RESEARCH ARTICLE

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Social Characteristics and Community Disparities in Chewing Betel and Mortality in Taiwanese Men: A Community-Correlation Study

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Abstract

Background: In Taiwan, oral cancer mortality is ≥5-fold higher in the community with the highest rate compared to the community with the lowest rate. However, little is known about the community disparity in health relevant to chewing betel in Taiwan and the social background of this disparity. **Methods:** A community-correlation study was conducted with data on social characteristics, male current chewing betel, and male mortality in each city/county of Taiwan. Data were collected via government websites open for public use. To explore the correlations of social characteristics with chewing betel and mortality at the community level, we calculated Spearman's rank correlation coefficients. **Results:** Prevalence of current chewing betel among men aged ≥18 years in 2017 in each city/county ranged from 3.1% to 19.2%. A significant positive correlation was found between chewing betel and age-standardized all-cause mortality in 2021–2022 among the 22 cities/counties (r=0.81, P<0.001). Types of cause-specific mortality with which chewing betel had positive correlations were malignant neoplasm (r=0.67, P<0.001), oral cancer (r=0.81, P<0.001), liver cancer (r=0.57, P=0.006), lung cancer (r=0.54, P=0.01), heart disease (r=0.51, P=0.02), stroke (r=0.69, P<0.001), chronic hepatitis/liver cirrhosis (r=0.75, P<0.001), nephritis/nephropathy (r=0.60, P=0.003), accident/injury (r=0.79, P<0.001), and suicide (r=0.65, P=0.001). Betel plantation area per person (r=0.75, P<0.001), betel sales stores per person (r=0.68, P<0.001), junior high school graduate or less (r=0.53, P=0.01), and low and low-middle household income (r=0.43, P=0.047) in 2017 correlated positively with chewing betel. **Conclusions:** Regional differences in betel plantation area, betel sales stores, low education, and low household income contributed to community disparities in chewing betel and health in Taiwanese men.

Keywords: Chewing betel- community disparity- mortality- social characteristics

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Introduction

Betel consumption is a popular habit in the Asia-Pacific region, especially in Taiwan, India, Bangladesh, and islands in the Pacific Ocean [1, 2]. The method of betel consumption varies among countries, and in Taiwan, it is common to chew a combination of betel nuts, betel leaves and lime paste [1, 3, 4]. Because these materials undergo chemical reactions that produce products with stimulant properties in chewers [5, 6], Taiwanese taxi drivers and truck drivers habitually chew betel [7, 8]. In addition, betel is given as a wedding gift and used as an aid during prayer in Taiwan [4]. In particular, Taiwanese aborigines, who account for approximately 2% of the population of Taiwan, follow the culture of chewing betel, and continuously chew betel [9, 10].

Betel is classified as a group 1 carcinogenic substance by the International Agency for Research on Cancer [11], and causality has been established between betel exposure and some types of cancer, especially oral cancer, due to the method of betel consumption [12, 13]. In recent years, in the Taiwanese population, the reported incidence of oral cancer has been 33–35 per 100,000 [14], and oral cancer has had the third or fourth highest incidence of all cancers [15]. In the Taiwanese male population, mortality from oral cancer is approximately 27 per 100,000 and oral cancer has the fourth highest cancer mortality in 2022 [16]. These indices of oral cancer in Taiwan are higher than those in other Asian countries where betel plantations and consumption are uncommon [17-19]. Therefore, betel consumption is a critical public health issue in Taiwan [20]. Interestingly, there is a community disparity in oral cancer mortality in Taiwan, in that oral cancer mortality is over 5-fold higher in the community with the highest rate compared to the community with the lowest rate after age-standardization [16, 21]. However, little is known about the community disparity in detailed health outcomes relevant to chewing betel in Taiwan and

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the social background characteristics associated with this community disparity. Therefore, the present study aimed to investigate this topic using data on social characteristics, chewing betel and all-cause and cause-specific mortality in each community of Taiwan.

