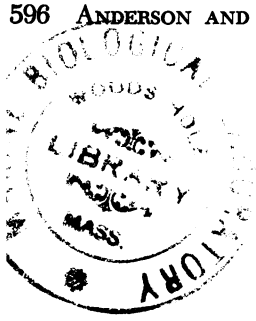
Canad. Med. Ass. J.
Mar. 23, 1963, vol. 88



Response to a Respiratory Survey

DONALD O. ANDERSON, M.D., F.R.C.P.[C],*
ROSALIE ZICKMANTEL, B.A.† and
BENJAMIN G. FERRIS, Jr., M.D.,‡
Vancouver, B.C. and *Boston, Mass., U.S.A.*

ABSTRACT

Respondents to a respiratory survey of Berlin, New Hampshire, residents in 1961 have been studied to assess the relationship between co-operation and respiratory disease prevalence. Two hundred and forty-three unco-operative subjects, interviewed at home, had significantly more morning phlegm and a lower vital capacity than carefully matched subjects who attended the central clinic. Fifty-one volunteers had the same prevalence of respiratory disease symptoms and physiological abnormalities as carefully matched subjects drawn from a probability sample of the city.

It is concluded that respiratory disease prevalence will be underestimated if calculated from studies of co-operative subjects who attend a clinic. Case-finding by respiratory disease screening clinics will also miss many persons who suffer from chronic bronchitis.

THE methods of survey research have recently been extensively applied to the study of the prevalence and etiology of chronic non-tuberculous respiratory disease. The development of a standardized respiratory questionnaire[1] and simple portable instruments to measure pulmonary ventilation[2] have made possible surveys of total population groups which have been sampled by probability sampling methods.

A *probability sample* is one which has been selected from the total population in question in such a way that the researcher can specify for each member of the population the probability that he or she will be included in the sample. For example, the *random sample* is a special type of probability sample where each person in the population has the *same chance* of being included in the sample. These sampling methods must be used if the researcher wishes to generalize from his observations on the sample to the population in question. Such generalization is, of course, basic to the estimation of disease prevalence. For nationwide surveys, very elaborate sampling procedures have to be set up.[3] Less elaborate procedures may be used for surveys in towns or other small areas, though many of these require a census or a current listing of the population.

Prevalence surveys are time-consuming and expensive when a probability sample is used; some of the problems pertaining to such surveys have been reviewed by Fletcher and Oldham.[4] Because of the simplicity of the respiratory survey, however, very high levels of public co-operation can be expected; response rates of over 95% of selected probability samples have been reported in United Kingdom and American surveys.

Some American investigators using survey methods have reported respiratory data on volunteer groups[5] or samples of which less than 80% of the selected subjects co-operate.[6] The rates of prevalence and the descriptive analyses of the respondents reported in these surveys are always open to question since it is impossible to predict or estimate the bias of subjects who make themselves available for examination.

The day may come when the respiratory survey will be used to screen populations for the presence of such respiratory symptoms as cough, phlegm production, wheezing and breathlessness, so that preventive measures may be introduced to prevent the progression of disease. At that time it will be important to know if persons with respiratory symptoms will report to a respiratory screening clinic.

The purpose of this communication is to present our experience with respondents to the Berlin, New Hampshire, respiratory survey of 1961. Because a proportion of the sample did not co-operate by coming to the respiratory clinic and had to be surveyed at home, the prevalence of respiratory symptoms and the presence of physiological abnormalities in this group of relatively unco-operative persons could be assessed separately. Volunteers to the survey comprised an additional study group.

THE BERLIN, N.H., SURVEY

During January and February, and again during June and July of 1961, we conducted a survey of a sample of 1261 persons, aged 25 to 74 years, who resided in the city of Berlin, New Hampshire. This city is a manufacturing centre of pulp and paper products situated midway between Boston, Mass., and Montreal, P.Q. Its population at the time was

From the Division of Epidemiology of the Department of Preventive Medicine and the Department of Medicine, Faculty of Medicine, University of British Columbia, Vancouver, B.C., and from the Department of Physiology, Harvard School of Public Health, Boston, Mass.
Supported in part by Grant MA1150 from the Medical Research Council of Canada, and Grant OH67 from the United States Public Health Service.
*Assistant Professor, Medicine and Preventive Medicine, University of British Columbia.
†Statistical Clerk, Division of Epidemiology, University of British Columbia.
‡Associate Professor of Environmental Health and Safety, Harvard School of Public Health, Boston, Mass., U.S.A.

