## 労災疾病臨床研究事業費補助金 歯科口腔保健と就労環境との関連に関する研究 分担研究報告書

#### 労働者の咀嚼効率と歯科保健状況及び咬合状態の自己評価との関連

| 研究代表者 | 川口陽子 | 東京医科歯科大学大学院健康推進歯学分野  | 教授   |
|-------|------|----------------------|------|
| 研究分担者 | 植野正之 | 埼玉県立大学保健医療福祉学部健康開発学科 | 教授   |
| 研究分担者 | 財津 崇 | 東京医科歯科大学大学院健康推進歯学分野  | 助教   |
| 研究協力者 | 金澤利哉 | 東京医科歯科大学大学院健康推進歯学分野  | 大学院生 |

#### 研究要旨

これまで咀嚼能力の判定では、主観的評価法としては咀嚼可能な食品や咬合状態の自己 評価を調べる質問票調査が、客観的評価法としてはピーナッツ等を使用した粉砕能力測定 法や、色変わりガム等による混和能力測定法が使用されてきた。近年、新しい咀嚼能力の 評価法として球形樹脂微粒子含有人工ガムが開発された。このガムは従来の測定法と比較 して操作性、判定の精度、試料の変質などの問題が少なく、高精度に咀嚼効率を測定でき ると考えられている。そこで、球形樹脂微粒子(カルナバワックス)を含有した人工ガム(ウ ェルカムガム®)を用いて咀嚼効率を評価し、歯科保健状況や咬合状態の自己評価との関連 について検討することを目的に、本研究を実施した。

運輸業、製造業の 10 か所の事業所に勤務する労働者 903 名(男性 709 名、女性 194 名、平均年齢 42.2±11.6 歳)を対象とした。事業所での歯科健診の際に、質問票調査、球 形樹脂微粒子含有人工ガムを用いた咀嚼効率の測定を実施し、これらの関連について検討 を行った。

その結果、以下のことが明らかになった。

- 1. 球形樹脂微粒子含有人工ガムで測定した咀嚼効率は、現在歯数や FTUs が少ないほど 有意に低く、また、未処置歯数が多いほど有意に低く、さらに歯周病、不正咬合有病 者は非有病者より有意に低いことが明らかになった。また、人工ガムによる咀嚼効率 は、年齢が高いほど有意に高いという結果が得られた。
- 2. 咬合状態の自己評価が良好な者は現在歯数と FTUs が有意に高く、未処置歯数は有意 に少なく、歯周病の有病者率が有意に低いことが判明した。
- 3. 咀嚼効率と咬合状態の自己評価との関連を分析したところ、単純分析では関連が認め られたが、咀嚼効率に影響する要因を調整して検討すると、咀嚼効率と咬合状態の自 己評価の有意な関連は認められなかった。

したがって、球形樹脂微粒子含有人工ガムによる咀嚼効率は、咀嚼能力を総合的にでは なく、粉砕能力等の咀嚼能力の一部を評価していると考えられた。年齢と咀嚼効率との関 連については、加齢に伴い歯の咬耗や摩耗が増加して、臼歯部の咬合接触面積が増加した 可能性が示唆された。

#### A. 研究目的

歯や口腔の役割として、咀嚼、発音・発 声、審美性等が挙げられる。その中でも特 に重要なのは、人間が生きていく上で必 要となる栄養を摂取するための咀嚼であ る。咀嚼には、口腔内に取り入れた食物を 噛みくだき、適度な大きさに分解し、嚥下 や消化を助けるという機能がある。また、 咀嚼は脳の満腹中枢を刺激し、過食を防 止することで、肥満予防を行うという機 能もある。さらに、咀嚼能力が不良な者は メタボリックシンドロームや糖尿病、高 血圧の有病率が高いことや咀嚼能力が良 好であることはストレスの軽減につなが ることが報告されている。そのため、咀嚼 は身体的および精神的な健康に影響を及 ぼすので、生涯にわたって良好な咀嚼能 力を保持することは重要であり、咀嚼能 力を評価することが必要と考えられる。

これまで咀嚼能力を測定する方法とし て、生米、ピーナツなどを咀嚼し、咀嚼後 の試料の粒子径を測定する粉砕能力を評 価する方法や、ガムやグミゼリーを咀嚼 して溶出した糖やゼラチン、色素を測定 するといった試料と唾液との混和能力を 評価する方法などが使用されてきた。

これらの方法は、生米など天然試料を 用いて粉砕能力を評価する方法は試料の 大きさ、硬さなどが均一ではないこと、唾 液との混和能力を評価する方法は時間の 経過とともに咀嚼後の試料が変質して測 定結果が変化することなどが指摘されている。

近年、咀嚼能力を評価する新しい方法 として、カルナバワックス粒子を含有し た球形樹脂微粒子人工ガム(ウェルカム ガム<sup>®</sup>、株式会社エグザマスティカ)が開発 された。この人工ガムは、人工試料である ため均一性が保たれている、咀嚼後の試 料が変化しない等の特徴があり、従来の 試料の欠点を補っている。さらに、測定結 果を咀嚼効率として連続変数として数値 化して示すことができるという特徴があ る。したがって、このガムは操作性、判定 の精度、試料の変質などの問題が少なく、 高精度に咀嚼効率を測定できると考えら れている。この人工ガムを使用した咀嚼 効率に関する研究は、これまで患者を対 象とし、治療前後での変化を比較すると いった方法で実施されてきたが、成人を 対象に集団レベルで咀嚼効率の調査を行 った報告は少ない。

そこで、本研究では、事業所での歯科健 診の際に球形樹脂微粒子人工ガムを用い て咀嚼効率を評価し、労働者の歯科保健 状況や咬合状態の自己評価との関連につ いて調査することを目的とした。

#### B. 研究方法

本研究の対象者は、東京都、神奈川県、 埼玉県、群馬県、栃木県、三重県にある、 製造業、運輸業の10か所の事業所に勤務 する労働者である。事業所での歯科健診 の際に、質問票調査および球形樹脂微粒 子含有人工ガム(ウェルカムガム®、株式 会社エグザマスティカ)を用いた咀嚼効率 の評価を行った。調査に参加したのは948 名(男性741名、女性207名)である。 その中で、無歯顎者および調査データに 欠損値がある45名を除外し、903名(男 性709名、女性194名、平均年齢42.2±11.6 歳)を分析対象とした。

#### 1. 質問票調査

自記式質問票を利用して、性別、年齢、 咬合状態の自己評価について調査した。

「自分の歯または入れ歯で左右の奥歯を しっかりとかみしめられますか?」とい う質問に対し、「左右両方かめる」、「片方 かめる」、「両方かめない」の回答の中から 選択してもらい、それぞれ咬合状態の自 己評価の良好群、普通群、不良群とした。

#### 2. 咀嚼効率

咀嚼効率の測定にはウェルカムガム® (株式会社エグザマスティカ)を用いた。 試料は 20.0mm×12.0mm×5.0mm、1.0g のガムであり、大きさ直径約250µmのカ ルナバワックス微粒子が平均2159±28個 含まれている。この微粒子は50gほどの 負荷により、形態を留めることなく粉砕 されるという特徴を有している。このガ ムを対象者に1秒間に1回のペースで25 回、自由に噛みやすい位置や方法で咀嚼 を行うよう指示した。

咀嚼後に回収したガムを圧延し、エグ ザマスティカ社の画像撮影・計測ソフト ウェアで撮影区画に残留する粒子数を算 出し、撮影区画とガムの面積比からガム 全体の残留粒子数を求めた。この残留粒 子数から一回の咀嚼によって破壊された 粒子の比率(%)、すなわち咀嚼効率(%) を算出した。

#### 3. 口腔保健状況

歯科用ミラーと WHO 式ペリオプロー ブを用いて口腔内診査を行った。第三大 臼歯を除外した 28 歯を対象とし、現在 歯数と未処置歯数を調査した。

臼歯部の咬合状況を評価する指標とし て、Functional Tooth Units(FTUs)を使 用した。FTUs は上下顎の同名大臼歯が 2 歯ある場合は 2、上下顎の同名小臼歯 が 2 歯ある場合は 1、片顎の臼歯のみの 場合や上下顎ともに臼歯がない場合は 0 として算出し、合計の数値で示される。 そのため、0~12 の値となる。

機能歯を現在歯のみに限定して評価す る n-FTUs、現在歯とインプラントやブ リッジのポンティック等の固定式補綴物 で評価する nif-FTUs、現在歯と固定式補 綴物及び可撤式補綴物のすべてを評価す る total-FTUs の 3 種類の FTUs を使用 した。 Community Periodontal Index (CPI) 改訂版による評価法を用いて、上下顎歯 列を6分割した分画の代表歯の検査を行 い、歯周病の診断を行った。CPI 歯周ポ ケットコードは、以下のとおりである。

コード0:4mm 未満の歯周ポケット

コード1:4-5mmの歯周ポケット

コード2:6mm以上の歯周ポケット その最大値を各人のスコアとした。スコ アが0の場合を歯周病なし、1または2 の場合を歯周病ありとした。

また、不正咬合や顎関節症は、視診と 触診により、精密検査や治療が必要と診 断された場合を疾患ありと診断した。

#### 4. 分析

年齢及び口腔保健状況の性別による比 較は、独立した t 検定または x<sup>2</sup>検定にて 分析した。年齢、口腔保健状況と咬合状 態の自己評価との関連は、一元配置分散 分析または x<sup>2</sup>検定にて分析した。また、 咀嚼効率を従属変数、性別、年齢、口腔 保健状況を独立変数とする重回帰分析を 行った。咬合状態の自己評価と咀嚼効率 との関連は Jonkheere-Terpstra の傾向 検定で分析し、さらに重回帰分析で咀嚼 効率に有意な関連の認められた要因を共 変量として共分散分析を行った。統計解 析は PASW Statistics ver. 18.0 (日本 IBM)を使用して行い、有意水準は 5%と した。 (倫理面への配慮)

