Can the Number of Present Teeth Be a Succinct Indicator of Diseases among the Elderly? Implications from the Hyogo 8020 Survey

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1. Introduction

Japan is one of the most rapidly aging countries in the world. Aging societies face many issues in terms of social, economic, and public health. It is expected that the socio-economic burden and the human resource requirements of care will increase as the population ages.

Oral health in aging societies is an important individual and public health concern. In 1989, the Japanese Ministry of Health, Labour and Welfare (MHLW) and the Japan Dental Association (JDA) jointly introduced the 8020 Movement for the purpose of dental and oral care. The movement aimed to encourage the general public to maintain 20 or more own teeth at the age of 80 through proper oral health approaches including prevention and improvement of oral diseases throughout their whole lives. Concrete objectives to achieve individual and societal oral health, such as maintenance and improvement of oral function, prevention of tooth loss, reduction in the prevalence of dental caries and periodontal diseases, and periodical oral health checkup, were proposed in Healthy Japan 21 (*Kenko Nippon 21*). At the sub-national level, the Hyogo Dental Association also promoted health to Hyogo prefectural residents through the key phrases of 'get healthy-start with oral health' and '8020 – long life with good health'. The rates of those who have 20 teeth have improved over the past decades among middle-aged and older adults. According to the most recent national report, approximately 38% of older adults who are at age 80 have 20 or more of their own teeth (Ministry of Health, Labour and Welfare, 2012).

The relationship between oral health and general health has been a public health concern recently, as oral function is fundamental to maintain the whole human body. In this regard, the relationships between oral health and general health status among the elderly are examined by many researchers and reviewers (Beck and Offenbacher, 2005; Griffin, et al., 2009; Kandelman, et al., 2008; 8020 Promotion Foundation, 2005 & 2006).

Circulatory system: Some studies indicate that the number of teeth can be an indicator of oral health to predict cardiovascular disease (CVD) (Holmlund, et al., 2010; Tu, et al., 2007). Some studies suggest some relationship between tooth loss and CHD or atherosclerosis (Abnet, et al., 2005; Bokhari, et al., 2011; Briggs, et al., 2006; Caplan, et al., 2009; Cronin, 2009; Desvarieux, et al., 2004; Dietrich, et al., 2008; Elter, et al., 2004; Holmlund, et al., 2010; Humphrey, et al., 2008; Joshipura, et al., 1996; Loesche, et al., 1998). On the other hand, some studies indicate no relationship between a fewer number of teeth and CHD

(Bokhari, et al., 2009; Syrjälä, et al., 2009). Possible relationship between fewer present teeth and stroke is reported by some studies (Abnet, et al., 2005; Heitmann and Gamborg, 2008; Shirotani, et al., 2005; Yoshida, et al., 2012). In contrast, other studies reported no such statistical evidence (Joshipura, et al., 2003; Syrjälä, et al., 2009).

Respiratory system: Terpenning and colleagues (2001) reported that the number of decayed teeth is associated with aspiration pneumonia. Poor periodontal health as reflected by missing teeth and plaque index is significantly associated with lower quality of life in chronic obstructive pulmonary disease (COPD) patients (Zhou,et al., 2011).

Diabetes: Tooth loss is increased by hyperglycemia in diabetic subjects (Arora, et al., 2009; Kaur, et al., 2009; Moore, et al., 2003). On the other hand, no significant difference between diabetics and non-diabetics is observed for the number of teeth (Marotta et al., 2012)

Mental conditions: Mental diseases, including dementia and Parkinson disease, show a relation ship with the number of present teeth (Einarsdóttir, et al., 2009; Ellefsen, et al., 2009; Hanaoka & Kashihara, 2009; Hugo, et al., 2007; Nakayama, et al., 2004). Some studies imply that number of teeth, including edentulism, may become indicators for dementia (Arrivé, et al, 2012; Stein, et al., 2007 & 2010).

Maintaining healthy teeth is not only necessary for the masticatory oral function, but is also important for nutrition intake and communication skills, which are all connected to the quality of life (QOL). However, it is not clearly determined how the number of teeth can be an independent indicator of a variety of health conditions. In this study, the number of teeth is examined as a possible independent indicator for some diseases.

