedly greater than that of the causes of increase predominant and operating in assistance of the 121 rises of mean temperature: and moreover, that the mean weekly force of the causes of increase engaged in antagonising the falls was nearly twice as great as that engaged in co-operating with the rises.

2nd. That the sum of the forces of the causes of *decrease* of sickness predominating in the 113 weeks of fall of temperature, and co-operating with the falls was decidedly greater than that of the causes of decrease predominant in the 75 weeks of rises of temperature and antagonising the rises. But that the mean weekly force of the causes of decrease engaged in antagonising the rises was greater than that engaged in co-operating with the falls.

2. *As respects the 128 weeks of slight change of temperature.*

I have assumed that the frequency with which supplementary causes of increase or decrease of sickness predominate is the same in weeks of slight, moderate, and considerable rise and fall of temperature, as in all weeks of change of temperature taken together, so that here and subsequently I have merely the question of force of operation to consider.

	Sum in degs. of rise.	Weekly mean.
The entire force of operation of the supplementary causes of increase of sickness when co-operating with the 40 slight rises of temperature	= 330·06°	— 8·25°
When antagonising, 29 slight falls of temperature.....	= 354·26°	— 12·22°
Sum in 69 weeks.....	= 684·32°	— 9·92°
	Degs. of fall.	
The entire force of operation of the supplementary causes of decrease of sickness when antagonising 30 slight rises of temperature	= 343·03°	— 11·43°
When co-operating with 29 slight falls of temperature	= 272·78°	— 9·40°
Sum in 59 weeks.....	= 615·81°	— 10·44°

Thus, in the weeks of slight change of mean temperature the *sum of the supplementary forces of increase* of sickness was decidedly *greater* than that of the supplementary forces of decrease—but the *mean weekly force of operation of the causes of decrease* when they predominated was rather *greater* than that of the causes of increase.

Comparing the force of operation of the supplementary causes of increase and decrease of sickness as exhibited in the weeks of slight rise with that exhibited in the weeks of slight fall of temperature, we find—

1st. That the sum of the forces of the causes of *increase* of sickness predominating in the 29 weeks of slight fall, and antagonising the falls, was rather greater than that of the causes of increase predominating in the 40 weeks of slight rise and co-operating with the rises; and also that the mean weekly force of the causes of increase engaged in antagonising the falls was greater than that engaged in co-operating with the rises.

2nd. That the sum of the forces of the causes of *decrease* of sickness predominating in the 30 weeks of slight rise and antagonising the rises was decidedly greater than that of the causes of decrease predominating in the 29 weeks of slight fall and co-operating with the falls; and also that the mean weekly force of the causes of decrease engaged in

antagonising the rises was greater than that engaged in co-operating with the falls.

3. *As respects the 160 weeks of moderate change of temperature.*

	Sum in degs. of rise.	Weekly mean.
The entire force of operation of the supplementary causes of increase of sickness when co-operating with the 40 moderate rises of temperature	= 272·15°	— 6·80°
When antagonising 35 moderate falls of temperature...	= 396·62°	— 11·33°
Sum in 75 weeks.....	= 668·77°	— 8·92°
	Degs. of fall.	
The entire force of operation of the supplementary causes of decrease of sickness when antagonising the 33 moderate rises of temperature	= 348·12°	— 10·55°
When co-operating with 52 moderate falls of temperature	= 406·65°	— 7·82°
Sum in 85 weeks.....	= 754·77°	— 8·88°

Thus, in the weeks of moderate change of mean temperature the *sum of the supplementary forces of decrease* of sickness was decidedly *greater* than that of the supplementary forces of increase. The *mean weekly force* with which either operated when predominant was, however, *nearly the same*.

Comparing the force of operation of the supplementary causes of increase and decrease of sickness as exhibited in the weeks of moderate rise with that exhibited in the weeks of moderate fall of temperature, we find—

1st. That the sum of the forces of the causes of increase of sickness predominating in the 35 weeks of moderate fall and antagonising the falls was very much greater than that of the causes of increase predominating in the 40 weeks of moderate rise and co-operating with the rises; and moreover, that the mean weekly force of the causes of increase engaged in antagonising the falls was also very much greater than that engaged in co-operating with the rises.

2nd. That the sum of the forces of the causes of decrease of sickness predominating in the 52 weeks of moderate fall of temperature, and co-operating with the falls, was decidedly greater than that of the causes of decrease predominating in the 33 weeks of moderate rise of temperature and antagonising the rises—but that the mean weekly force of the causes of decrease engaged in antagonising the rises was decidedly greater than that engaged in co-operating with the falls.

4. *As respects the 101 weeks of considerable change of temperature.*

	Sum in degs. of rise.	Weekly mean.
The entire force of operation of the supplementary causes of increase of sickness when co-operating with 41 considerable rises of temperature	= 244°20'	— 5°96'
When antagonising 16 considerable falls of temperature	= 232°28'	— 14°54'
Sum in 57 weeks.....	= 476°58'	— 8°36'
	Degs. of fall.	
The entire force of operation of the supplementary causes of decrease of sickness when antagonising the 12 considerable rises of temperature	= 177°85'	— 14°82'
When co-operating with 32 considerable falls of temperature	= 320°57'	— 10°01'
Sum in 44 weeks.....	= 498°42'	— 11°33'

Thus, in the weeks of considerable change of temperature, the sum of the supplementary forces of decrease of sickness was somewhat greater than that of the supplementary forces of increase—and moreover, the mean weekly force of the causes of decrease when they predominated was much greater than that of the causes of increase.