本研究は東京医科歯科大学歯学部倫理 審査委員会(No. D2014-139-01)の承認 を得て、実施された。

#### C. 結果

#### 1. 男女別の年齢、口腔保健状況

表1、2に男女別の年齢、口腔保健状況 を示す。

対象者の年齢は、男性が女性より有意 に高かった。現在歯数は性別による差は 認められなかったが、未処置歯数は男性 が女性より有意に多かった。n-FTUs、nif-FTUs、total-FTUsはいずれも女性が男性 より有意に高かった。歯周病の有病者率 は男性が女性より有意に高かった。不正 咬合、顎関節症の有病者率には性別によ る差はみられなかった。

#### 2. 年代別の咀嚼効率

図1、2、3に年代別の咀嚼効率を示す。 男性では、20代以下は、他の年代と比較 して咀嚼効率は有意に低かった。女性で は有意差は認められなかったが、やはり 年代が高いほど咀嚼効率が高かった。男 女を合わせた全体をみても、男性と同様 に、20代以下は他の年代と比較して、咀 嚼効率は有意に低かった。

# 3. 咬合状態の自己評価と関連する要因

表3、4に咬合状態の自己評価と関連す

る要因を示す。咬合状態の自己評価はそ れぞれ良好群 767 名、普通群 99 名、不良 群 37 名であった。

年齢は、咬合状態の自己評価の良好群 が、普通群、不良群より有意に低かった。 現在歯数は、良好群が、普通群、不良群よ り有意に多かった。未処置歯数は、良好群 が普通群、不良群より有意に少なかった。 n-FTUs、nif-FTUs、total-FTUsのいずれ においても、良好群は普通群、不良群より 有意に高い値であった。

また、歯周病の有病者率は良好群 10.8%、普通群 20.2%、不良群 27.0%であ り、咬合状態の自己評価と歯周病の有病 者率には有意な関連が認められたが、不 正咬合と顎関節症に関しては咬合状態の 自己評価との関連は認められなかった。

# 4. 咬合状態の自己評価と咀嚼効率との 関連

図 4 に咬合状態の自己評価と咀嚼効率 との関連を示す。咬合状態の自己評価と 咀嚼効率との関連をみると、咬合状態の 自己評価が悪くなるほど咀嚼効率は低く なる有意な傾向性が認められた。

## 5. 咀嚼効率と性別、年齢、口腔保健状況 との関連

咀嚼効率と性別、年齢、口腔保健状況と の関連を表 5 に示す。咀嚼効率と性別、 年齢、未処置歯数、total-FTUs、歯周病、 不正咬合、顎関節症との関連を重回帰分 析により分析した。なお、現在歯数、n-FTUs、nif-FTUs、total-FTUs にそれぞ れに高い相関が認められたため、total-FTUs を採択して分析を行った。

その結果、咀嚼効率は女性が男性より 有意に低く、年齢が高くなるほど有意に 高かった。また、咀嚼効率は未処置歯数が 多いほど、total-FTUs が低いほど有意に 低かった。さらに咀嚼効率は、歯周病有病 者は非有病者より、不正咬合有病者は非 有病者より有意に低かった。咀嚼効率と 顎関節症に有意な関連は認められなかっ た。

## 6. 咬合状態の自己評価別にみた調整済 み咀嚼効率

咬合状態の自己評価別にみた調整済み 咀嚼効率を図5に示す。重回帰分析で咀 嚼効率と有意な関連が認められた性別、 年齢、未処置歯数、total-FTUs、歯周病、 不正咬合を調整して共分散分析を行った ところ、咬合状態の自己評価と咀嚼効率 とに有意な関連は認められなかった。

#### D. 考察

本研究では、球形樹脂微粒子含有人工 ガムを使用して咀嚼効率を評価し、口腔 保健状況等との関連を調査した。ピーナ ッツやグミ等を使用した咀嚼能力評価法 には、試料の均一性、唾液による咀嚼後の 試料の変質等の課題が指摘されている。
本研究で使用した人工ガムは均質な材料
で唾液の影響もなく、多くの人がガム咀
嚼に慣れていることから、特に意識せず
に自然に近い咀嚼状況を評価できると考えられた。

人工ガムによる咀嚼効率は現在歯数、 未処置歯数、total-FTUs、歯周病、不正咬 合等の口腔保健状況との関連が認められ た。現在歯数や臼歯部の咬合状況は咀嚼 の重要な要素であるため、咀嚼効率と関 連していたと考えられた。う蝕による咬 合面の崩壊や疼痛は咀嚼障害を生じる可 能性があるため、未処置歯数は咀嚼効率 に影響すると考えられた。また、歯周病に 関しては、重度の歯周病による歯の動揺 や、歯周組織の感覚機能低下に起因して、 咬合力や咬合接触面積の低下が生じたこ とにより、咀嚼効率の低下に影響したと 考えられた。さらに、不正咬合による咬合 状態の不良や咬合接触面積の低下が咀嚼 効率の低下に影響したことが推察された。 顎関節症は咬合力などの咀嚼に関わる要 因と関連していることが考えられるが、 本研究では顎関節症の有病者が少ないこ ともあり、咀嚼効率との有意な関連が認 められなかったと考えられた。

年齢とともに咀嚼効率が有意に高くな った理由としては、以下のことが考えら れる。加齢とともに歯の摩耗や咬耗が有 意に増えること、また、歯の摩耗・咬耗に よって咬合接触面積が増加することが報 告されている。ガムに含まれる粒子を破 壊するには、上下の歯の咬合接触状況が 点状より面状である方が破壊に有利であ ったと考えられ、加齢に伴って増加した 咬耗・摩耗により臼歯部の咬合接触が面 接触となったために粒子を破壊しやすく なったと推察された。

質問票調査による咬合状態の自己評価 に関しては、これまで種々の食品の咀嚼 の可否や口腔保健状況との関連から妥当 性が確認されている。本研究においても 自己評価が不良な者は現在歯数と total-FTUs の値は低く、未処置歯数と歯周病有 病者率は高かった。この咬合状態の自己 評価とガムによる咀嚼効率との関連を、 咀嚼効率に影響する要因を調整して分析 したが、咬合状態の自己評価と咀嚼効率 とに有意な関連は認められなかった。

本研究で使用した人工ガムによる咀嚼 効率は、咀嚼能力を総合的にではなく、粉 砕能力等の咀嚼能力の一部を部分的に評 価していると考えられた。そのため、咀嚼 能力をより正確に評価していくためには、 今後、咀嚼効率に影響を与える要因をさ らに増やして調査することが必要と考え られた。

本研究は、労働者を対象に事業所にお いて歯科健診や咀嚼能力の評価が行われ た。そのため、診療室とは異なり、咀嚼に 関連する調査項目が限定され、咬合接触 面積等の咀嚼に関わる要因の情報が得ら れなかった。また、本研究では女性の数が 男性と比較して少なかった。今後、咀嚼能 力をより正確に評価していくためには、 これらの問題点を考慮して調査を行い、 分析していくことが必要と考えられた。

#### E. 結論

球形樹脂微粒子含有人工ガムによる咀 嚼効率は現在歯数、FTUs が少ないほど有 意に低く、また、未処置歯数が多いほど有 意に低く、さらに歯周病、不正咬合有病者 は非有病者より有意に低いことが明らか になった。また、年齢が高いほど有意に高 い数値を示した。咀嚼効率に影響する要 因を調整して咀嚼効率と咬合状態の自己 評価との関連を検討すると、有意な関連 は認められなかった。球形樹脂微粒子含 有人工ガムによる咀嚼効率は、咀嚼能力 を総合的ではなく部分的に評価している と考えられた。今後、咀嚼能力をより正確 に評価していくためには、咀嚼効率に影 ることが必要と考えられた。

**F.健康危険情報** なし

#### G. 研究発表

#### 1. 論文発表

Toshiya Kanazawa, Takashi Zaitsu, Masayuki Ueno, Yoko Kawaguchi: Masticatory performance measured with a chewing gum containing spherical resinous microparticles, International Journal of Clinical Preventive Dentistry, 14(4): 256-263, 2018.