2. Materials and methods

The data sets for this study were obtained from the Hyogo Dental Association for their Hyogo 8020 Survey 2005 one-year study data which combines two different National Health Insurance claims: dental service claims and medical service claims. The one-year study covers the period starting in May 2005 and ending in April 2006. The total target population for the survey is Hyogo residents aged 70 and over at the baseline of the study. Oral health information, including the number of present own teeth and the condition of occlusal contact at the baseline month (i.e., the month of May) is included. Details of the Hyogo Dental Association's Hyogo 8020 Survey are introduced by the Association (Hyogo Dental Association, 2005)

This study uses the sample of ages 70 through 99 (N = 30,844) who visited both dental and medical facilities in May 2005. In this study, the number of present teeth is examined to see the relationship with diseases appearing on medical service claims while age and condition of occlusal contact (whether they have a pair of remaining teeth that meet) are controlled. With consideration and

respect for the 8020 promotional approach, the number of present teeth is categorized into four groups. These are zero tooth (edentulous condition), 1 to 9 teeth, 10 to 19 teeth, and 20 and more teeth (Petersen, et al., 2004). The condition of occlusal contact is binary data asking if the patient maintains his/hers, which pertains to the masticatory function.

The disease categories on medical service claims are based on the *Shippei, shogai oyobi shiin bunrui* (International Statistical Classification of Diseases and Related Health Problems, tenth revision: ICD-10) by the Ministry of Health, Labour and Welfare of Japan. In this study, the *chu-bunrui* (equivalent to the ICD disease-based category) disease category is used. Eight diseases – coronary heart disease (CHD), stroke, pneumonia, chronic obstructive pulmonary disease (COPD), diabetes, dementia, Parkinson's disease, and Alzheimer's disease – are selected for this study.

To make the study sample represent the community-dwelling old age population of Hyogo prefecture, a weight variable is created based on the 2005 Census data for Hyogo prefecture. This weight variable is adjusted for single age. In this study, chi-square and logistic regression models are applied for statistical analyses. Men and women are examined separately.

3. Results

Among the unweighted sample of 30,844 from 70 through 99 years of age, men (N = 17,271) are less in numbers than women (N = 13,573). At the base line, the average age of the study sample is 76.2 years old (SD=4.9) for men and 76.5 years old (SD=5.1) for women.

The prevalence of diseases appearing on their medical claims is shown in Table 1. Diabetes is the most common disease among the eight diseases for the elderly men and women. Experience of coronary heart disease (CHD) and stroke follows after diabetes. Pneumonia is the fourth leading cause of death among the elderly in Japan but is not prevalent based on the medical claim records. Some mental diseases such as dementia and Alzheimer's disease are more common for women than men.

Table 1. Prevalence of selected diseases among the elderly who are aged 70 and over based on the report of medical claim (unweighted)

Diseases	Men (13,573)		Women (17,271)	
1. Coronary heart disease (CHD)	669	(4.9%)	679	(3.9%)
2. Stroke	560	(4.1%)	562	(3.3%)
3. Pneumonia	29	(0.2%)	26	(0.2%)
4. Chronic obstructive pulmonary disease (COPD)	188	(1.4%)	78	(0.5%)
5. Diabetes	1,132	(8.3%)	910	(5.3%)
6. Dementia	40	(0.3%)	79	(0.5%)
7. Parkinson's disease	78	(0.6%)	101	(0.6%)
8. Alzheimer's disease	48	(0.4%)	95	(0.6%)

The relationships between the categorized number of teeth and the prevalence of each disease for men and women are shown in Table 2. Overall, the number of teeth which is grouped into four categories and the diagnosis of disease show statistically significant differences for all eight disease cases. The category of small number of present teeth shows a relatively higher rate of existence of diagnosis of disease. The existence of CHD is slightly higher for men with one to nine teeth. Compared to those with 20 or more teeth, women with fewer teeth show a higher rate of CHD. Stroke is slightly higher among those with fewer teeth for both men and women. Both men and women show higher rates of pneumonia in the zero tooth category (edentulous person) than other categories. In contrast, both men and women with 20 or more present teeth reveal low rates of pneumonia. A relatively high rate of chronic obstructive pulmonary disease (COPD) is seen for men with fewer teeth. The rate differences for diabetes are small for both men and women. The rate of dementia is high for both men and women with fewer present teeth. The rates of Parkinson's disease are relatively high for those with fewer present teeth. Slightly different rates are seen for both men and women in Alzheimer' disease.

