THE NEW YORK COMMISSION ON VENTILATION

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THE major interest of the New York Commission on Ventilation since its revival¹ in the autumn of 1926 has centered on a comparative study of methods of schoolroom ventilation, especially in the schools of the New York Health Demonstrations areas.

The ventilation study in the Cattaraugus County schools² started in December, 1926, and now in its third year, has been primarily a fact-finding survey of air conditions and methods of heating in one- and two-room rural schools of frame construction. Records of the prevalence of respiratory illness as judged by the teachers have been studied with regard to size of the school, method of heating, average classroom temperature, and outdoor weather conditions.

Two-thirds of the forty-eight classrooms were heated by ordinary stoves; one-sixth by jacketed stoves, and the remainder by furnaces. The furnace-heated classrooms had the highest average temperatures and the most uniform heat distribution both horizontally and vertically; the rooms with jacketed stoves were next, while the rooms with ordinary stoves had the lowest average and the greatest horizontal and vertical variations in temperature. Lateral variations in temperature as great as 42, 43 and 46 degrees between the temperatures on the tops of occupied desks in a stove-heated classroom have been found to exist simultaneously. Average differences between floor and ceiling temperatures ranged ^TThe objectives of the Commission and the reasons for its revival are described in the Milbank Memorial Fund *Quarterly Bulletin*, July, 1927.

²A study of Rural School Ventilation, Contribution No. 2, New York Commission on Ventilation, *Public Health Reports*, United States Public Health Service (*in process of publication*). from 12 to 34 degrees. One observation showed the ceiling temperature to be 55° higher than at the floor level.

The furnace-heated rooms had the lowest rates of absenteeism (12.9 per cent); the rooms heated by jacketed stoves, the highest (14.8 per cent), with the stove-heated rooms only slightly less (14.4 per cent). Whether these rates have any definite relationship to the type of heating or whether they are due to other factors or to chance alone cannot be determined on the basis of this experience.

In absenteeism reported due to respiratory illness, there were but slight differences according to method of heating, rooms heated by ordinary stoves having the lowest, and furnace-heated rooms the highest rate. The highest total incidence of respiratory illness was reported from the rooms heated with jacketed stoves, the furnace- and stove-heated rooms having practically identical rates. It was interesting to note that all these rates were two and three times as high as those previously observed in similar studies in Syracuse and New York City.

A high correlation between precipitation³ and absenteeism due to respiratory illness, was found while no apparent relationship was discovered between such illnesses and low temperatures. During inclement weather rural school children run greater risks of wetting their clothing than do city pupils because of the long distances they must travel and the poor transportation available and this is probably an important factor in the higher rates of absenteeism and respiratory illness found among them.

In the first year of the study in Syracuse also started December, 1926, old-furnace-heated, naturally-ventilated schools showed lower rates of absenteeism and lower rates of

³Public Health Reports, United States Public Health Service, op. cit. Duffield, Thomas J., The Weather and the Common Cold, *Journal of American Public Health Association*, January, 1929.

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respiratory illness than did modern steam-heated, mechanically ventilated schools attended by pupils of similar age, sex and racial composition.⁴ In the second year⁵ when the number of schools was doubled and nurses replaced teachers in making the records of respiratory illness, the old furnaceheated schools again showed the lowest rates of general absenteeism, but not the best records for respiratory illness.

A test showed that the personal equation of the various nurses was one of the most important factors in the number of cases of respiratory illness reported among the pupils present in school. Because of this influence, no comparisons on this point are warranted from the second year's study.

In Syracuse, as in Cattaraugus County, precipitation and the distance pupils have to travel to school appear to be important factors in absenteeism. In the first year's study, absenteeism due to respiratory illness was found to be closely correlated with precipitation-while there appeared to be no adverse effect from low temperature alone. This was particularly true of the modern schools with mechanical ventilation. When the relative travel distance of pupils attending the old and modern schools was studied, it was found that the average of the maximum distances pupils attending the former had to travel was 0.22 miles, while the figure for the latter was 0.40 miles. Thus pupils attending the larger, modern schools ran twice as great a risk of wetting shoes and clothing as those going to the little old furnace-heated schools, and this fact may account largely for the higher rates

*New York Commission on Ventilation. Relation between Respiratory Illness and Air Conditions in Certain Syracuse Schools, *School and Society*, xxvi, No. 67,

December 17, 1927. Duffield, Thomas J., Effects of Mechanical and Natural Ventilation on the Health of School Children, Journal American Society Heating and Ventilating

Engineers, April, 1928, p. 327. Duffield, Thomas J., The School Ventilation Study in Syracuse, New York, 1926–1927, Journal of American Public Health Association, March, 1928. ⁶Duffield, Thomas J., Report on the Schoolroom Ventilation Study, Syracuse, New York, Journal of American Public Health Association, January, 1929. p. 64.

of absenteeism and respiratory illness found in the modern schools, whether they have fan or window ventilation.