2. 学会発表 なし

#### H. 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 |

|            |     | 全体              | 男性              | 女性              |             |
|------------|-----|-----------------|-----------------|-----------------|-------------|
|            |     | (N=903)         | (N=709)         | (N=194)         | 」<br>即<br>旧 |
| 年齢         | (歳) | $42.2 \pm 11.6$ | $42.9 \pm 11.7$ | $39.8{\pm}10.9$ | < 0.001     |
|            |     |                 |                 |                 |             |
| 現在歯数       | (歯) | $26.7 \pm 2.6$  | $26.7 \pm 2.7$  | $27.0\pm2.1$    | 0.065       |
|            |     |                 |                 |                 |             |
| 未処置歯数      | (歯) | $0.7{\pm}1.7$   | $0.8 \pm 1.8$   | $0.4{\pm}1.3$   | 0.004       |
|            |     |                 |                 |                 |             |
| n-FTUs     |     | $10.5 \pm 2.6$  | $10.4 \pm 2.6$  | $10.8 \pm 2.3$  | 0.033       |
| nif-FTUs   |     | $10.9 \pm 2.3$  | $10.8 \pm 2.4$  | $11.2 \pm 1.6$  | 0.003       |
| total-FTUs |     | $11.0\pm 2.0$   | $10.9 \pm 2.1$  | $11.2 \pm 1.6$  | 0.030       |
|            |     |                 |                 |                 |             |
| 咀嚼効率       | (%) | $1.35\pm0.48$   | $1.39\pm0.49$   | $1.23\pm0.43$   | < 0.001     |

#### 表1 男女別の年齢、歯の状況、咀嚼効率

表2 男女別の歯周病、不正咬合、顎関節の有病率

|      | 全体         | 男性         | 女性         | <i>(</i> <b></b> |
|------|------------|------------|------------|------------------|
|      | (N=903)    | (N=709)    | (N=194)    | p们且              |
| 歯周病  |            |            |            |                  |
| あり   | 113(12.5%) | 100(14.1%) | 13( 6.7%)  | 0.005            |
| なし   | 790(87.5%) | 609(85.9%) | 181(93.3%) | 0.005            |
| 不正咬合 |            |            |            |                  |
| あり   | 75( 8.3%)  | 56( 7.9%)  | 19( 9.8%)  | 0.000            |
| なし   | 828(91.7%) | 653(92.1%) | 175(90.2%) | 0.382            |
| 顎関節症 |            |            |            |                  |
| あり   | 18( 2.0%)  | 11( 1.6%)  | 7(3.6%)    | 0.000            |
| なし   | 885(98.0%) | 698(98.4%) | 187(96.4%) | 0.082            |

|            |     | 表3 咬合状態の自己評価別の年齢、歯の状況 |                 |                 |         |  |  |  |  |  |
|------------|-----|-----------------------|-----------------|-----------------|---------|--|--|--|--|--|
|            |     | 良好群                   | 普通群             | 不良群             | ,di     |  |  |  |  |  |
|            |     | (N=767)               | (N=99)          | (N=37)          | D 间已    |  |  |  |  |  |
| 年齢         | (歳) | $41.6 \pm 11.5$       | $45.3{\pm}11.5$ | $46.3 \pm 11.7$ | 0.001   |  |  |  |  |  |
| 現在歯数       | (歯) | $27.0\pm2.3$          | $25.6 \pm 3.1$  | $24.0 \pm 4.0$  | < 0.001 |  |  |  |  |  |
| 未処置歯数      | (歯) | $0.6 \pm 1.4$         | $1.3 \pm 2.3$   | $2.2 \pm 3.0$   | < 0.001 |  |  |  |  |  |
| n-FTUs     |     | $10.9 \pm 2.2$        | $8.7 \pm 3.3$   | $7.5 \pm 3.8$   | < 0.001 |  |  |  |  |  |
| nif-FTUs   |     | $11.2 \pm 1.8$        | $9.2 \pm 3.1$   | $7.8 \pm 3.9$   | < 0.001 |  |  |  |  |  |
| total-FTUs |     | $11.3 \pm 1.5$        | $9.5 \pm 2.9$   | $7.9 \pm 3.9$   | < 0.001 |  |  |  |  |  |

表4 咬合状態の自己評価別の性別、歯周病、不正咬合、顎関節症の有病率

|      | 良好群        | 普通群       | 不良群       | ,店           |
|------|------------|-----------|-----------|--------------|
| _    | (N=767)    | (N=99)    | (N=37)    | 」<br>即<br>「見 |
| 性別   |            |           |           |              |
| 男性   | 595(77.6%) | 86(86.9%) | 28(78.5%) | 0.007        |
| 女性   | 172(22.4%) | 13(13.1%) | 9(21.5%)  | 0.097        |
| 歯周病  |            |           |           |              |
| あり   | 83(10.8%)  | 20(20.2%) | 10(27.0%) | <0.001       |
| なし   | 684(89.2%) | 79(79.8%) | 27(73.0%) | <0.001       |
| 不正咬合 |            |           |           |              |
| あり   | 62( 8.1%)  | 9( 9.1%)  | 4(10.8%)  | 0.805        |
| なし   | 705(91.9%) | 90(90.9%) | 33(89.2%) | 0.000        |
| 顎関節症 |            |           |           |              |
| あり   | 16( 2.1%)  | 1( 1.0%)  | 1( 2.7%)  | 0 734        |
| なし   | 751(97.9%) | 98(99.0%) | 36(97.3%) | 0.704        |

表5 咀嚼効率と性別、年齢、口腔保健状況との関連

|            | 偏回帰係数  | 標準誤差  | p值      |
|------------|--------|-------|---------|
| 性別         | -0.155 | 0.037 | < 0.001 |
| 年齢         | 0.010  | 0.001 | < 0.001 |
| 未処置歯数      | -0.025 | 0.010 | 0.009   |
| total-FTUs | 0.045  | 0.008 | < 0.001 |
| 歯周病        | -0.140 | 0.047 | 0.003   |
| 不正咬合       | -0.139 | 0.055 | 0.011   |
| 顎関節症       | 0.101  | 0.108 | 0.350   |

性别:0男性、1女性

歯周病、不正咬合、顎関節症: 0なし、1あり









図3 年代別の咀嚼効率(全体)



図4 咬合状態の自己評価と咀嚼効率との関連



調整因子:性別、年齢、未処置歯数、total-FTUs、歯周病、不正咬合

#### 図5 咬合状態の自己評価別にみた調整済み咀嚼効率

#### 労災疾病臨床研究事業費補助金

歯科口腔保健と就労環境との関連に関する実証研究

分担研究報告書

#### 千葉県における歯科口腔保健と就労関係との関連に関する実証研究

| 研究分担者 | 佐藤  | 眞一  | 千葉県衛生研究所        | 技監    |
|-------|-----|-----|-----------------|-------|
| 研究協力者 | 吉岡み | そどり | 千葉県衛生研究所健康疫学研究室 | 室長    |
| 研究協力者 | 芦澤  | 英一  | 千葉県衛生研究所健康疫学研究室 | 上席研究員 |
| 研究協力者 | 相田  | 康一  | 千葉県衛生研究所健康疫学研究室 | 上席研究員 |
| 研究協力者 | 時田  | 一枝  | 千葉県衛生研究所健康疫学研究室 | 客員研究員 |

#### 研究要旨

千葉県では、歯科口腔保健と就労環境との関連に関する実証研究のため、前班から継 続する6事業所のうち協会けんぽが保険者である5事業所(運輸業、福祉業、その他-清掃業-、製造業、サービス)の従業員292名につき、平成26年11月から平成30年 10月のレセプトデータを突合した。Per protocolの157名を用いた制限のある preliminaryな解析まで実施し、歯科検診を行って3年目までの成績では、介入した初 年度あるいは2年度目に医療費の負荷が大きく増加したものの、追跡のみ行った3年度 目以降は横ばいと考えられる結果であった。

#### A. 研究目的

歯科口腔保健と就労環境との関連に関す<br /> る実証研究のためには、異なる規模、異な る業種の事業所で検討することが望ましい。 我々は、労災疾病臨床研究事業「歯科口腔 保健と作業関連疾患に関する実証研究(以 下、前班)において、平成25年度夏から、 組合健保 - 大規模事業所、共済-公的職場、 協会けんぽー中小事業所の候補を、それぞ れ選び、研究への参加依頼を行ってきた。 平成26年度、総選挙に伴い交付決定が年末 になった影響で、27年の年初からの再依頼 になった結果、27年度当初まで粘って検討 をいただいたが、3事業所(組合健保-大 規模事業所、共済一公的職場、協会けんぽ - 中小事業所でそれぞれ1事業所)で協力 を得ることができず、6 事業所で介入研究

を実施することとなった。これらは皆、中 規模事業所であるものの、業種は異なって いるので、本研究への参加を要請した。

千葉県には、歯科専門職がいなかったた め、歯学部ベースでマンパワーをかけられ るフィールドと異なり、研究者自らが理想 的条件下で行う efficacy study は行い得 ず、千葉県歯科医師会に歯科健診を委託す る形で effectiveness study を行うことと した。連絡調整や調査票収集には、歯科衛 生士をプロジェクトリーダー(客員研究員) として雇用し、衛生研究所に配置した。30 年度は共同研究者の1人である。本年度は、 保険者の立場からの効果(医療費の削減) を検討した。

#### B. 研究方法

前班の6事業所ともに、保険者にあるレ セプトを使った医療費解析についても本人 同意を取っていたので、保険者に照会し、 レセプト情報の取得を試みた。6事業所の うち5事業所の保険者は協会けんぽ千葉支 部であり、1事業所の保険者は共済だった。 協会けんぽ千葉支部と千葉県は包括協定を 結んでいるので問題なく取得できると考え ていたが、実際は協会内で千葉支部と本部 との交渉も必要となったため、文書のやり とりや事務手続きに時日を要し、データを 入手したのは平成31年3月1日となった。 共済については、千葉県職員共済、市町村 職員共済に分かれており、協会けんぽ以上 に事務手続きが困難であったため、次年度 の課題とした。

協会けんぽ千葉支部から入手したレセプ ト情報は、5事業所 292人の平成 26年 11 月分から平成 30年 10月分の4年間(入手 可能だった法定保存期間である過去 5年 間)、各月における医科・入院、医科・入 院外、歯科、薬剤及び合計の点数と日数で ある。

前班から継続して検討する課題と、方法 の概略は図1に示すものなので、デザイン 通りに平成27年度と平成28年度の歯科検 診をともに受診し、どちらかの年に口腔保 健指導を受けた157人に絞って(per protocol)解析し、概略の傾向を見ること とした。

レセプト発生月を以下の条件で分けた。 0:平成27年度歯科検診以前、10:平成27 年度非介入群の平成27年度歯科検診以降 平成28年度歯科検診以前、11:平成27年 度介入群の平成27年度歯科検診(初回口腔 保健指導含む)以降平成27年度2回目口腔 保健指導以前、12:平成27年度介入群の平 成27年度2回目口腔保健指導以降平成28 年度歯科検診以前、13:口腔保健指導を通 信で行った4-1事業所(運輸業)における 平成27年度介入群の平成27年度歯科検診

