# The Epidemiology of Oral and Oropharyngeal Cancer

## A Report of the Study in Mainpuri District, Uttar Pradesh, India *

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*Records of the Sarojini Naidu Medical College Hospital, Agra, India, suggested that there was a much higher endemicity of oral and oropharyngeal cancer in Mainpuri district, a rural area about 75 miles (120 km) from Agra City, than there was in Agra district itself. It was decided in 1963 to set up a complete cancer registry in Mainpuri district, based on the Sarojini Naidu Medical College and in association with the WHO International Reference Centre for the Histopathological Nomenclature and Classification of Oropharyngeal Tumours, which would, among other duties, undertake a study of the epidemiology by means of an intensive field-programme in the area. The epidemiological survey was carried out between March 1964 and September 1966. All factors considered to have any relevance to the disease were surveyed and particularly strong correlations were discovered between the prevalence of oral cancer and the use of local tobaccos (adulterated to a greater or lesser extent with various other materials), especially for chewing but also for smoking. There was also some correlation between prevalence of oral cancer and the use of certain alcoholic drinks. A number of other factors, most probably influencing or modifying the use of tobacco and alcohol, were found to be significant also.*

A powerful and effective strategy of cancer epidemiology is the determination of factors governing the occurrence and distribution of the disease through an intensive field-study in a highly endemic area. Previous data from the 1500 consecutive records of oral and oropharyngeal cancer in the Sarojini Naidu Medical College Hospital, Agra, India, indicated that the proportion of cases in patients from the district of Mainpuri was significantly in excess (30.9 %) of similar data for the district of Agra (14.7 %). A detailed epidemiological study on the frequency and the etiological factors of the cancer was planned and carried out in Mainpuri district during the period from March 1964 to September 1966, in connexion with a WHO international project on oral and pharyngeal cancers in South-East Asia.

### METHODS OF STUDY

Basic information on the population and the environment of the district was collected. Mainpuri is one of the five neighbouring districts of Agra, about 75 miles (120 km) from Agra City. It has a total area of 1980 square miles (5128 km²) with a population of about 1 million people divided into five *tehsils* or subdistricts. Table 1 shows the population in 1951 and 1961, the number of villages and towns and the total rural and urban population in the five *tehsils* of Mainpuri district. Table 2 shows the percentage of persons aged 35 years and above, in whom most oral cancer cases are found, in the total rural and urban population.

Based on this information, the following study-plan was made.

(1) An intensive cancer registry was established in the area for diagnosis and registration, and seven rural cancer-detection clinics were set up and staffed by a team of specialists sent from the

TABLE 1

POPULATION OF MAINPURI DISTRICT

| Tehsil | Population | | Density (No. per sq. mile) | No. of villages | Total rural populations 1961 | No. of towns | Total urban population, 1961 |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | 1951 | 1961 | | | | | |
| Kerhal | 116 767 | 138 168 | 536 | 192 | 130 556 | 1 | 7 612 |
| Jasrana | 171 813 | 198 945 | 541 | 269 | 191 432 | 2 | 7 513 |
| Bhogaon | 283 778 | 329 308 | 618 | 392 | 317 002 | 2 | 12 306 |
| Mainpuri | 212 611 | 262 283 | 551 | 245 | 221 264 | 2 | 41 019 |
| Shikohabad | 208 921 | 252 190 | 711 | 286 | 221 248 | 2 | 30 942 |
| Mainpuri district | 993 890 | 1 180 894 | 594 | 1 384 | 1 081 502 | 9 | 99 392 |

Sarojini Naidu Medical College. All medical practitioners in the area were asked to report all suspected cases of cancer to the clinics which were held twice-weekly in the primary health centre hospitals of the district. A team composed of a clinician, a radiologist, a pathologist and an epidemiologist visited each of these clinics. All persons seen or suspected by the local medical institutions or private practitioners to have cancer, including oral cancer, were asked to report to the nearby clinic of the registry. Smears and biopsy specimens were taken from the patients if oral cancer was clinically suspected. Those patients in whom cancer was confirmed were taken to the Sarojini Naidu Hospital for admission and treatment. This was a unique feature of the Mainpuri Cancer Registry which was really a positive cancer registry. The main point of difference from the ordinary cancer registry was that this positive registry was fortified by household and personal examinations made by the four trained investigators stationed in the district. Every medical practitioner was visited each week by the investigator located in the area to ascertain whether all the persons suspected of having cancer had been sent to the clinics. Diagnosis of cancer was accepted in principle, only when proved by biopsy or by positive smear examination. The incidence and prevalence rates of the disease in the district were calculated from these data. Detailed information was also obtained from the patients with regard to individual characteristics such as occupation, tobacco-chewing and smoking, and drinking habits. This part of the study served for the analysis of possible etiological factors in the development of oral cancer.

(2) An interview study was carried out for a 10% random sample of the population using the cluster sampling method. The five *tehsils* of Mainpuri district appeared to be reasonably homogeneous with respect to the population structure. A sample of 10% of the villages was selected from

TABLE 2

NUMBER AND PROPORTION OF PERSONS AGED 35 YEARS OR OVER IN POPULATION OF MAINPURI DISTRICT

| Age-group (years) | Total population | | Rural population | | Urban population | |
| --- | --- | --- | --- | --- | --- | --- |
| | No. | % | No. | % | No. | % |
| 35–54 | 214 149 | 20.5 | 193 323 | 20.4 | 20 826 | 20.8 |
| ⩾55 | 66 856 | 6.4 | 59 799 | 6.4 | 7 057 | 7.1 |
| Total | 281 005 | 26.9 | 253 122 | 26.8 | 27 883 | 27.9 |

each *tehsil* by simple random sampling without replacement so that any village once included in the sample was not removed from or duplicated in the sample. The total number of villages sampled was 139.

From the selected sample villages and town wards, all persons aged 35 years and over were personally interviewed and individually examined by the investigators stationed in the district making house-to-house visits. The number of persons actually interviewed is shown by *tehsils* in Table 3.

TABLE 3

NUMBER OF PERSONS INTERVIEWED AGED 35 YEARS AND OVER FROM EACH *TEHSIL* OF MAINPURI DISTRICT

| *Tehsil* | Total | Rural area | Urban area |
|---|---|---|---|
| Bhogaon | 9 443 | 9 001 | 442 |
| Jasrana | 5 062 | 4 906 | 156 |
| Kerhal | 3 847 | 3 630 | 217 |
| Mainpuri | 9 370 | 8 005 | 1 365 |
| Shikohabad | 7 275 | 6 472 | 803 |
| Total | 34 997 | 32 014 | 2 983 |

Suspected cases uncovered in the sample population were also referred to the rural cancer clinics. All interview forms were transferred to punched cards and the information on them served as the basis for the etiological study.

RESULTS OF THE STUDY

*Incidence rate*

A total of 600 cases of cancer were registered between March 1964 and September 1966, and of these 346 were confirmed as cancer of the oral cavity and oropharynx. Out of these, only cases of which the date of onset was between 1 January and 31 December 1964 were counted. The 121 cases of oral and oropharyngeal cancer thus diagnosed were divided by the number of the population in the district of Mainpuri and the annual incidence rate was thus calculated to be 10.25 per 100 000 population. Of these 121 cases, 27 were found to have come from the random sample area, although the sampling ratio was 1 : 10. This is due

TABLE 4

INCIDENCE RATE OF ORAL CANCER IN SAMPLE AREA BY SEX AND BY AGE-GROUPS

| Age-group (years) | Population | No. of cases arising between Jan. and Dec. 1964 | Rate per 100 000 population |
|---|---|---|---|
| Male | | | |
| 30 | 3 352 | 4 | 119.33 |
| 40 | 5 853 | 5 | 85.42 |
| 50 | 4 121 | 7 | 169.86 |
| 60 | 3 223 | 4 | 124.10 |
| Total | 16 549 | 20 | 120.85 |
| Female | | | |
| 30 | 3 319 | 1 | 30.12 |
| 40 | 5 087 | 2 | 39.31 |
| 50 | 3 052 | 1 | 32.71 |
| 60 | 2 227 | 3 | 134.71 |
| Total | 13 685 | 7 | 51.15 |

to the discovery of unrecognized cases during household visits and personal examination of the oral cavity by the investigators. In order to get more precise data on incidence, the rate was calculated, limiting the observation to the sampled area. During the period of study 72 cases of oral and oropharyngeal cancer were confirmed in the sampled area. Out of these, 27 had the date of onset in the year 1964, as stated above. This number, when divided by the population in the sampled area (126 063), gives us the annual incidence of 21.4 per 100 000 population. The sex- and age-specific incidence rates were calculated (Table 4) and are compared with similar calculation in other countries in Fig. 1.

It is clearly seen that the incidence rate in Mainpuri district is higher than that for any other country in any age-group for both males and females.

*Distribution by anatomical site of cancer*

The distribution by anatomical site of cancer cases registered in the district is summarized in Fig. 2. It is clear that in the majority of cases, the lesion was located in the buccal mucosa.

## FIG. 1. INCIDENCE RATE FOR CANCER OF THE ORAL CAVITY AND PHARYNX IN RELATION TO SEX, AGE AND COUNTRY [a, b]
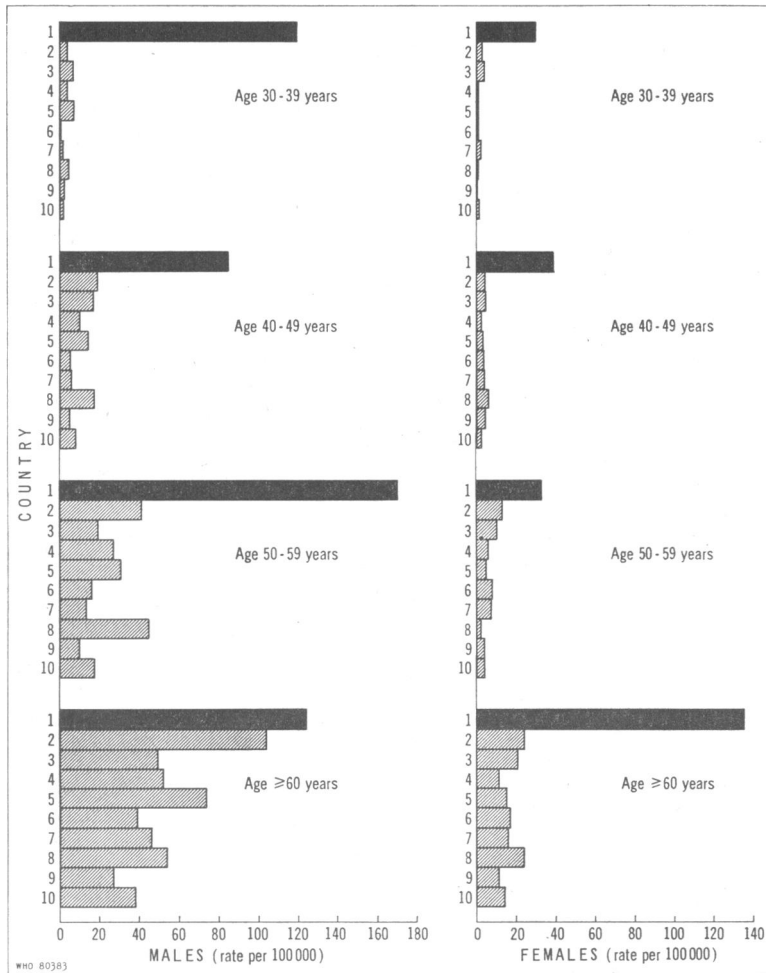


[a] Data from *Epidem. vital Statist. Rep.,* 1966, **19**, 577, except for India.
[b] 1, India (Mainpuri); 2, USA (Connecticut); 3, Israel; 4, Czechoslovakia; 5, Hungary; 6, Sweden; 7, England and Wales; 8, Yugoslavia; 9, Australia (Victoria); 10, New Zealand.

