PREVALENCE OF THE COMMONER EAR, NOSE, AND THROAT CONDITIONS IN THE ADULT RURAL POPULATION OF GREAT BRITAIN

A STUDY BY DIRECT EXAMINATION OF TWO RANDOM SAMPLES

BY
R. HINCHCLIFFE

*Wernher Research Unit on Deafness, Medical Research Council, London**

We have as yet no data on the prevalence, in the general adult population, of diseases of the ear, nose, and throat that are based upon the direct examination of random samples. This study was designed to remedy this defect.

METHOD

Two random samples of adults, stratified for age and sex, were each drawn from a rural population. We endeavoured to examine as many as possible of the people in these two samples. One of the samples was of the inhabitants of the Vale of Glamorgan in South Wales, and the other was of the inhabitants of Mid-Annandale (Dumfriesshire) in South-West Scotland. The first sample was examined in Glamorgan in July, September, and October, 1957, and the second sample was examined in Dumfriesshire in May and June, 1958. A mobile unit was used for the examinations and this has been described previously (Hinchcliffe and Littler, 1958).

SURVEY AREAS

The survey area in the Vale of Glamorgan comprised 24 parishes centred in Cowbridge, an old market town with a population just over 1,000.

The mid-Annandale area comprised eight parishes which cover an area of 136 square miles and are centred in Lockerbie, a small market town. This is also an agricultural area.

* Present address: Department of Otolaryngology, State University of Iowa, Iowa City.

SURVEY POPULATIONS

The populations of both areas had already been defined by private census for unrelated surveys. For our surveys, a random sample of 400 was drawn from each of two populations. Each sample was stratified for age and sex in the manner shown in Table I. We wished to compare the absolute threshold of hearing of our young adults directly with that of another sample. Consequently, we arranged for the age limits and size of our youngest sample to be as stated in Table I.

TABLE I
STRATIFICATION OF SAMPLE DRAWN IN EACH SURVEY AREA

Age (yrs) ..		18-24	25-34	35-44	45-54	55-64	65-74	All Ages
Sex	Male ..	50	30	30	30	30	30	200
	Female	50	30	30	30	30	30	200

PROCEDURE

For each of the two surveys, individuals in the sample populations were interviewed by home visitors (two in each survey), who explained the investigation and arranged a time for the examination. Individuals were examined in an unselected order.

Investigation of each individual comprised the following, and in this particular sequence:

- I. Completion of a questionnaire.
- II. A clinical otolaryngological examination

III. Clinical quantitative gustometry.	} Welsh Survey Only
IV. A bacteriological examination.
(For nasal carriage of <i>Staphylococcus aureus</i>)	
V. A radiological examination.
(For the condition of the paranasal sinuses)	
VI. Audiometry.	

A questionnaire relating to ear, nose, and throat symptoms and audiologic hazards was completed for each individual on his arrival at the mobile unit.

The clinical otolaryngological examination comprised anterior rhinoscopy, mirror examination of the post-nasal space and the larynx, and examination of the ears using a forehead mirror. Tuning-fork tests of hearing were also performed. In the Scottish survey, the clinical examination was restricted to the ears.

If cerumen was preventing adequate visualization of the tympanic membrane, it was removed. For cases of incomplete obstruction, the wax was removed in all but one case by means of a Jobson Horne curette. In the remaining case, one of soft wax, the wax was removed by syringing. For cases of complete occlusion of the external auditory meatus with wax, the following procedure was adopted if instrumental removal with a curette failed:

(i) Syringe	
	<i>if this failed</i>
(ii) Olive oil drops put in the meatus three times daily for one week	
	<i>then</i>
(iii) Re-syringe.	

If this procedure failed, the condition was denoted "impacted wax". Olive oil was used to soften the wax because, of the commoner cerumenolytics, this was the only one that had been shown to be significantly better than nothing (Hinchcliffe, 1955).

The threshold of perception for taste was determined, using a method of quantitative gustometry (Hinchcliffe, 1958).

The bacteriological examination was directed towards determining the prevalence of the nasal carriage of coagulase-positive *Staphylococcus aureus*. Both nasal vestibules of an individual were sampled with a saline-moistened nylon swab. In the evening, all swabs taken during the day were transported to the laboratory* and stored overnight in the

refrigerator. All strains of coagulase-positive staphylococci isolated on culture were typed by bacteriophage tests and tested for resistance to antibiotics.

The radiological examination consisted of taking two occipito-mental views of the skull with a 65 Kv. Newton Victor Model F Portable X-ray Unit. This unit was fitted with a special cone to prevent excessive radiation and scatter reaching the patient. The films were independently read by four doctors. The correct interpretation of the radiological appearances for each subject was taken as the modal value of the reports by the four observers. On occasion, a casting vote was required by the author. A group of observers was necessary because of the large inter-observer variation in the interpretation of x rays of the paranasal sinuses (Hinchcliffe, 1961). When four observers are used to read these films, the modal opinion for this random sample does not appreciably change with the number of observers employed.

As the final part of the full examination of the individual, the threshold of hearing by earphone listening was measured in each ear at the frequencies 125, 250, 500, 1,000, 2,000, 3,000, 4,000, 6,000, and 8,000 c/s. The additional frequency of 12,000 c/s was used in the Scottish survey. An instrument calibrated to the British Standard Specification for pure tone audiometers was used.

Note: Specimens of the questionnaire completed for each individual, the proforma for reporting the results of the clinical examination, and the proforma for the x-ray report may be obtained from the author.