Table 2. The relationships between the number of teeth and the prevalence of selected diseases for men and women aged 70 and over (weighted)

1. **CHD**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	21,202	1,097	22,299
	7.1%	7.1%	7.1%
1-9	68,410	3,719	72,129
	22.9%	24.0%	22.9%
10-19	92,326	4,688	97,014
	30.8%	30.3%	30.8%
20+	117,360	5,969	123,329
	39.2%	38.6%	39.2%
total	299,298	15,473	314,771
	100.0%	100.0%	100.0%

χ^2=11.8, p<0.01

Women	Diagnosis		
	No	Yes	total
Num. of teeth:	37,086	2,032	39,118
0	8.3%	9.9%	8.4%
1-9	116,489	5,409	121,898
	26.1%	26.4%	26.1%
10-19	137,264	7,039	144,303
	30.8%	34.3%	30.9%
20+	155,516	6,026	161,542
	34.8%	29.4%	34.6%
total	446,355	20,506	466,861
	100.0%	100.0%	100.0%

χ^2=310.2, p<0.001

2. **Stroke**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	21,347	952	22,299
	7.1%	7.2%	7.1%
1-9	69,053	3,076	72,129
	22.9%	23.4%	22.9%
10-19	92,884	4,130	97,014
	30.8%	31.4%	30.8%
20+	118,334	4,996	123,330
	39.2%	38.0%	39.2%
total	301,618	13,154	314,772
	100.0%	100.0%	100.0%

χ^2=8.3, p<0.05

Women	Diagnosis		
	No	Yes	total
Num. of teeth:	37,100	2,018	39,118
0	8.2%	11.9%	8.4%
1-9	117,354	4,544	121,898
	26.1%	26.8%	26.1%
10-19	139,054	5,249	144,303
	30.9%	30.9%	30.9%
20+	156,368	5,174	161,542
	34.8%	30.5%	34.6%
total	449,876	16,985	466,861
	100.0%	100.0%	100.0%

χ^2=348.1, p<0.001

3. **Pneumonia**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	22,107	192	22,299
	7.0%	26.7%	7.1%
1-9	71,904	225	72,129
	22.9%	31.3%	22.9%
10-19	96,849	165	97,014
	30.8%	22.9%	30.8%
20+	123,193	137	123,330
	39.2%	19.1%	39.2%
total	314,053	719	314,772
	100.0%	100.0%	100.0%

χ^2=502.6, p<0.001

Women	Diagnosis		
	No	Yes	total
Num. of teeth: 0	38,873	245	39,118
	8.3%	25.2%	8.4%
1-9	121,620	278	121,898
	26.1%	28.6%	26.1%
10-19	143,988	314	144,302
	30.9%	32.3%	30.9%
20+	161,406	136	161,542
	34.6%	14.0%	34.6%
total	465,887	973	466,860
	100.0%	100.0%	100.0%

χ^2=451.2, p<0.001

4. **COPD**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	21,880	419	22,299
	7.1%	9.3%	7.1%
1-9	70,613	1,516	72,129
	22.8%	33.5%	22.9%
10-19	95,779	1,235	97,014
	30.9%	27.3%	30.8%
20+	121,980	1,349	123,329
	39.3%	29.9%	39.2%
total	310,252	4,519	314,771
	100.0%	100.0%	100.0%

χ^2=377.1, p<0.001

Women	Diagnosis		
	No	Yes	total
Num. of teeth: 0	38,922	196	39,118
	8.4%	8.4%	8.4%
1-9	121,390	507	121,897
	26.1%	21.6%	26.1%
10-19	143,318	984	144,302
	30.9%	42.0%	30.9%
20+	160,885	657	161,542
	34.6%	28.0%	34.6%
total	464,515	2,344	466,859
	100.0%	100.0%	100.0%

χ^2=140.9, p<0.001

5. **Diabetes**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	20,425	1,875	22,300
	7.1%	7.3%	7.1%
1-9	66,350	5,779	72,129
	23.0%	22.5%	22.9%
10-19	88,493	8,521	97,014
	30.6%	33.1%	30.8%
20+	113,788	9,542	123,330
	39.4%	37.1%	39.2%
total	289,056	25,717	314,773
	100.0%	100.0%	100.0%

