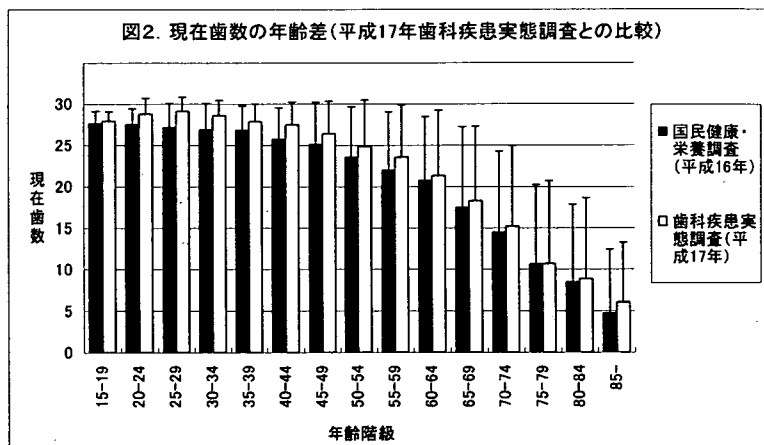


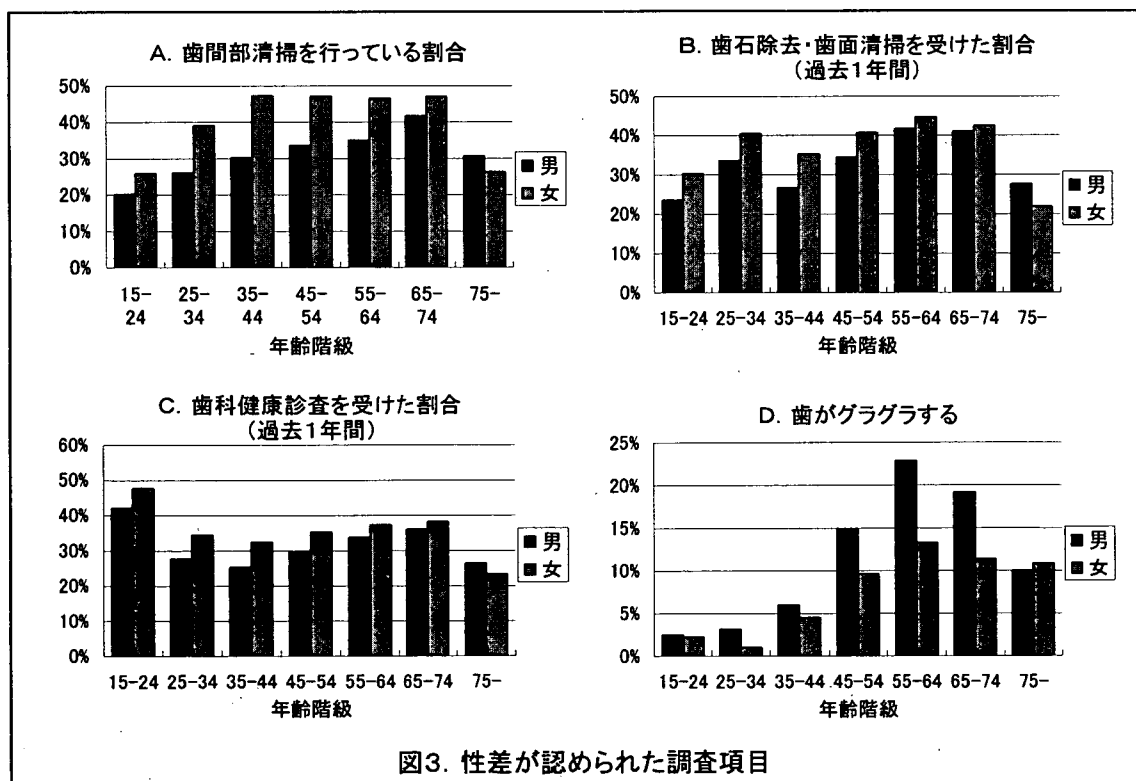
た可能性が考えられる。本調査では質問紙法により現在歯数を調べており、歯科疾患実態調査（歯科医師による口腔診査）と調査方法が異なるが、通常は質問紙法がやや高値を示す傾向がある点<sup>6,7)</sup>を踏まえると、平成17年歯科疾患実態調査との値の違いは選択バイアスによるものと考えられた。



## ② 性差 (図 3-A ~ D)

性差が認められた項目は、歯間部清掃 (図 3-A)、歯石除去・歯面清掃 (図 3-B)、歯科健康診査 (図 3-C)、「歯がぐらぐらする」 (図 3-D) の 4 項目であった。3つの歯科保健行動を示す項目は、いずれも比較的若い年齢層での性差が顕著で、いずれも女性が良好であった (図 3-A ~ C)。「歯がぐらぐらする」では男性の割合が高かった。

一般的に歯科保健行動は女性が良好であり<sup>8)</sup>、これが本調査でも再確認されたといえる (図 3-A ~ C)。「歯がぐらぐらする」の割合が男性で高かったのは、歯科医院への受診行動が女性に比べて遅れがちであるためと思われる。



### ③ 地域差 (図 4-A ~ E)

地域差が認められた項目は、歯間部清掃 (図 4-A)、歯石除去・歯面清掃 (図 4-B)、歯科健康診査 (図 4-C)、「歯をみがくと歯ぐきから出血する」(図 4-D)、現在歯数 (図 4-E) の 5 項目であった。3 つの歯科保健行動を示す項目は、いずれも比較的若い年齢層での地域差が顕著で、いずれも都市部が良好であった (図 4-A ~ C)。「歯をみがくと歯ぐきから出血する」では男性の割合が高かった (図 4-D)。現在歯数は都市部ほど高値を示していた (図 4-E)。

都市部の歯科保健行動が良好であった (図 4-A ~ C) のは、歯科医療環境も含めた社会生活環境等の影響によりセルフケアの考え方が浸透している影響と思われる。この点は歯磨き時の出血 (図 4-D) および現在歯数 (図 4-E) の地域差にも影響していると考えられるが、ことに現在歯数 (図 4-E) の場合は古くからの歯科医療環境に影響された可能性もある。なお、歯周疾患 (CPI コード 3 以上の保有者率) と現在歯数については、平成 17 年歯科疾患実態調査においても同様の地域差が確認されている<sup>5)</sup>。