Materials and Methods

Study design

A community-correlation study, or an ecological study, was conducted to investigate social characteristics associated with community disparities in chewing betel and all-cause and cause-specific mortality in Taiwan by exploring the correlations among these indices at the community level. A community was defined as each of the 22 cities/counties in Taiwan, including New Taipei City, Taipei City, Taoyuan City, Taichung City, Tainan City, Kaohsiung City, Ilan County, Hsinchu County, Miaoli County, Changhua County, Nantou County, Yunlin County, Chiayi County, Pingtung County, Taitung County, Hualien County, Penghu County, Keelung City, Hsinchu City, Chiayi City, Kinmen County, and Lienchiang County. Data on social characteristics, chewing betel and mortality in each city/county were collected via the Taiwanese government websites open for public use. Institutional review for ethical issues was needed because individuals were not involved in data used in this study.

The prevalence of current chewing betel in 2017 was 6.1% in the Taiwanese adult male population and varied among the 22 cities/counties to some extent [21]. In contrast, the prevalence of current chewing betel in 2017 was 0.3% in the Taiwanese adult female population and was broadly similar across the 22 cities/counties [21]. These facts suggested a community disparity in health attributable to chewing betel only for Taiwanese men. Therefore, we investigated the community-correlations of interest only for men. We used community data on chewing betel prevalence and mortality in a general male population (i.e., Taiwanese aborigines + Han Chinese + others) of the 22 cities/counties in Taiwan.

Data collection

Data collected via the Taiwanese government websites included social characteristics, current chewing betel (males only) [21], current other addiction behaviors (males only) and all-cause and cause-specific mortality (males only) [16, 22] in each city/county. Data on social characteristics, chewing betel and other addiction behaviors were from 2017, whereas data on mortality were from both 2021 and 2022, with the average taken as mortality per one year. Because we assumed that time-course data were necessary for causal factors and health outcomes, we set a time lag between causal factors (i.e., social characteristics, chewing betel and other addiction behaviors) and health outcomes (i.e., mortality). Data on social characteristics that we assumed as causes of chewing betel included total population size [23], proportion of Taiwanese aborigines among the total population [23], betel plantation area per person [23, 24], betel sales stores per person [23, 25, 26], proportion of junior high school graduates or less among people aged ≥15 years [27], proportion of low and low-middle income household members among the total population [28, 29], unemployment rate [30], and criminal offense rate [31]. Registration of betel sales stores on 31 December 2017 were summarized for each city/county. Low and low-middle income households were certified by the government and eligible for preferential treatment. The prevalence of current chewing betel and other addiction behaviors was determined for men aged ≥18 years. Data on other addiction behaviors that we assumed to be confounding factors for the association between chewing betel and mortality included smoking tobacco [21] and drinking alcohol of one unit per day or more [21]. Data on all-cause and cause-specific mortality included both crude and age-standardized mortality [16, 22]. Age-standardization was based on the world population in 2000 defined by the World Health Organization. Types of cause-specific mortality were based on the International Classification of Diseases, Tenth Revision (ICD-10) and used only if data were provided for both 2021 and 2022.

Statistical analysis

Spearman's rank correlation coefficients and P-values were obtained as indicators of the degree of the linearity between two variables. Analyses were performed using Stata 17 (StataCorp LP, College Station, TX, USA). All probability values were two-tailed, and the significance level was set at $P < 0.05$.

First, we examined the correlations between chewing betel prevalence and mortality among the 22 cities/counties of Taiwan to explore a community disparity in health relevant to chewing betel. Second, we examined the correlations of each of the social characteristics listed earlier with both the prevalence of chewing betel and mortality among the 22 cities/counties to explore both a community disparity in chewing betel relevant to social characteristics and a community disparity in health relevant to social characteristics. Third, we examined the correlation of the prevalence of chewing betel with both the prevalence of smoking tobacco and the prevalence of drinking alcohol among the 22 cities/counties to assess the existence and extent of potential confounding effects of these addiction behaviors on the association between chewing betel and health. Finally, we examined the intercorrelations among social characteristics in the 22 cities/counties to evaluate the potential confounding effects of other social characteristics on the association of a social characteristic with both chewing betel and health.