χ^2=83.5, p<0.001

Women	Diagnosis		
	No	Yes	total
Num. of teeth: 0	37,214	1,904	39,118
	8.4%	8.0%	8.4%
1-9	114,950	6,948	121,898
	25.9%	29.3%	26.1%
10-19	136,541	7,761	144,302
	30.8%	32.7%	30.9%
20+	154,457	7,085	161,542
	34.9%	29.9%	34.6%
total	443,162	23,698	466,860
	100.0%	100.0%	100.0%

χ^2=289.0, p<0.001

6. **Dementia**

Men	Diagnosis		
	No	Yes	total
Num. of teeth: 0	22,088	211	22,299
	7.0%	19.3%	7.1%
1-9	71,931	198	72,129
	22.9%	18.1%	22.9%
10-19	96,541	474	97,015
	30.8%	43.4%	30.8%
20+	123,120	210	123,330
	39.3%	19.2%	39.2%
total	313,680	1,093	314,773
	100.0%	100.0%	100.0%

χ^2=409.9, p<0.001

Women	Diagnosis		
	No	Yes	total
Num. of teeth: 0	38,299	819	39,118
	8.3%	22.9%	8.4%
1-9	120,464	1,434	121,898
	26.0%	40.1%	26.1%
10-19	143,856	447	144,303
	31.1%	12.5%	30.9%
20+	160,665	877	161,542
	34.7%	24.5%	34.6%
total	463,284	3,577	466,861
	100.0%	100.0%	100.0%

χ^2=1,677.8, p<0.001

7. **Parkinson's disease**

Men	Diagnosis No	Yes	total
Num. of teeth: 0	22,154	145	22,299
	7.1%	8.2%	7.1%
1-9	71,702	427	72,129
	22.9%	24.0%	22.9%
10-19	96,616	398	97,014
	30.9%	22.4%	30.8%
20+	122,520	809	123,329
	39.1%	45.5%	39.2%
total	312,992	1,779	314,771
	100.0%	100.0%	100.0%

χ^2=63.3, p<0.001

Women	Diagnosis No	Yes	total
Num. of teeth:	38,850	268	39,118
0	8.4%	9.6%	8.4%
1-9	120,965	933	121,898
	26.1%	33.5%	26.1%
10-19	143,375	928	144,303
	30.9%	33.4%	30.9%
20+	160,889	653	161,542
	34.7%	23.5%	34.6%
total	464,079	2,782	466,861
	100.0%	100.0%	100.0%

χ^2=170.0, p<0.001

8. **Alzheimer's disease**

Men	Diagnosis No	Yes	total
Num. of teeth: 0	22,237	63	22,300
	7.1%	5.4%	7.1%
1-9	71,857	272	72,129
	22.9%	23.5%	22.9%
10-19	96,695	319	97,014
	30.8%	27.5%	30.8%
20+	122,825	505	123,330
	39.2%	43.6%	39.2%
total	313,614	1,159	314,773
	100.0%	100.0%	100.0%

χ^2=14.4, p<0.01

Women	Diagnosis No	Yes	total
Num. of teeth:	38,840	278	39,118
0	8.4%	8.7%	8.4%
1-9	121,052	846	121,898
	26.1%	26.6%	26.1%
10-19	143,264	1,039	144,303
	30.9%	32.6%	30.9%
20+	160,522	1,020	161,542
	34.6%	32.0%	34.6%
total	463,678	3,183	466,861
	100.0%	100.0%	100.0%

χ^2=9.9, p<0.05

The outcomes of the logistic regression analyses for the association of between age, the condition of occlusal contact, categorized number of present teeth and the diagnoses of the eight selected diseases for men and women aged 70 and over are shown in Table 3. Compared to those with 20 or more present teeth, groups with fewer teeth show lower odds ratios of CHD for men. However, opposite outcomes are seen among the women. There are no noticeable results seen in the case of stroke. For pneumonia, groups with fewer teeth show higher odds ratios of disease rates than the category of 20 or more teeth for both men and women. For the case of COPD, higher odds ratios of disease rates are seen for groups with fewer teeth among men, but women show inconsistent results. For diabetes, higher odds ratios of disease rates are seen for groups with fewer teeth for women while men show conflicting outcomes. Men show lower odds ratios of the rate of dementia for fewer teeth for men but opposite results are seen for women. For Parkinson's disease, women show higher odds ratios of disease rates for those with fewer teeth, but men show inconsistency. For Alzheimer's disease, both men and women show lower odds ratio of disease rate.