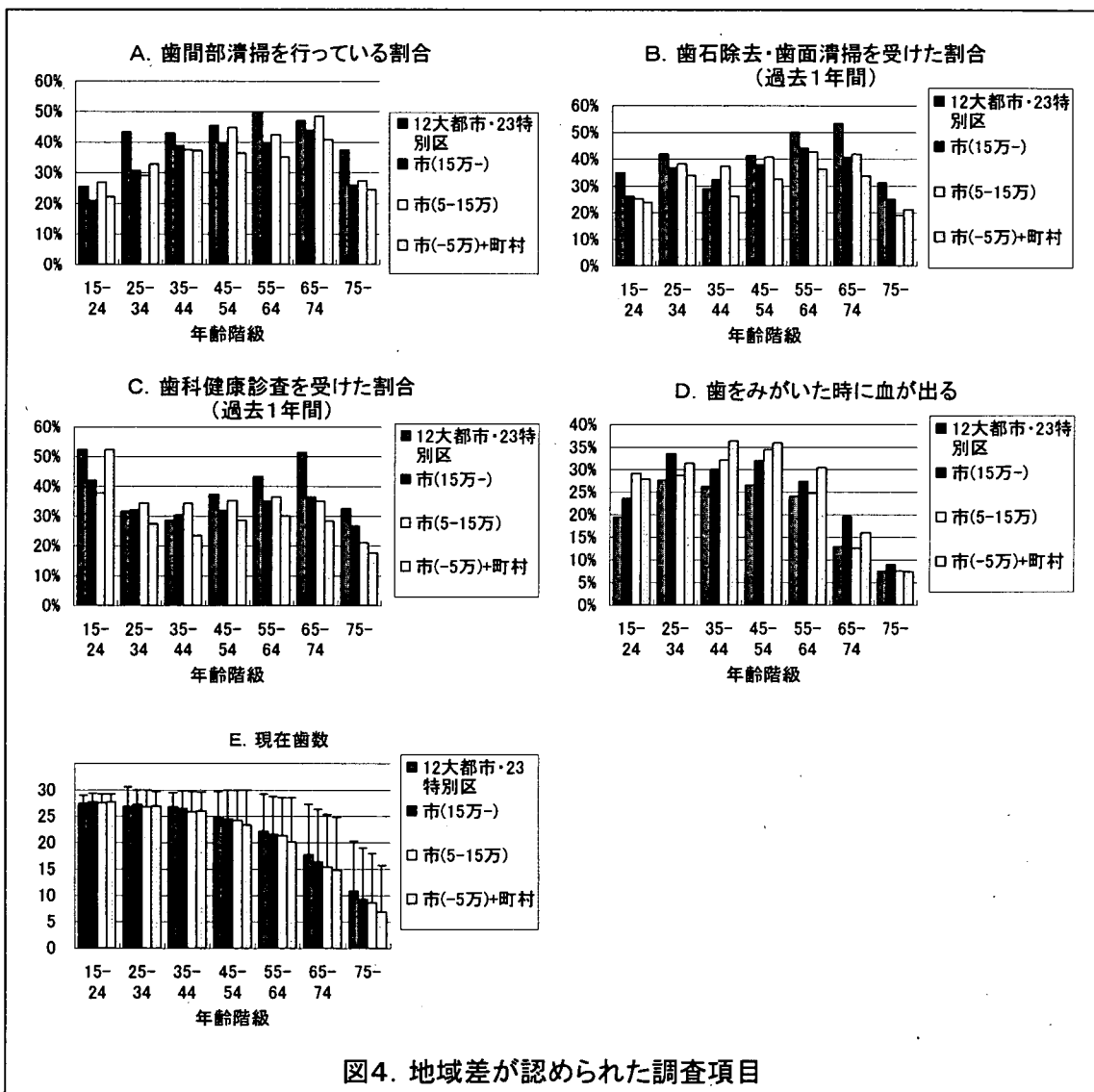


図4. 地域差が認められた調査項目

## 2) 要因分析

### ① 現在歯数

表2に現在歯数を目的変数とした重回帰分析結果を示す。説明力 (Adj R-squared) は44%で、比較的高い値を示した。

最も強い関連を示した要因は年齢で、高齢者の現在歯数が少ない傾向 (図2) が顕著であった。

地域差 (自治体規模) も有意で、前述したクロス集計結果 (図4-E) が、他要因から独立した関連を有していることが示された。

性差はクロス集計では関連が認められなかったが、女性のほうが有意に現在歯数が少ないことが示された。

仕事については、「その他 (高齢・病気など)」、「不明」、「保安、農林、運輸通信、生産工程・労務」の人で現在歯数が少なかった。

歯ぐきの自覚症状では、「歯ぐきが腫れている」と「歯がぐらぐらする」人は現在歯数が少なく、歯周疾患リスクの高い人は歯を失いやすいことが示された。一方、「歯をみがいた時に血が出る」と「歯ぐきが下がり歯の根が出ている」人の現在歯数は多かった。これは、これらの質問に肯定的に回答する意識はセルフケア行動の高さを反映したものであるためかもしれない。

歯科保健行動では、歯間部清掃と歯石除去・歯面清掃を行っている人の現在歯数が多く、セルフケアとプロフェッショナルケアによる歯の喪失予防効果が示唆された。

喫煙については、「現在、習慣的に喫煙」している人の現在歯数が少なく、1999年の歯科疾患実態調査と国民栄養調査のリンケージデータを用いた Hanioka らの報告<sup>9)</sup>を再確認できた。

表2. 現在歯数を目的変数とした重回帰分析の結果 (20歳以上)

N=7,290  
Adj R-squared = 0.440

説明変数		偏回帰係数	p値	95%信頼区間		標準偏回帰係数 (β)
年齢階級 (基準: 20-29歳)	30-39歳	-0.64	0.040	-1.26	-0.03	-0.03
	40-49歳	-2.13	<0.001	-2.76	-1.50	-0.09
	50-59歳	-4.89	<0.001	-5.50	-4.29	-0.22
	60-69歳	-8.33	<0.001	-8.97	-7.70	-0.37
	70歳-	-15.43	<0.001	-16.11	-14.76	-0.67
性 (基準: 男性)	女性	-1.30	<0.001	-1.71	-0.90	-0.07
自治体規模 (基準: 12大市・特別区)	市 (15万-)	-0.19	0.383	-0.62	0.24	-0.01
	市 (5-15万)	-0.62	0.016	-1.13	-0.12	-0.03
	市 (-5万) + 町村	-1.20	<0.001	-1.69	-0.71	-0.06
仕事 (基準: 専門職・管理職)	事務、販売、サービス	-0.16	0.557	-0.68	0.36	-0.01
	保安、農林、運輸通信、生産工程・労務	-0.86	0.002	-1.41	-0.31	-0.04
	家事従事者	0.00	0.997	-0.58	0.58	0.00
	その他 (高齢・病気など)	-2.05	<0.001	-2.69	-1.42	-0.08
	園児・学生	-0.40	0.534	-1.65	0.85	-0.01
歯ぐきの自覚症状 (基準: なし)	不明	-1.13	0.002	-1.85	-0.42	-0.03
	歯ぐきが腫れている	-0.89	0.001	-1.42	-0.37	-0.03
	歯をみがいた時に血が出る	0.63	0.001	0.25	1.01	0.03
	歯ぐきが下がり歯の根が出ている	0.69	0.001	0.30	1.09	0.03
	歯ぐきを押しすと膿が出る	-0.17	0.780	-1.39	1.05	0.00
	歯がぐらぐらする	-0.98	0.001	-1.53	-0.43	-0.03
歯科保健行動 (基準: 実施せず)	歯周病といわれ治療している	-0.53	0.102	-1.16	0.11	-0.02
	歯間部清掃	1.20	<0.001	0.86	1.53	0.07
	歯石除去・歯面清掃	2.22	<0.001	1.75	2.68	0.12
	歯磨き個別指導	0.01	0.968	-0.50	0.52	0.00
喫煙 (基準: 喫煙経験なし)	歯科健康診査	-0.14	0.554	-0.62	0.33	-0.01
	現在、習慣的に喫煙	-1.51	<0.001	-1.92	-1.09	-0.07
定数項	過去、習慣的に喫煙	-0.28	0.274	-0.78	0.22	-0.01
		28.29	<0.001	27.52	29.05	

## ② 咀嚼の状態

表3に咀嚼不調の有無を目的変数としたロジスティック回帰分析の結果を示す。説明力

(Pseudo R<sup>2</sup>)は24%であった。

最も強く関連していた要因は現在歯数で、これが少ないほど咀嚼不調を示す割合が高く、歯の喪失が咀嚼機能の低下を招くことが明瞭に示された。ただし、オッズ比が最も高かったのは0歯ではなく少数歯残存群(1-9歯)であった。

歯ぐきの自覚症状も比較的高い関連性を示し、6項目のうち5項目において自覚症状を有する人で咀嚼不調を示す割合が高いことが示され、歯周疾患自体の咀嚼への悪影響が示唆された。