about 18,000 persons. The study was undertaken to assess the prevalence of respiratory disease symptoms in an American city according to the standard British respiratory survey, and to assess the relative importance of cigarette smoking, atmospheric pollution and occupational exposure to dust and gas in the production of chronic non-specific respiratory disease. It was conducted during the time that the U.S. Public Health Service was assessing atmospheric pollution.[7]

The sampling procedure and the results of this survey have been reported elsewhere.[8, 9] In summary it was found that chronic non-specific respiratory disease was strongly influenced by age, sex and smoking habits of the respondents, but little influenced by atmospheric pollution or occupational exposure to irritant inhalants.

More than 95% of the probability sample was surveyed. The winter portion of the survey was conducted during a particularly cold season when maximum daily temperatures never exceeded 0° F. and for one week were below —20° F. The summer portion of the survey was carried out in mild rain or sunny weather, but was undertaken at a time when the townspeople frequently took their vacations. Despite these climatic deterrents, 76.6% of the respondents attended the survey clinic which had been set up in the Health Department at the City Hall adjacent to a public parking lot. The remainder, who failed to keep an appointment or who did not keep a reappointment after being contacted by telephone by the survey nurse, were visited by one of the two physicians conducting the survey and the full interview and physiological tests were administered in the home. All told, 23.4% of the 1167 respondents were interviewed at home; this group consisted of 99 males (18.3% of the total male respondents) and 174 females (27.8% of the total female respondents).

During the survey, extensive radio and newspaper publicity was given to the study, and 60 persons presented themselves uninvited to the clinic for examination. These volunteers were all interviewed and given the pulmonary function tests, but the physicians were unaware at the time of the interview that the subjects were volunteers until the end of the clinic day when the volunteer subjects were identified by the nurse. These volunteers have not been included in any of the previously published reports.

METHOD OF STUDY

Three groups exhibiting varying degrees of co-operation were available for study: unco-operative respondents who were interviewed at home (*home subjects*), co-operative respondents who came to the clinic (*clinic subjects*) and hyperco-operative subjects who volunteered (*volunteer subjects*). In addition, home and clinic subjects together comprised the group that was selected by sampling methods (*sample subjects*). Two questions could then be asked: (1) Do unco-operative persons have the same prevalence of respiratory disease symptoms as co-operative persons?; (2) Do volunteers have the same prevalence of these abnormalities as persons selected to be members of the total probability sample?

It was decided to answer these questions by reviewing the difference in symptoms and physiological abnormalities occurring between respondents interviewed at home and closely matched respondents interviewed at the clinic, and similarly by observing differences in these abnormalities between volunteers and closely matched respondents selected by chance through the sampling procedure used in the survey. The matching was done to reduce the variability that would occur due to differences in factors which are known to be related to chronic respiratory disease. Matching removes the effect of these factors and permits a more precise examination of the effect of co-operation in the first analysis, and volunteering in the second analysis.

The following criteria were used to pair subjects exactly:

1. *Age.*—Pairs were matched if their ages were in the same decade group: 25-34, 35-44, 45-54, 55-64 and 65-74 years.
2. *Sex.*—Pairs were matched exactly.
3. *Residence.*—Pairs were matched exactly for residence within the same one of three residential areas in the city of Berlin, selected on the basis of atmospheric pollution.[8]
4. *Current smoking habits.*—Pairs were matched exactly according to the following groups: never smoked tobacco products, ex-smoker of tobacco products (matched according to product), and present smoker of tobacco products (matched according to product). Current cigarette smokers were matched as closely as possible according to the quantity of cigarettes smoked daily, as less than 11, 11-20, 21-30, 31-40 and 41 or more cigarettes daily.*

If there was more than one possible match, the following criteria were used in the order indicated until only one matched pair was left: (1) marital status, (2) birthplace, (3) occupational exposure to pulmonary irritants, (4) season of the study, i.e., winter or summer survey, (5) years of residence in Berlin, and (6) interviewer. The exact definitions of these matched criteria have been previously published.[8, 9]

In the first match, only 243 of the 273 respondents interviewed at home (*home subjects*) could be matched to respondents interviewed at the clinic (*clinic subjects*). In the second match, only 51 of the 60 volunteers (*volunteer subjects*) could be matched to subjects selected by the sampling procedure (*sample subjects*). Sample subjects, of course, included both home and clinic subjects.

