Time Trends in the Mortality Rates for Tobacco- and Alcohol-Related Cancers within the Oral Cavity and Pharynx in Japan, 1950-94

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Mortality data of oral cancer over 40 years in Japan were analyzed to investigate time trends of the disease site-specifically and discuss the relation between these trends and the changing patterns of consumption of tobacco and alcohol beverages. Mortality rates were adjusted to the world standard population. In the males, overall oral cancer (ICD-9: 141-149) mortality rates have increased consistently from the lowest value of 1.25 (per 100,000 per year) in 1956 to 2.40 in 1992. The rates for females were constantly lower than those for males, and formed a modest peak of 0.96 in 1979. Regarding site-specific mortality rates, tongue cancer (141) presented a decreasing trend, while oro/hypopharyngeal (146,148) and mouth (143-145) cancers showed increasing patterns, particularly in males. When the changing patterns of male truncated rates for ages 35-64 were compared with those of the annual consumption of cigarette and alcohol per capita, the time trend of oro/hypopharyngeal cancer mortality was analogous to cigarette consumption rather than to alcohol consumption, mouth cancer vice versa, and tongue cancer was not related to tobacco or alcohol consumption. The present findings suggest that tobacco and alcohol have different site-specific effects on the development of cancers within the oral cavity and pharynx. J Epidemiol, 1999; 9: 46-52

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Mortality and incidence rates for cancers within the oral cavity and pharynx have been increasing in the second half of this century in many parts of the world 1-5). Reports 1, 2 from the United States indicated that a sharp increase in mortality from tongue cancer occurred among young white males in the 1980s, and a similar finding was observed in Scottish males 3). A report 4 from Denmark showed marked increases in the incidence of cancers of the mouth, pharynx and tongue after around 1960. Following these findings, a feature article 5 on mortality trends of cancers of digestive sites, using the World Health Organization database of 28 European countries, ascertained upward increases in oral and pharyngeal cancer particularly among young and middle-aged males in most of the countries during the period examined (1955-1989). Cancers within the oral cavity and pharynx are thus becoming an important public health problem worldwide.

Cigarette smoking and alcohol drinking have been considered major risk factors for these cancers 6, 7). However, their etiologic roles have usually been evaluated by treating all cancers within the oral cavity and pharynx as a single group, probably because these sites have the same histological background. Only limited studies 8-10 have examined the differential effects of these risk factors on anatomic sites, but no consistent conclusions have been obtained. In Japan, cigarette consumption has decreased since the mid-1970s, while alcohol consumption has constantly increased over the past 40 years. These different patterns of consumption provide a good opportunity to consider their different etiologic roles on the cancers of the oral cavity and pharynx. In the present study, we observed the mortality time trends of site-specific cancers of the oral cavity and pharynx during a recent 40-year period in Japan, and discuss the relation between these trends and the changing patterns of consumption of tobacco, alcohol, and green-yellow vegetables that have shown protective effects 12, 13 against oral cancer.

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MATERIALS AND METHODS

We retrieved the mortality data of cancers within the oral cavity and pharynx from the Japan national vital statistics for 1950-1994, which were tabulated in a form with the patients' cause of death, sex and 5-year age bracket. The earliest data used in the present study were for 1950, when the Sixth Revision of the International Classification of Diseases (ICD) became effective in Japan. Although four different revisions were in use during the period examined (1950 to 1994), we classified all death causes according to ICD 9, which codes malignant neoplasms of the lip, oral cavity and pharynx under the rubrics 140-149. In the present study, we used oral cancer as the term including all of the diseases under the rubrics 140-149. When conducting site-specific analyses, besides the tongue (141), we examined a group of mouth cancers consisting those of the gum (143), floor of mouth (144), and other and unspecified parts of mouth (145). We combined the oro- (146) and hypopharynx (148) because of their similarities of epidemiological characteristics, and excluded cancers of the lip (140), salivary glands (142), nasopharynx (147) and sites unspecified (149) because these four cancers have diverse etiologic factors such as viruses and ultraviolet radiation.

