



Mean Annual Hours of Sunshine and the Incidence of Dental Caries*

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A SURVEY made under the direction of the U. S. Public Health Service covering dental examinations of over 1,500,000 children has been published.¹† It seems worth while to evaluate such extensive data in relation to other factors than those indicated in the *Bulletin*. The data available on seasonal incidence of dental caries^{2, 3} suggest the interesting problem of ascertaining whether or not a correlation can be established between caries incidence and hours of sunshine available per annum. The U. S. Weather Bureau data on hours of sunshine serve as a reliable source of information on the latter variable.⁴‡

The present report covers only a small portion of the projected plan, namely, the 12-14 year age group of the white boys residing in rural and semirural areas of the United States. In the original *Bulletin* the greatest emphasis was placed on city populations. For the present study, we have

chosen the non-city groups (population groups below 5,000), which in many respects are probably more homogeneous than the population of towns and cities with their more variable ethnological groups and more diverse habits of living. There are 94,337 boys of 482 communities of 24 states in this group.

From the original data, the caries incidence per 100 children was determined by totalling the numbers of fillings in the temporary and permanent teeth, the numbers of cavities in the temporary and permanent teeth, and the numbers of extracted teeth, as reported by Mills.⁵ The number of individuals in all 482 community groups was then arranged in a frequency table having class-intervals of 50 cavities per 100 boys (Table I, Column A).

From the grouped data, the arithmetic mean, the standard deviation, and the mean's probable error were determined.* The mean, 353.50 cavities per 100 boys, is many times greater than its probable error, ± 0.295 ; therefore, we can safely assume that the mean value is representative of the hypothetical universe from which the sample is drawn, and that any error

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† Included in this study are additional but unpublished data from the same survey, used with the courtesy and permission of the Surgeon General.

‡ The methods of collecting these sunshine rates are described in the Weather Bureau *Bulletin* 802, U. S. Department of Agriculture, "Instruction for Care and Management of Electrical Sunshine Records," Circ. G., Instrument Division, Fifth Edition, by C. F. Marvin.

* Details of statistical calculations will be furnished those interested. The unpublished data used with the consent of the Surgeon General will also be supplied by the author.

TABLE I

Dental Cavities, per 100 Boys, of 12 to 14 Year Old White Boys, Living in Rural Areas or Towns of Less Than 5,000 Population Which Receive Varying Mean Annual Amounts of Sunshine, in Hours

	A	B	C	D	E
	Total— All Areas	Areas of More Than 3,000 Hours	Areas of 2,999–2,600 Hours	Areas of 2,599–2,200 Hours	Areas of Less Than 2,200 Hours
Number of boys involved	94,337	1,775	48,718	41,013	2,831
Average number of cavities per 100 (arithmetic mean)	353.50 ± 0.29 (σ = 133.50)	290.50 ± 1.79 (σ = 112.00)	323.00 ± 0.36 (σ = 119.00)	375.65 ± 0.42 (σ = 127.00)	485.75 ± 2.04 (σ = 161.00)
Difference between means of succeeding "sunshine hour" groups		(C-B) → 323.00 — 290.50 = 32.50 ± 1.83	(D-C) → 375.65 — 323.00 = 52.65 ± .56	(E-D) → 485.75 — 375.65 = 110.10 ± 2.08	

Frequency Distribution of Caries Rates

Cavities per 100 White Boys Aged 12 to 14	A	B	C	D	E
	94,337 Boys	1,775 Boys	48,718 Boys	41,013 Boys	2,831 Boys
0-49.9	0	0	0	0	0
50-99.9	854	0	854	0	0
100-149.9	2,168	282	1,481	405	0
150-199.9	8,406	138	5,974	2,193	101
200-249.9	12,328	304	6,231	5,793	0
250-299.9	11,415	251	7,596	3,179	389
300-349.9	13,640	202	7,138	6,152	148
350-399.9	13,823	99	6,228	7,275	221
400-449.9	10,708	438	5,603	4,290	377
450-499.9	9,583	43	4,171	5,086	283
500-549.9	6,031	18	1,637	3,923	453
550-599.9	2,159	0	1,347	692	120
600-649.9	1,633	0	419	949	265
650-699.9	492	0	0	492	0
700-749.9	484	0	39	148	297
750 & above	613	0	0	436	177

introduced by chance or accidental sampling is negligible.^{6, 7, 8}

From the official weather map furnished by the U. S. Weather Bureau "the mean annual amounts of sunshine, in hours" for various sections of the United States were determined. The observations from which this map is made are recorded at some 90 meteorological stations. For this study, these sunshine values are arranged into four divisions: (a) those areas having more than 3,000 hours; (b) those having

2,999 to 2,600; (c) 2,599 to 2,200; and (d) less than 2,200 hours of sunshine per year respectively.