Table 3. Odds ratios in multivariate logistic regression analyses for associations of the condition of occlusal contact, number of teeth with the diagnoses of selected diseases for men and women aged 70 and over (weighted)

1. **CHD**

	Men		Women	
Age	1.02	***	1.06	***
No occlusal contact	0.96		1.29	***
Num. teeth: 0	0.87	**	1.14	***
1-9	0.97		1.15	***
10-19	0.96	*	1.24	***
df	5		5	
-2 Log L	123,191	***	165,344	***

2. **Stroke**

	Men		Women	
Age	1.03	***	1.05	***
No occlusal contact	1.04		0.94	*
Num. teeth: 0	0.93		1.04	
1-9	1.00		0.89	***
10-19	1.00		1.03	
df	5		5	
-2 Log L	108,861	***	144,009	***

3. **Pneumonia**

	Men		Women	
Age	1.03	***	1.09	***
No occlusal contact	1.33	*	0.98	
Num. teeth: 0	9.14	***	3.47	***
1-9	3.33	***	1.75	***
10-19	1.54	***	2.16	***
df	5		5	
-2 Log L	9,802	***	13,247	***

4. **COPD**

	Men		Women	
Age	1.06	***	1.05	***
No occlusal contact	1.38	***	0.59	***
Num. teeth: 0	1.76	***	0.48	***
1-9	2.14	***	0.51	***
10-19	1.11	**	1.35	***
df	5		5	
-2 Log L	46,460	***	29,049	***

5. **Diabetes**

	Men		Women	
Age	0.96	***	0.97	***
No occlusal contact	0.73	***	1.05	*
Num. teeth: 0	0.96		1.42	***
1-9	0.87	***	1.53	***
10-19	1.15	***	1.31	***
df	5		5	
-2 Log L	176,851	***	186,637	***

6. **Dementia**

	Men		Women	
Age	1.14	***	1.17	***
No occlusal contact	1.07		0.25	***
Num. teeth: 0	2.71	***	0.27	***
1-9	1.08		0.29	***
10-19	2.22	***	0.26	***
df	5		5	
-2 Log L	13,401	***	36,349	***

7. **Parkinson's disease**

	Men		Women	
Age	1.02	***	1.00	
No occlusal contact	1.55	***	0.90	
Num. teeth: 0	1.41	**	1.54	***
1-9	1.23	*	1.73	***
10-19	0.65	***	1.57	***
df	5		5	
-2 Log L	21,854		33,869	***

8. **Alzheimer's disease**

	Men		Women	
Age	1.09	***	1.09	***
No occlusal contact	1.36	**	0.76	***
Num. teeth: 0	0.58	**	0.43	***
1-9	0.91		0.58	***
10-19	0.72	***	0.91	***
df	5		5	
-2 Log L	14,982	***	37,123	***

(*p<0.05, **p<0.01, ***p<0.001)
Occlusal contact is a dummy variable.
Number of teeth for 20+ is a dummy variable.

4. Discussion

In this study, the categorized number of teeth was explored for its relationship with eight diseases. In bivariate analyses, the relationships between the categorized number of teeth and the prevalence of eight diseases show statistically significant differences for both men and women. The smaller number of present teeth indicated relatively higher rates of diagnosis of disease. Dementia and pneumonia showed significant statistical differences for both sexes. However, the differences were not necessarily prominent for other diseases. The Ministry of Health, Labour, and Welfare, Japan (2012) reported that having 20 or more present teeth can demonstrate better chewing function than with a lower number of teeth. With the special focus on having 20 or more teeth, the outcomes showed lower prevalence of diseases for coronary heart disease (CHD), stroke, pneumonia, chronic obstructive pulmonary disease (COPD), diabetes, dementia, Parkinson's disease, and Alzheimer's disease, excepting for Parkinson's disease and Alzheimer's disease for men. The outcomes of the logistic regression analyses for the association of between categorized number of present teeth and eight diseases by controlling age and the condition of occlusal contact demonstrated consistent patterns for the cases of pneumonia and Alzheimer's disease for both men and women. Men and women showed opposite or somewhat different results for CHD, COPD, and dementia. Others show inconsistencyfor different categories for the number of teeth or statistically insignificant results.