Sex- and age-specific populations in the groups congregated in 5-year age brackets were derived from the national census data filed every five years, and those during intercensus years were interpolated linearly from the previous and subsequent census data. To obtain stable mortality rates, we used weighted five-year moving averages of deaths: \( \frac{n_0 + 2 \cdot n_1 + 4 \cdot n_2 + n_3 + 6 \cdot n_4 + n_5 + 4 \cdot n_6 + n_7}{16} \). As a result, the earliest and latest mortality rates yielded were for 1952 by using the data from 1950 to 1954, and for 1992 from 1990 to 1994, respectively. Age-adjusted rates for all ages and truncated 35-64 year-olds were based on the World Standard Population and plotted against the calendar year. In addition, five-year age-specific rates were plotted by the central year of birth in order to observe cohort effects. The available data from 1952 to 1992 inclusive made nine different birth cohorts in each of the five-year age classes. Among all the cohorts, those aged over 85 in 1952 made the oldest cohort born in a period centered on 1865, and those between the ages of 30-34 in 1992 made the youngest cohort centered on 1960. Unless otherwise stated in the text, the mortality rates are expressed per 100,000 per year. The mortality rates are illustrated by logarithmic scale because of their wide ranges, and deaths occurred under age 30 were excluded due to the small number of such cases.

RESULTS

Oral cancer

Figure 1 illustrates the age-adjusted mortality rates over the entire period from 1952 to 1992 and age-specific rates by central year of birth for oral cancer. In the males, the mortality rates for all ages tended to decrease in the early 1950s and showed in 1956 the lowest value of 1.25 followed by a consistent increase to 2.40 in 1992. A similar time trend was demonstrated among the truncated rates with the highest value of 4.53 in 1992, a value two-times greater than 2.21 in 1956. The age-specific analyses revealed that the later the birth year, the higher the mortality rates in every five-year age subgroup except for 1865-1900.
those in their 30s. In the females, the mortality rates for all and truncated ages were much lower than those in the males throughout the period examined. The rates for all ages remained relatively stable between 0.7 and 1.0 with a slight peak of 0.93 in 1979, and the latest value was 0.75 in 1992. Regarding the truncated rates, a similar time trend with higher values was obtained. The rates ranged from 1.1 to 1.4 and tended to decrease after modest peaks of 1.40 in 1969 and 1.42 in 1975. The age-specific analyses showed slight or no clear increases for all age subgroups except 85 and over.

**Tongue cancer**

The tongue cancer mortality rates are presented in Figure 2. The highest rates were 0.69 among the males in 1952 and 0.38

![Figure 2](image-url)

**Figure 2.** Mortality rates from tongue cancer (ICD 9, 141) in Japan. In the right panel, the broad and narrow lines represent the first and second five-year in decade of each age.

![Figure 3](image-url)

**Figure 3.** Mortality rates from mouth cancer (ICD 9, 143-145) in Japan. In the right panel, the broad and narrow lines represent the first and second five-year in decade of each age.
among the females in 1957 for all ages. Thereafter, the death rates declined gradually to 0.55 in males and 0.25 in females in 1992. Similar time trends were observed for the truncated rates but with higher values, particularly in males. The male age-specific rates showed downward trends among those over 60 and irregular but basically unchanged patterns between the ages of 30 and 59 years. In the females, the age-specific rates tended to decrease in all subgroups, particularly in those under 60 of age.

**Mouth cancer**

As depicted in Figure 3, the male mortality rates from mouth cancer for all ages showed a slight decrease in the 1950s, reaching a low of 0.20 in 1958, and then a gradual increase followed by unchanged rates in the 1980s. The rate in 1992 was 0.42, 2.1 times higher than that in 1958. The truncated rates in the males increased through the 1980s and reached 0.74 in 1992. The age-specific rates showed greater upward trends among those aged 50 and over, in particular, between 50 and 69. In the females, the mortality rates showed slight increases in all ages and the truncated ages, and no differences developed between those over the study period. The truncated rate of 0.22 in 1992 was 3.4 times less than the corresponding rate in the males. The age-specific rates showed modest increases among those over 55, but were unchanged between ages 40 and 54, and were irregular for ages under 40 due to the small numbers of deaths.