Frequency distributions of caries rates were made according to the mean annual sunshine value in hours for the community in which the children resided (Table I, Columns B, C, D, and E).

The arithmetic mean and the standard deviation with their probable errors were determined for each group. The means are 290.50 ± 1.79 cavities per

100 boys for the group living in localities having more than 3,000 hours per annum; 323.00 ± 0.36 , 375.65 ± 0.42 and 485.75 ± 2.04 in the B, C, D, and E groups respectively. In each case, the relations between the successive means and their probable errors is so great as to make it safe to assume that the mean values are representative of the respective hypothetical universes from which the samples are taken. The locations of the areas having the various mean annual amounts of sunshine in hours, are shown in Figure I. The mean caries incidence for those areas are graphically expressed in Figure II.

The probable errors of the differences between these various means have been determined. The difference between the means of the B and C groups is 32.50 ± 1.83 ; of the C and D groups 52.65 ± 0.56 ; and the D and E groups 110.10 ± 2.08 .

The lowest value is that between the B and C groups, but there the difference between the means exceeds the probable error of that difference 17.7 times.*

DISCUSSION

Jessen has written, "The conception that the weather exerts an influence on health of mankind is as old as the treatment of illness itself" (translation).⁹ Emerson has reported the influence of sunshine on growth of children and has noted that the incidence of acute infectious disease is lowest during the season having the greatest amount of sunshine.¹⁰ The relation of the seasons and dental caries incidence has been reported by McBeath and Zucker² and Erpf.³ In both investigations marked decrease in caries incidence was found in the months of greatest sunshine,

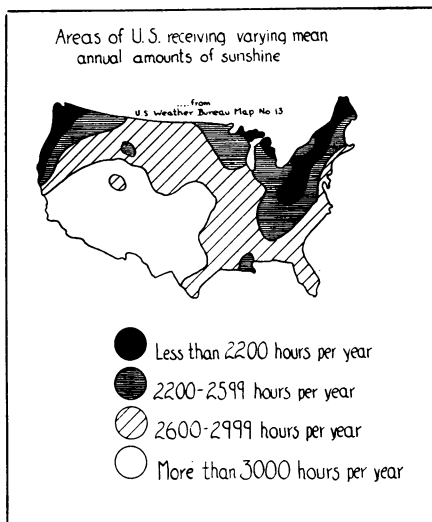


FIGURE I

when compared with those months having less sunshine.

Examinations of Indian children by members of the U. S. Public Health Service¹¹ seem to establish that those resident where the sun shines the greatest number of hours per year have

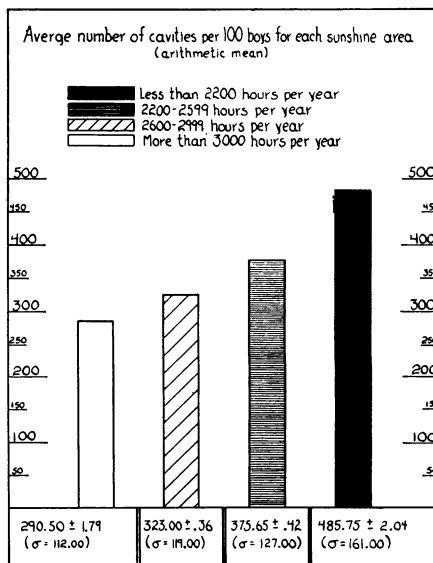


FIGURE II

* The chances are less than 1,000,000,000 to 1 that the observed difference between any two of the means is due to chance distribution. See: Sherman, Henry C. *Chemistry of Food & Nutrition*, Appendix D, Macmillan, 1937.

a coincidental decrease in caries incidence over those living in areas of less sunshine. Moore and associates¹² found that 5 year old children of San Diego, Calif., having 3,000 hours of sunshine per year, had only one-half as much dental decay as children of the same age of Portland, Ore., with only 2,000 hours per annum.

The statement of Bunting¹³ that sunshine has no correlation with dental decay is at variance with the results obtained in this statistical study of 94,337 children living in various sunshine areas.

SUMMARY

1. The mean caries incidence of 94,337 white boys, 12 to 14 years of age residing in rural and semi-rural areas of 24 states during 1934-1935, was 353.50 per 100 boys.

2. The mean caries incidence of these boys varies inversely with the hours of sunshine prevailing at their places of residence. The group residing in the area having over 3,000 hours of sunshine per year had 290.50 cavities per 100 boys; the 2,600-2,999 hour group, 323.00; the 2,200-2,599 group 375.65; and the group with less

than 2,200 hours 485.75 cavities per 100.

3. The data presented suggest an inverse relationship (not necessarily causal) between the caries-attack rate among samples of white boys 12 to 14 years of age, and the mean annual number of hours of sunshine recorded for the places of residence of these children.

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