Results

Correlations between chewing betel and mortality

The prevalence of current chewing betel among men aged ≥18 years in 2017 in each city/county ranged from 3.1% to 19.2% (Figures 1 and 2). All-cause mortality (/100,000 persons) per 1 year of 2021–2022 in each city/county also showed a wide distribution ranging from 569.9 to 1388.1, and the mortality remained widely distributed even after age standardization (Figure 2). There was a statistically significant positive correlation between chewing betel and age-standardized all-cause

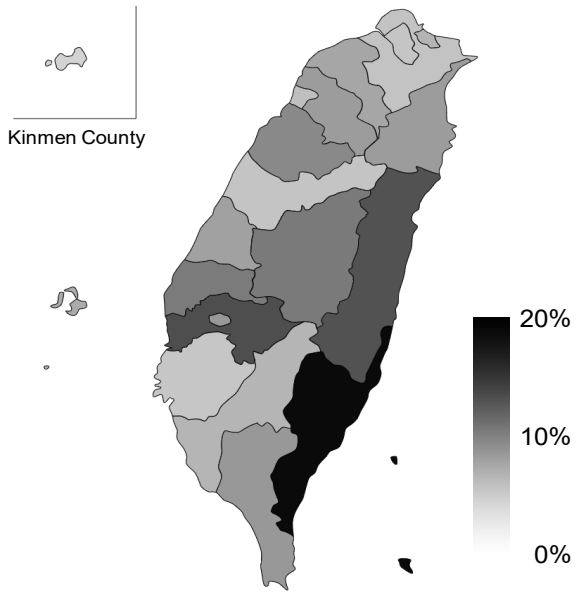

Figure 1. The Prevalence of Current Chewing Betel among Men Aged ≥ 18 Years in each of the 21 cities/counties in Taiwan except for Lienchiang County (4.3%).

mortality for men among the 22 cities/counties (r=0.81, P<0.001) (Figure 2 and Table 1). Types of cause-specific mortality with which chewing betel had significant positive correlations were malignant neoplasm (r=0.67, P<0.001), oral cancer (r=0.81, P<0.001), liver cancer (r=0.57, P=0.006), lung cancer (r=0.54, P=0.01), heart disease (r=0.51, P=0.02), stroke (r=0.69, P<0.001), chronic hepatitis/liver cirrhosis (r=0.75, P<0.001), nephritis/nephropathy (r=0.60, P=0.003), accident/injury (r=0.79, P<0.001), and suicide (r=0.65, P=0.001) (Table 1 and Supplementary Figure 1).

Correlations between social characteristics, chewing betel and mortality

Betel plantation area per person (/100,000 persons) in 2017 in each city/county ranged from 0 km2 to 26.5 km2 (Supplementary Figure 2c). Betel plantation area had a significant positive correlation with chewing betel (r=0.75, P<0.001) and age-standardized all-cause mortality (r=0.79, P<0.001) for men among the 22 cities/counties (Supplementary Figure 2c and Table 2a). Types of cause-specific mortality with which betel plantation area had significant positive correlations were malignant neoplasm, oral cancer, liver cancer, lung cancer, diabetic disease, stroke, chronic hepatitis/liver cirrhosis, nephritis/nephropathy, accident/injury, and suicide (Table 2a).

Betel sales stores per person (/100,000 persons) in 2017 in each city/county ranged from 4.4 to 103.4 (Supplementary Figure 2d). Betel sales stores per person had a significant positive correlation with chewing betel (r=0.68, P<0.001) and age-standardized all-cause mortality (r=0.65, P=0.001) for men among the 22 cities/counties (Supplementary Figure 2d and Table 2a). Types of cause-specific mortality with which betel sales stores had significant positive correlations were malignant neoplasm, oral cancer, liver cancer, heart disease, stroke, chronic hepatitis/liver cirrhosis, nephritis/nephropathy, accident/injury, and suicide (Table 2a).

The proportion of junior high school graduates or less among people aged ≥15 years in 2017 in each city/county ranged from 4.7% to 46.5% (Supplementary Figure 2e). Low levels of education had a significant positive correlation with chewing betel (r=0.53, P=0.01) and age-standardized all-cause mortality (r=0.49, P=0.02) for men among the 22 cities/counties (Supplementary Figure 2e and Table 2b). Types of cause-specific mortality with which low levels of education had significant positive correlations were malignant neoplasm, oral cancer, liver cancer, lung cancer, chronic hepatitis/liver cirrhosis, and accident/injury (Table 2b).

Table 1. Correlations between Current Chewing Betel (2017) and Mortality (2021–2022) for Men among the 22 Cities/Counties of Taiwan.