(初回口腔保健指導含む)以降平成28年度 歯科検診以前、201:平成28年度介入群の 平成28年度歯科検診(初回口腔保健指導含 む)以降平成28年度2回目口腔保健指導以 前、202: 平成 28 年度介入群の平成 28 年度 2回目口腔保健指導以降平成29年度歯科検 診以前(平成 29 年度歯科検診を実施しなか) った 4-4 事業所(福祉業)では追跡終了ま で)、203:口腔保健指導を通信で行った 4-1事業所における平成28年度介入群の平成 28 年度歯科検診(初回口腔保健指導含む) 以降追跡終了まで、220:平成28年度非介 入群の平成28年度歯科検診以降平成29年 度歯科検診以前(平成29年度歯科検診を実 施しなかった 4-4 事業所では追跡終了ま で)、230:口腔保健指導を通信で行った 4-1事業所における平成28年度非介入群の平 成28年度歯科検診以降追跡終了まで、302: 平成 27 年度非介入群の平成 29 年度歯科検 診以降追跡終了まで、320:平成27年度介 入群の平成 29 年度歯科検診以降追跡終了 まで。条件の記載において、以降、以前と 記載しているのは、日までの把握ができな いため歯科検診や口腔保健指導のあった月 を含まないとの意である。

まず、条件ごとに、データの月数、人数、 医科・入院、医科・入院外、歯科、薬剤及 び合計の点数と日数の和を求めた。入院が 生じるとその後の外来を含めた医療費が高 くなり、医療費分析への影響が大きいと考 えられることから、入院レセプトのあった 者を除いた解析も行った。

次に、個人ごと条件ごとに、医科・入院、 医科・入院外、歯科、薬剤及び合計の点数 の代表値(12か月換算)を求め、条件間で 比較した。この解析でも、入院が生じると その後の外来を含めた医療費が高くなり、 医療費分析への影響が大きいと考えられる ことから、入院レセプトのあった者を除い た解析も行った。

解析に際し、協会けんぽ千葉支部との約 定により、10人を切るサブグループの値を 表記することはしない。今回は、予備解析 であり、検定も行わない。

この研究は、千葉県衛生研究所倫理審査 委員会により許可され、研究分担者および 研究協力者は皆、千葉県衛生研究所利益相 反管理委員会により利益相反に該当しない 旨、通知されている。

#### C. 研究結果

条件ごとにみたデータの月数、人数、医 科・入院、医科・入院外、歯科、薬剤及び 合計の点数と日数の和を表 1-1 に、入院レ セプトのあった者を除いた条件ごとにみた データの月数、人数、医科・入院、医科・ 入院外、歯科、薬剤及び合計の点数と日数 の和を表 1-2 に示す。最も少ない人数のサ ブグループは 19 人であるから、表示可能で ある。

表には示さないが、それぞれの条件で、 点数を月数で除することで1月当たり点数 を求めることができる。

1-1 でみた 1 月当たり総費用は、予想さ れたように医科・入院を含む条件で高くな っていた。そこで、条件間の比較は、入院 レセプトのあった者を除いた集計(1-2)で 行った。

歯科点数は、事業開始前104点/月、事業 開始直後は急上昇(平成27年度介入群の平 成27年度歯科検診以降平成27年度2回目 口腔保健指導以前 218 点/月、平成 28 年度 介入群の平成 28 年度歯科検診以降平成 28 年度2回目口腔保健指導以前278点/月)、 以降開始前より高値で安定(132~230 点/ 月)だった。医科点数(事業開始前 337 点) /月)も、事業開始直後に上昇を認める(437 点/月、820点/月)が、以後は開始前と同レ ベルからやや高値(247~840 点/月)で安定 だった。薬剤点数(事業開始前178点/月) も、事業開始直後に上昇を認める(333 点/ 月、234 点/月)が、以後は開始前と同レベ ルからやや高値(96~296 点/月)で安定だ った。

次に、個人ごと条件ごとに、医科・入院、 医科・入院外、歯科、薬剤及び合計の点数 の代表値(12か月換算)を求め、条件間で 比較した結果(入院レセプトのあった者を 除いた集計とも)を表2に示す。

12 か月換算歯科点数は、事業開始前 1,263 点/年(入院レセプトのあった者を除 く・以下同じ、1,243 点/年)に対して、事 業開始直後は2.5倍程度に急上昇(平成27 年度介入群の平成27年度歯科検診以降平 成27年度2回目口腔保健指導以前2,561 点/年(2,611点/年)、平成28年度介入群 の平成28年度歯科検診以降平成28年度2 回目口腔保健指導以前3,308点/年(3,308 点/年)、以降開始前と同レベルからやや高 値で安定(1,108~2,661点/年)だった。医 科点数、薬剤点数の傾向も、表1の検討と 同様であった。保険者の負担した医療費は、 観察した4年の間で5,000円/年程度から 4,000円/年~10,000円/年に変化した。

#### D. 考察

大企業の単一健保で、歯科検診開始後3 年目まで医療費が増加したものの、4年目 から下がり出して6年目には開始前を下回 る効果を示した報告がある。本研究の結果 は、中規模事業所ではあるものの、歯科検 診を行って3年目までの成績では、介入し た初年度あるいは2年度目に医療費の負荷 が大きく増加したものの、追跡のみ行った 3年度目以降は横ばいと考えられる結果で あった。参加した6つの事業所とも、独自 の歯科検診を継続してはいないと聞いてい るので、介入前より減少するかどうかはな んとも言えない。来年度末までの本研究班 の期間内で医療費への長期効果を評価する ことはできないと考える。

今回の解析は、参加した 292 名すべての データを用いた intention to treat 解析 ではいこと、各々の事業所特性を考慮して いないこと、正規分布でないことがわかり ながら平均値を代表値として用いたこと、 観察期間内における協会けんぽ全体あるい は千葉支部の保険者負担の推移と比較して いない、といった制限のある preliminary な解析結果である。来年度の最終報告に向 け、精査し、再解析をする予定である。

- E.健康危険情報 なし
  - F. 研究発表
- 1. 論文発表 なし
- 2. 学会発表
- 吉岡みどり:歯科からのメタボ対策-咀嚼のチェック項目の活用に向けて-、
   第28回日本産業衛生学会全国協議会「産 業歯科保健部会フォーラム」特定健診・
   特定保健指導における歯科の役割、
   2018年9月16日、東京工科大学

#### G. 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

#### H. 謝辞

本年の事業実施に当たっては、鶴岡茂樹 支部長をはじめとする協会けんぽ千葉支部 の皆様から、多大な協力を得た。ここに記 して謝意を表します。

## 職域における歯科保健対策の有効性に関する実証研究 図1

(平成26-28年度、29-31年度 労災疾病臨床研究補助金事業)

【目的】業務と歯科関連の知見を収集し、また、職域における歯科保健対策の有効性 について疫学的実証研究を行い、効果的な職域における歯科保健対策について具体的 な提言を行う

【検証】1.職域における歯科保健対策は、歯科保健の向上に寄与する 2.職域における歯科保健対策は、医科疾患の発症と重症化防止に直接・間接的に関与する 3.職域における歯科保健対策は、職域の労働生産性の向上に直接・間接的に影響する 4.職域における歯科保健対策は、医療費の削減に直接・間接的に貢献する



表 1-1 条件ごとにみたデータの月数、人数、医科・入院、医科・入院外、歯科、薬剤及び 合計の点数と日数の和

|     |       |     | 医科·入院   |     | 医科·入院外    |     | 歯科      |     | 薬剤      |     | 合計        |       |
|-----|-------|-----|---------|-----|-----------|-----|---------|-----|---------|-----|-----------|-------|
|     | 月致    | 入致  | 点数      | 日数  | 点数        | 日数  | 点数      | 日数  | 点数      | 日数  | 点数        | 日数    |
| 0   | 1,260 | 157 | 810,988 | 120 | 540,721   | 662 | 134,308 | 200 | 309,944 | 312 | 1,795,961 | 1,294 |
| 10  | 905   | 82  | 93,484  | 21  | 531,611   | 556 | 168,481 | 247 | 200,118 | 300 | 993,694   | 1,124 |
| 11  | 156   | 52  | 41,844  | 7   | 68,830    | 76  | 33,294  | 39  | 55,294  | 40  | 199,262   | 162   |
| 12  | 364   | 52  | 222,138 | 28  | 230,166   | 245 | 49,392  | 61  | 122,879 | 107 | 624,575   | 441   |
| 13  | 255   | 23  | 0       | 0   | 97,707    | 129 | 24,180  | 38  | 51,447  | 76  | 173,334   | 243   |
| 201 | 168   | 57  | 0       | 0   | 137,813   | 93  | 46,658  | 74  | 39,404  | 50  | 223,875   | 217   |
| 202 | 739   | 57  | 114,346 | 19  | 385,843   | 385 | 112,634 | 163 | 176,505 | 200 | 789,328   | 767   |
| 203 | 671   | 25  | 111,964 | 14  | 239,199   | 363 | 142,093 | 176 | 170,773 | 186 | 664,029   | 739   |
| 220 | 688   | 52  | 89,018  | 22  | 452,624   | 443 | 113,761 | 156 | 338,920 | 260 | 994,323   | 881   |
| 230 | 622   | 23  | 645,905 | 32  | 275,501   | 336 | 130,695 | 181 | 125,948 | 198 | 1,178,049 | 747   |
| 302 | 514   | 34  | 59,000  | 9   | 458,317   | 280 | 114,789 | 208 | 101,091 | 146 | 733,197   | 643   |
| 320 | 686   | 45  | 884,339 | 112 | 1,019,877 | 428 | 131,642 | 186 | 215,270 | 236 | 2,251,128 | 962   |