*All the volunteers were matched exactly; 14 of the male and five of the female home-subjects were matched within 10 cigarettes smoked daily, and the remainder were matched exactly.

Data obtained by interview had been previously placed on standard I.B.M. 80-column data cards. The following symptoms, physiological abnormalities and disease states were then examined by the appropriate statistical tests on the University of British Columbia I.B.M. 1620 computer.

1. *Cough.*—An affirmative answer to the question "Do you cough at all on getting up, or first thing in the morning in winter?" was called a positive response.

2. *Phlegm.*—An affirmative answer to the question "Do you bring up any phlegm at all on getting up, or first thing in the morning in winter?" was called a positive response.

3. *Breathlessness.*—The questionnaire used presents the respondent with a sequential series of questions which permits a grading of breathlessness.[1] Each member of the pair was given a value from one to five representing a ranked measure of his degree of breathlessness.

4. *Colds going to the chest.* — An affirmative answer to the question "If you get a cold, does it usually go to your chest?" was called a positive response.

5. *Frequent chest infections.* — An affirmative answer, of at least two infections, to the question "In the past three years, have you had bouts of (increased)* cough and phlegm lasting for three weeks or more?" was called a positive response.

6. *Pulmonary function tests.*—Each respondent performed five forced expiratory volume tests with a Collins 6-litre recording vitalometer. The mean of the last three forced vital capacities (FVC) was calculated; the mean of the last three forced expiratory volumes expelled in one second ($FEV_{1.0}$)† was also calculated after the maximum slope of expiration had been extended back to the start line as time zero to adjust for individual differences in the speed of initiating a maximum expiration. Volumes were corrected to 37° C. and saturated at the ambient pressure (BTPS). In addition, the subjects made five expirations into a Wright peak-flow meter and the mean of the last three attempts was calculated and recorded as the peak expiratory flow rate (PEFR).

The following mean values were noted for each member of the matched pair: (1) FVC as recorded, (2) FVC as a per cent of predicted using a nomogram incorporating age, sex and standing height[10], (3) $FEV_{1.0}$ as recorded, (4) $FEV_{1.0}$ as a per cent of observed FVC, and (5) PEFR as recorded.

7. *Diagnosis:* A respondent was considered to have *chronic respiratory disease* if he complained of morning phlegm for as much as three months of the year for as long as three years, or if he was breathless walking at his own pace on the level, or who wheezed most days or nights, or who reported bronchial asthma which was still present, or who had an $FEV_{1.0}$ less than 60% of his FVC. The exact questions used to make this diagnosis have been previously published[8,9].

*The word in parenthesis was added for subjects who usually had cough or phlegm.

†Same as the "one-second timed vital capacity".

STATISTICAL METHODS

Two probable hypotheses were considered before the two groups of matched pairs were examined. For example, in the study of the effect of co-operation, the null hypothesis (H_0) was that home subjects and clinic subjects were alike with respect to the prevalence of respiratory disease; that is, any differences found would be no more than would be expected due to sampling error. The alternative hypothesis (H_1) was that home subjects and clinic subjects were dissimilar with respect to the prevalence of respiratory disease; that is, the differences in respiratory system abnormalities would be greater than expected by sampling error. Since we could not predict whether the home subjects or clinic subjects would have more respiratory system abnormalities, we used the so-called "two-tailed" statistical methods of analysis.

Two similar and probable hypotheses were also considered in the study of the effect of volunteering.

Because all the parameters that were known to be related to the prevalence of respiratory disease were matched for in the two groups, we assumed that any differences observed between the groups would be related to factors which caused the respondents to fall into these groups. The differences between the matched pairs were assessed by suitable parametric and nonparametric statistical methods of analysis. The level of statistical significance that was assigned *a priori* before H_0 was discarded and H_1 accepted was $P \leq .05$; a $P \leq .01$ was considered highly significant.