	Prevalence of current chewing betel	
Mortality (crude and age-standardized)	(Crude)	(Age-stand.)
All-cause	0.79**	0.81**
Malignant neoplasm (C00-C97)	0.69**	0.67**
Oral cancer (C00-C06, C09-C10, C12-C14)	0.80**	0.81**
Gastric cancer (C16)	0.1	-0.08
Liver cancer (C22)	0.59**	0.57**
Lung cancer (C33-C34)	0.58**	0.54**
Diabetic disease (E10-E14)	0.44*	0.4
Heart disease (I01-I02.0, I05-I09, I20-I25, I27, I30-I52)	0.61**	0.51*
Hypertensive disease (I10-I15)	0.46*	0.25
Stroke (I60-I69)	0.80**	0.69**
Chronic hepatitis/liver cirrhosis (K70, K73-K74)	0.79**	0.75**
Nephritis/nephropathy (N00-N07, N17-N19, N25-N27)	0.76**	0.60**
Accident/injury (V01-X59, Y85-Y86)	0.79**	0.79**
Suicide (X60-X84, Y87.0)	0.69**	0.65**

Spearman's rank correlation coefficient: * P<0.05, ** P<0.01

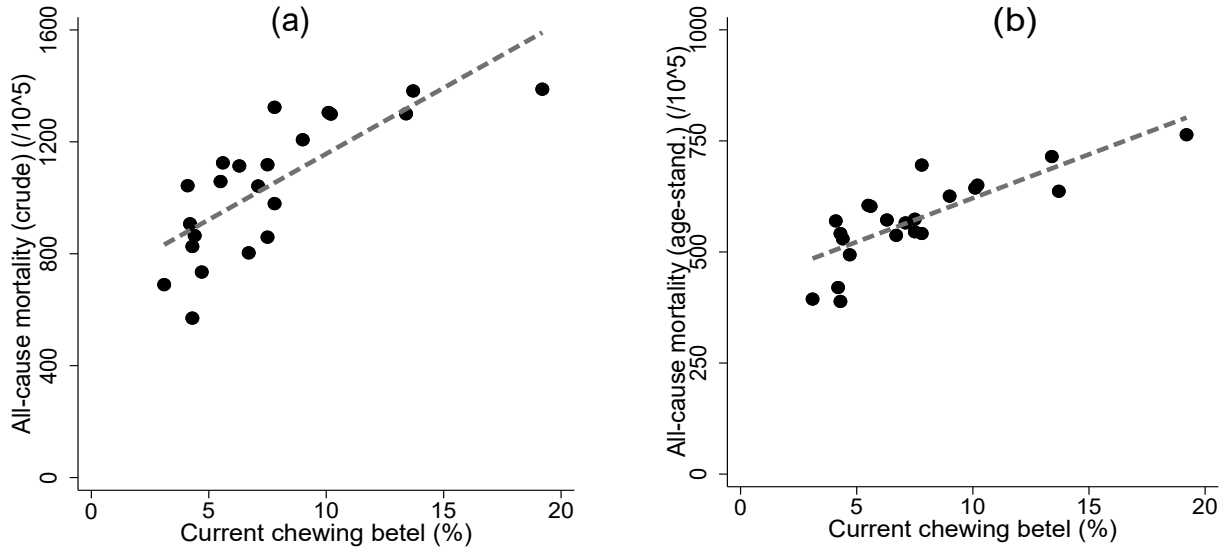

Figure 2. Scatter Plot of the Prevalence of Chewing Betel (%) in 2017 and (a) crude all-cause and (b) age-standardized all-cause mortality (/100,000) per 1 year of 2021–2022 for men among 22 cities/counties of Taiwan. Broken lines were drawn when the test for Spearman's rank correlation was significant (P<0.05).

The proportion of low and low-middle income household members among the total population in 2017 in each city/county ranged from 0.7% to 7.3% (Supplementary Figure 2f). Low household income had a significant positive correlation with chewing betel (r=0.43, P=0.047) and age-standardized all-cause mortality (r=0.71, P<0.001) for men among the 22 cities/counties (Supplementary Figure 2f and Table 2b). Types of cause-specific mortality with which low household income had significant positive correlations were malignant neoplasm, oral cancer, liver cancer, lung cancer, stroke, chronic hepatitis/liver cirrhosis, nephritis/nephropathy, and accident/injury (Table 2b).