表 1-2 入院レセプトのあった者を除いた条件ごとにみたデータの月数、人数、医科、歯科、 薬剤及び合計の点数と日数の和

|     |       | 1 *6 | 医       | 科   | 歯       | <b>举</b> | 薬       | 剤   | 合       | 計     |
|-----|-------|------|---------|-----|---------|----------|---------|-----|---------|-------|
|     | 月致    | 入致   | 点数      | 日数  | 点数      | 日数       | 点数      | 日数  | 点数      | 日数    |
| 0   | 1,210 | 151  | 407,620 | 589 | 125,883 | 181      | 215,606 | 287 | 749,109 | 1,057 |
| 10  | 861   | 78   | 346,455 | 494 | 159,282 | 238      | 182,477 | 272 | 688,214 | 1,004 |
| 11  | 153   | 51   | 66,798  | 72  | 33,294  | 39       | 50,983  | 36  | 151,075 | 147   |
| 12  | 350   | 50   | 181,592 | 226 | 46,280  | 58       | 68,890  | 91  | 296,762 | 375   |
| 13  | 255   | 23   | 97,707  | 129 | 24,180  | 38       | 51,447  | 76  | 173,334 | 243   |
| 201 | 168   | 57   | 137,813 | 93  | 46,658  | 74       | 39,404  | 50  | 223,875 | 217   |
| 202 | 710   | 55   | 349,177 | 348 | 107,481 | 158      | 169,756 | 182 | 626,414 | 688   |
| 203 | 616   | 23   | 199,370 | 263 | 122,543 | 147      | 165,484 | 169 | 487,397 | 579   |
| 220 | 640   | 49   | 302,823 | 362 | 100,465 | 138      | 190,040 | 192 | 593,328 | 692   |
| 230 | 515   | 19   | 161,960 | 218 | 116,164 | 158      | 74,841  | 117 | 352,965 | 493   |
| 302 | 499   | 33   | 419,051 | 247 | 114,789 | 208      | 92,796  | 131 | 626,636 | 586   |
| 320 | 609   | 40   | 150,162 | 217 | 127,946 | 183      | 58,472  | 120 | 336,580 | 520   |

| 表 2 | 個人ご | と条件ご | とにみた医科、 | 歯科、 | 薬剤及び合計の | 点数 |
|-----|-----|------|---------|-----|---------|----|
|-----|-----|------|---------|-----|---------|----|

| 【歯科】               |                 |          |            |                      |         |          |          |         |               |                |          |                 |
|--------------------|-----------------|----------|------------|----------------------|---------|----------|----------|---------|---------------|----------------|----------|-----------------|
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| n                  | 157             | 82       | 52         | 52                   | 23      | 57       | 57       | 25      | 52            | 23             | 34       | 45              |
| MEAN               | 1263.0          | 2216.4   | 2561.1     | 1628.3               | 1108.3  | 3307.5   | 2000.0   | 2545.6  | 2110.1        | 2522.2         | 2660.9   | 2275.9          |
| SD                 | 2535.7          | 3139.6   | 5829.7     | 3571.0               | 2340.0  | 5858.8   | 3039.7   | 3069.4  | 3925.7        | 3404.6         | 3052.8   | 3639.9          |
| MEDIAN<br>25% tile | 0.0             | //6.4    | 0.0        | 0.0                  | 0.0     | 0.0      | 558.3    | 1148.3  | 0.0           | 1849.7         | 1553.6   | 508.5           |
| Z5%tile            | 1620.2          | 2421.2   | 1604.0     | 1642.1               | 547.6   | 2022.0   | 2050.2   | 2205.6  | 2259.5        | 209.7          | 4692.1   | 2710.5          |
| MIN                | 1030.3          | 0.0      | 0.0        | 1043.1               | 0.0     | 0.0      | 2930.3   | 0.0     | 2338.5        | 0.0            | 4082.1   | 2/19.5          |
| MAX                | 14727.4         | 12890.2  | 23404.0    | 16244.6              | 9297.0  | 23876.0  | 12708.0  | 9645.9  | 19707.3       | 13246.7        | 10100.3  | 14778.4         |
|                    |                 |          |            |                      |         |          |          |         |               |                |          |                 |
| ※人院レセ              | <u>このあった者を</u>  | 除く       |            | 10                   | 10      | 201      |          |         |               |                |          |                 |
|                    | 0               | 10       | //         | 12                   | /3      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| MEAN               | 12/22           | 2201.4   | 2611.2     | 1596.7               | 1109.3  | 3307.5   | 2010.2   | 2304.6  | 1069.7        | 2708.0         | 2741.6   | 240             |
|                    | 2558.0          | 3063.3   | 5876.4     | 3596.7               | 2340.0  | 5858.8   | 2019.2   | 2394.0  | 3752.2        | 2708.9         | 2/41.0   | 2400.2          |
| MEDIAN             | 2000.0          | 809.6    | 0.0        | 0.0                  | 2340.0  | 0.0      | 558.3    | 10191   | 0.0           | 2040.9         | 1705.6   | 254.3           |
| 25%tile            | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 159.6          | 0.0      | 0.0             |
| 75%tile            | 1568.4          | 3431.2   | 1616.0     | 1327.3               | 547.6   | 3932.0   | 3039.6   | 3248.3  | 2296.0        | 3698.2         | 4825.6   | 2915.2          |
| MIN                | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 0.0            | 0.0      | 0.0             |
| MAX                | 14727.4         | 12890.2  | 23404.0    | 16244.6              | 9297.0  | 23876.0  | 12708.0  | 9645.9  | 19707.3       | 13246.7        | 10100.3  | 14778.4         |
|                    |                 |          |            |                      |         |          |          |         |               |                |          |                 |
| 【医科】               |                 |          |            |                      |         |          |          |         |               |                |          |                 |
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| n                  | 157             | 82       | 52         | 52                   | 23      | 57       | 57       | 25      | 52            | 23             | 34       | 45              |
| MEAN               | 12964.0         | 8256.3   | 8513.4     | 14911.1              | 4592.0  | 9822.5   | 10808.0  | 6267.0  | 8407.9        | 18146.1        | 12101.3  | 33317.7         |
| SU<br>MEDIANI      | 52410.3         | 22859.0  | 25918.2    | 4/640.2              | 6326.6  | 3/931.7  | 36063.7  | 9394.1  | 22988.7       | 48548.8        | 39319.2  | 103851.1        |
| 25%+il-            | 1/1/.5          | 2048.2   | 0.0        | 4144.3               | 2098.0  | 1952.0   | 2029.1   | 3019.2  | 1335.3        | 3105.1         | 2390.8   | 2397.8          |
| 25%tile            | 5/00.0          | 8/60.0   | 0.0        | 9/121                | 52550   | 5556.0   | 62250    | 71520   | 7/00 5        | 0.000<br>0.000 | 6454.0   | 201.0<br>5772 F |
| MIN                | 0490.0          | 0409.0   | 0403.0     | <u>9413.1</u><br>0.0 | 0000.9  | 0000.0   | 0200.0   | 0.0     | /409.0<br>0.0 | 3209.3<br>N N  | 0404.9   | 07/3.0          |
| MAX                | 404977.7        | 197172.0 | 175504.0   | 309437.1             | 30408.0 | 285740.0 | 210468.0 | 41873.8 | 157369.0      | 222707.5       | 221319.2 | 574133.6        |
| W T RELL           |                 |          |            |                      | 0010010 | 2007.010 |          |         |               |                |          |                 |
| ※人院レゼ              | <u>このめったるを</u>  | 际く 10    | 11         | 10                   | 10      | 201      | 202      | 202     | 220           | 220            | 202      | 220             |
| -                  | U<br>151        | 70       | // 51      | 12 50                | /3      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| MEAN               | 3875.2          | 47827    | 5239.1     | 6226.0               | 4592.0  | 9822.5   | 7585 3   | 3918.5  | 4659.9        | 3777.3         | 10085.8  | 2934.2          |
| SD.                | 5575.8          | 5996.5   | 10795.2    | 10792.6              | 6326.6  | 37931.7  | 28208.4  | 4180.1  | 8474.5        | 5914.9         | 38103.5  | 3556.7          |
| MEDIAN             | 1592.4          | 2439.3   | 0.0        | 4084.3               | 2598.5  | 1952.0   | 2425.1   | 2598.9  | 1076.0        | 2053.4         | 2332.8   | 1175.6          |
| 25%tile            | 0.0             | 805.6    | 0.0        | 306.4                | 900.3   | 0.0      | 943.4    | 95.8    | 0.0           | 445.7          | 480.8    | 241.1           |
| 75%tile            | 5000.6          | 7497.8   | 6202.0     | 8768.1               | 5855.9  | 5556.0   | 5266.9   | 6668.5  | 5044.4        | 3335.8         | 5882.2   | 4455.9          |
| MIN                | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 0.0            | 0.0      | 0.0             |
| MAX                | 32092.8         | 32431.6  | 51500.0    | 72605.1              | 30408.0 | 285740.0 | 210468.0 | 11972.4 | 48365.8       | 25104.9        | 221319.2 | 12846.4         |
|                    |                 |          |            |                      |         |          |          |         |               |                |          |                 |
| 【薬剤】               |                 |          |            | 10                   | 12      |          |          |         |               |                |          |                 |
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| MEAN               | 2055.4          | 2627.2   | 42524      | 4051.0               | 2425.0  | 07       | 2010.0   | 2042.2  | JZ<br>4971 5  | 2416.0         | 2202.5   | 2790.4          |
|                    | 10670.8         | 2037.2   | 10708.2    | 11336.1              | 2435.0  | 51635    | 4382.0   | 48514   | 12808.8       | 3417.8         | 3350.9   | 10649.3         |
| MEDIAN             | 345.6           | 1071.8   | 0.0        | 522.0                | 1329.0  | 0.0      | 695.4    | 617.8   | 525.8         | 757.8          | 507.0    | 432.0           |
| 25%tile            | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 160.1          | 33.4     | 0.0             |
| 75%tile            | 2220.0          | 3472.4   | 4072.0     | 2399.1               | 3694.2  | 3436.0   | 4458.0   | 3225.7  | 2819.1        | 3918.7         | 2782.6   | 2202.4          |
| MIN                | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 0.0            | 0.0      | 0.0             |
| MAX                | 124494.9        | 18403.6  | 53396.0    | 72728.6              | 11106.5 | 23084.0  | 17773.1  | 15884.0 | 76318.0       | 13118.1        | 11449.5  | 65244.0         |
| ※入院した              | のあった考を          | 险/       |            |                      |         |          |          |         |               |                |          |                 |
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| n                  | 151             | 78       | 51         | 50                   | 23      | 57       | 55       | 23      | 49            | 19             | 33       | 40              |
| MEAN               | 2119.7          | 2525.7   | 3998.7     | 2361.9               | 2435.0  | 2772.2   | 2853.8   | 3207.3  | 2891.8        | 1737.4         | 2160.9   | 1139.7          |
| SD                 | 3828.5          | 3822.4   | 10654.5    | 5432.1               | 3034.5  | 5163.5   | 4371.5   | 5029.4  | 6737.9        | 2551.0         | 3312.4   | 1606.1          |
| MEDIAN             | 284.4           | 998.2    | 0.0        | 426.9                | 1329.0  | 0.0      | 695.4    | 526.3   | 391.0         | 408.4          | 378.8    | 260.8           |
| 25%tile            | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 160.1          | 0.0      | 0.0             |
| 75%tile            | 2216.3          | 2889.2   | 2852.0     | 2022.9               | 3694.2  | 3436.0   | 4165.0   | 4567.4  | 2755.6        | 2584.1         | 2144.8   | 1624.1          |
| MAY                | 17200 4         | 10400.0  | <u>U.0</u> | 22000.0              | 11100 5 | 22004.0  | 0.0      | 15004.0 | 27400.0       | 0.0            | 11440 5  | 0.0<br>5070.4   |
| MAX                | 17390.4         | 18403.0  | 53396.0    | 32928.0              | 11100.5 | 23084.0  | 1///3.1  | 15884.0 | 37498.9       | 9472.4         | 11449.5  | 5970.4          |
| 【合計】               |                 |          |            |                      |         |          |          |         |               |                |          |                 |
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| n                  | 157             | 82       | 52         | 52                   | 23      | 57       | 57       | 25      | 52            | 23             | 34       | 45              |
| MEAN               | 17282.5         | 13109.9  | 15327.8    | 20590.4              | 8135.3  | 15902.1  | 15727.1  | 11854.9 | 15389.5       | 23085.2        | 17054.7  | 39374.0         |
| SD                 | 57505.1         | 24017.4  | 32088.7    | 55143.0              | 7818.1  | 39406.6  | 36946.6  | 12242.6 | 34564.5       | 49604.3        | 40573.5  | 113746.7        |
| MEDIAN             | 5053.2          | 6790.4   | 1662.0     | 77 <u>70.0</u>       | 6956.7  | 7660.0   | 6752.6   | 9645.9  | 6080.4        | 6376.2         | 6421.1   | 5658.0          |
| 25%tile            | 1093.7          | 2739.0   | 0.0        | 1623.4               | 2596.5  | 2216.0   | 2061.0   | 1351.8  | 956.7         | 3989.1         | 3727.0   | 1230.4          |
| 75%tile            | 10860.0         | 16078.6  | 16666.0    | 13194.9              | 11129.9 | 15788.0  | 15932.6  | 19643.6 | 15983.7       | 17048.1        | 13548.8  | 13405.5         |
| MIN                | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 0.0            | 0.0      | 0.0             |
| MAX                | 433995.4        | 203237.5 | 192748.0   | 329261.1             | 34910.2 | 294852.0 | 214926.0 | 47680.9 | 233687.0      | 231175.4       | 230633.6 | 639377.6        |
| <u>※入院レ</u> セ      | <u>zのあった者</u> を | 除く       |            |                      |         |          |          |         |               |                |          |                 |
|                    | 0               | 10       | 11         | 12                   | 13      | 201      | 202      | 203     | 220           | 230            | 302      | 320             |
| n                  | 151             | 78       | 51         | 50                   | 23      | 57       | 55       | 23      | 49            | 19             | 33       | 40              |
| MEAN               | 7238.2          | 9509.8   | 11849.0    | 10174.7              | 8135.3  | 15902.1  | 12458.3  | 9520.4  | 9520.3        | 8223.6         | 14988.2  | 6562.1          |
| SD                 | 8409.6          | 8976.8   | 20208.4    | 13838.8              | 7818.1  | 39406.6  | 28921.3  | 9217.3  | 13503.8       | 9706.9         | 39343.6  | 7431.1          |
| MEDIAN             | 4684.5          | 6412.9   | 1592.0     | 7322.6               | 6956.7  | 7660.0   | 6111.4   | 8634.9  | 5158.9        | 5273.3         | 6386.3   | 4084.2          |
| 25%tile            | 1053.4          | 2502.8   | 0.0        | 1431.4               | 2596.5  | 2216.0   | 2008.2   | 1185.5  | 848.7         | 3058.6         | 3694.9   | 750.9           |
| /5%tile            | 10072.3         | 13483.1  | 16520.0    | 12920.6              | 11129.9 | 15/88.0  | 13870.0  | 14920.8 | 12389.5       | 8119.7         | 13546.4  | 11236.3         |
|                    | 0.0             | 0.0      | 0.0        | 0.0                  | 0.0     | 0.0      | 0.0      | 0.0     | 0.0           | 0.0            | 0.0      | 0.0             |
| MAX                | 30925.5         | 3/600.4  | 99188.0    | 80814.9              | 34910.2 | Z9485Z.0 | Z14926.0 | 28360.5 | 08837.5       | 40529.8        | 230633.6 | JJ595.2         |