OBSERVERS

In the Welsh survey, the questionnaire was completed by the doctor who performed the clinical examination, but, in the Scottish survey, the questions were asked by a non-medically qualified personal assistant. Errors due to inter-observer variation were consequently eliminated within each of the two surveys.

All the clinical examinations in both surveys were performed by one and the same observer.

The audiometric tests in the Welsh survey were conducted by an experienced audiometric technician. In the Scottish survey, all the audiometry was done by the observer who also performed the clinical examinations, and who had had considerable experience with audiometric methods.

RESULTS AND REMARKS

To avoid separation of the data and the discussion relating to the prevalence of a given condition by

* Public Health Laboratory Service, Cardiff. (Director: Professor Scott Thomson).

results and remarks on unrelated conditions, we found it more convenient to combine "Results" and "Remarks" under a number of sub-headings.

We were successful in examining 90 per cent. of the Welsh sample and 95 per cent. of the Scottish sample.

I. EARS

(a) *Hearing*.—We have already reported the results on the distribution of thresholds of hearing (Hinchcliffe, 1959b). The absolute threshold of hearing of our normal young adults was shown to be that of the British Standard of the Normal Threshold of Hearing for Pure Tones by Earphone Listening (Hinchcliffe, 1959a).

(b) *Acoustic Trauma*.—Table II indicates the prevalence of hazards due to acoustic trauma in the rural male population. The Table indicates the difficulty, even in a rural population, of finding male adults who have not been exposed to acoustic trauma. Whilst 94 per cent. of the total female sample had never fired a gun, only 13.5 per cent. of the total male sample had never fired a gun.

We have already shown that a history of having fired a 0.303 calibre gun accounts for the sex difference in the threshold of hearing at 4,000 c/s for these young adults (Hinchcliffe, 1959a). Further analysis shows that there is a significant ($P < 0.05$) threshold shift at 2,000 c/s, and at this frequency only, in the clinically normal left ears of the males in the youngest age group who had fired a 12-bore rifle only. This was in comparison with the clinically normal left ears of similarly aged males who had never fired a gun. Moreover, there was a correlation between the threshold shift in the left ear and the stated number of rounds of 12-bore ammunition

fired. The product moment correlation coefficient was 0.72, which was again significant at the 5 per cent. level. Therefore, the threshold shift in a person's audiogram at 2,000 c/s is, *inter alia*, directly related to the number of rounds of 12-bore ammunition that he has fired in his lifetime. Inspection of the data showed that a more linear relationship was obtained by plotting the threshold shift against the logarithm of the stated number of rounds of 12-bore ammunition fired. Using this relationship, a linear regression equation was derived as follows:

$$y = 3.93 \log x + 1.5 \text{ dB,}$$

where x = stated number of 12-bore rounds fired
and y = hearing loss at 2,000 c/s in the left ear.

It is surprising that the 12-bore rifle should first show its damaging effects at 2,000 c/s, instead of at 4,000 c/s which is the commonest locus for acoustic trauma. The threshold shift is, however, not marked. A history of having fired a thousand rounds of 12-bore ammunition would, according to the regression equation, produce a shift of less than 15 dB at 2,000 c/s. It is possible that the subsequent development of a traumatic notch due to firing many more 12-bore rounds might show a migration of the locus of maximum threshold shift to 4,000 c/s.

In our youngest sample, two males had used a 0.22 rifle only. Their thresholds of hearing were normal. However, neither had fired more than thirty rounds of ammunition.

(c) *Occupational Noise Hazard*.—Table III (opposite) illustrates the prevalence of a current occupational noise hazard,* even in a rural population.

* A potential occupational noise hazard was considered to have existed if the subjects had had, for at least one year, a job where, at one time or another, it was so noisy that they had to raise their voice to be heard.

TABLE II
PREVALENCE OF POTENTIAL ACOUSTIC TRAUMA FROM RIFLE FIRE

Factors in Potential Trauma	Sample	Age Group (yrs)					
		18-24	25-34	35-44	45-54	55-64	65-74
(a) Percentage of rural male population who had ever fired a 0.303 calibre rifle	Welsh . .	33	59	75	55	54	41
	Scottish	49	66	80	72	59	48
(b) Median stated number of rounds of 0.303 ammunition fired by those who had used this calibre gun	Welsh . .	50	200	300	1000	600	650
	Scottish	100	500	200	200	1000	1000
(c) Percentage of rural male population who had ever fired a 12-bore rifle	Welsh . .	53	76	71	69	75	67
	Scottish	31	34	23	28	41	52
(d) Median stated number of rounds of 12-bore ammunition fired by those who had used this calibre gun	Welsh . .	125	150	400	500	1000	500
	Scottish	175	85	550	200	200	300

PREVALENCE OF EAR, NOSE, AND THROAT CONDITIONS

131

TABLE III

PERCENTAGE OF RURAL POPULATION WITH A POTENTIALLY NOISE-HAZARDOUS OCCUPATION

Sex	Sample	Age Group (yrs)					
		18-24	25-34	35-44	45-54	55-64	65-74
Male	Welsh	43	48	53	34	46	18
	Scottish	51	58	50	51	44	22
Female	Welsh	15	4	4	0	0	0
	Scottish	29	6	10	10	0	0

These were the individuals who stated that they had a job where, at one time or another, it was so noisy that they had to raise their voice to be heard. Sataloff's criterion for a potentially hazardous noisy environment (Sataloff, 1957).