During 1928-1929 an effort has been made both in the studies in Syracuse and in the Bellevue-Yorkville district of New York City to overcome the difficulties experienced during the preceding year. In Syracuse, the effect of a single variable-the rate of air change-is being studied. Adjoining or adjacent classrooms in seven mechanically ventilated schools occupied by pupils of the same age, sex, racial origin, with the same distance to walk to school, et cetera, are supplied, respectively, with 30 and 10 cubic feet of air per pupil per minute. In two modern unit-ventilated schools in New York, similar conditions have been established. In the third school in the New York study, an effort is being made to determine which method of ventilation-the window-gravity method, as recommended by the former Commission, or the unit system of mechanical ventilation with air change at the rate of from 10 to 15 cubic feet of outdoor air per pupil per minute—is the more conducive to the pupils' health.

Investigations, similar in nature to the studies already described, under way in New Haven,⁶ Cleveland,⁷ and certain suburbs of Chicago,⁸ the last named being financed in part by the Commission, have been watched with interest.

The Commission has also made grants in aid of three laboratory studies:

(a) A Study of Body Radiation, by L. B. Aldrich of the Smithsonian Institution under the direction of its secretary, Dr. Charles G. Abbot.

⁶Greenburg, Leonard, A Study of the Relationship Between Type of Ventilation and Respiratory Illness in Certain Schools of New Haven, Conn., *Public Health Reports*, lxiv, No. 6, February 8, 1929, p. 285.

⁷Childs, L. W., M.D., The School Ventilation Study in Cleveland, Journal of American Public Health Association, January, 1929, p. 59.

⁸Shaughnessy, Dr. H. J., The Relation Between Respiratory Disease Absenteeism and Ventilation in Some Suburbs of Chicago, presented at the School Ventilation Symposium, American Public Health Association Meeting, Chicago, 1928.

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- (b) A Study of the Effects of Drafts, by Leonard Greenburg of the Yale School of Medicine under the direction of Professor C.-E. A. Winslow, and
- (c) A Study of Atmospheric Ionization, by Professor Earl B. Phelps, at the College of Physicians and Surgeons, Columbia University.

The study of the total heat output of the human body has interested many physiologists. Some, notably Rubner, have attempted to determine the rôles of the various methods of heat transfer in effecting this body heat loss. The Research Laboratory of the American Society of Heating and Ventilating Engineers interested in this matter since 1922, has very recently completed a study in which the importance of evaporation both from the skin and from the respiratory tract has been determined for a wide range of temperatures and humidities.⁹ Without a means of determining separately the amounts of heat loss by radiation and convection, they were forced to group these losses, although anyone who stops to consider the matter will realize that radiant heat losses are related to the surface temperatures and proximity of the surrounding bodies while convection is a function of the temperature and motion of the air.

In a recent article¹⁰ the writer raised the question of the importance of radiation losses from the pupils and the relation of such losses to the per capita floor space in the seating section of the average classroom. Correspondence with Dr. Charles G. Abbot, director of the Smithsonian Institution, regarding this question led to a study, which though by no means exhaustive, was referred to in the 1928 Annual Report of the Institution as a "novel, interesting and successful research on the cooling of the human body by radiation and

⁹Houghten, F. C., and others, Heat and Moisture Loss from the Human Body and Its Relation to Air Conditioning Problems, *Journal American Society Heating and Ventilating Engineers*. (In process of publication.) ¹⁰Duffield, Thomas J., A Preliminary Note on Radiant Body Heat and the School Ventilation Problem, *American School Board Journal*, July, 1927.