年齢階級も有意で、40歳以上で咀嚼不調を示す割合が高かった。これは、加齢自体というより、加齢とともに生じやすい歯の不具合等による者ではないかと思われた。

仕事では、「その他(高齢・病気など)」で咀嚼不調を示す割合が高かった。

喫煙については、「現在、習慣的に喫煙」している人は、咀嚼不調を示す割合が高かった。

このほか、女性で咀嚼不調を示す割合がやや高く、歯間部清掃を行っている人では咀嚼不調を示す割合がやや低かった。

なお、補綴に関して、インプラントを入れていると回答した人は、咀嚼不調を示す割合がやや低かったが、この質問は誤答割合が多く(図1-D)、その影響と思われた。

表3. 咀嚼不調の有無を目的変数としたロジスティック回帰分析の結果(20歳以上)

咀嚼不調なし: 何でもかんで食べることができる  
咀嚼不調あり: 一部かめない食べ物がある/かめない食べ物が多い/かんで食べることはできない

Number of obs = 7,202

Pseudo R<sup>2</sup> = 0.236

説明変数		オッズ比	p値	95%信頼区間	
年齢階級(基準:20-29歳)	30-39	0.94	0.771	0.62	1.43
	40-49	1.80	0.003	1.22	2.65
	50-59	2.16	<0.001	1.48	3.15
	60-69	2.01	<0.001	1.36	2.97
	70-	2.65	<0.001	1.76	3.99
性(基準:男性)	女性	1.28	0.006	1.07	1.52
自治体規模(基準:12大市・特別区)	市(15万-)	1.05	0.590	0.87	1.27
	市(5-15万)	1.09	0.417	0.88	1.35
	市(-5万)+町村	0.90	0.319	0.73	1.11
仕事(基準:専門職・管理職)	事務、販売、サービス	0.99	0.969	0.77	1.28
	保安、農林、運輸通信、生産工程・労務	1.21	0.135	0.94	1.55
	家事従事者	0.88	0.342	0.67	1.15
	その他(高齢・病気など)	1.59	<0.001	1.23	2.07
	園児・学生	1.73	0.170	0.79	3.78
	不明	1.21	0.237	0.88	1.66
現在歯数(基準:28歯以上)	0	9.98	<0.001	7.07	14.09
	1-9	14.18	<0.001	10.37	19.39
	10-19	9.46	<0.001	7.15	12.52
	20-27	3.15	<0.001	2.50	3.97
歯ぐきの自覚症状(基準:なし)	歯ぐきが腫れている	1.81	<0.001	1.48	2.21
	歯をみがいた時に血が出る	1.38	<0.001	1.17	1.62
	歯ぐきが下がって歯の根が出ている	1.30	0.001	1.11	1.52
	歯ぐきを押すと膿が出る	1.51	0.067	0.97	2.35
	歯がぐらぐらする	2.17	<0.001	1.78	2.63
	歯周病といわれ治療している	1.30	0.029	1.03	1.64
補綴(基準:なし)	義歯	1.14	0.179	0.94	1.37
	ブリッジ	0.91	0.249	0.78	1.07
	インプラント	0.74	0.046	0.55	1.00
歯科保健行動(基準:なし)	歯間部清掃	0.83	0.010	0.72	0.96
	歯石除去・歯面清掃	0.82	0.059	0.67	1.01
	歯磨き個人指導	1.13	0.271	0.91	1.41
	歯科健康診査	1.00	0.965	0.81	1.22
喫煙(基準:喫煙しない)	現在、習慣的に喫煙	1.36	0.001	1.14	1.63
	過去、習慣的に喫煙	1.17	0.138	0.95	1.44

### ③「進行した歯周炎」

表4に、「進行した歯周炎」の有無を目的変数としたロジスティック回帰分析の結果を示す。説明力

(Pseudo R<sup>2</sup>)は8%と高くなかった。

最も関連の強かった要因は、年齢階級で、50～60歳代で「進行した歯周炎」を有する人の割合が最も高かった。

次いで高い関連性を有していたのが現在歯数で、歯の喪失が進んだ人では「進行した歯周炎」を有する割合も高いことが示された。

歯科保健行動では、いずれの項目も実施者のほうが「進行した歯周炎」を有する割合が高いという結果であった。これは「進行した歯周炎」が質問紙に回答した自覚症状を基に定義づけられているため、セルフケア行動の高い人ほど、セルフチェックを熱心に行うことが自覚症状の高さを招いたためではないかと思われた。

喫煙については、現在および過去喫煙者は「進行した歯周炎」を有する割合が高いことが示され、1999年の歯科疾患実態調査と国民栄養調査のリンケージデータを用いたOjimaらの報告<sup>10)</sup>と同様の所見が得られた。

このほか、「進行した歯周炎」は、女性でやや多く、学生で少ない傾向にあることが示された。

地域差は認められなかった。

### 3)健康日本21「歯の健康」の行動目標の重複に関する分析(図4)

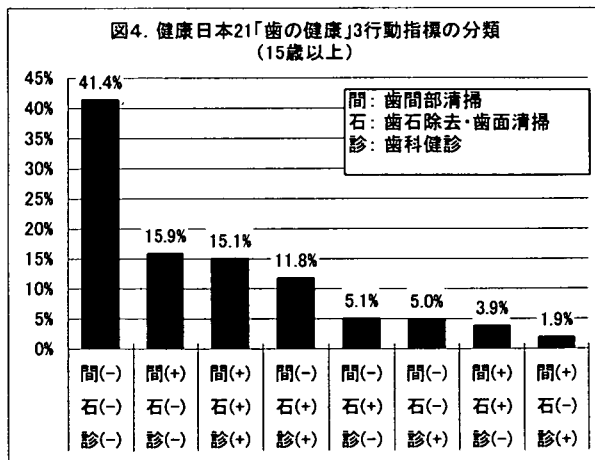
健康日本21「歯の健康」における歯科保健行動に関する目標値(歯間部清掃、歯石除去・歯面清掃、歯科健康診査)の相互関係をみたところ、割合が最も高かったのは、いずれも「なし」であった(41%)。次いで、歯間部清掃のみ(16%)、

表4.「進行した歯周炎」の有無を目的変数としたロジスティック回帰分析の結果(20歳以上)

「進行した歯周病」は、下記のいずれかに該当する場合を指す:  
歯の根が出ている/歯ぐきを押すと膿が出る/歯がぐらぐらする/歯周病(歯槽膿漏)と言われ治療している

N = 6,866  
Pseudo R<sup>2</sup> = 0.0822

説明変数		オッズ比	p値	95%信頼区間	
年齢階級 (基準:20-29歳)	30-39	1.56	0.001	1.19	2.04
	40-49	2.64	<0.001	2.03	3.44
	50-59	4.78	<0.001	3.70	6.17
	60-69	4.17	<0.001	3.19	5.45
	70-	3.18	<0.001	2.36	4.28
性(基準:男性)	女性	1.19	0.022	1.03	1.37
自治体規模 (基準:12大市・特別区)	市(15万-)	0.91	0.241	0.79	1.06
	市(5-15万)	0.97	0.719	0.81	1.16
	市(-5万)+町村	1.03	0.699	0.87	1.23
仕事 (基準:専門職・管理職)	事務、販売、サービス	1.04	0.682	0.87	1.25
	保安、農林、運輸通信、生産工程・労務	1.03	0.739	0.85	1.25
	家事従事者	0.96	0.687	0.78	1.18
	その他(高齢・病気など)	1.13	0.268	0.91	1.42
	学生	0.43	0.042	0.19	0.97
	不明	1.01	0.954	0.78	1.30
現在歯数 (基準:28歯以上)	1-9	1.47	0.001	1.17	1.84
	10-19	1.97	<0.001	1.63	2.36
	20-27	1.37	<0.001	1.20	1.57
歯科保健行動 (基準:実施せず)	歯間部清掃	1.16	0.010	1.04	1.30
	歯石除去・歯面清掃	1.34	<0.001	1.14	1.57
	歯磨き個別指導	1.20	0.031	1.02	1.42
	歯科健康診査	1.17	0.062	0.99	1.37
喫煙(基準:喫煙しない)	現在、習慣的に喫煙	1.63	<0.001	1.41	1.89
	過去、習慣的に喫煙	1.56	<0.001	1.31	1.85