RESULTS

A. *The Effect of Co-operation*

Distributions of the characteristics of the 243 home subjects are presented in Tables I and II. About 63% of these subjects were female; in the total population sample only 53% were female[8]. This excess proportion of females in the relatively nonco-operative group was *highly significant*. Nevertheless, when differences due to this abnormal sex distribution were taken into account, the home subjects were not found to differ from what was predicted from the total population sample,[8] when examined by a chi-square goodness-of-fit test.

A clinic subject was closely matched to each home subject for each of these characteristics as explained under "Method of Study". The differences in respiratory abnormalities between the matched home subjects and clinic subjects were assessed by a variety of appropriate statistical tests.

TABLE I.—CHARACTERISTICS OF THE 243 HOME SUBJECTS CONSIDERED IN THE BERLIN, N.H., RESPIRATORY SURVEY, 1961

	No.		No.
Sex:		*Dust exposure:*	
Male	89	None	215
Female	154	1 - 4 yrs.	8
Age in years:		5 - 9 "	11
25 - 34	30	10 - 14 "	4
35 - 44	42	15 - 19 "	3
45 - 54	47	35 - 39 "	2
55 - 64	72	*Gas exposure:*	
65 - 74	52	None	191
Marital status:		1 - 4 yrs.	14
Single	17	5 - 9 "	11
Married	195	10 - 14 "	6
Widowed	26	15 - 19 "	6
Divorced	4	20 - 24 "	1
Unknown	1	25 - 29 "	2
Birthplace:		30 - 34 "	3
U.S.A.	186	35 - 39 "	7
Canada	53	45 + "	2
Other	4		
Area of residence:			
Polluted +++	115		
Polluted ++	64		
Polluted +	64		

The following was observed:

1. *Cough and phlegm.*—Of the 243 pairs, there was a difference in the reported presence of the symptom of morning cough in 74 pairs. Neither the home subjects nor the clinic subjects had a significantly greater prevalence of morning cough as tested by a simple sign test[11]. There was also a difference in the reported presence of the symptom of morning phlegm in 74 pairs; for phlegm, however, there was a *significantly* greater number of home subjects reporting morning phlegm than of sample subjects.

2. *Breathlessness.*—Eleven members of the 243 pairs had musculoskeletal diseases which interfered with the appreciation of the subjective symptom of breathlessness; these affected pairs were eliminated from the analysis. No significant difference was found in the degree of breathlessness between the remaining 232 matched pairs by the Wilcoxson signed-rank test for ranked differences.[12]

3. *Frequent chest infections and colds going to the chest.*—While 68 and 116 pairs differed in the reported presence of these two respective complaints, neither the home subjects nor the clinic subjects had a significantly greater number with either complaint as tested by a sign test[11].

4. *Pulmonary function tests.*—The difference between the matched home subject and the clinic subject for each of the five measures of ventilation was calculated and the mean difference determined between 228 matched pairs. Fifteen home subjects did not perform these tests. Table III records this mean difference, the standard error of the mean difference and the t-statistic obtained under the hypothesis that if the two groups are the same (H_0), the mean difference should be zero[13]. It will be noted that the vital capacity (FVC), expressed as a percentage of predicted according to a standard nomogram[10], was *highly significantly* lower in the home subjects. These home subjects were not found to be significantly shorter than the clinic subjects. None of the other t-tests was significant.

It appears to us that these home subjects did not have a greater prevalence of physiological obstruction because their $FEV_{1.0}$ and PEFR were not significantly different from those of the more co-operative clinic patients. The low FVC, however, may reflect a lack of co-operation: the subjects may not have taken the time to exhale all their vital capacity. They probably took in an adequate breath since their expiratory flow rates were not reduced and this measurement is quite sensitive to lung volume. It was also possible that we did not put enough water into the spirometer when it was used in a home and, therefore, we could not record the last bit of a subject's FVC; we have considered it unlikely that this occurred often enough to explain the observed statistical difference.