## FIG. 2. ORAL AND OROPHARYNGEAL CANCER: PERCENTAGE OF CASES CLASSIFIED ACCORDING TO ANATOMICAL SITE OF LESIONS
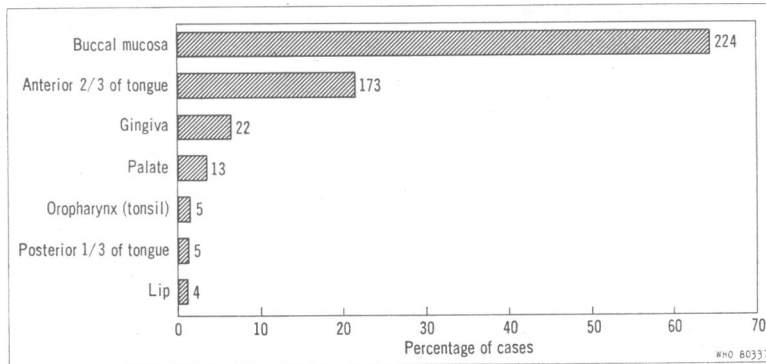
*Factors associated with the occurrence of oral cancer*

Detailed information was available with regard to the individual characteristics of both the oral cancer cases and the population. A period prevalence rate, defined as the number of confirmed oral cancer cases diagnosed during the study-period (March 1964 to September 1966) per 100 population, was calculated according to the presence or absence of the factors, or according to the magnitude of the factors. The size of the population in Mainpuri district, according to each factor, was estimated from the data for the random-sample area. Statistical tests for the significance of the difference from the average prevalence rate were performed. The expected rate was calculated by applying the average rate in the whole Mainpuri area to the population for each factor category. If the actual rate was found to be higher than the expected rate by more than 3 standard errors the data were marked (+ +); if the rate was higher than the expected rate by more than 2 standard errors, the entry was marked (+). If the rate was found to be significantly less than the average, (–) was used to indicate significance at less than the 5 % level, and (– –) to indicate significance at less than the 1 % level. The same designations are used in Fig. 3–9 and Tables 5–8, 20, 21, 24 and 32.

*Regional variation*

Within the district, oral cancer is found to be significantly more frequent in Mainpuri *tehsil* and significantly less frequent in Jasrana and Shikohabad *tehsils* (Table 5).

TABLE 5

PREVALENCE RATE OF ORAL CANCER IN RELATION TO PLACE OF RESIDENCE

| Place of residence | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Mainpuri | 94 180 | 150 | 1.60 (+ +) |
| Karhal | 38 710 | 39 | 1.01 |
| Jasrana | 50 360 | 15 | 0.30 (–) |
| Shikohabad | 72 360 | 47 | 0.65 (– –) |
| Bhogaon | 94 090 | 95 | 1.01 |
| Total | 349 710 [a] | 346 | 0.99 |

[a] Excluding 10 persons of unknown address.

*Sex*

The rate of oral cancer in males was found to be significantly higher, and the rate in females was significantly less, than the average (Table 6).

TABLE 6

PREVALENCE RATE OF ORAL CANCER IN RELATION TO SEX

| Sex | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Male | 207 090 | 296 | 1.43 (+ +) |
| Female | 142 610 | 47 | 0.33 (– –) |
| Unknown | 10 | 3 | – |
| Total | 349 710 | 346 | 0.99 |

*Age*

With the advancement of age, a clear-cut tendency to increasing frequency of oral cancer was noted. The rate for the 35–44-year-old age-group

TABLE 7

PREVALENCE RATE OF ORAL CANCER IN RELATION TO AGE

| Age-groups | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 35–39 | 80 070 | 38 | 0.47 (– –) |
| 40–44 | 65 830 | 46 | 0.70 (–) |
| 45–49 | 61 160 | 56 | 0.92 (+ +) |
| 50–54 | 48 450 | 72 | 1.49 |
| 55–59 | 33 130 | 41 | 1.24 |
| 60–64 | 29 940 | 46 | 1.54 (+) |
| 65–69 | 15 510 | 14 | 0.90 |
| 70–74 | 9 470 | 12 | 1.27 |
| 75–79 | 2 710 | 5 | 1.85 |
| ≥80 | 3 390 | 15 | 4.42 (+ +) |
| Age unknown | 50 | 1 | 20.00 |
| Total | 349 710 | 346 | 0.99 |

was seen to be significantly less, and that for persons 60 years old and over was significantly higher, than average (Table 7).

### TABLE 8

### PREVALENCE RATE OF ORAL CANCER IN RELATION TO RELIGION

| Religion | Estimated population | No. of cases | Period prevalence rate (⁰/₀₀) |
|---|---|---|---|
| Hindu | 330 300 | 318 | 0.96 |
| Muslim | 17 380 | 24 | 1.38 |
| Jain | 1 510 | 4 | 2.65 (+) |
| Christian | 350 | 0 | 0 |
| Buddhist | 90 | 0 | 0 |
| Sikh | 80 | 0 | 0 |
| Total | 349 710 | 346 | 0.99 |

### TABLE 9

### PREVALENCE RATE OF ORAL CANCER IN RELATION TO MONTHLY INCOME

| Income-group (rupees) | Estimated population | No. of cases | Period prevalence rate (⁰/₀₀) |
|---|---|---|---|
| 1– 50 | 145 860 | 151 | 1.04 |
| 51–100 | 113 870 | 114 | 1.00 |
| 101–150 | 26 190 | 19 | 0.73 |
| ≥151 | 14 810 | 21 | 1.42 |
| Unknown | 48 980 | 41 | 0.84 |
| Total | 349 710 | 346 | 0.99 |

*Religion*

No significant difference was noted by religion except that the rate for Jains was found significantly higher than the average (Table 8).

*Income*

No clear-cut tendency was noted in the influence of difference in monthly income (Table 9).

*Occupation*

A strikingly higher rate was observed among agricultural-rent receivers and money-lenders. The rate was also significantly higher than average among unskilled workers and business workers (Table 10 ; Fig. 3).

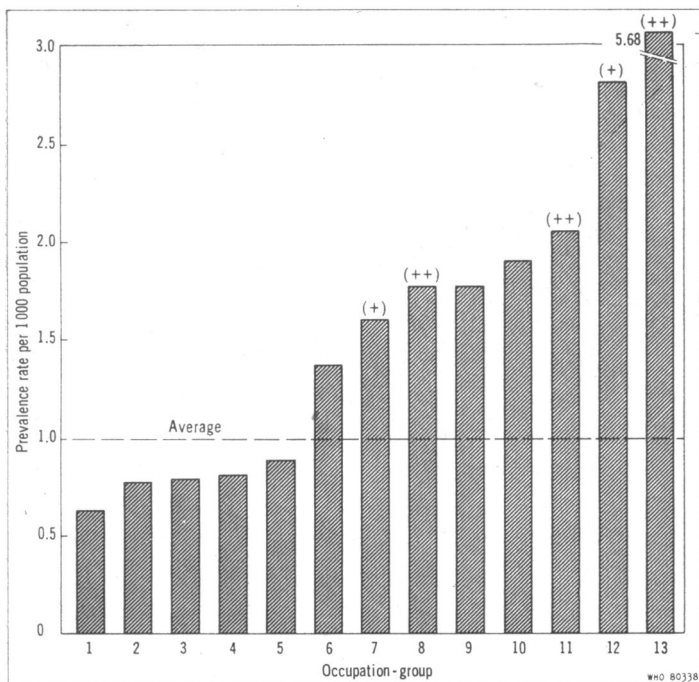*Education*

With the increase of educational level, the rate



### FIG. 3

### PREVALENCE RATE OF ORAL CANCER IN RELATION TO OCCUPATION OF PATIENTS [a]

[a] 1, 2, Cultivators of land: wholly or mainly owned (1), wholly or mainly unowned (2); 3, learned professions; 4, dependants; 5, private services; 6, skilled workers; 7, agricultural labourers; 8, office workers; 9, government services; 10, retired (pension-holders); 11, unskilled workers; 12, miscellaneous; 13, agricultural-rent receivers and money-lenders.

TABLE 10

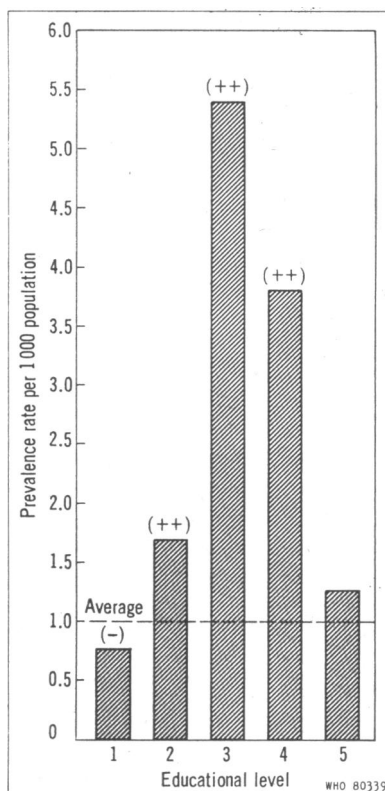PREVALENCE RATE OF ORAL CANCER IN RELATION TO OCCUPATION

| Occupation | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Agricultural occupations | | | |
| Cultivators of land wholly or mainly owned | 197 920 | 124 | 0.63 |
| Cultivators of land wholly or mainly unowned | 11 630 | 9 | 0.77 |
| Cultivating labourers | 20 670 | 33 | 1.60 |
| Non-cultivating owners of land | — | — | — |
| Agricultural-rent receivers and money-lenders | 3 700 | 21 | 5.68 |
| Non-agricultural occupations | | | |
| Unskilled workers | 26 840 | 55 | 2.05 |
| Skilled workers | 11 790 | 16 | 1.36 |
| Learned professions | 2 520 | 2 | 0.79 |
| Government service | 3 940 | 7 | 1.78 |
| Private service | 2 270 | 2 | 0.88 |
| Business | 16 420 | 29 | 1.77 |
| Retired (pension-holders) | 1 050 | 2 | 1.90 |
| Dependants | 48 430 | 39 | 0.81 |
| Miscellaneous | 2 480 | 7 | 2.82 |
| Unknown | 50 | 0 | — |
| Total | 349 710 | 346 | 0.99 |

FIG. 4

PREVALENCE RATE OF ORAL CANCER IN RELATION TO STANDARD OF EDUCATION OF PATIENTS[a]



[a] 1, Illiterate; 2, literate; 3, primary school; 4, junior high school; 5, high school and above.

was found to go up. It was significantly higher than the average among the literate and among people with education up to junior high school grade (Table 11 ; Fig. 4).

TABLE 11

PREVALENCE RATE OF ORAL CANCER IN RELATION TO EDUCATION

| Educational level | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Illiterate | 302 270 | 230 | 0.76 |
| Literate | 32 060 | 54 | 1.68 |
| Primary school | 6 870 | 37 | 5.39 |
| Junior high school | 5 260 | 20 | 3.80 |
| High school and above | 3 180 | 4 | 1.26 |
| Unknown | 70 | 0 | — |
| Total | 349 710 | 346 | 0.99 |

*Food*

The rate for vegetarians and non-vegetarians was found to be almost the same (Table 12).

TABLE 12

PREVALENCE RATE OF ORAL CANCER IN RELATION TO TYPE OF FOOD

| Type of food | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Vegetarian | 223 390 | 213 | 0.95 |
| Non-vegetarian | 126 280 | 131 | 1.04 |
| Unknown | 40 | 2 | — |
| Total | 349 710 | 346 | 0.99 |

*Chewing habits*

The rate for oral cancer in daily quid-chewers was noted to be significantly higher while that for non-chewers was significantly less than the average (Table 13 ; Fig. 5A).