すべて実施（15%）、歯間部清掃のみ実施せず（12%）の順であった。

## 2. 小児（1～14歳）

### 1) 記述統計分析

#### ① 年齢差(図6-A～C)

虫歯予防対策（図6-A）は、フッ化物配合歯磨剤とフッ化物歯面塗布を実施している割合が高く、6歳くらいまで年齢とともに高くなる傾向を示し、それ以上の年齢層ではほぼ一定であった。間食回数は（図6-B）、低年齢児で頻度が高い傾向を示した。歯磨きの個人指導を受けた割合（図6-C）は、上の年齢層でやや低かったものの年齢差は小さかった。歯石除去・歯面清掃を受けた割合（図6-C）は、小学校中学年相当の年齢が最も高かった。

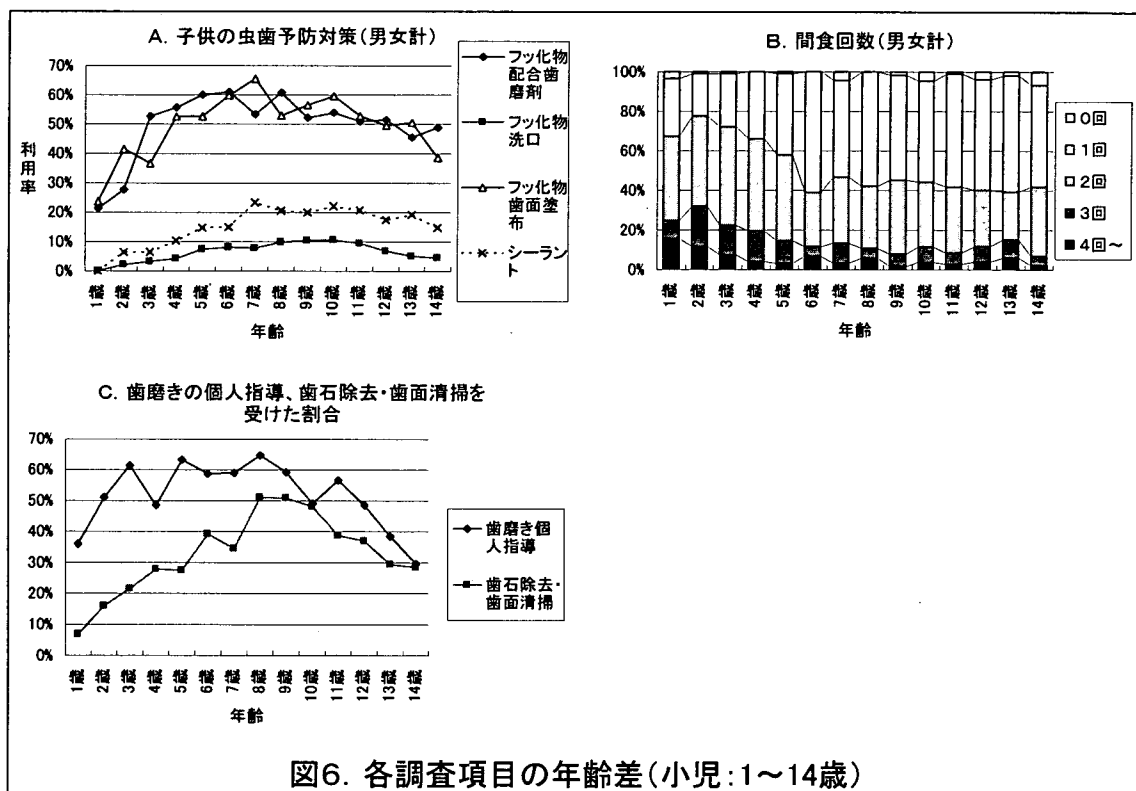


図6. 各調査項目の年齢差(小児:1～14歳)

#### ② 性差

全体的に性差は顕著ではなく、フッ化物配合歯磨剤・フッ化物歯面塗布の実施で、女性がやや高い傾向を示した（図7）のみであった。

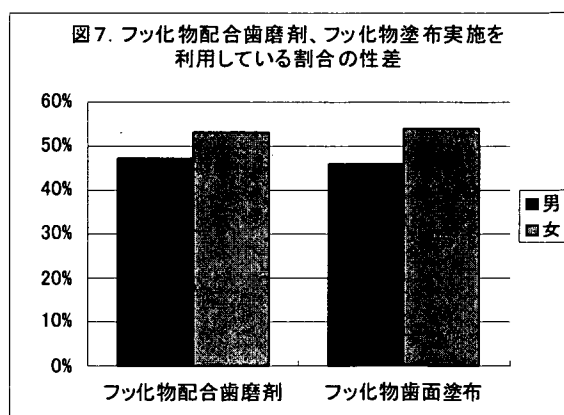
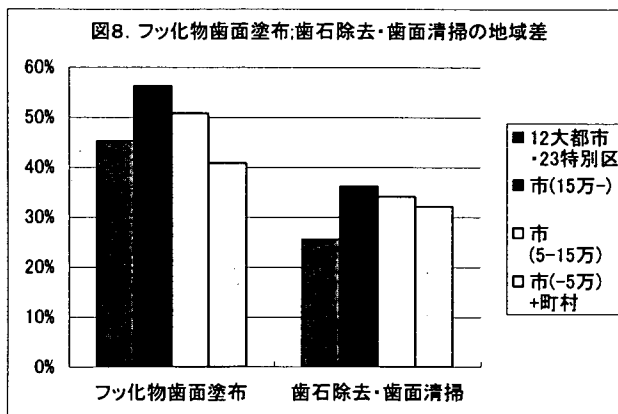


図7. フッ化物配合歯磨剤、フッ化物歯面塗布実施を利用している割合の性差

### ③ 地域差

全体的に地域差も顕著ではなく、フッ化物歯面塗布と歯石除去・歯面清掃において地域差が認められた(図8)ものの傾向は不定であった。



## 2) 要因分析

### ① 間食回数

表5に間食回数(3回以上)を目的変数としたロジスティック回帰分析の結果を示す。説明力(Pseudo R<sup>2</sup>)は6%と高くなかった。

有意であった要因は、年齢階級と予防処置(フッ化物歯面塗布、シーラント)のみであった。

年齢階級では低年齢児(1-4歳)は間食回数が他の年齢階級に比べて多く、間食による甘味摂取対策が、この年齢層におけるう蝕予防対策として重要であることが示された。

フッ化物歯面塗布とシーラントでは、いずれもこの予防対策を実施している小児で間食回数が少ないことが示され、予防処置を受ける層が必ずしもハイリスク層と一致していないことが示された。

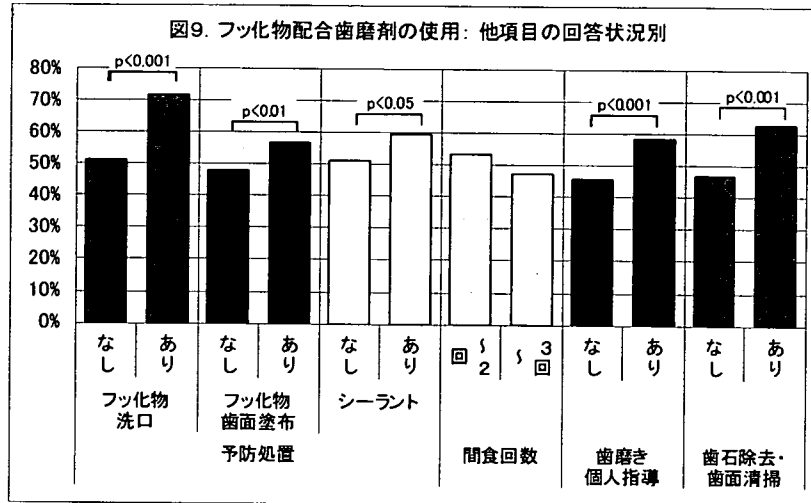
表5. 間食回数(3回以上)を目的変数としたロジスティック回帰分析の結果(1~14歳)