資料1

#### 第28回日本産業衛生学会全国協議会 抄録

[演題名]歯科からのメタボ対策

咀嚼機能チェック項目の活用に向けて

[所属機関名 氏名]

千葉県衛生研究所 健康疫学研究室長 吉岡みどり

[抄録本文]

2014 年度に安藤雄一氏を代表とする「生活習慣病の発症予防に資するための歯科関 連プログラムの開発とその基盤整備に関する研究」に参加し「歯科口腔保健と生活習 慣病の発症予防に関する研究や特定健診・特定保健指導への歯科関連プログラム導入 マニュアルの作成」に協力した。2015 年度からは川口陽子氏を代表とする「歯科口腔 保健と作業関連疾患との関連に関する実証研究」に参加し,県内 6 業種(運輸・その他 サービス(清掃)・製造・福祉・水道・サービス),388 名を対象に 6 事業所初となる歯科 健診・歯科保健指導を実現した。

職場健診のみの事業所に対し歯科健診,歯科保健指導を実現可能にした背景には,研 究班本部の専門家による県歯科医師会,県歯科衛生士会への技術指導が行われたこと。 プロジェクトマネジャーとして県歯科衛生士会から推薦された人材を導入できたこ と。こうした現場を動かすための多職種連携によるチーム対応が可能となったことが 挙げられる。

この度は、県保健師として新たな質問項目の追加に対し保健指導従事者等へのヒアリングを行ったので報告したい。

「問診票に追加項目があることは承知しているが,詳細理解には至らない。」「新設項目 は意識して見ているが,指導への展開には力量の差がでる。」「これまで少数だが,行動 変容し成果を上げている対象者へ褒めたたえ励ましのメッセージを贈ることもあった が,電話による勤務時間内での指導反応は,迷惑や不平不満様の反応の方が多い。経過 確認では言い訳が多く,感謝されることは少ないと感じている。」「服薬,たばこを優先 事項とし,詳細項目にまで及ばないこともある。」「特定保健指導に該当した場合は,丁 寧に22の質問項目を見る。」「追加項目による要指導該当者は少ない印象。担当する特 定保健指導該当 70~80 名の内 "思うように噛めない"自覚者は,歯周病の既往のある 2~3 名であった。」「歯科口腔保健への導入は,メタボ該当者への食べる早さの確認か ら咀嚼機能へ導く方が入りやすい。」

以上,現時点では問13 "咀嚼機能"項目の追加は認識しているものの,事後対応協議 には至らず,担当者個人に任されている段階にあった。

今後 "歯からのメタボ対策"としては, 我々から健康づくり推進協議会等, 健康課題 や事業評価検討会議の場での情報提供や提案などにより, 保険者に向けてデータヘル ス計画への歯科保健の位置づけや計画評価のための PDCA サイクルの構築を促し, 精度 管理に対する関心を喚起していきたい。

また,特定健康診査・特定保健指導の質的向上を図るため,担当者研修を担当する事務局への情報提供を進めていこうと考えている。

これらが効果的に進むための背景として、事業主が健康経営や健康投資の視点が持てるように,身近な相談役である産業医や保健スタッフによる情報提供や提案を通じたアプローチが欠かせないと考える。