TABLE 13

PREVALENCE RATE OF ORAL CANCER IN RELATION TO FREQUENCY OF TOBACCO-CHEWING

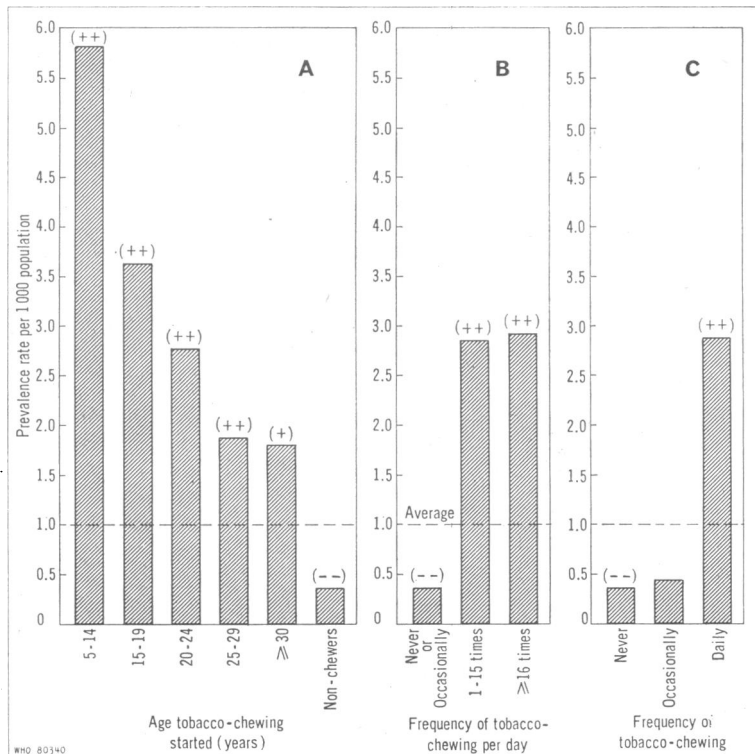| Frequency of tobacco-chewing | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Daily | 86 700 | 251 | 2.90 |
| Occasionally | 11 680 | 5 | 0.43 |
| Never | 251 330 | 90 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

TABLE 14

PREVALENCE RATE OF ORAL CANCER RELATED TO THE AGE AT WHICH TOBACCO-CHEWING WAS STARTED

| Age chewing started (years) | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 5–14 | 6 870 | 40 | 5.92 |
| 15–19 | 16 030 | 58 | 3.62 |
| 20–24 | 22 230 | 61 | 2.74 |
| 25–29 | 15 000 | 28 | 1.87 |
| ≥30 | 38 290 | 69 | 1.80 |
| Non-chewers [a] of tobacco | 251 290 | 90 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

[a] Including 9 persons with unknown chewing habits.

FIG. 5

PREVALENCE RATE OF ORAL CANCER IN RELATION TO FREQUENCY OF TOBACCO-CHEWING BY PATIENTS (A),
TO AGE AT WHICH PATIENTS STARTED TO CHEW TOBACCO (B),
AND TO FREQUENCY OF TOBACCO-CHEWING PER DAY BY PATIENTS (C)

*Age aspect of tobacco-chewing habit*

A clear-cut tendency was noted that the earlier the habit of chewing started, the higher the risk of developing oral cancer (Table 14; Fig. 5B).

*Frequency of quid-chewing per day*

The risk of developing oral cancer was found to become higher with increasing frequency of chewing per day (Table 15; Fig. 5C).

## TABLE 15
### PREVALENCE RATE OF ORAL CANCER IN RELATION TO FREQUENCY OF DAILY TOBACCO-CHEWING

| Daily frequency of chewing | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 1–15 times | 82 410 | 236 | 2.86 |
| ≥16 times | 5 480 | 16 | 2.92 |
| Never and occasionally | 261 820 | 94 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

*Duration of each chewing*

It was noted that the longer the duration of quid-chewing, the higher the rate of oral cancer. If the quid was chewed for more than 30 minutes the risk appeared to be 15 times higher than for non-chewers, and 3 times higher than for the chewers of 1–10 minutes' duration (Table 16; Fig. 6A).

## TABLE 16
### PREVALENCE OF ORAL CANCER IN RELATION TO PERIOD OF RETENTION OF TOBACCO-QUID IN THE MOUTH

| Retention of quid (min) | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 1–10 | 40 270 | 78 | 1.94 |
| 11–20 | 28 760 | 55 | 1.91 |
| 21–30 | 18 680 | 69 | 3.69 |
| ≥31 | 9 650 | 53 | 5.49 |
| Non-chewers [a] of tobacco | 252 350 | 91 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

[a] Including 9 persons with unknown chewing habits.

*Observation by frequency of chewing and by duration of each chew*

In order to observe the effect between total length of time of exposure of the buccal mucosa to the quid, a cross-tabulation was prepared for frequency of chewing against duration of each chew. A clear-cut dose–effect relationship was observed, the highest risk being noted in cases where buccal mucosa was exposed to the quid for more than 8 hours per day (Table 17, Fig. 6B).

## TABLE 17
### PREVALENCE RATE OF ORAL CANCER IN RELATION TO PERIOD OF EXPOSURE OF BUCCAL MUCOSA TO TOBACCO-QUID

| Period of exposure (min) | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| up to 99 | 53 720 | 123 | 2.29 |
| 100–299 | 33 670 | 90 | 2.67 |
| 300–499 | 9 400 | 31 | 3.30 |
| ≥500 | 2 230 | 12 | 5.38 |

*Sleeping with tobacco-quid in the mouth*

A clear-cut increase of the risk was noted if the quid was kept in the mouth during sleep. If this was a regular habit, the risk of oral cancer was found to be 36 times higher than for non-chewers and about 6 times higher than for daytime tobacco-chewers only (Table 18; Fig. 6C).

## TABLE 18
### PREVALENCE RATE OF ORAL CANCER IN RELATION TO HABIT OF RETAINING TOBACCO-QUID IN MOUTH DURING SLEEP

| Sleeping with quid in mouth | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Daily | 1 740 | 23 | 13.22 |
| Occasionally | 10 790 | 58 | 5.38 |
| Daytime only | 85 790 | 175 | 2.04 |
| Non-chewers of tobacco | 251 390 | 90 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

FIG. 6

PREVALENCE RATE OF ORAL CANCER IN RELATION
TO 4 FACTORS ASSOCIATED WITH TOBACCO-QUID
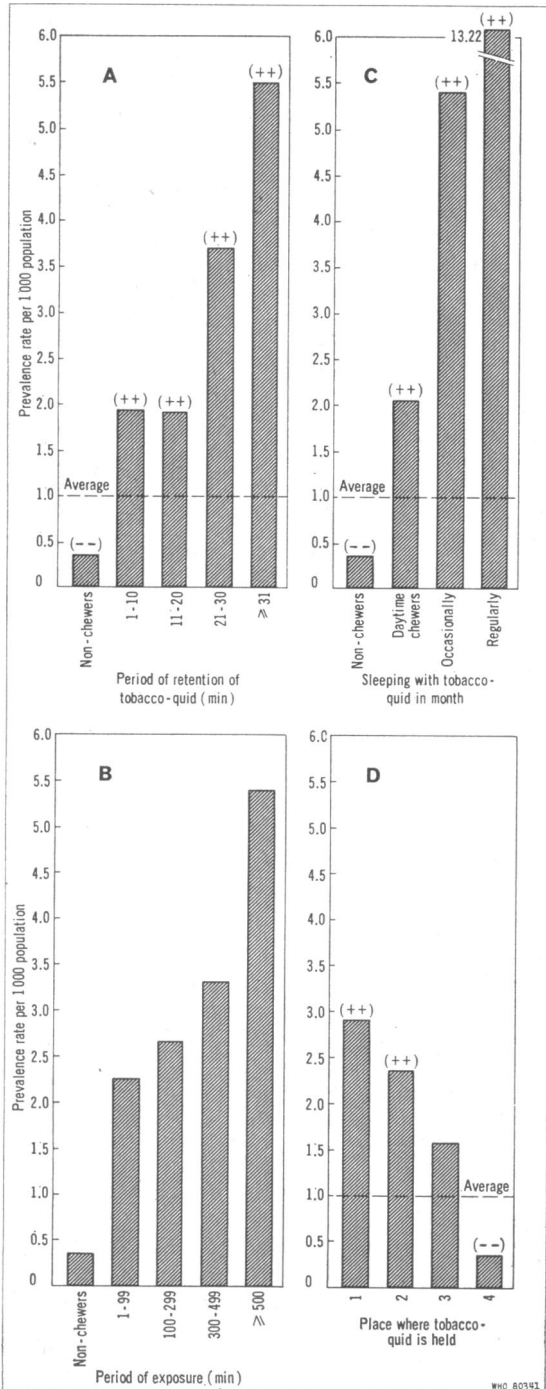
*Site where quid is held in mouth*

The oral cancer prevalence rate was found to be highest if the quid was kept on one side of the mouth only. If it was kept on both sides of the mouth indifferently, the rate became lower but was still significantly higher than average (Table 19; Fig. 6D).

TABLE 19

**PREVALENCE RATE OF ORAL CANCER IN RELATION TO THE PLACE IN THE MOUTH WHERE THE QUID WAS RETAINED**

| Site | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Labial fold | 4 430 | 7 | 1.58 |
| One side of buccal fold | 51 490 | 148 | 2.89 |
| Both sides of buccal fold | 42 410 | 100 | 2.36 |
| Non-chewers of tobacco | 251 380 | 91 | 0.36 |
| Total | 349 710 | 346 | 0.99 |

*Type of tobacco used for chewing*

In Uttar Pradesh, two types of chewing tobacco are commonly used. These are called " Mainpuri " and " Pattiwala " tobacco. The tobacco which is sold in the market as Mainpuri brand is actually a mixture of tobacco with slaked lime, finely cut betel nut, and powdered cloves or camphor; all these ingredients are intimately mixed together. Pattiwala tobacco is sun-cured tobacco leaf-only, and this type of tobacco is used with or without lime.

TABLE 20

**PREVALENCE RATE OF ORAL CANCER IN RELATION TO TYPE OF TOBACCO CHEWED**

| Type of tobacco | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Mainpuri | 17 160 | 134 | 7.81 (++) |
| Pattiwala | 71 610 | 84 | 1.17 |
| Mainpuri and Pattiwala | 8 950 | 37 | 4.13 (++) |
| Other (Kapuri, Rampuri, Moradabadi) | 760 | 1 | 1.32 |
| Non-chewers of tobacco | 251 210 | 90 | 0.36 (− −) |
| Unknown | 20 | 0 | — |
| Total | 349 710 | 346 | 0.99 |

In the present study, the risk of oral cancer was found to be highest if Mainpuri tobacco only was chewed. The risk was also significantly higher if both Mainpuri and Pattiwala tobacco were chewed. The risk of oral cancer among the chewers of Pattiwala tobacco only was significantly different from the average prevalence rate although it was higher than that for non-chewers (Table 20).

## Money spent on tobacco per day

The risk was found to go up sharply with increase in the amount of money spent on tobacco per day. When 75 paisa (¾ of 1 rupee) or more were spent for purchasing tobacco, the risk was found to go up 100 times compared with non-chewers (Table 21).

TABLE 21

PREVALENCE RATE OF ORAL CANCER IN RELATION TO QUANTITY OF TOBACCO CONSUMED DAILY, EXPRESSED IN TERMS OF MONEY SPENT ON TOBACCO

| Money spent on tobacco (paisa) | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 0– 6 | 67 240 | 161 | 2.39 (+ +) |
| 7–37 | 19 710 | 77 | 3.91 (+ +) |
| 38–74 | 680 | 4 | 5.88 (+ +) |
| 75–100 | 260 | 9 | 34.62 (+ +) |
| Non-chewers [a] of tobacco | 261 820 | 95 | 0.36 (− −) |
| Total | 349 710 | 346 | 0.99 |

[a] Including persons of unknown habits.