Table III indicates that occupational noise hazards might be a factor influencing the hearing of rural females also. However, the threshold of the clinically normal youngest group of Scottish women was not significantly different from the British Standard for the Normal Threshold of Hearing. A slight but significant difference in thresholds of hearing was, however, detected between those young women who reported an occupational noise hazard and those who did not.

(d) *Conductive Deafness*.—As a qualitative test for conductive deafness, we used the Rinne tuning-fork test. We have shown that this is a valid, reliable test for conductive deafness and, on these particular samples, indicates a conductive deafness of 17 dB or more at 500 c/s (Hinchcliffe and Littler, 1961).

Analysis of the data showed that the prevalence of conductive deafness was significantly lower in the 18 to 24-year age group than in either the 35 to 44 or the 55 to 64-year age groups.

Table IV shows the composition of the conductive deafness in this series. Further analysis attempted to show which of the listed conditions might be responsible for the increase in conductive deafness with age. A one-tailed, exact test for 2×2 Tables showed that there was a significantly ($P < 0.02$) greater number of perforations in the 55 to 64-year age group than in the 18 to 24-year age group. There was, however, no significant increase in the prevalence of scarred tympanic membranes with age. There was also a significantly ($P < 0.05$) greater number of cases of otosclerosis in the 55 to 64-year age group than in the 18 to 24-year age group. The increase in conductive deafness with age is therefore due to an increase in the prevalence of both chronic middle-ear infections and of otosclerosis.

Our finding that chronic otitis media is the commonest cause of conductive deafness in the general

TABLE IV

CAUSES OF CONDUCTIVE DEAFNESS IN THE TWO RANDOM SAMPLES OF THE RURAL POPULATION

Condition	Number of Cases	Percentage
1. Chronic suppurative otitis media (Active 7 cases; Inactive 14 cases)	21	32
2. Secondary middle ear sclerosis (i.e. scarred tympanic membranes)	20	31
3. Otosclerosis	12	18
4. Radical mastoid operation	3	5
5. Congenital abnormalities	3	5
6. Exudative otitis media	2	3
7. Acquired meatal atresia	1 each	6
8. Chronic adhesive otitis		
9. Impacted wax*		
10. Traumatic conductive deafness (Ossicular chain disruption)		
All Conditions	65	100

* i.e. cerumen which was occluding the external auditory meatus and which had resisted the prescribed course of syringing and application of the cerumenolytic.

N.B. It is possible that some of the cases of conductive deafness that were attributed to secondary middle ear sclerosis were, in fact, cases of otosclerosis with scarred tympanic membranes. If we assume that the probability of the occurrence of otosclerosis is unaffected whether the membranes are scarred or not, then the proportion of cases of conductive deafness due to otosclerosis would be raised to about 20 per cent. by introducing this correction. The error is therefore not appreciable.

population agrees with the finding of Bentzen and Jølnes (1955). This is in contrast to other samples where otosclerosis may be the commonest cause of conductive deafness (Shambaugh, Wallner, Greene, and Shambaugh, 1933; Kodicek and Garrad, 1954).

Extrapolation of our data would indicate a prevalence of conductive deafness in schoolchildren of the order of twenty to thirty cases per 1,000. Falbe-Hansen (1954), in data on Copenhagen schoolchildren, which he says agrees with similar investigations in other countries, gives the value as about 90 cases per 1,000. If, as he says, his data is representative of schoolchildren in general, it indicates that about three-quarters of the cases of conductive deafness in children are not permanent. It is noteworthy that Falbe-Hansen was able to cure three-quarters of his series of conductive deafness by adenoidectomy, radiotherapy, Politzerization, and/or vibration massage.

(e) *Presbycusis*.—The prevalence of presbycusis was assessed as follows. We arbitrarily adopted the criterion that a 25 dB speech hearing loss is the level at which a hearing defect commences to handicap an individual.* To convert our data on the ability of individuals to hear pure tones to their ability to hear speech, we used the simple method of transformation described by Fletcher (1950). This gives the

* Steinberg, Montgomery, and Gardner (1940) have stated that a hearing loss of 25 dB at frequencies up to 1,760 c/s begins to be a handicap.

speech hearing loss in a particular ear as equivalent to the average of the two least threshold shifts at the three frequencies 500, 1,000, and 2,000 c/s. Since presbycusis entails a greater deterioration of the hearing at 2,000 c/s than at the other two frequencies, this transformation procedure resolves itself into averaging the threshold shifts at the two frequencies 500 and 1,000 c/s. Table V shows the percentage of individuals in each age group who had clinically normal ears but a computed speech hearing loss of more than 25 dB.

TABLE V
PREVALENCE OF PRESBYCUSIS AS A FUNCTION OF AGE

Age Group (yrs)	Per cent. with Speech Hearing Loss Greater than 25 dB
18-24	0
25-34	0
35-44	0
45-54	4.9
55-64	6.2
65-74	21.0

Percentage of individuals, in each age group, who have a hearing loss for speech (=speech reception threshold) in excess of 25 dB. Speech hearing losses computed from pure tone threshold audiograms.

(f) *Tinnitus*.—Table VI shows the prevalence of tinnitus (history of) as a function of age.

There was no correlation between those individuals who experienced, or had experienced, tinnitus and those individuals who worked, or had worked, for more than one year in conditions where it was stated to be so noisy that they had to raise their voice to be heard.

TABLE VI
PREVALENCE OF TINNITUS AS A FUNCTION OF AGE

Age Group (yrs)	History of Tinnitus
18-24	21
25-34	27
35-44	24
45-54	27
55-64	39
65-74	37

Percentage of individuals in each age group who, at one time or another, have noticed noises in their ears or their head.