Total population size, proportion of Taiwanese aborigines among the total population, unemployment rate, and criminal offense rate did not have any significant correlations with chewing betel among the 22 cities/counties (Supplementary Figures 2a, b, g, and h and Tables 2a and b).

Correlations between chewing betel and each of smoking tobacco and drinking alcohol

The prevalence of current smoking tobacco among

Table 2a. Correlations of Social Characteristics (2017) with Current Chewing Betel (2017) and Mortality (2021–2022) for Men among the 22 cities/counties of Taiwan.

	Total population size	Prop. of Taiwanese aborigines	Betel plantation area per person	Betel sales stores per person
Prevalence of current chewing betel	-0.23	0.42	0.75**	0.68**
Mortality (age-standardized)				
All-cause	-0.07	0.43*	0.79**	0.65**
Malignant neoplasm (C00-C97)	-0.06	0.03	0.64**	0.47*
Oral cancer (C00-C06, C09-C10, C12-C14)	-0.11	0.22	0.78**	0.68**
Gastric cancer (C16)	0.11	-0.02	0.56**	0.37
Liver cancer (C22)	-0.43*	0.27	-0.26	0.13
Lung cancer (C33-C34)	-0.13	-0.14	0.53*	0.48*
Diabetic disease (E10-E14)	-0.06	0.28	0.36	0.47*
Heart disease (I01-I02.0, I05-I09, I20-I25, I27, I30-I52)	-0.04	0.43*	0.68**	0.43*
Hypertensive disease (I10-I15)	0.02	0.37	0.25	0.21
Stroke (I60-I69)	0.26	0.2	0.53**	0.21
Chronic hepatitis/liver cirrhosis (K70, K73-K74)	-0.31	0.51*	0.64**	0.80**
Nephritis/nephropathy (N00-N07, N17-N19, N25-N27)	-0.13	0.25	0.67**	0.69**
Accident/injury (V01-X59, Y85-Y86)	-0.27	0.51*	0.70**	0.75**
Suicide (X60-X84, Y87.0)	-0.25	0.36	0.55**	0.77**

Spearman's rank correlation coefficient: * P<0.05, ** P<0.01

Table 2b. Correlations of Social Characteristics (2017) with Current Chewing Betel (2017) and Mortality (2021–2022) for Men among the 22 cities/counties of Taiwan.

	Prop. of junior high school graduates or less	Prop. of low and low-middle income household members	Unemployment rate	Criminal offense rate
Prevalence of current chewing betel				
Mortality (age-standardized)				
All-cause	0.49*	0.71**	0.04	0.46*
Malignant neoplasm (C00-C97)	0.47*	0.75**	-0.01	0.32
Oral cancer (C00-C06, C09-C10, C12-C14)	0.56**	0.71**	-0.17	0.31
Gastric cancer (C16)	0.56**	0.57**	0.15	0.39
Liver cancer (C22)	0.09	0.09	-0.2	-0.04
Lung cancer (C33-C34)	0.48*	0.59**	-0.2	0.07
Diabetic disease (E10-E14)	0.41	0.37	0.22	0.38
Heart disease (I01-I02.0, I05-I09, I20-I25, I27, I30-I52)	0.17	0.43*	0.07	0.47*
Hypertensive disease (I10-I15)	-0.26	0.16	0.2	0.08
Stroke (I60-I69)	-0.05	0.33	0.19	0.28
Chronic hepatitis/liver cirrhosis (K70, K73-K74)	0.67**	0.57**	-0.27	0.19
Nephritis/nephropathy (N00-N07, N17-N19, N25-N27)	0.31	0.50*	-0.28	0.25
Accident/injury (V01-X59, Y85-Y86)	0.72**	0.51*	-0.25	0.31
Suicide (X60-X84, Y87.0)	0.33	0.19	-0.1	0.50*

Spearman's rank correlation coefficient: * P<0.05, ** P<0.01

Table 3. Correlations of Current Chewing Betel (2017) with Current Smoking Tobacco and Drinking Alcohol (2017) for Men among the 22 cities/counties of Taiwan.