## Smoking

A significant difference in the prevalence rate of oral cancer was found with the magnitude of habit
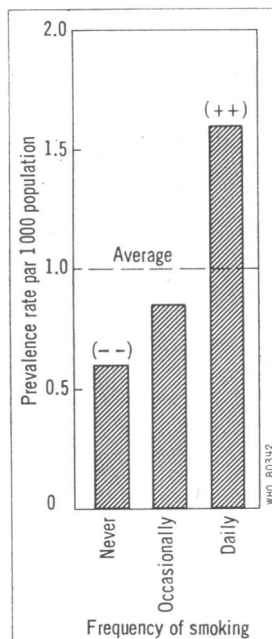
TABLE 22

PREVALENCE RATE OF ORAL CANCER IN RELATION TO TOBACCO-SMOKING

| Frequency of smoking | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Daily | 131 110 | 210 | 1.60 |
| Occasionally | 11 800 | 10 | 0.85 |
| Never | 206 800 | 126 | 0.61 |
| Total | 349 710 | 346 | 0.99 |

of smoking (Table 22 ; Fig. 7). The rate for daily smokers was found to be 2.5 times higher than for non-smokers.

FIG. 7

PREVALENCE RATE OF ORAL CANCER IN RELATION TO FREQUENCY OF TOBACCO-SMOKING BY PATIENTS



## Age aspect of smoking habit

The age at which the smoking habit was started did not make much difference to the risk (Table 23).

TABLE 23

PREVALENCE RATE OF ORAL CANCER IN RELATION TO AGE AT WHICH TOBACCO-SMOKING WAS STARTED

| Age started smoking (years) | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| 5–14 | 18 770 | 24 | 1.28 |
| 15–19 | 42 830 | 54 | 1.26 |
| 20–24 | 38 480 | 53 | 1.38 |
| 25–29 | 18 010 | 27 | 1.50 |
| ⩾30 | 24 890 | 62 | 2.49 |
| Non-smokers and unknown | 206 730 | 126 | 0.61 |
| Total | 349 710 | 346 | 0.99 |

## Type of smoking

There are four main ways of smoking tobacco in the Mainpuri district. They are (1) *bidi,* (2) *chilum,* (3) hookah, and (4) cigarette. Cigars are also smoked. The *bidi* is the local form of cigarette about 2–3 inches long (5 cm–7.5 cm). It is made by rolling in the fingers a quarter to a half gram of tobacco flakes in a rectangular piece of a dried leaf of *temburni (Diospyros melanoxylon).*

The *chilum* is a conical clay pipe usually about 4 inches (10 cm) long; a pebble is inserted from above to prevent the tobacco from dropping down when the pipe is filled and lighted.

The hookah is a kind of water-pipe. The tobacco smoke from the upper bowl passes through a wooden tube and through the water of the receptacle, and then enters the mouth of the smoker through a long pipe.

In the present study, the risk was found to be significantly higher among *bidi* and cigar smokers, but among other types of smokers no significant difference in the risk was found (Table 24).

### TABLE 24
PREVALENCE RATE OF ORAL CANCER IN RELATION TO TYPE OF SMOKING

| Type of smoking | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| *Bidi* | 30 400 | 109 | 3.60 (+ +) |
| Cigarette | 1 050 | 1 | 0.95 |
| Hookah | 5 410 | 10 | 1.85 |
| Cigar | 80 | 2 | 25.00 (+ +) |
| *Chilum* | 72 110 | 55 | 0.76 |
| *Bidi* and cigarette | 920 | 0 | — |
| *Bidi* and hookah | 3 490 | 2 | 0.57 |
| *Bidi* and *chilum* | 11 190 | 32 | 2.86 (+ +) |
| Hookah and *chilum* | 14 270 | 4 | 0.28 |
| *Bidi,* hookah and *chilum* | 0 | 5 | — |
| Unknown | 210 790 | 126 | 0.60 |
| Total | 349 710 | 346 | 0.99 |

## Drinking

The rate was noted to become higher with increase in the extent of using alcoholic drinks. A risk about 10 times higher was observed among regular drinkers compared with non-drinkers (Table 25; Fig. 8A).

### TABLE 25
PREVALENCE RATE OF ORAL CANCER IN RELATION TO HABITS OF USING ALCOHOLIC DRINKS

| Frequency of drinking | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| Regularly | 1 090 | 10 | 9.17 |
| Occasionally | 13 720 | 39 | 2.84 |
| Never | 334 900 | 297 | 0.89 |
| Total | 349 710 | 346 | 0.90 |

## Type of drink

Three kinds of alcoholic drinks were mainly used: *tarrah,* which is a country-made, non-refined wine prepared by fermenting cereals; *tari,* which is a mild type of drink made by fermenting the sap or fruit of the date palm; and whisky (imported).

*Tarrah*-drinkers showed a higher frequency of oral cancer than those using *tari.* However, the highest frequency was observed among whisky drinkers (Table 26; Fig. 8B).

### TABLE 26
PREVALENCE RATE OF ORAL CANCER IN RELATION TO TYPE OF ALCOHOLIC DRINK USED

| Type of drink | Estimated population | No. of cases | Period prevalence rate (°/oo) |
|---|---|---|---|
| *Tarrah* | 10 740 | 36 | 3.35 |
| *Tari* | 1 870 | 3 | 1.60 |
| *Tarrah* and *Tari* | 1 800 | 6 | 3.33 |
| Whisky | 280 | 5 | 17.36 |
| Non-drinkers and unknown | 335 020 | 296 | 0.88 |
| Total | 349 710 | 346 | 0.99 |

## Quantity of alcohol consumed daily

The oral cancer rate was found to go up with increasing consumption of alcoholic drinks. People

FIG. 8
PREVALENCE RATE OF ORAL CANCER IN RELATION TO FREQUENCY OF USE
OF ALCOHOLIC DRINKS BY PATIENTS (A), TO TYPE OF ALCOHOLIC DRINKS USED (B),
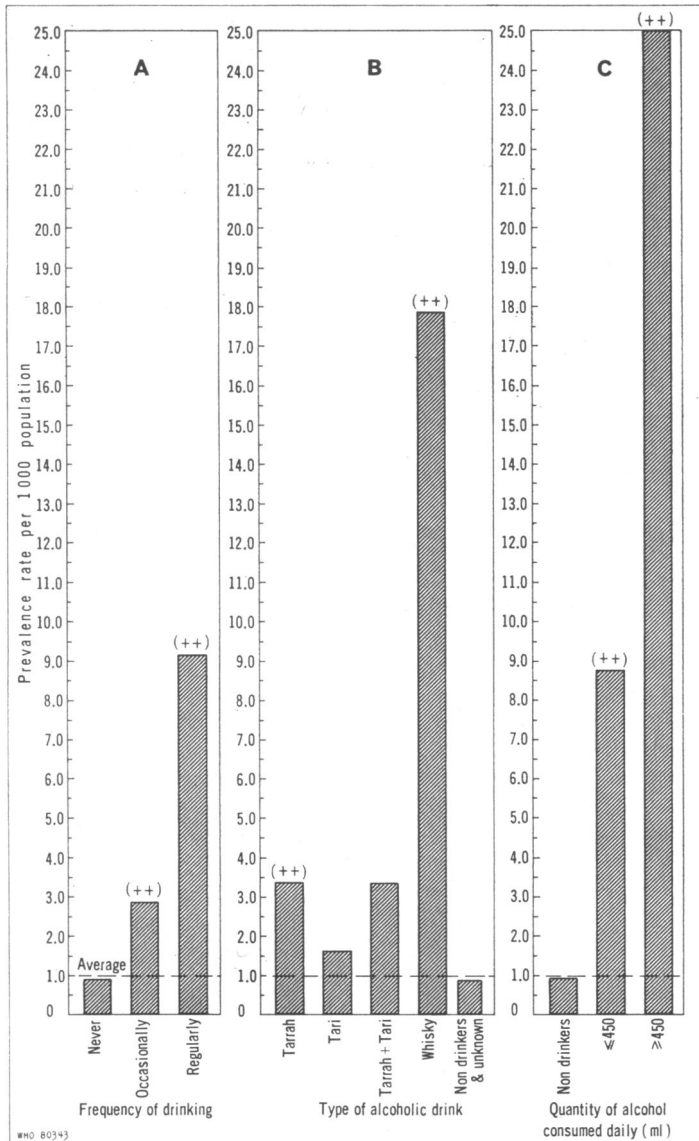AND TO QUANTITY OF ALCOHOL CONSUMED DAILY BY PATIENTS (C)

TABLE 27

PREVALENCE RATE OF ORAL CANCER IN RELATION
TO THE QUANTITY OF ALCOHOL CONSUMED DAILY

| Alcohol consumed daily (ml) | Estimated population | No. of cases | Period prevalence rate (⁰/₀₀) |
|---|---|---|---|
| <450 | 1 030 | 9 | 8.74 |
| >450 | 360 | 9 | 25.00 |
| Non-drinkers and unknown | 348 320 | 328 | 0.94 |

TABLE 28

PREVALENCE RATE OF ORAL CANCER IN RELATION
TO FREQUENCY OF TEETH-CLEANING

| Frequency of teeth-cleaning | Estimated population | No. of cases | Period prevalence rate (⁰/₀₀) |
|---|---|---|---|
| Daily | 267 310 | 244 | 0.91 |
| Occasionally | 17 440 | 18 | 1.03 |
| Never | 6 980 | 12 | 1.72 |
| Edentulous | 57 890 | 71 | 1.23 |
| Unknown | 90 | 1 | — |
| Total | 349 710 | 346 | 0.99 |

TABLE 29

PREVALENCE RATE OF ORAL CANCER IN RELATION
TO TEETH-CLEANING MATERIALS

| Materials | Estimated population | No. of cases | Period prevalence rate (⁰/₀₀) |
|---|---|---|---|
| Dental twig | 17 620 | 33 | 1.87 |
| Dung-ash | 112 540 | 58 | 0.52 |
| Charcoal powder | 13 960 | 34 | 2.44 |
| Burnt tobacco | 840 | 0 | — |
| Tooth-powder | 17 050 | 45 | 2.64 |
| Tooth-paste | 1 260 | 4 | 3.17 |
| Water | 112 180 | 86 | 0.77 |
| Salt and oil | 4 990 | 0 | — |
| Mitti (soil) | 4 710 | 3 | 0.64 |
| No cleaning and unknown | 64 560 | 83 | 1.29 |
| Total | 349 710 | 346 | 0.99 |

FIG. 9

PREVALENCE OF ORAL CANCER IN RELATION
TO METHODS OF TEETH-CLEANING USED
BY PATIENTS [a]
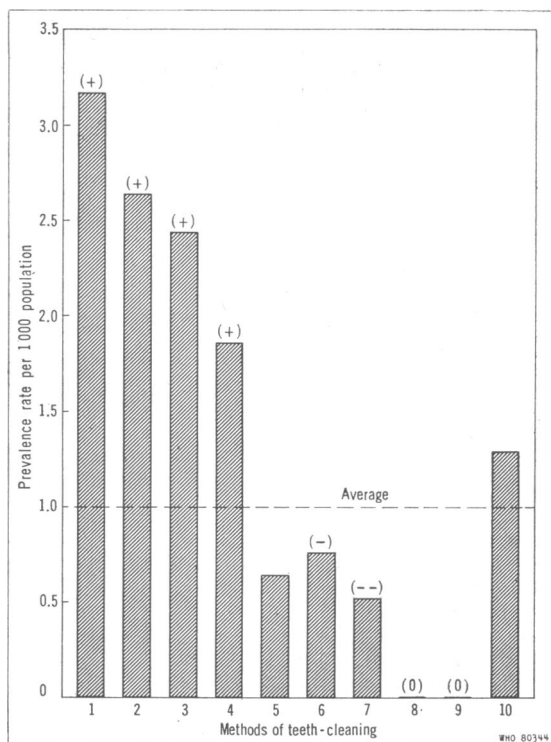


[a] 1, Toothpaste; 2, tooth-powder; 3, charcoal powder; 4, dental twig; 5, *mitti* (soil); 6, water; 7, dung-ash; 8, burned tobacco; 9, salt + oil; 10, no cleaning and unknown.

taking 450 ml or more of alcoholic drinks per day stood the highest risk, which was about 20 times higher than for non-drinkers (Table 27; Fig. 8C).