**Oropharyngeal cancer**

Figure 4 illustrates the mortality from cancers of the oropharynx plus hypopharynx. In the males, the mortality rates rose by 13-fold from 0.06 in 1952 to 0.79 in 1992 for all ages, and a similar increase occurred in the truncated rates from 0.11 to 1.52 with two notches in 1961 and 1972. The age-specific rates increased markedly in all age subgroups except those in their 30s. In the females, in contrast, increases in the mortality rates continued up to the mid-1980s and downward trends thereafter occurred for both all ages and the truncated ages, although the latter had higher values throughout the study period. The age-specific rates showed irregular patterns, mainly due to the small numbers of deaths, but unchanged trends following steep increases were observed in most of the age subgroups.

**Tobacco, alcohol and green-yellow vegetables consumption**

Figure 5 shows the trends of annual consumption of cigarettes and alcohol per capita with those of the male truncated rates of tongue, oro/hypopharyngeal and mouth cancers which were already shown (Figure 2-4). The daily consumption of green-yellow vegetables (hereafter referred to as GYV) per capita was added to the Figure. Cigarette consumption increased consistently except for the period during World War II, formed a peak of 3,947 per person/year in 1977 and then decreased gradually, while alcohol consumption increased up to 8.95 1/person/year in 1992 after the war. GYV consumption fluctuated but increased substantially from 38.6 in 1962 to 80.9 g/day/person in 1992. The changing pattern of tongue cancer mortality did not parallel that of cigarette, alcohol or GYV consumption. The trend of oro/hypopharyngeal cancer mortality was rather analogous to that of cigarette consump-
Figure 5. Changing patterns of tobacco, alcohol and green-yellow vegetables (GYV) consumption per capita with male truncated mortality rates of cancers of the tongue (ICD 9, 141), mouth (143-145) and oropharynx (146, 148) for the years 1920-1992. A dotted part in a line of GYV consumption shows estimations from the preceding and following values.

Figure 5. Changing patterns of tobacco, alcohol and green-yellow vegetables (GYV) consumption per capita with male truncated mortality rates of cancers of the tongue (ICD 9, 141), mouth (143-145) and oropharynx (146, 148) for the years 1920-1992. A dotted part in a line of GYV consumption shows estimations from the preceding and following values.

DISCUSSION

In the present study, we used the mortality data collected throughout Japan for over 40 years since 1950. The mortality trends noted here are likely to be accurate. Were the trends caused solely by changes in the methods of description on death certificates, or in the notification or coding practices for the diseases, the changing patterns of mortality between males and females would have been identical, in contrast to the present result (Figure 1). Comparability of mortality rates was unlikely to be held over a study period, however, because the probability of oral cancer patients who survived for more than five years has been increasing. Therefore the mortality of the cancer in recent years reflected the corresponding incidence much less than what it had used to be. We must keep this fact in mind when looking at the time trends of oral cancer mortality rates.

In most of the European countries, New Zealand and the USA, upward trends in oral cancer mortality have been recognized since the mid-20th century, particularly in the truncated ages of 35-64 among males. These changes are caused by increases in the mortality rates occurring among the cohorts born only after some point between 1905 and 1920. Such cohort effects are rarely found among females, who have much lower mortality rates from these cancers than males. The present study of Japanese subjects also showed the increasing trend of oral cancer in males after 1956, and lower rates among females than males (Figure 1). However, a steeper trend in the truncated rates were not observed. In addition, constant cohort-based increases were observed among males throughout the birth years of 1865-1960. In the males, the latest mortality rates
were 2.40 for all ages and 4.53 for the truncated ages. These values are comparable with those in Norway, Sweden, Netherlands, Iceland, and England and Wales, whose rates are rather low among 28 European countries.8

Congregating all cancers within the oral cavity and pharynx into a single group such as oral cancer as shown above was advantageous to international comparisons because most of the published studies treated mortality data in this way. Grouping the cancers together, however, masks different patterns of cancer mortality at individual anatomic sites and may influence etiologic considerations. We therefore conducted site-specific analyses and clarified a decreasing trend of tongue cancer (Figure 2) but increasing trends of cancers of the mouth (Figure 3) and oro/hypopharynx (Figure 4) among the males.