(g) *Vertigo*.—At one time or another, 23 per cent. of the sample had experienced vertigo. There was a tendency for the proportion of people who had experienced, or did experience, vertigo to increase with age. Table VII shows the prevalence of vertigo (past or present) as a function of age. Most of the episodes of vertigo that had been experienced were transient and not troublesome, but 15 per cent. of those who had experienced vertigo had had recurrent sustained vertigo with or without other symptoms over a period of at least one year. In the entire sample, two persons gave a classical history of post-traumatic

TABLE VII
PREVALENCE OF HISTORY OF VERTIGO AS A FUNCTION OF AGE

Age Group (yrs)	History of Vertigo
18-24	17
25-34	20
35-44	19
45-54	23
55-64	35
65-74	29

Percentage of subjects in each age group who suffer, or have suffered, from dizziness or giddiness.

positional vertigo, and one a history indicative of having had vestibular neuronitis. From the history, one case of vertigo appeared to be due to epilepsy, and one case was associated with epilepsy.

A history of recurrent sustained vertigo occurred in over 3 per cent. of the population and is probably a measure of the prevalence of endolymphatic hydrops, ranging from the mildest to more severe types. One case, however, had been associated with episodic concurrent aphasia, and another with episodic concurrent diplopia. McKenzie (1951) says that symptoms alone are a poor foundation for a diagnosis, and Ménière's disease is no exception. We have therefore given a more restricted connotation to this condition by including the objective sign of a low tone threshold shift in the criteria for its acceptance in this study (see Table IX for computed prevalence).

In view of the demonstrated positive correlation between the prevalence of arteriosclerosis and that of vertigo (Droller and Pemberton, 1953), the bulk of the vertiginous histories (especially the episodes of transient vertigo) in the older individuals may well be arteriosclerotic in origin. It would, however, be difficult to attribute this etiology to vertigo experienced by younger individuals.

(h) *Wax*.—Cerumen completely occluded 12.5 per cent. of the external auditory meatuses in the total sample. There was a significant sex difference. 23 per cent. of males had one or both meatuses occluded as compared with 13 per cent. of females. Table VIII shows how the clearance of the cerumen in these cases was achieved.

TABLE VIII
METHODS OF CLEARANCE OF CERUMEN FROM COMPLETELY OCCLUDED MEATUSES

Method of Clearance	Wax curette	Syringing only	Syringing plus drops	
	..	..	..	50
	..	..	..	33
	..	..	..	12
Ears remaining Occluded	..	..	..	5
Total	..	..	..	100

(i) *Ear Disease*.—Table IX shows the measured prevalence of the principal aural conditions, together with the limits within which the true prevalence probably lies.

TABLE IX
PREVALENCE OF THE COMMONER AURAL CONDITIONS
IN THE RURAL POPULATION

Condition		Measured Prevalence (per 1,000)	95 per cent. Confidence Limits of Prevalence
Scarred tympanic membranes ..		128	105–154
Perforated tympanic membranes ..		30	19–45
Chalk patches		28	18–43
Chronic otitis externa	Primary ..	18	9–30
	Secondary ..	4	1–12
Inactive chronic suppurative otitis media		18	9–30
Active chronic suppurative otitis media		11	5–21
Otosclerosis		11	5–21
Ménière's disease		11	5–21
Cortical mastoid operations		8	3–18
Exudative otitis media		5	1–14
Radical mastoid operations		4	1–12
Chronic adhesive otitis		3	0·3–10

II. NOSE

(a) *Clinical and Radiological Findings*.—Here the greater portion of the data is provided by the radiological and bacteriological investigations. The prevalences of the principal nose and sinus conditions are shown in Table X.

TABLE X
PREVALENCE OF THE COMMONER NASAL CONDITIONS
IN THE RURAL POPULATION

Condition		Measured Prevalence (per 1,000)	95 per cent. Confidence Limits of Prevalence
Acute rhinitis		11*	3-28
Nasal polyposis		17	6-36
Chronic suppurative maxillary sinusitis	Criterion i	25	12-48
	Criterion ii	17	6-36
Maxillary sinusitis (radiographic index)		107	77-144
Frontal sinus agenesis	Bilateral	39	22-65
	Unilateral	104	75-141
	Either ..	143	109-184

* If we include the Scottish sample and restrict the criteria to those who answer in the affirmative to the question "Do you have a cold now?", the prevalence is 25 per 1,000 population.

Several inter-relationships were investigated. There was no significant correlation between those individuals who had upper respiratory symptoms in general, or nasal signs in general, and those who had radiological changes in the maxillary sinuses. There was also no demonstrable association between individuals with nasal symptoms or clinical signs and those with absent frontal sinuses. The following significant ($P < 0.05$) positive correlations were, however, found.

(i) Between those individuals who had upper respiratory symptoms and those who had positive rhinoscopic signs (χ^2 with Yates' correction = 4.4).

(ii) Between those individuals with a history of mucopurulent nasal discharge and those with radiological signs (generalized opacity, fluid level, mucosal thickening, or cyst) in one or both antra (χ^2 with Yates' correction = 4.46). The probability of radiological signs in respect of the maxillary sinuses was 0.19 if there was no history of mucopurulent discharge, but 0.44 if there was a history.

(iii) Between those individuals with visible evidence of mucopus in the nose and those who were nasal carriers of coagulase-positive *Staphylococcus aureus* (χ^2 with Yates' correction = 3.98). The probability of being a nasal carrier was increased by 58 per cent. when mucopus was present in the nose.