*Cleaning of teeth*

Little difference was noted in association with the habit of cleaning the teeth, although the rate of oral cancer was highest among those people who did not clean their teeth (Table 28).

*Type of mouth-cleaning*

The highest rate was observed among people who used tooth-powder[1] and also charcoal-powder. The risk among those using dung-ash to clean the teeth was seen to be significantly less than average (Table 29; Fig. 9).

---

[1] Containing chalk, soap, peppermint and other flavouring agents in varying proportions.

FIG. 10

CROSS-TABULATION OF ALL FACTORS EXAMINED WITH TYPE OF TOBACCO CHEWED BY PATIENTS
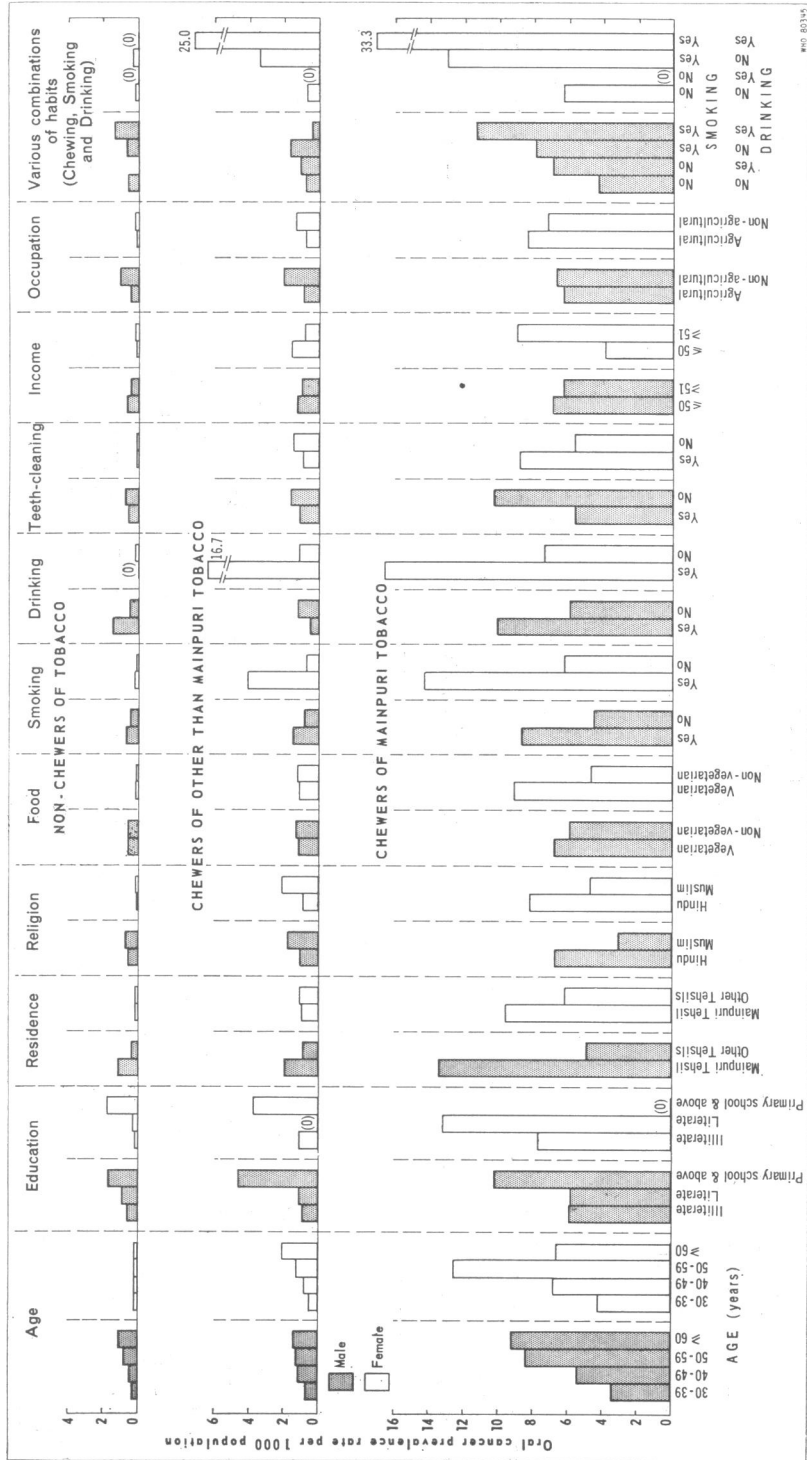
## TABLE 30

### PREVALENCE RATE OF ORAL CANCER IN RELATION TO CHEWING, SMOKING AND DRINKING HABITS ACCORDING TO SEX

| Chewing habits | Neither smoking nor drinking habits | | | Drinking but not smoking habits | | | Smoking but not drinking habits | | | Both smoking and drinking habits | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estim. pop. | No. of cases | Prev. rate (%o) | Estim. pop. | No. of cases | Prev. rate (%o) | Estim. pop. | No. of cases | Prev. rate (%o) | Estim. pop. | No. of cases | Prev. rate (%o) | Estim. pop. | No. of cases | Prev. rate (%o) |
| **Males** | | | | | | | | | | | | | | | |
| Non-chewers of tobacco | 3 809 | 19 | 0.50 | 16 | 0 | 0 | 7 884 | 50 | 0.64 | 572 | 9 | 1.57 | 12 261 | 78 | 0.64 |
| Mainpuri tobacco | 1 025 | 41 | 4.00 | 88 | 6 | 6.81 | 914 | 72 | 7.88 | 259 | 29 | 11.20 | 2 286 | 148 | 6.47 |
| Other kinds of tobacco | 3 076 | 25 | 0.81 | 184 | 2 | 1.09 | 2 560 | 43 | 1.68 | 342 | 1 | 0.29 | 6 162 | 71 | 1.15 |
| Total | 7 910 | 85 | 1.07 | 288 | 8 | 2.78 | 11 338 | 165 | 1.46 | 1 173 | 39 | 3.32 | 20 709 | 297 | 1.43 |
| **Females** | | | | | | | | | | | | | | | |
| Non-chewers of tobacco | 11 239 | 8 | 0.07 | 4 | 0 | 0 | 1 613 | 4 | 0.25 | 4 | 0 | 0 | 12 860 | 12 | 0.09 |
| Mainpuri tobacco | 282 | 18 | 6.38 | 3 | 0 | 0 | 46 | 6 | 13.04 | 3 | 1 | 33.33 | 334 | 25 | 7.49 |
| Other kinds of tobacco | 945 | 7 | 0.74 | 2 | 0 | 0 | 117 | 4 | 3.42 | 4 | 1 | 25.00 | 1 068 | 12 | 1.12 |
| Total | 12 466 | 33 | 0.26 | 9 | 0 | 0 | 1 776 | 14 | 0.79 | 11 | 2 | 18.18 | 14 262 | 49 | 0.34 |
| Grand total | 20 376 | 118 | 0.58 | 297 | 8 | 2.69 | 13 114 | 179 | 1.37 | 1 184 | 41 | 3.46 | 34 971 | 346 | 0.99 |

*Cross-tabulation of each of the factors studied with the type of tobacco chewed*

As the effect of chewing, especially of Mainpuri tobacco, is quite apparent, each one of the observed factors was cross-tabulated according to the type of tobacco chewed. The result of this cross-tabulation clearly demonstrated a greatly higher prevalence rate for oral cancer among Mainpuri tobacco chewers in combination with whatever other factor (e.g., sex, age, education, residence, religion, food, smoking, drinking, income or occupation). The rate among those who chewed other kinds of tobacco was observed to be consistently lower than among those who chewed Mainpuri tobacco (Fig. 10).

*Effect of various combinations of habits of chewing, smoking and drinking*

If the habit of smoking and drinking is added to the habit of chewing Mainpuri tobacco, the risk was found to be the highest, being about three times as high as the risk among those people with the Mainpuri-tobacco-chewing habit only. (An ex-

ceptionally higher rate of oral cancer among female drinkers is probably explained by the small size of the sample.) It is of interest to note that such a trend does not exist in males chewing other kinds of tobacco (Table 30 ; Fig. 11).

*Correlation of habit and site of cancer*

In general, a similar tendency was noted both for cancer of the buccal mucosa, gingiva, and lip, and for cancer of the anterior two-thirds of the tongue, with regard to the various combinations of chewing, smoking and drinking habits, the highest risk being among people with all these habits (Table 31 ; Fig. 12). If the risk among those using Mainpuri tobacco only is compared with the risk among those who do not chew Mainpuri tobacco but who do smoke tobacco and use alcoholic drinks, the frequency of cancer of the anterior two-thirds of the tongue is found to be somewhat different from the frequency on the lip buccal mucosa and gingiva. This indicates that the effect of chewing is relatively less for anterior two-thirds of the tongue.

FIG. 11

PREVALENCE RATE OF ORAL CANCER IN RELATION TO CHEWING AND SMOKING TOBACCO
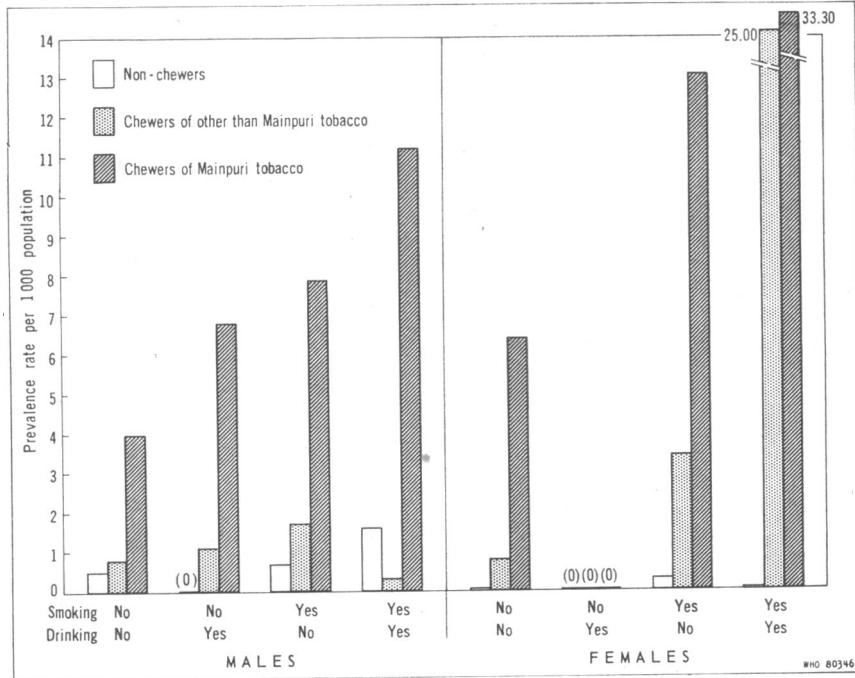AND USING ALCOHOLIC DRINKS BY PATIENTS CLASSIFIED ACCORDING TO SEX