Several case-control studies9,10 evaluating oral cancer site-specifically revealed that both tobacco and alcohol act as independent risk factors for tongue cancer. Our study, however, presented inconsistent findings: tongue cancer mortality showed a downward trend in spite of the upward patterns of cigarette and alcohol consumption per capita (Figure 5). Cigar and pipe tobacco also carry a risk9,10 of developing tongue cancer, and oral snuff is considered to have caused the steep increase in this mortality rate among the younger generation in the United States1,2, although a study of Scottish males31 argues against such a causal relation. In Japan, these types of tobacco usage (cigars, pipes and snuff) have scarcely been engaged in over a long period. It is unlikely hence that a marked decrease in the number of people with such smoking habits occurred to the extent to affect the trend of tongue cancer mortality observed here. Decreases in the prevalence of heavy smokers and drinkers might be a plausible explanation for our inconsistent finding. Unfortunately, we do not have sufficient information related to these statistics, but such an explanation is doubtful because upward patterns were found in not only the consumption of cigarette and alcohol but also the mortality rates of mouth and oro/hypopharyngeal cancers for which tobacco and alcohol act as risk factors. The changing pattern of GYV consumption, which have been reported to be protective against oral cancer52,15, also dose not explain the inconsistent findings. Over the past 40 years, the prevalence of Japanese with decayed but untreated teeth has decreased from 50% to less than 10%25. This reduction may contribute to the downward trend of the tongue cancer mortality. A case-control study30 showed that people smoking and drinking heavily with poor dentition presented substantially higher odds ratios for oral cancer than those with adequate dentition. This study, however, did not analyze the cases with tongue cancer alone and the dentition status was judged only by the number of decayed teeth. Further research is needed on this point.

In case-control studies8,9,10 focusing on oro/hypopharyngeal cancer, the odds ratios of smoking adjusted for alcohol consumption as well as those of alcohol adjusted for tobacco consumption showed values significantly higher than unity, and their values increased in accord with the increases in tobacco and alcohol consumption. These findings do not conflict with our present results. However, we found that the changing pattern of oro/hypopharyngeal cancer mortality was analogous to that of cigarette consumption rather than alcohol consumption. The approximately 15-year lag which was observed in the two changing patterns between the cancer mortality and tobacco consumption is thought to be a latent period. This assumption can be supported by a couple of epidemiological studies. Statistical increases in odds ratios of years of cigarette smoking for oral cancer (not limited to oro/hypopharyngeal cancer), initiate at around 20 years of smoking period9,15, and a sharp increase in tongue cancer mortality among young white males in the 1980s in the USA is ascribed to the increasing use of oral snuff since the early 1970s1,2. The changing pattern of mouth cancer mortality in the present study was, in contrast, much more like that of alcohol consumption rather than cigarette consumption. This result is in accord with the finding that the odds ratios for the cancer elevate with increases in alcohol consumption9,10,11,13. As in the case of tongue cancer, however, mortality trends of oro/hypopharyngeal and mouth cancers did not seem to correlate with the changing patterns of GYV.

The combined effects8,9,14 of tobacco and alcohol, and the effect of the dietary factors31 (other than GYV) reported to be protective against oral cancer can distort the present results in addition to the ecological fallacy frequently found in studies of this type and changes in the survival rates26 of oral cancer over the study period. Our results suggest, however, that tobacco and alcohol have differential risk effects on cancers of various anatomic sites within the oral cavity and pharynx.

REFERENCES

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