Apart from the presence of pus or mucopus in the nose, the only other abnormality on rhinoscopic examination which is worthy of mention is the allergic type nasal polyp. The measured prevalence of nasal polyposis was seventeen cases per 1,000. This affords some objective measure of the prevalence of nasal allergy.

No sex differences were demonstrable in the clinical or radiological data. Cysts of the antra appeared to be commoner in younger adults.

The absence of any correlation between individuals with upper respiratory symptoms in general and those with radiological changes in the maxillary sinuses is almost certainly due to the varied aetiology responsible for upper respiratory symptoms in general. Moreover, many individuals with chronic sinusitis are symptom free. If we become more specific and consider a single symptom only, and one (e.g. mucopurulent nasal discharge) that might be considered to be related, on logical analysis, to

radiological changes in the sinuses (on the assumption that these are principally infective in their aetiology) then we do find a significant correlation between symptoms and radiological signs.

The precise importance that can be attached to particular upper respiratory symptoms in these surveys is uncertain. There is considerable inter-observer variation in reported prevalences of respiratory symptoms in general (Cochrane, Chapman, and Oldham, 1951; Schilling, Hughes, and Dingwall-Fordyce, 1955). Analysis of our results showed that, in the Scottish sample, nasal block was stated to be, or to have been, experienced by a significantly greater number of women in the 45 to 54-year age group than in the 65 to 74-year age group. In view of the similar ecological conditions obtaining for the two groups, this is unlikely to be the case. Moreover, in the case of males in the Scottish sample also, there is a significant difference between these two age groups for those who stated that they did suffer, or had suffered, from nasal block. But in this case a higher prevalence is recorded in the older age group. There is therefore some doubt about the validity of the question referring to the symptom of nasal block.

In view of the uncertain validity of upper respiratory symptoms in epidemiological studies, we sought to concentrate on radiological methods to assess the prevalence of sinusitis. In analogy with the electrocardiographic index of the prevalence of ischaemic heart disease described by Thomas, Cochrane, and Higgins (1958), we suggest a radiological index of the prevalence of sinusitis, as shown in Table X. It should be stressed that this is an index of sinusitis that may be neither chronic nor suppurative. In children, the radiological changes in the sinuses may be permanent in only about one half (Bjuggren, Kraepeliën, and Lind, 1952) or one quarter (Nitsch, 1957) of the cases. For our sample of adults, however, we consider that it is unlikely that temporary sinus conditions account for such an appreciable portion. In view of the statement of van Dishoeck and Franssen (1957) that an allergic factor is demonstrable in more than 60 per cent. of cases of chronic purulent sinusitis, the suspicion may arise that, even if the radiological changes are permanent, they may not have an infective aetiology. This statement, however, applies to the aetiology and pathogenesis, and not to the pathology, of the condition. A consideration of the work of Buch (1949) indicates that our radiological index of maxillary sinusitis is, allowing for a margin of temporary changes, a measure of the prevalence of chronic suppurative sinusitis, irrespective of the possibility of an allergic

factor in its pathogenesis. Moreover, by using a group of observers to read the x-rays of the sinuses, it is also possible that we have reduced, if not eliminated, the false positive results (10 per cent.) that Buch obtained.

In an attempt to eliminate the factor of temporary change in our radiological measurement of the prevalence of sinusitis, we can combine our clinical data with our radiographic data. Where the prevalence of chronic suppurative sinusitis is shown in Table X, Criterion *i* (see Appendix) permits the use of data from both the questionnaire and the clinical examination, but Criterion *ii* utilizes the results of the questionnaire only. These alternatives have been used because criteria for the occurrence of chronic suppurative sinusitis have not yet been defined for epidemiological purposes. It is possible that future surveys may not be conducted by, or be able to make use of, an observer experienced in clinical otolaryngological examinations. Moreover, Criterion *ii* is more rigid in its definition, but because it is more restricted, and in view of the remarks made by Daggett (1954), this criterion will give a deflated value of the prevalence of active chronic suppurative maxillary sinusitis. The symptom of purulent or mucopurulent nasal discharge was chosen to establish Criterion *ii* because it is the predominant symptom in chronic infections of the paranasal sinuses (Thornell, 1944). Moreover, we have shown that it is the only symptom that is significantly correlated with radiological changes in the sinuses.

A consideration of our results, together with Buch's data on the proportion of active cases of undiagnosed sinusitis, would indicate that the prevalence of active chronic suppurative maxillary sinusitis in the rural population of Great Britain is of the order of 50 per 1,000 population. In view of the statement by Meer, Andrassy, Bodo, Codrea, Foldessy, and Sirban (1957) that the prevalence of sinusitis in agricultural workers is low, our measured prevalence value is probably exceeded in urban areas. Individuals with positive findings in respect to the sinuses should be followed up to investigate the persistence of both radiological and clinical changes.

This appraisal of the prevalence of sinusitis illustrates very well the necessity for rigid criteria in defining a given condition.

Our measured prevalence of 4 per cent. for bilateral frontal agenesis compares well with values of 3 and 5 per cent. reported for European races by Chalmagne (1953) and by Longo and Blandino (1956) respectively.

(b) *Bacteriology: Nasal Carriage of Staphylococcus Aureus*.—The prevalence of the nasal carriage of both penicillin-sensitive and penicillin-resistant strains of coagulase-positive *Staphylococcus aureus*

is shown, as a function of age and sex, in Table XI. Fig. 1 shows the prevalence of the nasal carriage of the staphylococcus (sensitive or resistant strains) as a function of age, with sex as parameter.