0: 間食回数2回以下  
1: 間食回数3回以上  
例数=1,215  
Pseudo R<sup>2</sup>=0.058

説明変数		オッズ比	p値	95%信頼区間	
年齢階級 (基準:5-9歳)	1-4歳	2.22	<0.001	1.47	3.35
	10-14歳	0.83	0.407	0.53	1.29
性(基準:男性)		1.04	0.800	0.75	1.46
各予防処置の実施 (基準:非実施)	フッ化物歯面塗布	0.91	0.588	0.65	1.28
	フッ化物洗口	1.78	0.070	0.96	3.30
	フッ化物塗布	0.65	0.019	0.45	0.93
	シーラント	0.52	0.032	0.28	0.94
歯磨き個人指導の実施(基準:非実施)		1.17	0.393	0.81	1.69
歯石除去・歯面清掃の実施 (基準:非実施)		0.98	0.930	0.65	1.49
自治体規模 (基準:12大都市・特別区)	市:15万人以上	0.89	0.611	0.56	1.41
	市:5~15万人	1.04	0.901	0.60	1.79
	市:5万未満+町村	0.69	0.178	0.41	1.18
世帯員数 (基準:2-3人)	4人	1.43	0.130	0.90	2.27
	5人	1.43	0.188	0.84	2.45
	6人~	0.91	0.732	0.51	1.60

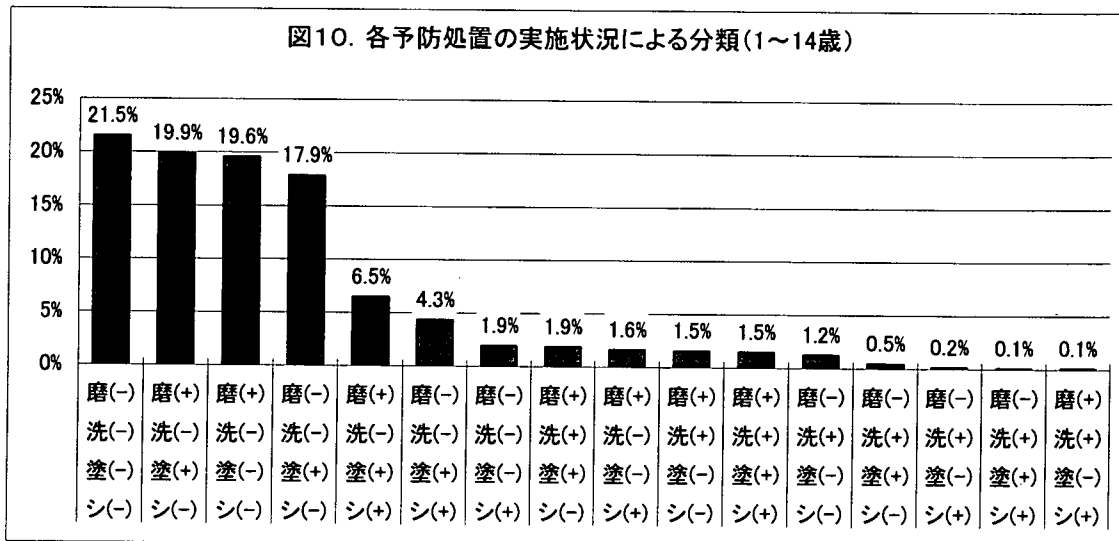
## ② フッ化物配合歯磨剤の使用と他指標の関連

図9に、フッ化物配合歯磨剤の使用者（保護者が、これを利用としていると質問紙に回答した小児）は、各予防行動を実施しているほど高い割合を示した。この結果は、フッ化物洗口、フッ化物歯面塗布、シーラント、歯磨き個人指導、歯石除去・歯面清掃を行っている人は、歯磨剤中にフッ化物が配合されていることをよく知っていることを示すものと解釈できる



## 3) 健康日本 21「歯の健康」の行動目標の重複に関する分析(図10)

予防処置（フッ化物配合歯磨剤、フッ化物洗口、フッ化物歯面塗布、シーラント）の実施状況について相互の関連をみたところ、最も高い割合を示したのは、いずれも実施していない場合であった（21%）。これに次ぐのが、フッ化物配合歯磨剤・フッ化物歯面塗布のみ実施（20%）、フッ化物配合歯磨剤のみ実施（20%）、フッ化物歯面塗布のみ実施（18%）であり、この3つで全体の6割近くを占めていた。





## 文献

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**D. 研究発表**

**1. 論文発表**

なし

**2. 学会発表**

なし

**E. 知的財産権の出願・登録状況**

**1. 特許取得**

なし

**2. 実用新案登録**

なし

**3. その他**

なし

# III. 研究成果の刊行に関する一覧表

口腔保健と全身の QOL の関係に関する総合研究

(H19-医療-一般-008)

研究成果の刊行に関する一覧表

雑誌

発表者名	論文タイトル	発表雑誌	巻号	ページ	出版年
T Ansai, Takata Y, I Soh, S Akifusa, et al.	Relationship between chewing ability and 4-year mortality in a cohort of 80-year-old Japanese people.	Oral Disease	13	214-219	2007
Yoshihara A, Deguchi T, Hanada N, et al.	Renal functional and periodontal disease in elderly Japanese.	J. Periodontal	78	1241-1248	2007
Yoshihara A, Hiroto mi T, Takano N, et al.	Serum markers of chronic dehydration are associated with saliva spinability.	J. Oral Rehabilitation	34	733-738	2007
Yoshihara A, Takano N, Ogawa H, et al.	Longitudinal relationship between root caries and serum albumin.	J. Dental Research	57	151-162	2007
永山寛, 木村 靖男, 島田美 恵子, et al.	地方都市在住高齢者における日常生活での歩数と体力との関係.	体力科学	57	151-162	2008

## **IV. 研究成果の刊行物・別刷**

口腔保健と全身の QOL の関係に関する総合研究

(H19-医療-一般-008)

## ORIGINAL ARTICLE

# Relationship between chewing ability and 4-year mortality in a cohort of 80-year-old Japanese people

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**OBJECTIVE:** Poor oral health has been reported to be a risk indicator of mortality, however, few data are available regarding the relationship between chewing ability and mortality. We examined the relationship between self-assessed chewing ability and mortality in elderly subjects.

**DESIGN:** Prospective study.

**SUBJECTS AND METHODS:** Participating in the study were 697 people (277 males, 420 females) from 1282 individuals (80 years old) residing in Fukuoka Prefecture, Japan. Data on oral and systemic health status through questionnaires, accompanied by physical and laboratory blood examinations were obtained. Chewing ability was assessed based on the number of types of food each subject reported as able to chew by questionnaire.

**RESULTS:** A total of 108 subjects died between 1998 and 2002. Those with the lowest number of chewable foods were associated with higher risk of mortality than those with the ability to chew all of the 15 types of food surveyed [hazard ratio (HR) = 2.38, 95% confidence interval (95% CI) = 1.07–5.29], though other parameters including current smoking, low serum albumin, and poor physical health status were more significant. Further, reduced chewing ability of soft foods increased the risk (HR = 2.65, 95% CI = 1.20–5.87).