5. *Disease presence.*—The presence of chronic respiratory disease in the matched pairs is presented in Table IV. Data are presented on only 222 pairs since data for 21 subjects were either incomplete or the respondent had a musculoskeletal disease. There is no significant tendency for one group of subjects to have more respiratory disease than the other when measured by the so-

TABLE II.—SMOKING CHARACTERISTICS OF THE 243 HOME SUBJECTS CONSIDERED IN THE BERLIN, N.H. RESPIRATORY SURVEY, 1961

	No.		No.
Smoking habits:		*Current cigarettes smoked daily:*	
Never smoked	110	Never smoked cigarettes	118
Ex-smoker:		Ex-smoker of cigarettes	13
Cigarettes only	8	1 - 10 daily	29
Pipe and/or cigars	2	11 - 20 "	36
All products	3	21 - 30 "	39
Present smoker:		31 - 40 "	5
Cigarettes only	103	41 + "	3
Pipe and/or cigars	8		
All products	9		

TABLE III.—ANALYSIS OF DIFFERENCES IN PULMONARY FUNCTION BETWEEN 228 MATCHED HOME AND CLINIC SUBJECT PAIRS, BERLIN, N.H., 1961

	FVC	*FVC as % of predicted*	*$FEV_{1.0}$*	*$FEV_{1.0}$ as % of FVC*	*PEFR*
	litres	*per cent*	*litres*	*per cent*	*litres per minute*
Mean difference*.	−6.81	−3.99	−11.00	−1.01	−3.79
Standard error	6.36	1.51	23.13	0.98	9.30
t-statistic	1.07	2.65	0.48	1.03	0.41
Significance	None	.01 > P > .001 Highly significant	None	None	None

*Sum of (the value for each home subject minus the value for the matched clinic subject) divided by the number of pairs, 228.

TABLE IV.—PRESENCE OF CHRONIC RESPIRATORY DISEASE IN MATCHED PAIRS OF HOME SUBJECTS AND CLINIC SUBJECTS, BERLIN, N.H., RESPIRATORY SURVEY, 1961

	Home Subjects		
Clinic subjects	*No disease*	*Disease*	*Total pairs*
No disease	119	38	157
Disease	40	25	65
Total pairs	159	63	222

TABLE V.—CHARACTERISTICS OF THE 51 VOLUNTEERS TO THE BERLIN, N.H., RESPIRATORY SURVEY, 1961

	No.		No.
Sex:		*Area of residence:*	
Male	20	Polluted +++	15
Female	31	Polluted ++	28
Age in years:		Polluted +	8
25 - 34	9	*Dust exposure:*	
35 - 44	16	None	46
45 - 54	10	1 - 4 yr.	2
55 - 64	12	10 - 14 "	2
65 - 74	4	40 - 44 "	1
Marital status:		*Gas exposure:*	
Single	4	None	43
Married	45	1 - 4 yr.	3
Widowed	2	5 - 9 "	2
Divorced	0	10 - 14 "	2
Birthplace:		40 - 44 "	1
U.S.A.	40		
Canada	9		
Other	2		

called "marginal chi-square test" after appropriate correction for continuity.[14]

B. *The effect of volunteering*

Distributions of the characteristics of the 51 volunteers are presented in Tables V and VI. As a group the volunteers did not differ significantly in these characteristics, including sex, from what was predicted from the total population sample[8] as examined by a chi-square goodness-of-fit test.

A sample subject was closely matched to each volunteer for each of these characteristics. The differences in respiratory system abnormalities between the matched volunteers and sample subjects were then assessed by the same statistical tests as were used in the study of the effect of co-operation.

1. *Cough and phlegm.*—Of the 51 pairs, there was a difference in the reported presence of the symptom of morning cough in 20 of the pairs, and in the reported presence of the symptom of morning phlegm in 12 of the pairs. Neither the volunteer group nor the sample subject group had a significantly greater number with either symptom as determined by a sign test.[11]

2. *Breathlessness.*—Of the 51 volunteers, two had musculoskeletal diseases which interfered with the appreciation of the subjective symptom of breathlessness. No significant difference was found in the degree of breathlessness between the remaining 49 matched pairs by the Wilcoxson signed-rank test for ranked differences.[12]

TABLE VI.—SMOKING CHARACTERISTICS OF THE 51 VOLUNTEERS TO THE BERLIN, N.H., RESPIRATORY SURVEY, 1961

	No.		No.
Smoking habits:		*Current cigarettes smoked daily:*	
Never smoked	25	Never smoked cigarettes	27
Ex-smoker:		Ex-smoker of cigarettes	4
Cigarettes only	4	1 - 10 daily	3
Pipe and/or cigars	1	11 - 20 "	11
Present smoker:		21 - 30 "	4
Cigarettes only	17	31 - 40 "	2
Pipe and/or cigars	1	41 + "	0
All products	3		

3. *Frequent chest infections and colds going to the chest.*—While 19 and 25 pairs differed in the reported presence of these two respective complaints, neither the volunteer group nor the sample subject group had a significantly greater number for either complaint as measured by a sign test.[11]

4. *Pulmonary function tests.*—The difference between the matched volunteer subject and the sample subject for each of the five measures of ventilation was calculated, and the mean difference determined between the 51 matched pairs. Table VII records this mean difference, the standard error of the mean difference and the t-statistic obtained under the hypothesis that if the two groups are the same, the mean difference should be zero.[13] None of the t-tests was significant.