TABLE XI
PREVALENCE OF NASAL CARRIAGE OF *STAPHYLOCOCCUS AUREUS*, BY AGE GROUP AND SEX

Sex	Cases	Age Group (yrs)					
		18-24	25-34	35-44	45-54	55-64	65-74
Female	Number examined	46	28	23	27	26	23
	Penicillin sensitive strains	14	11	5	10	7	5
	Partially resistant strains*	4	2	1	1	4	3
	Very resistant strains†	3	0	2	0	0	0
	No growth	25	15	15	16	15	15
Male	Number examined	49	28	28	29	24	26
	Penicillin sensitive strains	19	8	9	6	4	4
	Partially resistant strains*	4	1	1	2	0	0
	Very resistant strains†	1	2	1	0	1	0
	No growth	25	17	17	21	19	22

* Circle of inhibition about one half of the diameter shown by the Oxford staphylococcus.

† No noticeable inhibition of growth around penicillin containing disc.

The graph shows that the prevalence of the nasal carriage of coagulase-positive *Staph. aureus* declines linearly with age in males. Unpublished data by Williams (1947) also indicate that there is a decline in the prevalence of the nasal carriage of this organism with age. Our extrapolated predicted value of 53 per cent. prevalence at the age of 15 years is identical with the prevalence value reported by Williams (1947) for the second decade. Presumably, there is a reversal of the age v. prevalence trend in this age period since the data given by Cunliffe (1949) show that nasal carriage increases from about 20 per cent. at the age of 1 year to about 60 per cent. at the age of 9 years. Hallman (1937) found the peak prevalence for the nasal carriage of *Staph. aureus* in the age group 13 to 19 years (60.5 per cent.). As Cunliffe (1949) says, it is tempting to speculate on these variations in the nasal flora. The gradual fall with age may be a reflection of an increasing immunity, but may, on the other hand, result from a less intimate contact with the community than occurs during the school years.

A significant sex difference can be demonstrated in our data when the two oldest age groups are combined. Analysis of the data of Elwood (1951) for the nasal carriage of staphylococci by 126 patients on first attendance at hospital shows a sex difference (female greater than male) which is significant at the 1 per cent. level. It is possible that the divergence of the female trend line from the male trend line with increasing age reflects reinforcement of the female reservoir by the greater staphylococcal reservoir in children. However, Brzezinski (1939) showed that the male population has a higher antistaphylolysin titre than the female population.

It is to be noted that Miles, Williams, and Clayton-Cooper (1944) have demonstrated seasonal differences in the nasal carriage of *Staph. aureus*, the peak prevalence being found in the months of July and October. These were also the months during which we conducted this particular survey. Our prevalence rates may therefore represent maximal values. Moreover, recent data given by McDonald, Miller, Jevons, and Williams (1960), for the prevalence of the nasal carriage of staphylococci by Royal Air Force recruits, indicate a somewhat lower prevalence than we obtained for our corresponding group of males. A consideration of the data of Miles and others (1944) and of McDonald and others (1960) for the prevalence in males for rural areas and for the appropriate geographical region suggests that our prevalence data should be multiplied by a factor of 0.7 to give a representative average value devoid of seasonal fluctuations.

The higher prevalence of nasal carriage of *Staph. aureus* in individuals with visible evidence of mucopus in the nose was not associated with any particular phage type. The association was probably due to the increased moisture in the nasal cavity (Thomson, 1960).

III. MOUTH AND PHARYNX

(a) *Teeth*.—The edentulous state as a function of age is shown in Fig. 2 (opposite). For comparison, data obtained on a group of coal-miners by Cochrane (1960) is also shown in the Figure.

There is a linear rise in the edentulous state with age. Moreover, there is a significant shift to the left of the curve for Cochrane's sample of English coal-miners. This indicates that miners reach a state of dental insufficiency about 5 years earlier than men living in a rural community. The two lines probably express the prevalence of the edentulous state of the country as a whole.

(b) *Taste*.—The distribution of the taste threshold has already been reported (Hinchcliffe, 1958). In the sample where taste was tested, there was one case of taste blindness.

(c) *Tonsils*.—Nearly twice as many people had had their tonsils removed in the Scottish sample as in the Welsh sample (see Table XII).

TABLE XII
PREVALENCE OF TONSILLECTOMIZED INDIVIDUALS
(PER CENT.) BY AGE GROUP*

Sample	Age Group (yrs)					
	18-24	25-35	35-44	45-54	55-64	65-74
Welsh	24	16	19	0	8	4
Scottish	40	26	24	22	15	9

* Calculated from answers to questionnaire.

This difference was significant at the 0.1 per cent. level, i.e. highly significant. Of those who had had the operation, 4 per cent. had had it on two occasions. A definite age at which tonsillectomy was performed was given by 91 per cent. of those in the sample who admitted to having had the operation. The distribution of the stated age when tonsillectomy was performed is shown in Fig. 3; 14 per cent. of the stated ages were in excess of 20 years.

The regional difference in the prevalence of tonsillectomy is interesting. In a survey of 1,434 Royal Air Force recruits born between 1930 and 1936, Carne (1956) found that the prevalence of tonsillectomy was slightly, but significantly, greater in recruits from Scotland than in those from Wales.

FIG. 2.—Prevalence of the edentulous state as a function of age.