**CONCLUSION:** Chewing ability was associated with mortality in a population of 80-year-old community residents, and may be a predictor for survival rate.

*Oral Diseases* (2007) 13, 214–219

**Keywords:** chewing ability; masticatory; dental; elderly; mortality

## Introduction

The Japanese population is aging rapidly, and it has been estimated that people over 65 years of age will account for approximately 22% of the total population by 2010. In 2000, the 'Healthy Japan 21' campaign was initiated in order to promote overall fitness, including oral health, in the 21st century, with the goal of the campaign being to extend healthy life expectancy and improve the quality of life. In 1998, the 8020 Data Bank Survey, a community-based, cross-sectional survey, was designed and conducted in Japan in order to collect baseline data regarding the systemic and dental health of 80-year-old subjects, and to promote the idea that individuals should have at least 20 original teeth by the age of 80. In our previous cross-sectional study, we provided findings indicating that dental status and chewing ability were associated with systemic health status, such as electrocardiographic abnormalities, physical fitness, blood pressure, and activity of daily living in octogenarians (Takata *et al*, 2001, 2004a,b; Matsumura *et al*, 2003).

To date, associations between oral and systemic health in elderly subjects have been documented, while chronic periodontitis has been a particular focus of attention, due to its association with various chronic diseases such as cerebrovascular disease (Wu *et al*, 2000), coronary heart disease (Beck *et al*, 1996; Jansson *et al*, 2001), pulmonary diseases (Hayes *et al*, 1998), and overall mortality (DeStefano *et al*, 1993). It has been suggested that these associations may be the result of a common factor, i.e., smoking (Hujoel *et al*, 2002).

On the other hand, it remains to be fully elucidated whether chewing ability is correlated with mortality in elderly subjects, because few community-based survey results are available regarding the relationships between oral functions, such as chewing ability, and mortality (Appollonio *et al*, 1997a; Nakanishi *et al*, 1999). Most recently, Nakanishi *et al* (2005) reported that self-assessed chewing disability may be associated with a

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greater risk of mortality in community-residing people aged 65 and older. However, as that survey only included questions regarding demographics, health status, and psychosocial variables, variables commonly associated with chronic diseases were not included in their analyses.

In order to analyze the effects of additional potential confounders, in the present report, we investigated the association between chewing ability and mortality in 80-year-old community dwelling subjects using a 4-year follow-up study.

## Subjects and methods

### Study population

The present study began as a population-based cross-sectional study performed from 1997 to 1998, known as the 8020 Data Bank Survey, which focused on the oral and systemic health conditions of 80-year-old residents in Japan. The target population in this study consisted of subjects born in 1917 who were residents of Fukuoka Prefecture, on Kyushu Island, in southern Japan. We did not consider the effects of age on changes that might potentially confound factors related to systemic condition, e.g., blood pressure, serum cholesterol, and serum glucose. All 80-year-old individuals residing in nine districts, including three cities (Buzen, Yukuhashi, and Munakata), four towns (Katsuyama, Tikujo, Toyotsu, and Kanda), one village (Shinyoshitomi), and one ward (Tobata of Kitakyushu City), were invited to participate in the survey. Of the 1282 individuals contacted, 697 (277 males, 420 females) agreed to participate, and 672 of those completed a questionnaire regarding life style, oral and systemic health, and also underwent the physical, laboratory blood, and oral examinations. The Human Investigations Committee of Kyushu Dental College approved the survey, and all subjects gave written informed consent prior to participation.

### Baseline data

The baseline survey was performed in March 1998, which included a medical examination, a standardized medical history, a standardized dental examination, and laboratory tests. Demographic variables in the risk models included gender, place of residence, family status (whether the subject lived alone or not), and marital status of the person being examined. Disease risk factors evaluated during the baseline clinical examination included serum total cholesterol, systolic and diastolic blood pressure, fasting serum glucose, serum albumin, cigarette smoking status (never, past, or current), daily alcohol consumption, body mass index, regular physical activity, self-rated general health, self-rated mental health, healthcare behavior (i.e., regular check-up by a family doctor), and physical health status. The physical health status was determined by public health nurses who classified the subjects as either independent or dependent, i.e., requiring daily assistance. The subjects took part in a face-to-face interview, and answered containing 37 questions about oral and systemic health status, use of medical (or dental) services, personal

hygiene and healthcare practices (including smoking habit), and medical conditions. Information on self-assessed chewing ability was based on the following question regarding the number of types of food: 'Can you chew any of the following 15 types of food?'. The response was a simple dichotomous variable (yes/no). The number of foods that subjects reported being able to chew was used as an independent variable in our analyses. To date, questionnaires concerning food intake have proved valuable in epidemiologic surveys of masticatory function in the elderly (Leake, 1990; Slade *et al*, 1996; Miura *et al*, 1998). Here, we used the criteria as described previously (Yamamoto, 1972): 15 different types of food were divided into four groups, ranging from very hard to chew to easy to chew, namely, three foods were very hard to chew (hard rice crackers, peanuts, and yellow pickled radish), six foods were moderately hard to chew (French bread, beefsteak, octopus in vinegar, pickled shallots, dried scallops, and dried cuttlefish), three foods were slightly hard to chew (konnyaku, a tubular roll of boiled fish paste, and squid sashimi), and three foods were easy to chew (boiled rice, tuna sashimi, and grilled eel).

### Follow-up survey

The present study was designed to analyze the results of follow-up examinations of all of the participants in our previous study and was performed at the end of March 2002, i.e., 4 years after the baseline investigation had been conducted. As for subjects who died, we recorded the date and cause of death according to resident registration cards and official death certificates, which were available in the registers at the Public Health Centers of each district included in the study. Deaths were classified by trained physicians according to the International Classification of Disease, 10th revision. Of the 697 subjects who took part in the baseline survey, there were no losses to follow-up, as even the 14 subjects who had moved from Fukuoka Prefecture after the initial survey were successfully traced.

### Statistical analysis

The associations of demographic, physical health, oral health, clinical, biochemical, and lifestyle variables with mortality were assessed using univariate Cox proportional hazards models. The Kaplan–Meier method was used to estimate cumulative survival according to the number of chewable foods categorized into four groups, which was based upon results shown in our previous reports (Takata *et al*, 2004a,b); group A ( $n = 204$ ): all 15 foods, group B ( $n = 307$ ): 10–14 foods, group C ( $n = 134$ ): 5–9 foods, and group D ( $n = 40$ ): 0–4 foods. The log rank test was used to assess the significance of differences between survival curves. The associations of chewing ability categorized based on total number of chewable foods or the ability to chew the four types of food (from 'easy' to 'very hard'), and mortality were also analyzed using multivariate Cox analysis, with adjustment for statistically significant (and marginally significant) variables shown by univariate Cox analysis as dichotomized variables, which included gender (female

vs male), physical health status (poor vs good), and cigarette smoking status (never, past, and current), and continuous variables, which included body mass index, serum cholesterol, fasting serum glucose, serum albumin, and diastolic blood pressure.

All statistical analyses were performed using SPSS 11.0 for Windows (SPSS, Chicago, IL, USA). The criterion for statistical significance was set at 0.05 in all of the analyses.

## Results

In the 4-year period from March 1998 to March 2002, 108 of the subjects (58 males, 50 females) died. In

univariate Cox proportional hazards analyses, factors showing a statistically significant relationship with mortality were gender, smoking status, physical health status, body mass index, serum total cholesterol, and serum albumin (Table 1).