	(a)	(b)	(c)
(a) Prevalence of current chewing betel	—		
(b) Prevalence of current smoking tobacco	0.24	—	
(c) Prevalence of current drinking alcohol*	0.36	0.44	—

Spearman's rank correlation coefficient: P=0.20 for (a) vs. (b), P=0.36 for (a) vs. (c), and P=0.11 for (b) vs. (c). Drinking alcohol was defined as drinking 1 or more unit of alcohol per day. *Data missing for 2 counties

men aged ≥18 years in 2017 in each of the 22 cities/counties ranged from 17.7% to 41.3%. The prevalence of current drinking alcohol of one unit per day or more among men aged ≥18 years in 2017 in each of the 20 cities/counties ranged from 20.7% to 39.3% (alcohol data were missing for 2 counties). Neither smoking tobacco nor drinking alcohol had any significant correlation with chewing betel for men among the 22 and 20 cities/counties, respectively (Table 3).

Intercorrelations among social characteristics

Some social characteristics had significant positive or inverse correlations with other social characteristics among the 22 cities/counties (Table 4).

Discussion

The prevalence of chewing betel among male adults in each city/county of Taiwan showed a wide distribution, likely to be in accordance with the community disparity in all-cause and some types of cause-specific mortality in Taiwanese men. Regional differences in betel plantation area per person, betel sales stores per person, proportion of junior high school graduates or less, and proportion of individuals with low and low-middle household income were likely to be in accordance with the community disparity in chewing betel and all-cause and some types

Table 4. Intercorrelations among Social Characteristics (2017) in the 22 cities/counties of Taiwan.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
(a) Total population size	—							
(b) Prop. of Taiwanese aborigines	-0.12	—						
(c) Betel plantation area per person	0.21	0.44*	—					
(d) Betel sales stores per person	-0.51*	0.42	0.48*	—				
(e) Prop. of junior high school graduates	-0.34	0.19	0.43*	0.50*	—			
(f) Prop. of low income household members	0.06	0.18	0.47*	0.49*	0.24	—		
(g) Unemployment rate	0.52*	0.07	0.09	-0.3	-0.39	0.01	—	
(h) Criminal offense rate	0.02	0.2	0.42	0.34	-0.004	0.31	0.36	—

Spearman's rank correlation coefficient: * P<0.05

of cause-specific mortality in Taiwanese men. However, total population size, Taiwanese aboriginal origin, unemployment, and criminal offense did not contribute to the community disparity in male chewing betel. Although several studies have identified personal characteristics associated with chewing betel [10, 32, 33], no study to date has investigated whether community characteristics were associated with both chewing betel and its related health characteristics in Taiwan.

The clear strong correlation that we observed between chewing betel and mortality for men in each community suggested a community disparity in health attributable to chewing betel. Although our study was limited to serious diseases that lead to death, the results summarized in Tables 1 and 2 suggested that a community disparity in health is present for malignant neoplasm (especially oral cancer, liver cancer, and lung cancer), heart disease, stroke, chronic hepatitis/liver cirrhosis, nephritis/nephropathy, accident/injury, and suicide. Previous epidemiological studies reported associations of chewing betel with these diseases (other than accident/injury and suicide) [12, 13, 34-38], supporting the results of our study. Although our study was an ecological study, it is noteworthy that our study showed correlations between chewing betel and accident/injury and suicide. However, causality should be considered carefully. The characteristics of individuals who like chewing betel with physiological activities [5, 6], for example, manual labor and driving for long hours [7, 8], may easily lead to accidents and injuries. Meanwhile, chewing betel is addictive [39] and is associated with common mental disorders [40]. Consequently, betel chewers who have these characteristics are more likely to commit suicide.

Of the social characteristics that lead to a community disparity in both chewing betel and health, characteristics directly relevant to chewing betel were betel plantation area per person and betel sales stores per person. These results suggested that the community disparity in chewing betel and health depends on whether residents were close to betel supply sources. As shown in Table 4, the correlation between betel plantation area per person and betel sales stores per person was weak to moderate (r=0.48) among the 22 communities. Therefore, these two social characteristics may independently influence the community disparity in chewing betel and health. However, we must draw conclusions carefully as to betel plantation area per person in light of the relevant scatter plots in Supplementary Figure 2. It is reasonable that regional differences in betel sales stores per person, in other words the ease of purchasing betel, may contribute to the community disparity in chewing betel and health mentioned earlier. Despite the popularity of betel consumption in some countries of the Asia-Pacific region [1, 2], there is a unique commercial form of betel in Taiwan sold by young women with fancy clothing inside or outside of stores with ornate decorations, who are known as "betel nut beauties" [8]. "Betel nut beauties" are thought to encourage Taiwanese people to consume betel [8]. However, we must pay attention to the reverse causality, such that a higher demand for betel may lead to a greater number of betel sales stores.