生活習慣の改善に関する歯科口腔保健の取組の端緒から,生活習慣病予防へと根を 広げたい。 資料2

























# 歯科保健指導介入1年後の歯科健診結果の変化

|     | △┐栞  | H28   |      |       |  |  |
|-----|------|-------|------|-------|--|--|
|     | 小八种  | 異常なし  | 要指導  | 要治療   |  |  |
|     | 異常なし | 良好不変群 | 悪化群  |       |  |  |
| H27 | 要指導  |       | 不変群  |       |  |  |
|     | 要治療  | 良好群   | (改善) | 悪化不変群 |  |  |
| 図1  |      |       |      |       |  |  |

| 4   | + 대강 코봇 |       | H28  |       |
|-----|---------|-------|------|-------|
|     | 1 XH 0+ | 異常なし  | 要指導  | 要治療   |
|     | 異常なし    | 良好不変群 | 悪化群  |       |
| H27 | 要指導     |       | 不変群  |       |
|     | 要治療     | 良好群   | (改善) | 悪化不変群 |
| 図 2 |         |       |      |       |

\_\_\_\_

| 表1   |      |      |     |     |     |  |  |  |  |  |
|------|------|------|-----|-----|-----|--|--|--|--|--|
| 介入群  |      | H28  |     |     |     |  |  |  |  |  |
|      |      | 異常なし | 要指導 | 要治療 | 合計  |  |  |  |  |  |
|      | 異常なし | 9    | 0   | 20  | 29  |  |  |  |  |  |
| L127 | 要指導  | 2    | 0   | 6   | 8   |  |  |  |  |  |
| Π21  | 要治療  | 10   | 5   | 86  | 101 |  |  |  |  |  |
|      | 合計   | 21   | 5   | 112 | 138 |  |  |  |  |  |

## 表2

| · · · · · · · · · · · · · · · · · · · |        | H28  |     |     |     |  |  |  |  |
|---------------------------------------|--------|------|-----|-----|-----|--|--|--|--|
|                                       | 174.0+ | 異常なし | 要指導 | 要治療 | 合計  |  |  |  |  |
|                                       | 異常なし   | 12   | 2   | 12  | 26  |  |  |  |  |
| H27                                   | 要指導    | 3    | 2   | 6   | 11  |  |  |  |  |
|                                       | 要治療    | 9    | 7   | 88  | 104 |  |  |  |  |
|                                       | 合計     | 24   | 11  | 106 | 141 |  |  |  |  |

|    | 業種   | 年齢 | 性<br>別 | 齲歯数 | 歯科健診<br>結果                         | 歯科健診<br>変化所見                                    | 定期健康診断結果<br>変化所見  | 質問票による生活変化  |
|----|------|----|--------|-----|------------------------------------|---|---|---|
| 1  | L 運輸 | 45 | 男      | 5   | 要治療<br>歯                           | < <sup>*</sup> リオスクリーン:<br>陽性→陽性<br>CPI<br>歯石消失 | 心電図所見:あり<br>変化なし<br>メタポ非該当  | 欠勤、早退:なし<br>歯科通院:無→有(終了後、休み時間利用)<br>受診間隔:3年以内→半年<br>身のまわりの管理:問題あり→なし<br>痛み/不快:少しあり→なし<br>不安/ふさぎ込み:なし→少しあり<br>口腔気になること:あり(外観・発話・口臭・歯ぎしり)→<br>なし<br>かかりつけ歯科医:できた<br>フッ素入り歯磨、デンタルフロス:未→時々使用<br>ゆっくりよく噛む:いいえ→時々<br>歯科医院での歯みがき指導:いいえ→はい<br>家族、周囲の健康への関心:はい→いいえ |
| 12 | 2 運輸 | 60 | 男      | 1   | 要治療<br>歯石<br>齲<br>調<br>常<br>な<br>し | < <sup>*</sup> リオスクリーン:<br>陽性→陰性<br>CPI<br>歯垢消失 | 既往歴: <b>高血圧症、</b><br>糖尿病、胆石、悪<br>性腫瘍<br>心電図所見:あり<br>→なし<br>胃部X線所見:あ<br>り→なし | 健康状態:あまり良くない→よくない<br>歯や歯肉の健康状態:あまり良くない→よくない<br>歯科受診:過去3年以内→1年以内 休日利用<br>移動の程度:歩き回るのに少し問題あり→問題なし   |
|    |      |    |        |     |                                    |   |   |   |

|   | 業<br>種          | 年齢 | 性<br>別 | 齲歯数 | 歯科健診結<br>果                   | 歯科健診<br>変化所見   | 定期健康診断結果<br>変化所見  | 質問票による生活変化   |
|---|-----------------|----|--------|-----|------------------------------|--|---|--|
| 3 | 製造              | 48 | 男      | 2   | 要治療<br>歯石<br>歯歯<br>→<br>異常なし | <ul> <li>ペ リオスクリーン:</li> <li>陽性→陰性</li> <li>CPI</li> <li>歯石消失</li> </ul> | BMI:17→16.6<br>やせ気味注意<br>自覚症:眼精疲労<br>頭痛、頭重、<br>尿潜血:-→+<br>頻尿(10回以上)<br>夜間不眠 | 健康状態:まあ良い→ふつう<br>欠勤:7日→5.5日<br>過去1年間に歯口腔症状による欠勤:半休2回→なし<br>歯科通院:欠勤1日・休日3日→休日利用5日<br>受診間隔:3か月以内→半年<br>普段の活動:少し問題あり→なし<br>口腔気になること:口臭→口臭・発話・痛み<br>本数:28本→24本<br>歯みがき出血:いつも→時々<br>かかりつけ歯科医:できた<br>フッ素入り歯磨:いいえ→はい<br>歯科医院での歯みがき指導:いいえ→はい |
| 4 | 製造              | 55 | 男      | 0   | 要治療<br>歯石除去<br>歯周病<br>→異常なし  | ペリオスクリーン:<br>陰性→陰性<br>CPI<br>歯石消失  | F-GPT上昇 73→75<br>BMI:28.9 変化なし<br><b>血圧:166/105→148/97</b><br>白血球:微増傾向      | 勤務形態:日勤→日勤・夜勤<br>歯科通院:休日利用10日→休日10日・就業、休み時<br>間10日<br>健康状態:痛み/不快:少し(持続)<br>気になる状態:口臭(持続)<br>仕事多忙で受診困難:はい→いいえ   |
| 5 | その他<br>サービ<br>ス | 43 | 女      | 2   | 要治療<br>齲歯<br>→異常なし           | ペリオスクリーン:<br>陽性→陰性   | 所見なし<br>既往歴:貧血<br>Q21:生活習慣改善<br>1カ月以内に改善意向                                  | 歯科通院:遅刻・早退 1日→ 休日利用 2日<br>健康状態:不安/ふさぎ込み:ない→中程度あり   |

|   | 業<br>種           | 年<br>齢 | 性<br>別 | 新規齲<br>歯数 | 歯科健診<br> 結果  | 歯科健診<br>変化所見                 | 定期健康診断結果<br>変化所見   | 質問票による生活変化   |
|---|------------------|--------|--------|-----------|--------------|------------------------------|--|--|
| 1 | その他<br>サービ<br>ス業 | 24     | 男      | 8         | 要治療<br>→要治療  | ペリオスクリーン、<br>CPI<br>悪化       | 1年間で5 Kg体重増<br>肥満、総コレ・LDL・中性脂<br>肪・GPT・GOT・γ-GPT上昇、<br>HDL低下             | 欠勤:16日→4日, 早退:8時間→4時間<br>歯科通院:無→有<br>口腔気になること:なし→噛み具合・外観<br>かかりつけ歯科医:できた                                   |
| 2 | 製造業              | 46     | 男      | 6         | 異常なし<br>→要治療 | 齲蝕、^゚リオス<br>クリーン CPI歯<br>垢悪化 | <b>Г-GPT</b> 上昇 24→36<br>体重1Kg減、 脂質減少                                    | 歯肉状態:改善<br>フッ素入歯磨:使用   |
| 3 | 福祉               | 21     | 女      | 6         | 要指導<br>→要治療  | 齲蝕、CPI・<br>歯垢悪化              | 中性脂肪 28<br>白血球数 9300   | 歯科通院:1→6日<br>歯肉状態:改善   |
| 4 | 製造業              | 30     | 男      | 5         | 要指導<br>→要治療  | 齲蝕                           | なし   | 健康状態:良い→ふつう<br>歯科通院:0→3日へ  |
| 5 | その他<br>サービ<br>ス業 | 25     | 男      | 4         | 異常なし<br>→要治療 | 齲蝕、CPI・<br>歯垢悪化              | 5 Kg体重増加 γ-GTP・GPT<br>上昇 脂質すべて上昇 白<br>血球減少                               | 体調:ふつう→良い 遅刻:0→1日と30分<br>歯の状態:普通→まあ良い<br>歯肉出血:時々→ない<br>歯科通院:仕事多忙歯科医院いけない→時々                                |
| 6 | 製造業              | 44     | 男      | 4         | 要指導<br>→要治療  | 齲蝕、CPI・<br>歯垢悪化              | 聴力・ピロリ菌<br>2年連続所見あり  | 歯肉状態:ふつう→あまり良くない<br>通院:2日→1日 歯肉出血:時々→ない<br>不安ふさぎこみ:1→2<br>かかりつけ歯科医:ない→ある                                   |
| 7 | 製造業              | 55     | 男      | 4         | 要治療<br>→要治療  | 齲蝕、CPI・<br>歯垢悪化              | 体重3Kg増 HDL: 減少<br>中性脂肪:127→249 2倍<br>心電図:不完全右脚ブロッ<br>ク→RR <sup>/</sup> 型 | 健康状態:あまり良くない→まあ良い、<br>歯・歯肉の状態:あまり良くない→良い、<br>身の回りの管理・普段の活動・痛み・不快感・不<br>安、ふさぎこみ:1→2、<br>間食:しない→する 喫煙:しない→する |