The unadjusted survival rates for number of chewable foods categorized into four groups (groups A–D, see the Subjects and methods section) were analyzed using the Kaplan–Meier method, followed by log rank tests. Among the subjects, group D had a significantly increased rate of mortality when compared with group A (log rank test,  $P = 0.02$ ). As for males, the log rank test showed that the survival curves between groups A and D had statistical significance ( $P = 0.005$ ), while no

Characteristic	Entire cohort ( <i>N</i> = 697) (%)	Mortality ( <i>N</i> = 108) (%)
<i>Demographic</i>		
Female	420 (60.3)	50 (46.3)*
<i>Region</i>		
Subjects from cities	459 (65.9)	69 (63.9)
<i>Family status</i>		
Live alone	162 (23.2)	18 (16.7)
<i>Marital status</i>		
Currently married	341 (48.9)	57 (52.8)
<i>Physical health status</i>		
Good	554 (79.5)	72 (66.7)**
<i>Oral health status</i>		
Number of teeth	8.0 (8.9)	6.8 (8.5)
Number of missing teeth	23.9 (8.9)	25.2 (8.5)
Number of chewable foods	11.6 (3.6) <sup>a</sup>	11.0 (3.8)
% of self-care	508 (72.9)	75 (69.4)
% of oral hygiene	287 (41.1)	32 (29.6)
<i>Medical examinations</i>		
Serum total cholesterol (mg dl <sup>-1</sup> ) <sup>b</sup>	205.7 (38.1)	194.5 (40.1)*
Fasting serum glucose (mg dl <sup>-1</sup> ) <sup>b</sup>	121.1 (53.2)	129.6 (61.5)
Serum albumin (g dl <sup>-1</sup> ) <sup>b</sup>	4.23 (0.31)	4.05 (0.37)**
Systolic blood pressure (mmHg)	150.4 (23.1)	148.1 (21.8)
Diastolic blood pressure (mmHg)	78.9 (12.3)	76.9 (11.3)
<i>Disease risk factors</i>		
Body mass index	22.7 (3.3)	21.9 (3.2)*
<i>Regular physical activity</i>		
Yes	385 (55.2)	55 (50.9)
<i>Regular checkup by family doctor</i>		
Yes	555 (79.6)	85 (78.7)
<i>Regular checkup by family dentist</i>		
Yes	452 (64.8)	69 (63.9)
<i>Self-rated general health</i>		
Good	285 (40.9)	41 (37.9)
<i>Self-rated mental health</i>		
Good	607 (87.1)	96 (88.9)
<i>Self-report of smoking</i>		
Current	89 (12.8)	30 (27.8)**
Past	166 (23.8)	32 (29.6)*
Never	439 (63.0)	46 (42.6)
Unknown	3 (0.4)	0 (0)
<i>Self-report of daily alcohol consumption</i>		
Never	293 (42.0)	51 (47.2)
Seldom	179 (25.7)	31 (28.7)
Sometimes	63 (9.0)	7 (6.5)
Habitual	130 (18.7)	19 (17.6)
Unknown	32 (4.6)	0 (0)

Table 1 Baseline characteristics of 80-year-old subjects and those who died during 4-year follow-up

Data indicate the number of subjects (%) or mean (s.d.).

<sup>a</sup>Data available for 685 people.

<sup>b</sup>Complete data for serum total cholesterol, fasting serum glucose, and serum albumin were available for 672 people and 102, respectively.

*P* values are by univariate Cox proportional hazards analysis: \* $P < 0.01$ ; \*\* $P < 0.001$ .



statistically significant differences were observed for females.

To analyze whether poor chewing ability was independently related to mortality, multivariate-adjusted mortality risks were calculated, using a multivariate model in which the statistically significant and marginally significant variables shown in Table 1 were used. Table 3 shows the results of multivariate Cox proportional hazards analyses. Group D, namely subjects who were able to chew the lowest number of chewable foods, was associated with 2.4-fold higher risk of mortality than group A, which consisted of subjects able to chew all 15 foods (Table 2). Physical health status (poor), smoking status (current), and serum albumin (continuous) were also significantly associated with mortality [hazard ratio (HR) = 2.31, 95% confidence interval (95% CI) = 1.21–4.39; HR = 2.63, 95% CI = 1.47–4.70; and HR = 0.27, 95% CI = 0.14–0.53, respectively] (Table 2).

Next, we calculated the multivariate-adjusted hazard ratios according to the differences in the four types of chewable foods, i.e., from easy to chew to very hard to chew, and found that a reduction in ability to chew easy-to-chew foods increased the risk of mortality (HR for 0–1 vs 3 = 2.65,  $P < 0.02$ ) (Table 3). Further, a reduction in ability to chew slightly hard-to-chew foods also tended to be associated with the risk of mortality (HR for 0–1 vs 3 = 1.78,  $P = 0.08$ ) (Table 3).

## Discussion

### Main findings

The results from this prospective population-based study can be summarized as follows: (1) there was a close relationship between self-assessed chewing ability and mortality in a cohort study of 80-year-old subjects; (2) among the four different types of chewable foods, a reduction in ability to chew soft foods was associated with a much higher risk of mortality; and (3) chewing

Table 2 Hazard ratios of 4-year mortality by multivariate analysis using Cox proportional hazards model

Characteristic	Adjusted hazard ratio	95% CI	P value
Number of chewable foods			
A: 15	1.0		
B: 10–14	1.19	0.71–1.99	0.51
C: 5–9	1.19	0.63–2.25	0.59
D: 0–4	2.38	1.07–5.29	0.03
Gender: female	0.88	0.51–1.50	0.64
Physical health status: poor	2.31	1.21–4.39	0.01
Self-report of smoking			
Never	1.0		
Past	1.50	0.83–2.71	0.18
Current	2.63	1.47–4.70	0.001
Body mass index	0.95	0.89–1.02	0.14
Serum total cholesterol	1.00	0.99–1.01	0.81
Fasting serum glucose	1.00	1.00–1.01	0.07
Serum albumin	0.27	0.14–0.53	<0.001
Diastolic blood pressure	1.00	0.98–1.02	0.84

Table 3 Adjusted hazard ratios of 4-year mortality according to the differences in the four types of foods that they had difficulty in chewing using Cox proportional hazards model

Type of foods	Adjusted hazard ratio	95% CI	P value
Number of easy-to-chew foods			
3	1.0		
2	0.98	0.49–1.97	0.95
0–1	2.65	1.20–5.87	0.02
Number of slightly hard-to-chew foods			
3	1.0		
2	0.87	0.46–1.64	0.67
0–1	1.78	0.93–3.42	0.08
Number of moderately hard-to-chew foods			
6	1.0		
4–5	0.98	0.55–1.74	0.95
2–3	1.53	0.87–2.68	0.14
0–1	1.52	0.82–2.80	0.19
Number of very hard-to-chew foods			
3	1.0		
2	0.82	0.47–1.42	0.48
0–1	1.26	0.76–2.08	0.38

Adjusted for gender, physical health status, body mass index, cigarette smoking status, serum total cholesterol, fasting serum glucose, serum albumin, and diastolic blood pressure.

ability may be an independent risk marker for mortality. Our results support those obtained in previous cross-sectional surveys showing that self-assessed masticatory disability is associated with a decline in general health (Österberg *et al*, 1996; Takata *et al*, 2004a,b). Recently, a cohort study concerning the relationship between masticatory disability and mortality in Japanese aged 65 and older assessed masticatory ability according to answers by the subjects to a few simple questions (e.g., ‘Can you chew any type of food?’) (Nakanishi *et al*, 2005). Those results showed that self-assessed masticatory disability was significantly associated with a greater risk of mortality (HR = 1.63, 95% CI = 1.30–2.03). Further, an association between chewing ability and mortality was found, which was similar to that shown in the present study, though in a different age group. However, it is necessary to keep in mind that there are limitations to interpretation of the results of their study, as they were based solely on questionnaires, and adjustment for variables commonly associated with chronic diseases including metabolic syndrome, such as results of laboratory blood examinations, smoking status, and medical history, were not included in the statistical analyses.