Comparing the force of operation of the supplementary causes of increase and decrease of sickness, as exhibited in the weeks of considerable rise, with that exhibited in the weeks of considerable fall of temperature, we find,—

1st. That the sum of the force of the causes of *increase* of sickness predominating in the 41 weeks of considerable

rise, and co-operating with the rises, was a little greater only than that of the causes of increase predominating in the 16 weeks of considerable fall, and antagonising the falls—but that the mean weekly force of the causes of increase engaged in antagonising the falls, was very much greater than that engaged in co-operating with the rises.

2nd. That the sum of the forces of the causes of *decrease* of sickness predominating in the 32 weeks of considerable fall, and co-operating with the falls, was nearly twice as great as that of the causes of decrease predominating in the 12 weeks of considerable rise, and antagonising the rises—but that the mean weekly force of the causes of decrease engaged in antagonising the rises was decidedly greater than that engaged in co-operating with the falls.

DISTRIBUTION OF FORCE OF THE SUPPLEMENTARY CAUSES OF INCREASE AND DECREASE OF SICKNESS.

We may, in the last place, bring together the numbers which show the manner in which the force of the supplementary causes of increase and decrease of sickness appears to have been distributed.

1. *Supplementary causes of increase.*

A. As regards the sum of these forces = $1823^{\circ}\cdot03$ of rise.

	In degs. of rise.
Engaged in antagonising 16 considerable falls	= $232^{\circ}28'$
co-operating with 41 considerable rises ...	= $244^{\circ}30'$
co-operating with 40 moderate rises	= $272^{\circ}15'$
co-operating with 40 slight rises	= $330^{\circ}06'$
antagonising 29 slight falls	= $354^{\circ}26'$
antagonising 35 moderate falls	= $396^{\circ}62'$

B. As regards their mean weekly force = $9^{\circ}\cdot07$ of rise.

	In degs. of rise.
When co-operating with considerable rises	= $5^{\circ}96'$
moderate rises	= $6^{\circ}80'$
slight rises	= $8^{\circ}25'$
antagonising moderate falls	= $11^{\circ}33'$
slight falls	= $12^{\circ}22'$
considerable falls	= $14^{\circ}54'$

2. *Supplementary causes of decrease.*

A. As regards the sum of their forces = $1868^{\circ}68$ of fall.

	In degs. of fall.
Engaged in antagonising 12 considerable rises	= $177^{\circ}85^{\circ}$
co-operating with 29 slight falls	= $272^{\circ}78^{\circ}$
co-operating with 32 considerable falls ...	= $320^{\circ}57^{\circ}$
antagonising 30 slight rises	= $343^{\circ}03^{\circ}$
antagonising 33 moderate rises	= $348^{\circ}12^{\circ}$
co-operating with 52 moderate falls	= $406^{\circ}65^{\circ}$

B. As regards their mean weekly force = $9^{\circ}94$ of fall.

	Degs. of fall.
When engaged in co-operating with moderate falls.....	= $7^{\circ}82^{\circ}$
slight falls	= $9^{\circ}40^{\circ}$
considerable falls ...	= $10^{\circ}01^{\circ}$
antagonising moderate rises.....	= $10^{\circ}55^{\circ}$
slight rises	= $11^{\circ}43^{\circ}$
considerable rises ...	= $14^{\circ}82^{\circ}$

A few further deductions may be made from these two tables, viz. :

1st. That the mean weekly force of the supplementary causes both of increase and of decrease of sickness when engaged respectively in *antagonising* falls or rises of temperature *was greater* than when engaged respectively in co-operating with rises or falls of temperature.

2nd. That the mean weekly force of the supplementary causes of decrease engaged in *co-operating* with falls was greater than that of the supplementary causes of increase engaged in co-operating with rises of temperature.

This difference is least remarkable when comparing weeks of slight and moderate rise with weeks of slight and moderate fall; but it is very strongly marked indeed when comparing weeks of considerable rise with weeks of considerable fall.

The inference is that the falls, and especially the considerable falls when they produce decrease of sickness act less independently than do the rises of mean temperature when the latter increase sickness.

3rd. That the mean weekly force of the supplementary

causes of increase of sickness engaged in *antagonising* falls was slightly greater than that of the supplementary causes of decrease engaged in antagonising rises of temperature.

This, indeed, was only the case when comparing weeks of slight and moderate falls with weeks of slight and moderate rises, nor was the difference then very great. On the contrary, the mean weekly force of the causes of decrease antagonising considerable rises was slightly greater than that of the causes of increase antagonising considerable falls.

EXPLANATION OF THE DIAGRAMS. Nos. 1 to 7. 1859—65.

The irregular line ~~~~~~ represents mean temperature.

The thin line ————— represents mean temperature of corresponding period from 1814—1856. (Glaisher's Tables, 1858.)

Intermediate black line ————— represents the new cases of sickness.

Thick upper black line ————— represents barometric weight.

Space coloured *pink* represents mean daily range of temperature.

Space coloured *blue* represents humidity of atmosphere, each transverse line corresponding to two degrees of humidity above 50 (saturation = 100).

Space coloured *indigo* represents the weekly amount of rainfall; eight transverse lines corresponding to one inch.

1863.

DIAGRAM 5.

Each transverse line represents 2 degs. of Humidity & 0.125 in. of rainfall above 50 degrees.

1865.

adopted mean Temp. of middle day of each week.