However, an almost identical proportion (just over 30 per cent.) of recruits from rural areas had had the operation in both Scotland and Wales. Carne's finding that 32 per cent. of his entire sample had had tonsillectomy is identical with our value for our comparable age group 18 to 24 years) from the Scottish and Welsh sample combined. It is therefore probable that the combined data on tonsillectomy from the author's surveys are representative of the country as a whole. As we have shown, however, there are more localized regional differences. To what extent are these discrete regional differences due to differences in the attitude of the medical profession to this operation? There appeared to be no regional differences in the prevalence of disease of the ears, nose, or throat. Moreover, Table XII shows a decline in the prevalence of tonsillectomized individuals with age, but there was no associated trend in the prevalence of ear, nose, and throat diseases with age, and *there was no significant difference in the prevalence of ear, nose, and throat disease in general, or of radiological sinus signs in particular, amongst those who had had the operation*

and those who had not. A consideration of the data shown in Table XII and Fig. 3 (overleaf) indicates that the prevalence of tonsillectomy in Great Britain was on the increase at least until about the year 1941.

Our finding that the most common age for the operation was 5 years (see Fig. 3) agrees with that of Rolleston (1939). Carne found that the most common age at which the operation had been performed in his sample was 7 years. Our data suggest that this discrepancy may be due to a tendency that is now developing to delay the age for the operation. Carne states that it is reasonable to assume that the peak prevalence for the operation is associated with the physiological hypertrophy of the tonsils which occurs from the fourth to the eighth years. In this respect, it is worth noting the recent demonstration of Okabe (1958) that tonsillar hypertrophy in school children showed no correlation with either physique or intelligence.

IV. POST-NASAL SPACE AND LARYNX

In the Welsh sample, where mirror examination of the post-nasal space and larynx was attempted,

FIG. 3.—Distribution of stated age at which tonsils were removed.

one male and four female subjects refused to have the examination. Moreover, in the others, one or both locations could not be adequately visualized in 30 per cent. of the sample. Topical anaesthetization was not employed. Furthermore, abnormal findings were infrequent in the post-nasal spaces and larynges that were adequately visualized. Consequently, it is recommended that mirror examinations of the post-nasal space and larynx should be discontinued in surveys of this type.

An impression was obtained that laryngeal and post-nasal examinations were frequently more difficult to perform in these predominantly normal populations than in clinic populations. Presumably more co-operation might be expected in people who attend hospital with symptoms referable to the upper respiratory tract than in individuals selected at random from the general population.

GENERAL REMARKS

General agreement, with few exceptions, in the results for the two areas sampled indicates that the composite results for the two main samples are probably representative of the adult rural population of the country as a whole. Moreover, since age differences were more usually not demonstrable for disease prevalence, the ascertained prevalences will be generally applicable. It is possible that our samples were too small to demonstrate age differences.

CONCLUSIONS

The general agreement between the results of the two surveys means that we can now state the broad otorhinolaryngological characteristics of the rural population of Great Britain. Further surveys should investigate urban, specific industrial, and, perhaps, specific geographical populations. The feasibility of

measuring the prevalence of ear, nose, and throat conditions has now been established.

SUMMARY

Two random samples, stratified for age and sex, of the rural population in Great Britain were otologically and audiometrically examined. Good agreement between the two sets of results indicates the general applicability of the calculated prevalence values to the rural population of the country as a whole. One of the samples was also examined radiologically with respect to the paranasal sinuses, and nasal swabs were also taken to ascertain the prevalence of the nasal carriage of *Staphylococcus aureus*. The feasibility of both the radiological and bacteriological examinations for epidemiological purposes was, at the same time, demonstrated.

My thanks are due to Dr. T. S. Littler, Director of the Medical Research Council Wernher Research Unit on Deafness, to Dr. J. C. Gilson, Director of the Medical Research Council Pneumoconiosis Research Unit, and to Dr. C. Clayson, Physician Superintendent, Lochmaben Hospital, for their help and advice. I am also indebted to Prof. A. L. Cochrane and the Medical Research Council Epidemiological Team for their assistance in this project.