TABLE VII.—ANALYSIS OF DIFFERENCES IN PULMONARY FUNCTION BETWEEN 51 MATCHED VOLUNTEER AND SAMPLE SUBJECT PAIRS, BERLIN, N.H., 1961

	FVC	*FVC as % of predicted*	$FEV_{1.0}$	$FEV_{1.0}$ *as % of FVC*	*PEFR*
	litres	*per cent*	*litres*	*per cent*	*litres per minute*
Mean difference*.	−9.12	+0.29	−7.95	−0.21	−8.60
Standard error...	13.18	3.01	12.04	2.09	20.42
t-statistic.....	0.69	0.10	0.66	0.10	0.42
Significance.....	None	None	None	None	None

*Sum of (the value for each volunteer minus the value for the matched sample subject) divided by the number of pairs, 51.

5. *Disease presence.*—The presence of chronic respiratory disease in the matched pairs is recorded in Table VIII. Data are presented on only 49 pairs, since two volunteers could not be assessed because of musculoskeletal disease. Some discordance between the pairs is indicated by these data: 15 volunteers had disease while their matched sample subjects did not, and conversely eight sample subjects had disease while their matched volunteers did not. This degree of discordance is not significant by the "marginal chi-square test" after correction for continuity and could, therefore, have arisen by chance.[14]

TABLE VIII.—PRESENCE OF CHRONIC RESPIRATORY DISEASE IN MATCHED PAIRS OF VOLUNTEERS AND SAMPLE SUBJECTS, BERLIN, N.H., RESPIRATORY SURVEY, 1961

	Volunteers		
Sample subjects	*No disease*	*Disease*	*Total pairs*
No disease	22	15	37
Disease	8	4	12
Total pairs	30	19	49

DISCUSSION

The high response rate, more than 95%, obtained in the Berlin, N.H., respiratory survey[8], has been attributed to extensive publicity, telephone calls to the recalcitrant, provision of transportation, and finally, for the most nonco-operative, interviews in the home or more rarely at work by one of the physicians conducting the survey. About 76% of the sample co-operated reasonably well with a home visit. This is similar to what was reported by Higgins.[15]

The analyses of the home subjects which we have reported here were undertaken first to find out if the poorly co-operating group could be omitted in a prevalence survey. An equally important question was: are the individuals who have symptoms more likely to co-operate? If this second question should be answered "yes", a "voluntary" screening clinic for respiratory disease would be most efficient in time and cost, since it would attract the high disease-risk group.

To study the prevalence of respiratory system abnormalities in the more nonco-operative respondents, home subjects were matched closely with clinic subjects for all those factors which were known to be related to the prevalence of respiratory disease. Age, sex, atmospheric pollution and current smoking habits were chosen to be the most important factors that had to be matched closely, on the basis of the analyses of the total group which have already been published.[8, 9] The matching procedure removed the effect of these important variables so that the effect of co-operation could be more completely appreciated.

The results of this study indicate that the un-co-operative home subjects did indeed have more morning phlegm than the more co-operative clinic patients; they did not, however, have more serious respiratory disease characterized by breathlessness or frequent chest illnesses. They did, as a group, have a smaller mean vital capacity when expressed as a percentage of predicted vital capacity based upon age, sex and standing height, but they did not have more pulmonary obstruction as measured by the peak expiratory flow rate and the one-second timed vital capacity.