In order to maintain chewing ability, replacement of missing teeth is likely important. In the present study, subjects with no replacements for missing teeth (in other words, inadequate dentition) had approximately 1.7-fold higher risk for mortality than those with at least some replacements ( $P = 0.19$ ) (data not shown). Further, adjusted Cox analyses showed that the mortality rate for subjects with fixed dentures used to replace missing teeth was approximately 40% lower than that of subjects with removable complete dentures ( $P < 0.05$ ) (data not shown). Our findings suggest that maintenance

of chewing ability with healthy natural dentition or adequate replacement of missing dentition may be important for the general health of elderly subjects. To date, several surveys have shown that the quality of life was compromised by dental and oral disorders (Sheiham *et al*, 2001a). Thus, clinicians should be aware of oral functions in order to promote and preserve the general health of elderly subjects.

This study was a part of the 8020 Data Bank Survey in Japan, in which 80-year-old populations were investigated to gain baseline data. To date, such epidemiological surveys of community-dwelling octogenarians are rare, though a recent 10-year follow-up study of 226 subjects (80 years old) showed that poor dental health was linked to increased mortality (Hämäläinen *et al*, 2003). The report noted that each missing tooth increased mortality by 2.6% over a 10-year period, while our results showed that mortality rate increased by 2.0% for each missing tooth over a 4-year period, which were similar findings.

Whether the observed association between chewing ability and systemic health is causal remains unclear at present. It is possible that common etiological factors are responsible for the observed associations, for example socioeconomic state, smoking habit, lifestyle, health-related behavior, and genetics (Anderson *et al*, 1997; Scott *et al*, 1997; Lantz *et al*, 1998; Lee, 2000). In the present study, other significant parameters in explaining mortality risk included current smoking, low serum albumin, and poor physical health. Considering that statistical significance for chewing ability was not so high, the deterioration of chewing ability may be partly contributory to mortality risk.

Poor chewing ability may be linked to limitation of their pleasure to eat and choice of a healthy diet, and further influence nutrition. It has been reported that dental status has an effect on nutritional status, as several studies have reported that impaired dentition status is associated with poor nutritional intake (Joshi-pura *et al*, 1996; Appollonio *et al*, 1997b; Krall *et al*, 1998; Sheiham and Steele, 2001). In addition, a longitudinal relationship between tooth loss and detrimental changes in dietary intake was recently reported (Hung *et al*, 2003). Reduction in chewing ability can influence individual food selection, resulting in marked changes in dietary intake of some key nutrients, such as non-starch polysaccharides (fiber) (Walls, 1999). It is also suggested that dental status was related to the blood levels of key nutrients, such as plasma ascorbate and plasma retinol (Sheiham *et al*, 2001b). The combined detrimental effects caused by not consuming a variety of foods and nutrients could lead to a higher risk of developing chronic diseases.

#### Limitations of the study

A potential weakness of this study is biases introduced by participation. The participants were 672 subjects (52.4%) from a target population of 1282 subjects and the data may be somewhat biased, as the present elderly subjects were generally in good health, and might have been more eager and/or able to participate in this

survey. Thus, our findings may indicate an association in generally healthy elderly subjects. The selection bias of losses to follow-up was relatively negligible, as all of the subjects were traced by a mortality survey, though survival bias must also be considered in that context. In the total group of subjects, there were 1.5-fold more females than males. Japanese females tend to live longer than Japanese males, as the average life span in Japan in 2003 was 78.4 years for males, and 85.3 years for females. We considered that the difference in number of subjects according to gender in the present study represents a microcosm of present-day Japanese society.

One additional limitation of the present study is that the number of mortality events was very low, which implies weaknesses in the associations observed in the present study. Nevertheless, our 4-year follow-up study revealed a significant association between chewing ability and mortality. Additional follow-up of these elderly subjects may provide additional findings of interest in the future.

In conclusion, our results showed a significant relationship between chewing ability and mortality in elderly individuals, even after extensive adjustment for potential confounding variables including gender, physical health status, smoking status, and various laboratory test results. Further, a reduction in ability to chew soft foods was found to increase the risk of mortality. Thus, the ability to chew may be considered as an independent predictor of mortality in community-dwelling elderly subjects, though the present findings did not reveal causality.

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# Renal Function and Periodontal Disease in Elderly Japanese

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**Background:** Chronic renal failure involves a slow, progressive loss of renal function over months or years. It is possible that periodontal disease and chronic kidney disease might share common risk factors. This study investigated whether a link exists between periodontal disease and chronic renal function in community-dwelling elderly subjects.

**Methods:** A total of 145 study subjects, all 77 years of age, participated in this study. A periodontal examination was carried out by trained dentists. Urine was collected over 24 hours, and blood was taken on the morning of the dental exam. The volume of creatinine per 24 hours (Cre\_U) and volume of urine per 24 hours were used as urinary markers of kidney function; serum creatinine levels (Cre\_S) were used as a blood marker of kidney function. Creatinine clearance per 24 hours was calculated as  $\text{Cre\_U}/\text{Cre\_S}$ . In addition, biochemical parameters of bone turnover were measured: urinary deoxypyridinoline (U-DPD) as a bone resorption marker and serum osteocalcin (S-OC) as a bone formation marker. Multiple regression analysis was used to evaluate the relationship between the percentage of periodontal sites with  $\geq 6$ -mm clinical attachment level (%  $\geq 6$ -mm CAL) and renal function, as well as the relationship between %  $\geq 6$ -mm CAL and bone metabolism. The %  $\geq 6$ -mm CAL was used as the dependent variable. The number of remaining teeth, smoking habit, gender, use of interdental brushes or dental floss, volume of urine per 24 hours, and creatinine clearance per 24 hours were independent variables in the first test. In addition, the number of remaining teeth, smoking habits, gender, use of interdental brushes or dental floss, U-DPD, and S-OC were independent variables in the second test.

**Results:** Multiple regression analysis showed that creatinine clearance per 24 hours and S-OC were significantly associated with %  $\geq 6$ -mm CAL per person. The standardized coefficients were 0.26 ( $P = 0.015$ ) and  $-0.27$  ( $P = 0.006$ ), respectively.

**Conclusions:** The %  $\geq 6$ -mm CAL was significantly associated with renal function and bone metabolism markers. This study suggests that the increased incidence of chronic renal failure that occurs with age might increase the probability of severe periodontal disease in community-dwelling elderly subjects. *J Periodontol* 2007; 78:1241-1248.

## KEY WORDS

Bone; elderly; metabolic process; periodontitis; renal failure.

Older adults have an increased risk of chronic renal insufficiency. Chronic renal failure involves a slow, progressive loss of renal function over months or years. Initially it begins without symptoms, and as renal function decreases, blood pressure increases and urea accumulates, leading to uremia and fluid volume overload.<sup>1,2</sup> It is possible that atherosclerotic cardiovascular disease, imbalances in bone metabolism, and chronic kidney disease may share common risk factors;<sup>3-6</sup> for example, renal insufficiency is known to increase osteoclast-related bone turnover and may influence bone metabolic parameters.<sup>7</sup> Osteoporosis is characterized by a low bone mass caused by an imbalance of skeletal turnover and is also known to influence periodontal disease progression.<sup>8</sup>

Several studies have attempted to address the relationship between periodontal disease and chronic renal failure in the past 10 years, but findings have been inconsistent: some studies failed to suggest any significant relationship,<sup>9-12</sup> whereas others reported that patients with chronic renal failure showed significantly higher plaque and calculus accumulation, gingival inflammation, and lower salivary secretion.<sup>13-17</sup> Many risk factors that predispose patients to periodontal disease and accelerate its progression also appear

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