At the individual level, a low educational level is associated with chewing betel [32, 33]. In addition, a previous study using multilevel analysis suggested that at the community level, a higher prevalence of low education is associated with a higher prevalence of chewing betel [32]. Similarly, low income is also associated with chewing betel at both the individual [33] and community levels [32]. Consistent with these results, our study suggested that regional differences in low education and low household income contributed to the community disparity in both chewing betel and its related health characteristics.

The proportion of Taiwanese aborigines among the total population in the majority of communities was approximately 2%. While that proportion is equivalent to that in Taiwan overall, there is the exception of a few communities. Such a skewed distribution in the proportion of Taiwanese aborigines across communities in Taiwan may have prevented us from detecting a possible community disparity in chewing betel using a community-correlation approach. However, as betel is a part of Taiwanese aboriginal culture [1, 4] in communities where the proportion of Taiwanese aborigines was over 20%, the prevalence of chewing betel was also higher than in the other communities. For Taiwanese aborigines who persist in their traditional culture of betel, behavior such as quitting chewing betel is difficult to modify, because of its strong identity with their culture [9]. It is notable that some communities with relatively high proportions of Taiwanese aborigines showed higher prevalences of chewing betel than other communities. Consequently, the results of our study do not refute a community disparity in chewing betel attributable to Taiwanese aborigines.

The present study had several limitations. First, it was a community-correlation study, or an ecological study, which simply clarifies a community-correlation of interest. Therefore, personal and other social characteristics may have confounded the community-correlations of interest. As for the community-correlation between chewing betel and mortality, we must consider the confounding effects of smoking tobacco and drinking alcohol on our results [20]. However, the low correlations of smoking tobacco and drinking alcohol with chewing betel may indicate that the confounding effects of these addiction behaviors were negligible. On the other hand, some social characteristics correlated moderately. Therefore, when interpreting the community-correlation of social characteristics with chewing betel and mortality, caution should be used owing to the confounding effects of those other social characteristics. Second, the results of our study do not indicate a causal relationship between chewing betel and health, although our results regarding the community-correlations between chewing betel and all-cause and some types of cause-specific mortality were consistent with the results from typical epidemiological studies, such as cohort studies based on individual data. Third, we investigated the community disparity in health using vital statistics in each city/county, and therefore, health outcomes were limited to serious diseases and death rather than onset of disease. The results of our study may have been attributable to regional differences in medical

service. In addition, types of cause-specific mortality, especially types of malignant neoplasm, were limited to those for which all 22 cities/counties had data. Finally, we could not collect relevant data from Taiwanese aborigines persisting in the culture of betel [9, 10] and thereby are better targets for betel control. Given these limitations, concurrent cohort studies that collect data from both individuals and communities are required in the future to provide more reliable evidence.

In conclusion, our data suggest that regional differences in betel plantation area, betel sales stores, low education, and low household income contributed to the community disparity in malignant neoplasm (especially oral cancer, liver cancer, and lung cancer), heart disease, stroke, chronic hepatitis/liver cirrhosis, nephritis/nephropathy, accident/injury, and suicide via chewing betel in Taiwanese men. To reduce the community disparity in health attributable to chewing betel in Taiwanese men, it is necessary to draw attention to the social background characteristics behind chewing betel and to consider a population strategy for betel control.

Author Contribution Statement

All authors conceived and were involved in the design of the study, data acquisition, statistical analysis, interpretation of the results, and writing the manuscript. AN was responsible for Chinese language translation. KN provided study supervision.

Acknowledgements

Notice

This study includes the approved Master's thesis of Ai Namizato, which was written in Japanese and unpublished.

Statement of Ethics

Institutional review for ethical issues was needed because individuals were not involved in data used in this study.

Availability of Data

Data are available upon request.

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