Clearly, therefore, these home subjects had a prevalence of certain respiratory abnormalities that was greater than that of clinic subjects. It is true that lowered vital capacity could be a reflection of poor co-operation, but the greater prevalence of morning phlegm is also important; it will be recalled that this is an early sign of chronic bronchitis.[16] We conclude, therefore, that a prevalence survey which omits this group will underestimate the prevalence of certain respiratory symptoms and signs in the population. For the same reason, any pulmonary disease screening program that may be developed which depends upon community attendance at a central clinic, will miss individuals who have the greater prevalence of chronic productive cough. This omission will be of great public health importance since preventive measures are likely to be directed towards interrupting the natural history of the progression of chronic bronchitis and irreversible obstructive lung disease.

The second question which we considered was: Do volunteers have the same prevalence of respiratory disease symptoms and physiological abnormalities as subjects selected by a probability sampling procedure? This was also answered by a matching procedure; in this case, by matching volunteers with sample subjects for the same factors which were matched to investigate the effect of co-operation. It was concluded that volunteers did have the same prevalence of these abnormalities as sample subjects.

The implications of this conclusion about volunteers may not be immediately apparent, for it is quite obvious that the researchers who already have a probability sample of 1261 individuals, would not likely contaminate their results by including a small group of 51 additional volunteers. The conclusion, however, becomes important when considered as one part of a study of the epidemiology of chronic respiratory disease, because the volunteer is unlike the sample subject.

The fact that the volunteer is different is demonstrated by his act of *volunteering*. It is true that the sample subject had to *co-operate*, and co-operation is somewhat more closely related to volunteering than is nonco-operation. In this survey, only 2.5% of the probability sample completely refused to co-operate.[8] Co-operation, however, particularly after reappointments or a personal home visit by the interviewer, is quite different from volunteering, which is a situation where the subject is motivated to take the initiative and establish the interview relationship. It cannot be assumed that he completely differs, for had the sample subject been given the chance he too might have volunteered. This is particularly true for the co-operative sample subjects whose motivation is probably different from that of the less co-operative subjects.

Factors related to motivation were not specifically studied in the Berlin survey, but it is likely that motivation was different at each level of co-operation. It cannot, however, be concluded that the groups are fixed so that subjects would remain in the same group at a second survey. Time and the location of the survey combine with constitutional or psychological factors within the individual at the moment he is contacted by the survey team, so that he responds to the survey process in a positive or a negative way. The instability of these groups was actually noted during the Berlin survey. About 88% of the winter sample was interviewed during January and February of 1961, but in June and July, during the survey of the summer sample, recontact of those who refused increased the response rate of the winter group to 97%. It is our impression that those persons who refused to co-operate at the first contact were co-operative when approached five to six months later, and usually attended the clinic.

It cannot be assumed that the study has been so designed to demonstrate the importance of *co-operation* or *volunteering* alone. In a simple chemical experiment it may be possible to set up a study design where the effect of only one variable can be assessed by itself. In epidemiological studies or even in controlled clinical trials, the situation

Canad. Med. Ass. J.
Mar. 23, 1963, vol. 88

is much more complex. For example, in this study, volunteering and its extreme alternative, unco-operation, may be related to intelligence, extent of knowledge, reading ability, length of living in the area, knowledge of friends or relatives with chronic respiratory disease, or such psychological traits as fear, anxiety or curiosity, to mention a few of the many factors completely uncontrolled.

We believe that these factors should be analyzed in further respiratory surveys which incorporate a design to assess some of the constitutional and psychological differences between volunteers and sample subjects.

CONCLUSION

Respondents to the Berlin, N.H., respiratory survey of 1961 have been studied to observe the effects of co-operation and volunteering upon the prevalence of respiratory symptoms and physiological abnormalities. Two hundred and forty-three relatively unco-operative subjects had significantly more morning phlegm and lower vital capacity, expressed as a per cent of predicted, than carefully matched subjects who were more co-operative. It was further found that 51 volunteers had no difference in the prevalence of respiratory disease symptoms or physiological tests than carefully matched subjects drawn from the probability sample of the city.

The influence of co-operation upon the prevalence of disease reported in respiratory surveys and the case-finding activities of respiratory disease screening clinics is discussed.