REFERENCES

- Bentzen, O., and Jølnes, K. (1955). *Acta otolaryng.* (Stockh.), **45**, 189.
- Bjuggren, G., Kraepeliën, S., and Lind, J. (1952). *Ibid.*, **42**, 287.
- Brzezinski, S. (1939). *Schweiz. Z. allg. Path. Bakt.*, **2**, 18.
- Buch, A. (1949). *Acta otolaryng.* (Stockh.), Suppl. 77.
- Carne, S. (1956). *Brit. med. J.*, **2**, 19.
- Chalmagne, J. (1953). *Acta oto-rhino-laryng. belg.*, **7**, 280.
- Cochrane, A. L. (1960). Personal communication.
- , Chapman, P. J., and Oldham, P. D. (1951). *Lancet*, **1**, 1007.
- Cunliffe, A. C. (1949). *Ibid.*, **2**, 411.
- Daggett, W. I. (1954). *Practitioner*, **173**, 668.
- Dishoeck, H. A. E. van, and Franssen, M. G. C. (1957). *Pract. oto-rhino-laryng.*, **19**, 502.
- Droller, H., and Pemberton, J. (1953). *J. Laryng.*, **67**, 689.
- Elwood, J. S. (1951). *J. Path. Bact.*, **63**, 745.
- Falbe-Hansen, J. (1954). *Acta otolaryng.* (Stockh.), **44**, 157.
- Fletcher, H. (1950). *J. acoust. Soc. Amer.*, **22**, 1.
- Hallman, F. A. (1937). *Proc. Soc. exp. Biol. (N.Y.)*, **36**, 789.
- Hinchcliffe, R. (1955). *Brit. med. J.*, **2**, 722.
- (1958). *Acta otolaryng.* (Stockh.), **49**, 453.
- (1959a). *Ibid.*, **50**, 411.
- (1959b). *Acustica (Stuttgart)*, **9**, 303.
- (1961). *J. Laryng.*, **75**, 101.
- and Littler, T. S. (1958). *Ann. occup. Hyg.*, **1**, 114.
- — (1961). *J. Laryng.*, **75**, 201.
- Kodicek, J., and Garrad, J. (1954). *Ibid.*, **68**, 406.
- Longo, G., and Blandino, G. (1956). *Boll. Mal. Orecch.*, **74**, 414.
- McDonald, J. C., Miller, D. L., Jevons, M. P., and Williams, R. E. O. (1960). *Proc. roy. Soc. Med.*, **53**, 255.
- McKenzie, W. (1951). *J. Laryng.*, **65**, 70.
- Meer, P., Andrassy, L., Bodo, A., Codrea, A., Foldessy, Z., and Sirban, I. (1957). *Oto-rino-laring (București)*, **2**, 115.
- Miles, A. A., Williams, R. E. O., and Clayton-Cooper, B. (1944). *J. Path. Bact.*, **56**, 513.
- Nitsch, K. (1957). *M Schr. Kinderheilk.*, **105**, 251.
- Okabe, H. (1958). *Igaku Kenkyu*, **28**, no. 12, p. 10 (4548). (English summary, p. 27).
- Rolleston, C. (1939). *Brit. J. Child. Dis.*, **36**, 251.
- Sataloff, J. (1957). "Industrial Deafness". McGraw-Hill.
- Schilling, R. S. F., Hughes, J. P. W., and Dingwall-Fordyce, J. (1955). *Brit. med. J.*, **1**, 65.
- Shambaugh, G. E., Wallner, L. J., Greene, L. D., and Shambaugh, G. E. Jr. (1933). *Arch. Otolaryng.* (Chicago), **18**, 430.
- Steinberg, J. C., Montgomery, H. C., and Gardner, M. B. (1940). *J. acoust. Soc. Amer.*, **12**, 291.
- Thomas, A. J., Cochrane, A. L., and Higgins, I. T. T. (1958). *Lancet*, **2**, 540.
- Thomson, S. (1960). Personal communication.
- Thornell, W. C. (1944). *Proc. Mayo Clin.*, **19**, 470.
- Williams, R. E. O. (1947). *Quoted by Cunliffe* (1949). (Personal communication).

See Appendix Overleaf

APPENDIX

CRITERIA ADOPTED FOR GIVEN ABNORMALITIES WHERE THESE ARE NOT SELF-EVIDENT

Condition/Disease	Criteria
Ageusia	Inability to detect or recognize any of the test solutions for the four taste qualities when in a concentration corresponding to 100 gusts (<i>i.e.</i> sucrose 115 gm/100 ml.; sodium chloride 34.7 gm/100 ml.; quinine sulphate 0.0417 gm/100 ml.; tartaric acid 0.794 gm/100 ml.).
Conductive Deafness	A true Rinne negative response.
Conductive Deafness, Congenital	Conductive deafness with an anatomical abnormality of the conducting mechanism of the ear that is identifiable as of the congenital type.
Conductive Deafness, Traumatic	Stationary conductive deafness immediately following a head injury and with intact, unscarred tympanic membrane.
Ménière's Disease	Recurrent, spontaneous, sustained vertigo for a period of not less than one year, and associated with nausea or vomiting but not with loss of consciousness. Imperforate tympanic membranes. Partial/complete sensori-neural hearing loss for low tones in one or both ears.
Otitic Blast Injury	Centrally-perforated tympanic membrane with no evidence of polyp or cholesteatoma and with non-progressive ipsilateral deafness dating from a blast injury.
Otitis, Chronic Adhesive	Conductive deafness in the presence of an opaque, immobile, unscarred tympanic membrane.
Otitis Externa, Chronic Inactive	External auditory meatus shows generalized scaling of walls with no evidence of cerumen.
Otitis Externa, Chronic Active, Primary	Meatus occupied or lined with discharge, Imperforate tympanic membrane. No concurrent or recent aural pain.
Otitis Externa, Chronic Active, Secondary	Meatal walls generally inflamed, with no evidence of wax formation and associated active chronic suppurative otitis media.
Otitis Media, Chronic Suppurative, Inactive	Perforated tympanic membrane with no history of blast injury and no evidence of aural discharge.
Otitis Media, Chronic Suppurative, Active	Perforated tympanic membrane with no history of blast injury but with evidence of aural discharge—either direct visible evidence or observation that cotton-wool on a wire carrier is moistened.
Otitis Media, Exudative	Intact tympanic membrane showing hair-line and/or bubbles.
Otosclerosis	Visibly normal tympanic membrane in presence of true Rinne negative response.
Rhinitis, Acute	Inflamed nasal mucosa together with affirmative answer to the question: "Have you a cold at the moment?"
Sinusitis, Maxillary (Radiographic Index)	Presence of generalized opacity of, mucosal thickening of, or "fluid level" in, one or both maxillary sinuses, as determined by the modal opinion of four readers of the occipito-mental skull films.
Sinusitis, Chronic Suppurative Maxillary	<p>Criterion <i>i</i> As for maxillary sinusitis, together with (a) a history (in questionnaire) of one or more symptoms referable to nose for not less than one year; and (b) visible evidence of mucopus or pus in nose, or a history of purulent/mucopurulent discharge for at least one year.</p> <p>Criterion <i>ii</i> As for maxillary sinusitis, together with a history of mucopurulent discharge for at least one year.</p>