This study has limitations based on the characteristics of survey data. The data include those who visited both dental and medical facilities at a base line month, when the number of teeth was counted together with the confirmation of the condition of occusal contact. These are the only cases to match both dental and medical insurance claims while their medical claims are followed for an entire year.

The data sets used for men and women included more than 30,000 cases in total, and were both

weighted for the purpose of enhancing the external validity of this study. However, due to the baseline condition of selecting samples, the weighted data itself may not fully represent residents aged 70 and over in Hyogo prefecture.

The diseases used in this study were selected from a literature review of diseases with some implication of a relationship with the number of teeth or tooth loss. Many studies examine the relationship between periodontal diseases and systemic diseases of the whole body. The names of diseases recorded on medical claims were obtained in the survey. In this study, prevalent cases are not able to separate with incidence. In this regard, causal relationships might not necessarily be adequately examined, especially in the logistic analyses. A longitudinal study with proper duration may possibly overcome this issue. Since there is a study that indicates a relationship between the number of present teeth and mortality (Padilha, et al., 2008), mortality data is recommended to be added in a future study. Beyond the data sets used in this study, the addition of several covariates for the future different studies may enable relationships between the number of teeth and diseases to be seen more clearly.

5. Conclusion

It will be useful for the general public if the number of teeth can be used as a succinct indicator of the occurrence of disease. At this moment, only with this study, it is difficult to plainly conclude if the number of teeth itself can be a proper indicator of disease among the elderly. This attempt can be further examined with studies of the mechanism which may be involved with some pathological steps to connect the number of teeth and diseases.

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Can the Number of Present Teeth Be a Succinct Indicator of Diseases among the Elderly? Implications from the Hyogo 8020 Survey

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Oral health is one of the most important issues in aging societies. The relationship between oral health and general health has been a public health concern because oral function is essential to maintaining the entire human body. Research has not clarified how the number of remaining teeth can be an independent indicator of a variety of health conditions.

To examine the relationship between the number of teeth and disease, the data sets for the baseline of the study were obtained from the Hyogo Dental Association's Hyogo 8020 Survey 2005, a one-year study containing information for patients aged 70 and over who visited both dental and medical facilities in May 2005. The unweighted sample size was 30,844 (17,271 men and 13,573 women) from 70 through 99 years of age.

The categorized number of present teeth (0, 1–9, 10–19, and 20+), condition of occlusal contact, and age were used to observe the diagnosis of eight diseases for this study: coronary heart disease (CHD), stroke, pneumonia, chronic obstructive pulmonary disease (COPD), diabetes, dementia, Parkinson's disease, and Alzheimer's disease. The study data was weighted for Hyogo prefectural residents using the 2005 Census data.

The relationships between the categorized number of teeth and eight diseases showed differences for both men and women in bivariate analyses. A smaller number of present teeth indicated relatively higher rates of dementia and pneumonia. However, the differences were not significant for other diseases. For both sexes, having 20 or more teeth showed lower prevalence of CHD, stroke, pneumonia, COPD, diabetes, dementia, Parkinson's disease, and Alzheimer's disease, excepting Parkinson's disease and Alzheimer's disease for men. The outcomes of the logistic regression analyses revealed consistent patterns for a low number of teeth with a high odds ratio (OR) for pneumonia and a low OR for Alzheimer's disease in both men and women. However, men and women showed opposite or somewhat different results in terms of ORs for CHD, COPD, and dementia. Others showed inconsistency in different categories for the number of teeth or else statistically insignificant results.

From this study alone, it is difficult to conclude if the number of teeth itself can be a proper indicator of disease among the elderly. This study has some limitations in terms of sampling, available proper variables, and longitudinal design for causal relationships. Mortality data should also be considered in attempting to clarify the pathological mechanisms between the number of remaining teeth and disease incidence.