REFERENCES

1. FAIRBAIRN, A. S., WOOD, C. H. AND FLETCHER, C. M.: *Brit. J. Prev. Soc. Med.*, 13: 175, 1959.
2. McKERROW, C. B.: Use of pulmonary function test in epidemiological work, *In*: Industrial pulmonary diseases, edited by E. J. King and C. M. Fletcher; Little, Brown & Company, Boston, 1960, p. 127.
3. United States, National Health Survey: Statistical design of the health household—interview survey, by staff of the U.S. National Health Survey and the Bureau of Census, United States Public Health Service Publication No. 584-A2, United States Department of Health, Education, and Welfare, Public Health Service, Division of Public Health Methods, Superintendent of Documents, Government Printing Office, Washington, D.C., 1958.
4. FLETCHER, C. M. AND OLDHAM, P. D.: *In*: Medical surveys and clinical trials, edited by L. J. Witts, Oxford University Press, London, 1959, p. 45.
5. PEMBERTON, J. AND MACLEOD, K. I. E.: *Public Health Rep.*, 71: 1213, 1956.
6. BOWER, G.: *Amer. Rev. Resp. Dis.*, 83: 684, 1961.
7. Robert A. Taft Sanitary Engineering Center: Technical Report A62-9. In quest of clean air for Berlin, New Hampshire. Report of cooperative survey by P. A. Kenline, Division of Air Pollution, Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio, 1962.
8. FERRIS, B. G., JR. AND ANDERSON, D. O.: *Amer. Rev. Resp. Dis.*, 86: 165, 1962.
9. ANDERSON, D. O. AND FERRIS, B. G., JR.: *New Engl. J. Med.*, 267: 787, 1962.
10. MILLER, W. F., JOHNSON, R. L., JR. AND WU, N.: *J. Appl. Physiol.*, 14: 157, 1959.
11. DIXON, W. J. AND MASSEY, F. J., JR.: Introduction to statistical analysis, 2nd ed., McGraw-Hill Book Company, Inc., New York, 1957, p. 280.
12. WILCOXSON, F.: Some rapid approximate statistical procedures, American Cyanamid Co., New York, 1949.
13. DIXON, W. J. AND MASSEY, F. J., JR.: Introduction to statistical analysis, 2nd ed., McGraw-Hill Book Company, Inc., New York, 1957, p. 124.
14. FISHER, S.: *J. New Drugs*, 2: 84, 1962.
15. HIGGINS, I. T. T.: *In*: Recent studies in epidemiology, edited by J. Pemberton and H. Willard, Blackwell Scientific Publications, Oxford, 1958, p. 43.
16. Ciba Guest Symposium: Terminology, definitions, and classification of chronic pulmonary emphysema and related conditions: *Thorax*, 14: 286, 1959.

Skiing Injuries

J. M. McINTYRE, M.D., F.R.C.S.[C], *Montreal*

ABSTRACT

This report, based on a study of 471 consecutive skiing accidents, is concerned with the contributory causes, mechanisms, treatment and prevention of the more common skiing injuries.

Over 80% of injuries occur in skiers under the age of 30 years. Most injuries involve the lower extremities, and are ligamentous. One-third of all injuries are fractures. This distribution is the common experience in most ski centres which have organized facilities for treatment of such injuries.

This study shows that rapid handling and early treatment of casualties ensures minimal suffering, accurate diagnosis, prevention of complications and earlier rehabilitation of injured skiers. Many of the causes of skiing accidents can be prevented by control of skiing conditions, and proper instruction of younger skiers.

IT IS difficult to obtain accurate statistics on the frequency of skiing injuries because many injuries are never reported. According to the 1957 reports of United States National Ski Patrol, the accident rate varies from 2.2 to 13.0 per 1000 skiers per day, depending on skiing conditions. In 1959 Erskine[1] stated that the average injury rate was 2.7 injuries per 1000 skiers per day. If this is true, a ski resort accommodating 4000 skiers a week would be expected to have 160 accidents during the season. From the experience of Dr. Laird Wilson of Montreal and myself, this is the approximate accident rate in the ski area of St. Marguerite, Quebec, where we operate a clinic for the care of skiing injuries.

The injury rate from skiing is too high, and merits special study. The factors contributing to the high rate of injury should be made widely known, because prevention is so important. The Canadian

Presented as part of a Symposium on Athletic Injuries at the Ninety-Fifth Annual Meeting of the Canadian Medical Association, Winnipeg, Man., June 21, 1962.

*Director, Department of Orthopedics, Montreal Children's Hospital; Associate Surgeon, St. Mary's Hospital, and Orthopedic Consultant, Queen Mary Veterans Hospital.