TABLE 31

PREVALENCE RATE OF ORAL CANCER IN RELATION TO CHEWING, SMOKING AND DRINKING ACCORDING TO SITE OF EACH CANCER

| Chewing habits | Neither drinking nor smoking habits | | | Drinking but not smoking habits | | | Smoking but not drinking habits | | | Both smoking and drinking habits | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Estim. pop. | No. of cases | Prev. rate (°/oo) | Estim. pop. | No. of cases | Prev. rate (°/oo) | Estim. pop. | No. of cases | Prev. rate (°/oo) | Estim. pop. | No. of cases | Prev. rate (°/oo) | Estim. pop. | No. of cases | Prev. rate (°/oo) |
| **Buccal mucosa, gingiva and lip** | | | | | | | | | | | | | | | |
| Non-chewers of tobacco | 15 048 | 14 | 0.09 | 20 | 0 | 0 | 9 477 | 34 | 0.36 | 576 | 5 | 0.87 | 25 121 | 53 | 0.21 |
| Mainpuri tobacco or Mainpuri + other tobaccos | 11 307 | 46 | 3.52 | 91 | 5 | 5.49 | 960 | 64 | 6.66 | 262 | 26 | 9.92 | 2 620 | 141 | 5.38 |
| Other kinds of tobacco | 4 021 | 19 | 0.47 | 186 | 0 | 0 | 2 677 | 35 | 1.31 | 346 | 2 | 0.58 | 7 230 | 56 | 0.77 |
| Total | 20 376 | 79 | 0.38 | 297 | 5 | 1.68 | 13 114 | 133 | 1.01 | 1 184 | 33 | 2.79 | 34 971 | 250 | 0.71 |
| **Tongue** | | | | | | | | | | | | | | | |
| Non-chewers of tobacco | 15 048 | 13 | 0.09 | 20 | 0 | 0 | 9 477 | 14 | 0.15 | 576 | 4 | 0.69 | 25 121 | 31 | 0.12 |
| Mainpuri tobacco or Mainpuri + other tobaccos | 1 307 | 9 | 0.69 | 91 | 1 | 1.09 | 960 | 11 | 1.15 | 262 | 4 | 1.53 | 2 620 | 25 | 0.95 |
| Other kinds of tobacco | 4 021 | 8 | 0.19 | 186 | 2 | 1.07 | 2 677 | 12 | 0.45 | 346 | 0 | 0 | 7 230 | 22 | 0.30 |
| Total | 20 376 | 30 | 0.14 | 297 | 3 | 1.01 | 13 114 | 37 | 0.28 | 1 184 | 8 | 0.68 | 34 971 | 78 | 0.22 |
| **Other sites** | | | | | | | | | | | | | | | |
| Non-chewers of tobacco | 15 048 | 0 | 0 | 20 | 0 | 0 | 9 477 | 6 | 0.063 | 576 | 0 | 0 | 25 121 | 6 | 0.02 |
| Mainpuri tobacco or Mainpuri + other tobaccos | 1 307 | 3 | 0.23 | 91 | 0 | 0 | 960 | 1 | 0.104 | 262 | 2 | 0.76 | 2 620 | 6 | 0.22 |
| Other kinds of tobacco | 4 021 | 4 | 0.09 | 186 | 0 | 0 | 2 677 | 2 | 0.07 | 346 | 0 | 0 | 7 230 | 6 | 0.08 |
| Total | 20 376 | 7 | 0.03 | 297 | 0 | 0 | 13 114 | 9 | 0.068 | 1 184 | 2 | 0.17 | 34 971 | 18 | 0.05 |
| Grand total | 62 208 | 116 | 0.19 | 891 | 8 | 0.89 | 39 342 | 179 | 0.45 | 3 552 | 43 | 1.21 | 104 913 | 346 | 0.33 |

FIG. 12
PREVALENCE RATE OF ORAL CANCER CLASSIFIED ACCORDING TO SITE IN RELATION TO CHEWING AND SMOKING
TOBACCO AND USING ALCOHOLIC DRINKS BY PATIENTS
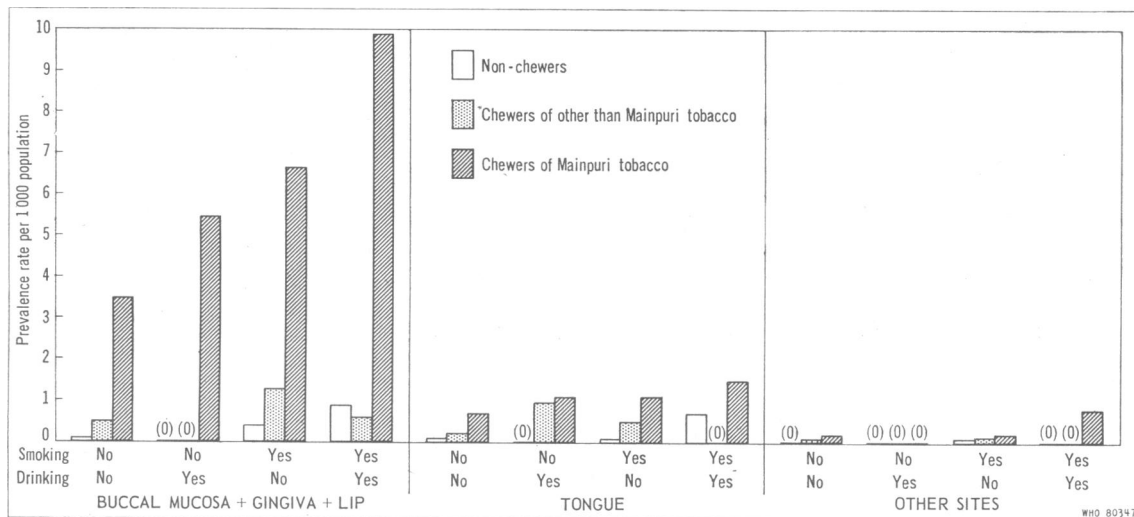


## Statistical summary of observations

All the observed phenomena relating to factors associated with oral cancer are summarized in Table 32, which also indicates when the association was proved to be significantly in excess of the 1% and 5% levels, and when significantly less than the 1% and 5% levels. The effect of chewing Mainpuri tobacco in relation to oral cancer is quite apparent from this summary table.

### CHARACTERISTICS OF USERS OF
### MAINPURI TOBACCO

When an attempt is made to interpret any epidemiological data, the intercorrelation of all factors under observation, and especially the correlation with the major factors, must be carefully considered. As the chewing of Mainpuri tobacco was found to be closely associated with the occurrence of oral cancer, an attempt was made to observe the interrelationship between the chewing of Mainpuri tobacco and various other factors in order to ascertain to what extent the major factor explains observed variations in the risk of oral cancer caused by subsidiary factors.

As shown in Fig. 13, the percentage of Mainpuri tobacco users was higher in males than in females, slightly higher over the age of 50 than in other age-groups, higher among Muslims than Hindus, higher among non-vegetarians than among vegetarians, higher among non-smokers than among smokers. Within the category of those who smoked, the frequency of oral cancer was higher among *bidi-* and cigarette-smokers, higher among drinkers, not different according to teeth-cleaning habits, higher among those with a non-agricultural occupation, and higher among better-educated people. Within the category of those who chewed tobacco, the frequency was higher among daily chewers compared with occasional chewers, higher among people who started chewing at an earlier age, slightly higher among frequent chewers. Almost no difference was observed among people retaining the quid on one side or on both sides of mouth. It was higher among prolonged chewers, higher among persons who retained the quid in the mouth regularly during sleep, higher among people spending more money to purchase tobacco. Certain social and other characteristics of those using Mainpuri tobacco are clearly indicated by these comparisons which should be taken into account when the reasons for the observed variations in the risk of oral cancer, according to each of these factors, are being considered.

TABLE 32

## FACTORS SIGNIFICANTLY ASSOCIATED WITH DEVELOPMENT OF ORAL CANCER

| Factor | Significantly above expected rate [a] | | Significantly below expected rate [b] | |
|---|---|---|---|---|
| *Tehsil* of residence | Mainpuri | (++) | Jasrana<br>Shikohabad | (− −)<br>(− −) |
| Sex | Male | (++) | Female | (− −) |
| Age (yr) | 50–54<br>60–64<br>80 and above | (++)<br>(+)<br>(++) | 35–39<br>40–44 | (− −)<br>(−) |
| Religion | Jain | (+) | — | |
| Income | — | | — | |
| Occupation | Agricultural rent-receivers | (++) | Cultivators of land, wholly or mainly owned | (−) |
| | Unskilled workers<br>Business workers<br>Cultivating labourers | (++)<br>(++)<br>(+) | | |
| Education | Literate<br>Primary school<br>Junior high school | (++)<br>(++)<br>(++) | Illiterate | (−) |
| Food | — | | — | |
| Chewing habits<br>  Age chewing started (yr) | Daily chewers<br>5–14  (++)   15–19<br>20–24  (++)   25–29<br>               30 | (++)<br>(++)<br>(++)<br>(+) | Non-chewer<br>Non-chewer | (− −)<br>(− −) |
|   Frequency of chewing<br>    per day | Up to 15<br>⩾16 | (++)<br>(++) | Non-chewer | (− −) |
|   Duration of each chew<br>    (min) | >30<br>21–30<br>11–20<br>1–10 | (++)<br>(++)<br>(++)<br>(++) | Non-chewer | (− −) |
|   Sleeping with quid in<br>    mouth | Regularly<br>Occasionally<br>Daytime only | (++)<br>(++)<br>(++) | Non-chewer | (− −) |
|   Type of tobacco | Mainpuri<br>Mainpuri +<br>    Pattiwala | (++)<br>(++) | Non-chewer | (− −) |
|   Money used for tobacco<br>    per day (paise) | ⩾75 | (++) | Non-chewers of<br>  tobacco | (− −) |
| | 44–74<br>7–43<br>0– 6 | (++)<br>(++)<br>(++) | | |
|   Side of mouth retaining<br>    quid | One side | (++) | Non-chewers of<br>  tobacco | (− −) |
| | Both sides | (++) | | |
| Smoking frequency<br>  Age smoking started<br>  Type of smoking | Daily<br>—<br>*Bidi*  (++)   Cigar<br>*Bidi*  (+)    *Chilum* | (++)<br><br>(++)<br>(++) | Non-smokers<br>—<br>—<br>— | (− −) |
| Drinking frequency<br><br>  Type of drinking taken<br><br>  Quantity of alcohol taken<br>    (ml) | Regular<br>Occasional<br>*Tarrah*<br>Whisky<br><450<br>>450 | (++)<br>(++)<br>(+)<br>(++)<br>(++)<br>(++) | —<br>—<br>—<br>—<br>—<br>— | |
| Cleaning of teeth<br>  Type of cleaning material | Tooth-powder<br>Charcoal powder<br>Dental twig<br>Toothpaste | (+)<br>(+)<br>(+)<br>(+) | Dung-ash<br>Water | (− −)<br>(−) |

[a] (+) Actual rate higher than expected rate by more than 2 standard errors; (++) actual rate higher than expected rate by more than 3 standard errors.

[b] (−) Significantly less than average at the 5 % level; (− −) significantly less than average at the 1 % level.

## DISCUSSION

The characteristics of the present study in Mainpuri lie in the methodology of investigation. Most of the previous work reported in the literature was based mainly on the so-called controlled case study or retrospective study. In the present study, a direct measurement of risk was made, based on a classification according to various environmental conditions, of the population of the district. There is no doubt that the most reliable epidemiological information can be obtained if the calculation of the incidence rate or the prevalence rate is based on the appropriate population at risk. It was in order to obtain such data that a systematic cancer registry was instituted in Mainpuri. The data for the numerator were obtained by the careful inquiries of registered oral cancer cases while the detailed information with regard to the denominator population was obtained by conducting household interview study for the cluster samples randomly selected from the district. The information and data obtained from the study with regard to the incidence as well as the etiology could thus be considered as of unique epidemiological value. The results of the study will therefore not be compared in detail with most of the previously reported studies, since the quality of the present data is believed to be essentially different from that of previous studies on the epidemiology of oral cancer.