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convection." A report of this study¹¹ recently published, shows that "at normal indoor temperature, in still air and with the subject normally clothed and at rest, body heat losses are distributed as follows: (a) evaporation of water, 24 per cent; (b) radiation, 46 per cent; and (c) convection, 30 per cent."

The fact that radiation is so large a factor in body heat loss suggests how important it is that this form of heat loss should not be interfered with and how necessary it is to have a knowledge of its importance through a wide range of temperatures, humidities, and under different rates of air motion.

No results are yet available from the study of the relation of drafts to respiratory illness for which a grant was made in the autumn of 1928. This research was an outcome of the 1926–1927 Syracuse study where the average temperatures of rooms in naturally ventilated schools were found to be somewhat higher than in those with mechanical ventilation. There was no perceptible difference in the relative humidities from the few observations made. It was assumed that the rates of air change were higher in the mechanically ventilated rooms and that this higher rate of air change involved higher velocities of air about the pupils, a condition that would make for a lower "effective temperature," which in combination with wet feet and clothing would promote evaporation of the water and result in chilling. It is hoped that this study may shed some light on this matter.

Until recently there has been no demonstrable difference between the air in mechanically-ventilated and windowventilated schools, the chemical composition, the physical qualities and other conditions being equal, although individual observers held the opinion that the air of the mechan-

¹¹Aldrich, L. B., A Study of Body Radiation, *Smithsonian Miscellaneous Collections*, lxxxi, No. 6, December 1, 1928.

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ically-ventilated school was "dead" whereas in the school with window ventilation it had life. It has been suggested¹² that the ionization of the atmospheric oxygen might differ under the two methods of ventilation and that this phenomenon might explain the suggestive differences that had puzzled previous investigators.

To make possible a study of atmospheric ionization the Commission has provided apparatus for the measurement of the electrical conductivity of air in the newly established Air Research Laboratory at the College of Physicians and Surgeons, Columbia University.

Another item, involving no laboratory investigations, but which, because it combined the results of earlier experiments both in the fields of thermodynamics and of human metabolism, may be included here, resulted in the determination of the amount of air at various temperatures required to offset the average heat output of the pupils.¹³ If the findings of Hermans, Flugge, Leonard Hill and the American Society of Heating and Ventilating Engineers that for periods of exposure up to two or three hours, comfort and physiological reactions of persons in closed rooms are associated with the combined effect of the physical properties of the atmosphere -its temperature, humidity and motion-rather than with its chemical composition, are properly applicable to repeated exposures of similar duration such as the pupils experience in attending school, then the school ventilation problem can be solved, in theory at least, by supplying the air of the chemical composition ordinarily found out of doors in such quantity, at such temperature and at such velocity as will exactly compensate for the sensible heat output of the pupils.

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¹²Hartman, F. E., Has Air a Vital Property? Journal American Society Heating and Ventilating Engineers, February, 1926.

¹³Duffield, Thomas J., How Much Fresh Air Does the School Child Need? Journal of the American Medical Association, April 21, 1928.

The calculations indicate that during the greater part of the school year, it would be necessary to supply much smaller quantities of air than the "30 cubic foot" standard, provided the air can be introduced into the classroom at its outdoor temperature without causing drafts.

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In addition to the publication of articles bearing on the Commission's work in school, health and engineering journals, a complete list of which may be obtained from the Commission's headquarters, the secretary has addressed school, health, and industrial groups and has consulted with school boards, ventilating engineers, architects and welfare agents on the subject of school, office and factory ventilation.

The Commission has made a collection of the laws dealing with the subject of school ventilation from all the states except North Carolina, from which the information does not appear to be available. Of the twenty-four states having in 1926 laws or regulations requiring 30 cubic feet of air per pupil per minute for at least certain of the schools within its boundaries, only one, Virginia, has modified its legislation so that window ventilation might be legalized. The Commission took no active part in this legislative change.

While the entire subject was under review, the Commission has not deemed it wise to undertake any aggressive campaign for the revision of existing legislation regulating the practice of school ventilation in the various states or municipalities. The Commission approved an article¹⁴ emphasizing the importance of maintaining certain air conditions in the classroom rather than the method of ventilation, but there is no evidence that this paper has had any effect on legislation existing at the time of its publication.

¹⁴Duffield, Thomas J., School Ventilation Laws, *Journal American Society Heating and Ventilating Engineers*, June, 1927, xxxiii, No. 6, p. 388.