### Incidence

The incidence rate for oral and oropharyngeal cancer obtained from this study is 21.4 per 100 000 population, which is strikingly higher than the corresponding rates in other countries for either sex and also for any age-group. Although for years it was stated that the frequency of oral cancer in India is much higher than in other parts of the world, the results presented here should be regarded as the first evidence obtained by strictly observing pathological requirements as well as by using modern epidemiological procedures for the measurement of the size of the problem in the community.

### Factors associated with the disease

*Region.* It was observed that the prevalence rate was significantly higher in the *tehsil* of Mainpuri. This aggregation of cases could be explained in part by the availability of diagnostic treatment and facilities in the district hospital of Mainpuri.

*Sex.* The higher prevalence rate of oral cancer in males was clearly shown in the present study. This finding could be explained by the wider use of tobacco by males compared with females, but part of the reason must have been the low frequency of smoking and drinking by females.

*Age.* The fact that the prevalence rate for oral cancer increases with advancing age must be a reflection of the effect of a latency period intervening after the start of a chewing habit in younger persons, in addition to the higher susceptibility to cancer of older persons.

*Income.* As there was no difference in the prevalence rate of oral cancer according to the different categories of income, this factor could be excluded from the list of contributory factors, at least in the Mainpuri district.

*Occupation.* The fact that agricultural-rent receivers show the highest prevalence rate for oral cancer strongly suggests that the behaviour pattern characteristic of this occupation group must have some influence on the occurrence of the disease ; most likely it is due to the more frequent use of Mainpuri tobacco.

*Education.* The fact that the higher the education level, the higher the prevalence rate is quite important in relation to etiology as well as to the establishment of a future cancer-control programme. It must also reflect the wider use of Mainpuri tobacco among educated people. When the risk is calculated on the basis of a fixed daily expenditure on tobacco, it is found to be almost the same at all levels of education (Fig. 14).

*Food.* There was no difference at all in the prevalence rate for oral cancer between vegetarians and non-vegetarians. This indicates that the factor of etiological significance cannot be associated with food or eating habits.

*Tobacco chewing.* The habit of chewing tobacco was found to be quite common among oral cancer patients and the prevalence rate for this kind of cancer was found to be about 8 times higher among daily chewers than among with non-chewers.

*Age aspects of chewing.* It was noted that the prevalence rate for oral cancer was 10 times higher in tobacco chewers who acquired the habit before the age of 15 years than in non-chewers. The fact that the earlier the age at which chewing

FIG. 13

PERCENTAGE OF PERSONS CHEWING MAINPURI TOBACCO CLASSIFIED ACCORDING
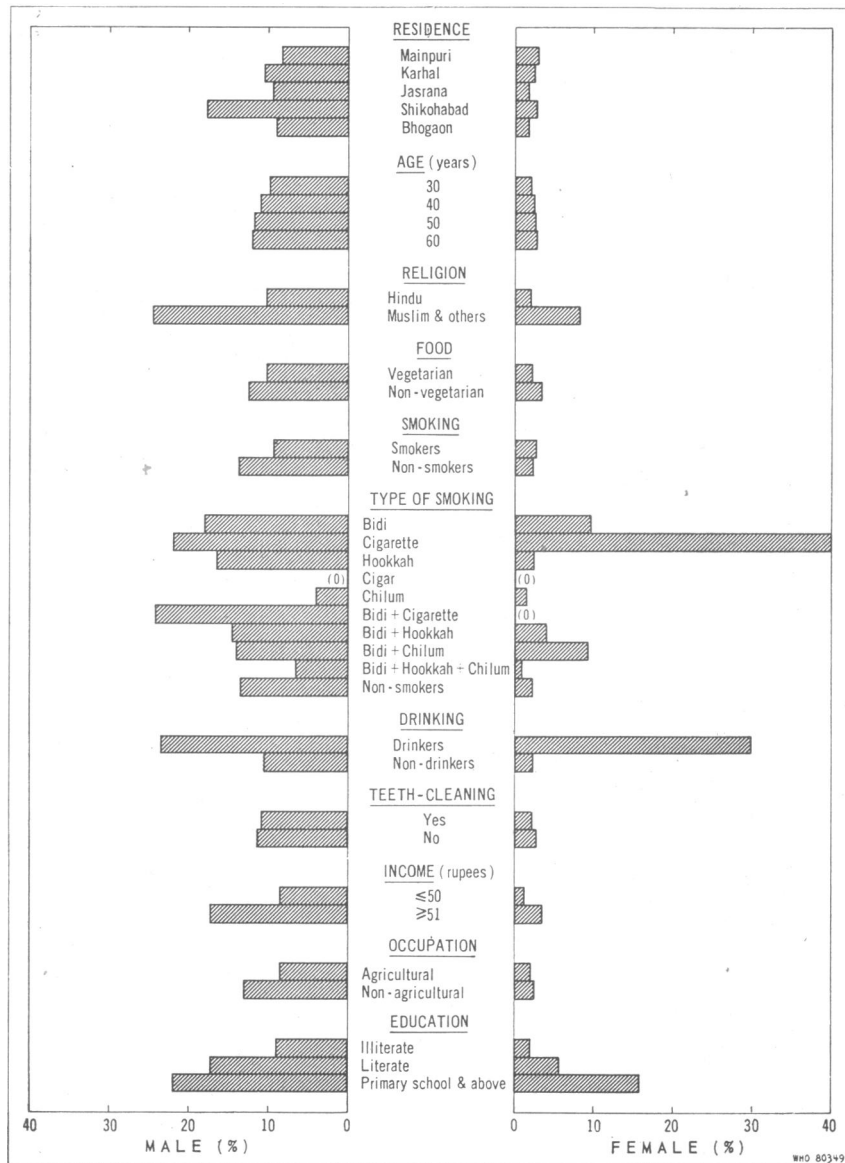TO EACH FACTOR STUDIED

FIG. 13

PERCENTAGE OF PERSONS CHEWING MAINPURI TOBACCO CLASSIFIED ACCORDING
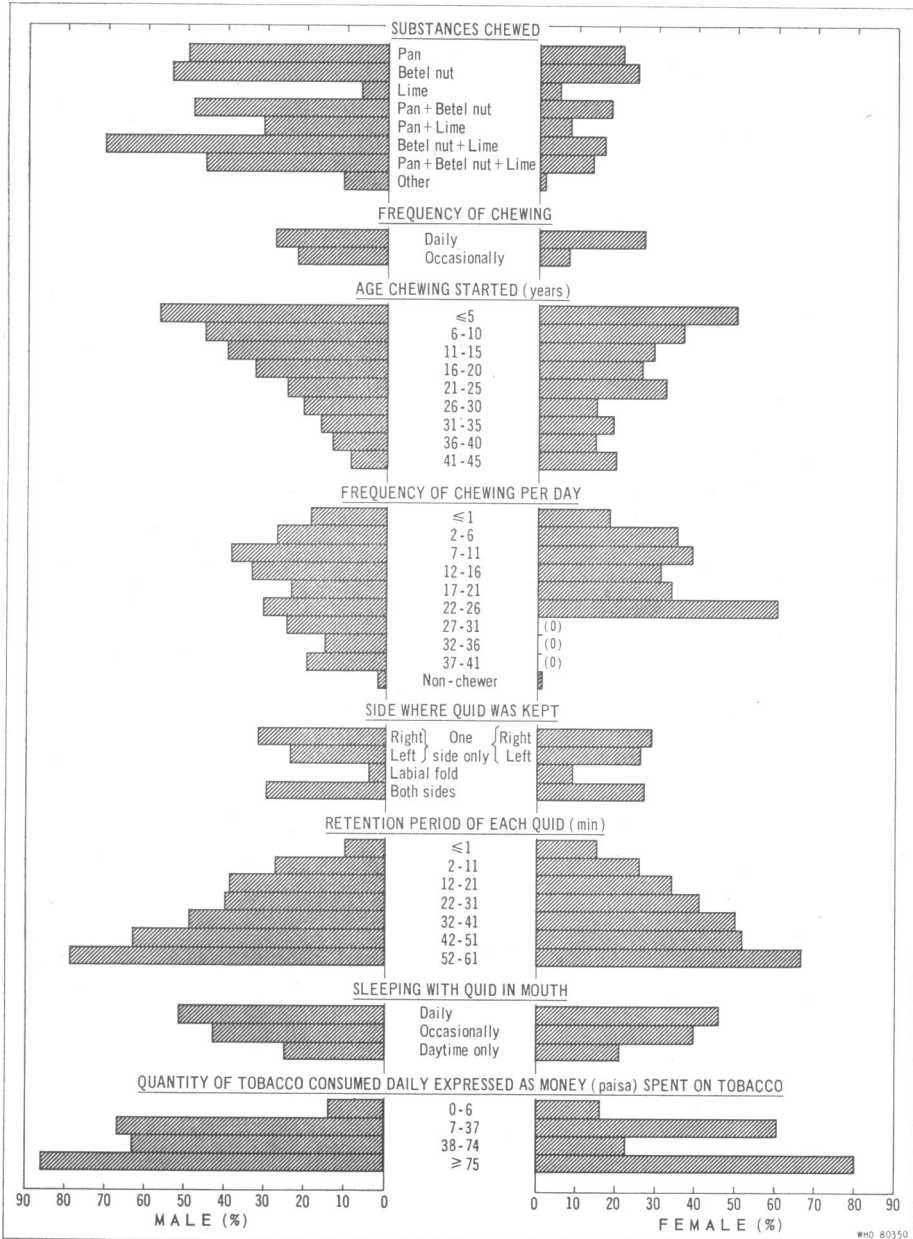TO EACH FACTOR STUDIED

(*continued*)



SUBSTANCES CHEWED

Pan
Betel nut
Lime
Pan + Betel nut
Pan + Lime
Betel nut + Lime
Pan + Betel nut + Lime
Other

FREQUENCY OF CHEWING

Daily
Occasionally

AGE CHEWING STARTED (years)

≤5
6 - 10
11 - 15
16 - 20
21 - 25
26 - 30
31 - 35
36 - 40
41 - 45

FREQUENCY OF CHEWING PER DAY

≤1
2 - 6
7 - 11
12 - 16
17 - 21
22 - 26
27 - 31        (0)
32 - 36        (0)
37 - 41        (0)
Non - chewer

SIDE WHERE QUID WAS KEPT

Right } One   { Right
Left  } side only { Left
Labial fold
Both sides

RETENTION PERIOD OF EACH QUID (min)

≤1
2 - 11
12 - 21
22 - 31
32 - 41
42 - 51
52 - 61

SLEEPING WITH QUID IN MOUTH

Daily
Occasionally
Daytime only

QUANTITY OF TOBACCO CONSUMED DAILY EXPRESSED AS MONEY (paisa) SPENT ON TOBACCO

0 - 6
7 - 37
38 - 74
≥ 75

90  80  70  60  50  40  30  20  10  0        0  10  20  30  40  50  60  70  80  90
MALE (%)                                              FEMALE (%)

WHO 80350

PREVALENCE RATE OF ORAL CANCER IN RELATION
TO TYPE OF TOBACCO CHEWED BY PATIENTS [a]
OF DIFFERENT EDUCATIONAL LEVELS
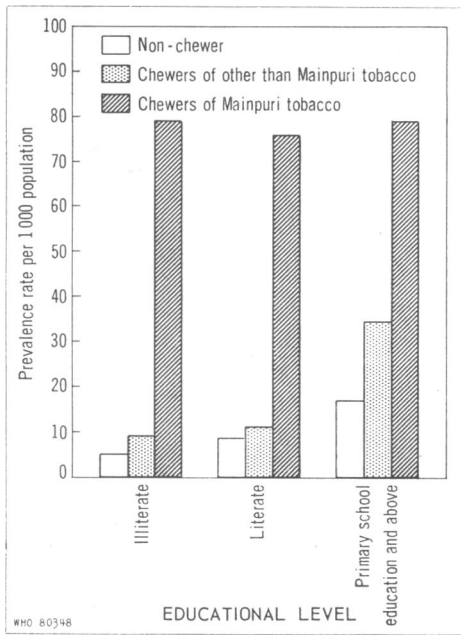


[a] Limited to those spending up to 6 paisa per day on tobacco.

was started, the higher was the rate of oral cancer, could be regarded as one of the data indicating the presence of a so-called dose–effect relationship, in the sense that the duration of the habit over the years influences the level of occurrence of oral cancer.

*Frequency of chewing per day.* The risk of oral cancer was shown to rise with an increase in frequency of chewing per day. This also should be included as an evidence of the presence of dose–effect relationship.

*Duration of each chewing.* A clear-cut dose-effect relationship was obtained by observing the effect of duration of chewing each quid on the risk of oral cancer. This fact suggests the necessity, and the effect, of prolonged exposure of mucous membranes to the quid in promoting the occurrence of oral cancer.

*Sleeping with a tobacco-quid in the mouth.* The most striking dose–effect relationship was observed in association with the habit of sleeping with a quid in the mouth. If the quid is chewed

regularly it is noted that the risk rose to 30 times higher than that for non-chewers. This again clearly indicates that the prolonged exposure of the quid causes significant changes in the mucosa.

• *Type of tobacco used for chewing.* The most important finding in this study is the fact that it is Mainpuri tobacco which is mainly responsible for elevating the risk of developing oral cancer. As has been already mentioned, Mainpuri tobacco is a ready-made mixture of finely cut betel nut, slaked lime and tobacco, while Pattiwala tobacco is ordinary cured tobacco and is taken with or without lime and mostly without betel nut. The exact reason why Mainpuri tobacco has a far greater association with oral cancer when it is frequently chewed than Pattiwala tobacco has must be one of the most important subjects of study in this field. Detailed chemical analysis, as well as analysis of the biological effect of Mainpuri tobacco in comparison with Pattiwala tobacco, is strongly recommended in order to lead to a clear idea of the mechanism of cancer-promotion which comes from the habit of tobacco-chewing.

*Money spent on tobacco per day.* An impressive dose–effect relationship was seen in the effect of the quantity of tobacco chewed per day on the risk of oral cancer. If 75 paisa or more are spent on the purchase of tobacco per day, the amount chewed must be 50 g. Among those spending this amount, the frequency of oral cancer was about 100 times higher than in non-chewers. The quantitative aspects of the causation of oral cancer by the habit of chewing tobacco could be considered as based on this finding.

*Site where quid is held.* If the quid is kept on one side of the mouth the risk of oral cancer was observed to be higher than if it was kept indifferently on both sides of the mouth. This phenomenon could be interpreted as the dosage becoming doubled if the quid is kept on one side only.

*Smoking.* Another important finding arising from this study is the absence of any association with the habit of smoking tobacco. No increased risk was observed among daily smokers.

*Age aspects of smoking.* In sharp contrast to the significant association observed in relation to the age at which tobacco-chewing was started, little difference was noted in the risk in relation to the age at which tobacco-smoking began. This must be further evidence that smoking has little to do with the causation of oral cancer in Mainpuri district.

*Type of smoking.* When the effect of smoking was observed in association with the presence or absence of the tobacco-chewing habit, it was found that the risk of oral cancer was slightly higher for the two habits combined than for either habit separately. Apparently, smoking appeared to accelerate slightly the effect of chewing.

*Drinking.* A clear-cut dose–effect relationship was observed with the extent of using alcoholic drinks and the risk of oral cancer. When the effect of drinking was observed according to the presence or absence of the tobacco-chewing habit, it was clearly seen that the effects of these two habits were independent of each other and when they were combined, the risk became higher. Although the importance of drinking in the etiology of oral cancer should not be overlooked, this factor could not be considered as a main reason for the high frequency of oral cancer in Mainpuri district. The reason for such an interpretation of the facts is that one cannot get reliable information about drinking in India because of special local situations. Another reason is that there is no evidence to suggest that the type and amount of alcohol consumed in Mainpuri district are different from the type and amount in other districts. The drinking habit should therefore be considered

as a contributory factor in promoting the effect of tobacco-chewing when both habits exist together.

*Combination of habits.* The fact that the highest risk was observed in persons having all three habits—chewing, smoking and drinking—must be significant both etiologically and also for a cancer-control programme. Observation of oral cancers according to site shows that the effect of various habits on the anterior two-thirds of the tongue is not essentially different from the effect on the buccal mucosa, the gingiva and the lip, although the combined habits of smoking and drinking, in the absence of tobacco-chewing, appeared to have a more pronounced effect on the anterior two-thirds of the tongue than on the buccal mucosa.

*Cleaning of teeth.* No significant effect on oral cancer was observed in relation to cleaning the teeth, or to the extent of this practice. Therefore, this factor should be considered as minor. Although a notable difference in the frequency of oral cancer according to the materials used for mouth-cleaning was noted, this is closely related to the socio-economic conditions, especially to the educational level, and should therefore be considered as the indirect or secondary effect of such fundamental conditions.

## ACKNOWLEDGEMENTS

## RÉSUMÉ

Des données portant sur 1500 cas de cancer de la bouche et de l'oro-pharynx, tirées des registres du Sarojini Naidu College Hospital d'Agra, Inde, indiquaient que la proportion de cas parmi les malades venant du district de Mainpuri (21,4 pour 100 000) dépassait de façon significative (30%) les données correspondantes dans le district d'Agra lui-même, et dans d'autres régions du monde, pour les deux sexes et tous les groupes d'âge. Entre mars 1964 et septembre 1966, on a organisé et mené, dans le cadre du projet international OMS d'études du

cancer de la bouche et du pharynx dans l'Asie du Sud-Est, une enquête épidémiologique détaillée sur la fréquence de ce cancer dans le district de Mainpuri et sur les facteurs étiologiques qui lui sont liés.

Mainpuri est l'un des cinq districts voisins de celui d'Agra; il a une superficie totale d'à peu près 5128 km² et une population d'un million d'habitants environ. Après avoir réuni des renseignements de base sur la population et le milieu, on a élaboré et mis en œuvre un plan de recherche. Un service intensif d'enregistrement

des cancers a été créé, afin que tous les cas soient diagnostiqués et enregistrés, et sept centres ruraux de dépistage, ouverts deux fois par semaine et dirigés par une équipe de spécialistes, ont été mis en place. Tous les médecins de médecine générale de la région ont été invités à signaler les cas suspects de cancer aux centres. On a prélevé des frottis et des biopsies chez toutes les personnes que l'on soupçonnait atteintes de l'affection; en cas de confirmation, les malades étaient envoyés au Sarojini Naidu Hospital pour y être hospitalisés et traités. Le service d'enregistrement des cancers de Mainpuri jouait donc un rôle actif dans la détection de la maladie et son action était complétée par le travail de quatre enquêteurs expérimentés, séjournant dans le district, qui pratiquaient des examens familiaux et individuels. L'enquêteur visitait tous les practiciens de son secteur une fois par semaine pour s'assurer que toutes les personnes chez qui on soupçonnait un cancer avaient été dirigées sur un centre. Une étude par interrogatoires a d'autre part été faite sur un échantillon aléatoire de 10 % des habitants de Mainpuri âgés de 35 ans et plus, chaque sujet étant personnellement questionné et examiné. Les nouveaux cas suspects ont été envoyés aux centres et toutes les données collectées au cours des entrevues ont été transférées sur cartes perforées en vue d'une étude étiologique ultérieure. On a noté, pour chaque personne, des détails sur la profession, le niveau d'instruction, la religion et des habitudes comme le fait de chiquer ou de fumer du tabac

(quantité, sorte et fréquence), de boire (nature et quantité), de se laver la bouche et les dents, etc.

On a constaté des corrélations directes entre un certain nombre des facteurs étudiés et l'incidence du cancer de la bouche, mais l'usage du tabac à chiquer de Mainpuri jouait un rôle certain et il y avait une nette relation dose-effet entre le cancer de la bouche et la fréquence et la durée de la mastication, ainsi que les quantités utilisées. On a aussi établi une relation entre la consommation de boissons alcoolisées locales, du whisky surtout, et le risque de cancer de la bouche, bien que, pour plusieurs raisons, ce facteur ne puisse pas être considéré comme une cause majeure de la forte endémicité du cancer de la bouche. La consommation d'alcool ne jouerait qu'un rôle auxiliaire. En fait, la prédisposition la plus forte a été observée parmi les personnes chez lesquelles existaient plusieurs habitudes, particulièrement celles de mâcher et fumer du tabac (surtout du tabac de Mainpuri) et de boire.

Cette enquête se caractérise surtout par les méthodes auxquelles on a eu recours. La plupart des travaux antérieurs sur ce sujet étaient surtout fondés sur l'étude contrôlée de cas ou des études rétrospectives. Au cours des présentes investigations, on a mesuré directement le risque, en fonction des diverses conditions de milieu, dans la population du district et il ne fait aucun doute que cette technique permet de réunir les renseignements épidémiologiques les plus sûrs.

*Annex*

## MAINPURI TOBACCO AND ITS PREPARATION

Mainpuri tobacco is extensively manufactured in various parts of Mainputi district and also in some of the neighbouring districts. It is basically a mixture of the following ingredients :

(1) Tobacco leaves

(2) Finely cut betel nuts

(3) Slaked lime

(4) Cloves

(5) Cardamom seeds

(6) *Kewara* (extract from the fragrant flower of *Pandanus odoratissimus)*

(7) Sandalwood powder.

*Source*

Mainpuri tobacco is prepared from the leaves of tobacco plants cultivated in Aliganj (Etah district) and Karimanj (Farrukhabad district)—each some 55 km from Mainpuri—and in Rampur (Etah district)—some 65 km from Mainpuri. The slaked lime is obtained from Udaipur (Rajasthan) and Satna (Madhya Pradesh). Betel nuts are obtained from Bombay, Calcutta, Assam and Madras.

*Preparation*

Pieces of tobacco leaves, finely cut betel nut and other ingredients are mixed thoroughly with lime. The finished product is a dry powder with coarse particles of betel nut and tobacco. Two types of Mainpuri tobacco are used in the Mainpuri district. They are the Kapuri type, and the Long type.

Another type of tobacco is known as *Aunchhe wala* tobacco—the so-called "Pattiwala tobacco"—which was previously prepared in Aunchae, some 40 km from Mainpuri. The salient points of difference between the different kinds of Mainpuri tobacco and Pattiwala tobacco are shown in Table 33.

### TABLE 33.  INGREDIENTS OF MAINPURI AND PATTIWALA TOBACCOS

| Ingredients | Mainpuri tobacco | | Pattiwala tobaccos |
|---|---|---|---|
| | Kapuri type | Long type | |
| Tobacco | Major ingredient | Main ingredient | Main ingredient |
| Other ingredients | | | |
| Slaked lime | Constantly used | Constantly used | Constantly used |
| Betel nuts | Thick cut (dry betel nuts used) | Finely cut nuts kept wet for 5-6 days then cut with betel nut cutters | Thick cut |
| Cloves | Constantly used | Constantly used | Constantly used |
| *Ilaichi* (cardamon) | Constantly used | Constantly used | Constantly used |
| Sandalwood powder | nil | Constantly used | nil |
| *Kewara* (extracted from flowers of *Pandanus odoratissimus)* | | | |
| Camphor | Constantly used | nil | nil |
| *Shital chini* (allspice) | Used by addicts | May or may not be used by those who are habituated | |
| *Peppermint* | Constantly used | nil | nil |
| *Jaiphal* (nutmeg) | nil | nil | May be used |
| *Javitri* (mace) | nil | nil | May be used |
| *Kattha* (catechu) | nil | May be used | May be used |