| 健診受診者を知る(視る)  |
|---|
| 実証研究から学んだこと   |
| 重症度に関わりなく、歯科保健への「準備期」<br>特に「関心期」にあるものへの介入効果が高かった。   |
| 千葉県       vs 兵庫県       オプション         職場健診型       メプション       レーレーレーレーレーレーレーレーレーレーレーレーレーレーレーレーレーレーレー |

| 8  | 現在、たばこを習慣的に吸っている。<br>(※「現在、習慣的に喫煙している者」とは、「合計 100 本以上、又は6ヶ<br>月以上吸っている者」であり、最近 1ヶ月間も吸っている者) | ①はい ②いいえ   |
|----|---|--|
| 9  | 20歳の時の体重から10kg以上増加している。   | Dial aniz  |
| 10 | 1回30分以上の軽く汗をかく運動を週2日以上、1年以上実施   | ①はい ②いいえ   |
| 11 | 日常生活において歩行又は同等の身体活動を1日1時間以上実施   | ①はい ②いいえ   |
| 12 | ほぼ同じ年齢の同性と比較して歩く速度が速い。  | ①はい ②いいえ   |
| 13 | 食事をかんで食べる時の状態はどれにあてはまりますか。  | <ol> <li>① 何でもかんで食べることだできる</li> <li>② 歯や歯ぐき、かみあわせたど気になる部分があり、カみにくいことがある</li> <li>③ ほとんどかめない</li> </ol> |
| 14 | 人と比較して食べる速度が速い。   | ①速い ②ふつう ③遅い   |
| 15 | 就寝前の2時間以内に夕食をとることが週に3回以上ある。   | ①はい ②いいえ   |
| 16 | 朝昼夕の3食以外に間食や甘い飲み物を摂取していますか。   | <ol> <li>毎日 ②時々</li> <li>ほとんど摂取しない</li> </ol>  |
| 17 | 朝食を抜くことが週に3回以上ある。   | ①はい ②いいえ   |

| _  | 保健指導が有効な対象を探す                         |  |
|----|---------------------------------------|--|
| 21 | 運動や食生活等の生活習慣を改善してみようと思いますか。           | <ol> <li>改善するつもりはない</li> <li>②改善するつもりである<br/>(概ね6か月以内)</li> <li>③近いうちに(概ね1か月以内)<br/>改善するつもりであり、少し<br/>ずつ始めている</li> <li>④既に改善に取り組んでいる<br/>(6か月未満)</li> <li>⑤既に改善に取り組んでいる<br/>(6か月以上)</li> </ol> |
| 22 | 生活習慣の改善について保健指導を受ける機会があれば、利用しま<br>すか。 | ①はい ②いいえ   |
|    |                                       | ``   |





| 新たな展開(人材育成)<                                    | - 職域:健診事後の充実化<br>- 行政:保健サービスの格差是正<br>教育:健康寿命への関心喚起 |
|---|--|
| 1 千葉県主催<br>特定健診・特定保健指導従事者研修<br>への組み込み(市町村、民間対象) | (定年制の見直し)<br>(1回/年)研修プログラム                         |
| 2 (独)労働者健康安全機構千葉産業                              | 保健総合支援センター主催                                       |
| 平成30年度セミナー 後期研修テー                               | -マへの組み込み   |
| 3 県立保健医療大学 健康科学部歯科                              | 衛生学科との   |
| 共同研究に向けた取組 ―――――――――――――――――――――――――――――――――――― | 地職腫との共同研究体験  |

Ⅲ. 研究成果の刊行に関する一覧表

#### 研究成果の刊行に関する一覧表

#### 1. 原著論文

- ①著者: Naoki Toyama, Ayano Taniguchi-Tabata, Nanami Sawada, Yoshio Sugiura, Daiki Fukuhara, Yoko Uchida, Hisataka Miyai, Aya Yokoi, Shinsuke Mizutani, Daisuke Ekuni, Manabu Morita
  - タイトル : Does Instruction of Oral Health Behavior for Workers Improve Work Performance? -Quasi-Randomized Trial

②著者:金子 昇、葭原明弘、濃野 要、山賀孝之、財津 崇、川口陽子、宮崎秀夫
 タイトル:職域における歯科健診と個別保健指導による行動変容
 雑誌名:口腔衛生会誌 69巻:27-33ページ、2019年

- ③著者: Toshiya Kanazawa, Takashi Zaitsu, Masayuki Ueno, Yoko Kawaguchi タイトル: Masticatory Performance Measured with a Chewing Gum Containing Spherical Resinous Microparticles
  - 雑誌名: Int J Clin Prev Dent 2018;14(4):256-263 https://doi.org/10.15236/ijcpd.2018.14.4.256

#### 2. 総説論文

著者: Takashi Zaitsu, Tomoya Saito, Yoko Kawaguchi: タイトル: The Oral Healthcare System in Japan 雑誌名: Healthcare 2018, 6, 79; doi:10.3390/healthcare6030079

#### 3. 学会発表

- 1) 財津 崇, 斉藤智也, 西山 暁, 植野正之, 川口陽子. 顎関節症状と労働パフォーマンスとの関 連について. 第67回日本口腔衛生学会・総会 2018.05.18・20 札幌市教育文化会館, 北海道.
- 2) 財津 崇, 金澤利哉, 斉藤智也, Kaung Myat Thwin, Zar Chi Kyaw Myint, 大城暁子, 竹原祥子, 植野正之, 川口陽子. 労働者の健康関連 QOL と口腔保健状況との関連について. 第67回日本口腔衛生学会・総会 2018.05.18-20 札幌市教育文化会館, 北海道.
- 3) 植野正之、大城暁子、財津 崇、川口陽子 某健康保険組合の被保険者を対象とした医療費に 関する分析 第67回日本口腔衛生学会・総会 2018.05.18-20 札幌市教育文化会館, 北海道.

雜誌名: Int. J. Environ. Res. Public Health 2018, 15, 2630; doi:10.3390/ijerph15122630

- 4) 杉村日向子、財津 崇、斉藤智也、金澤利哉、大城暁子、植野正之、川口陽子:労働者の口臭 の有無と関連する要因について 第67回日本口腔衛生学会・総会 2018.05.18-20 札幌市教 育文化会館,北海道.
- 5) 斎藤智也、財津 崇、植野正之、川口陽子 口臭に関わる職業関連要因について 第67回日本 口腔衛生学会・総会 2018.05.18-20 札幌市教育文化会館, 北海道.
- **6)** Naoki Toyama, Daisuke Ekuni, Ayano Tabata, Manabu Morita: Is a work sift schedule associated with oral status and health behaviors? A cross-sectional study, The 13<sup>th</sup> International Conference of Asian Academy of Preventive Dentistry (AAPD) 2018.11.21-23. Khon Kaen, Thailand
- 7) Toyama N, Taniguchi-Tabata A, Ekuni D, Morita M. Effects of the oral hygiene instruction on oral health behaviors and periodontal health in Japanese workers. EuroPerio9 Amsterdam, Holland 2018.06.20~23.
- 8) 吉岡みどり:歯科からのメタボ対策一咀嚼のチェック項目の活用に向けて一、第28回日本産業衛生学会全国協議会「産業歯科保健部会フォーラム」特定健診・特定保健指導における歯科の役割、2018年9月16日、東京工科大学
- **9)** Tomoya Saito, Takashi Zaitsu, Masayuki Ueno, Yoko Kawaguchi: Oral malodor and occupational parameters in Japanese workers, The 96th General Session of the International Association for Dental Research conference (IADR), London, United Kingdom, July 25-28, 2018.


International Journal of *Environmental Research and Public Health* 



#### Article

# Does Instruction of Oral Health Behavior for Workers Improve Work Performance?—Quasi-Randomized Trial

Naoki Toyama <sup>1</sup>, Ayano Taniguchi-Tabata <sup>2,\*</sup>, Nanami Sawada <sup>1</sup>, Yoshio Sugiura <sup>1</sup>, Daiki Fukuhara <sup>1</sup>, Yoko Uchida <sup>1</sup>, Hisataka Miyai <sup>1</sup>, Aya Yokoi <sup>1</sup>, Shinsuke Mizutani <sup>3,4</sup>, Daisuke Ekuni <sup>1</sup> and Manabu Morita <sup>1</sup>

- Department of Preventive Dentistry, Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, Okayama 700-8558, Japan; pu171qxi@s.okayama-u.ac.jp (N.T.); de422027@s.okayama-u.ac.jp (N.S.); de421022@s.okayama-u.ac.jp (Y.S.); de20041@s.okayama-u.ac.jp (D.F.); de20006@s.okayama-u.ac.jp (Y.U.); pqpp0n70@s.okayama-u.ac.jp (H.M.); yokoi-a1@cc.okayama-u.ac.jp (A.Y.); dekuni7@md.okayama-u.ac.jp (D.E.); mmorita@md.okayama-u.ac.jp (M.M.)
- <sup>2</sup> Department of Preventive Dentistry, Okayama University Hospital, Okayama 700-8558, Japan
- <sup>3</sup> Section of Geriatric Dentistry and Perioperative Medicine in Dentistry, Division of Maxillofacial Diagnostic and Surgical Sciences, Faculty of Dental Science, Kyushu University, Fukuoka 812-8582, Japan; mizutani@dent.kyushu-u.ac.jp
- <sup>4</sup> OBT Research Center, Faculty of Dental Science, Kyushu University, Fukuoka 812-8582, Japan
- \* Correspondence: de19026@s.okayama-u.ac.jp; Tel.: +81-86-235-6712

Received: 31 October 2018; Accepted: 22 November 2018; Published: 24 November 2018



**Abstract:** Oral disease can cause economic loss due to impaired work performance. Therefore, improvement of oral health status and prevention of oral disease is essential among workers. The purpose of this study was to investigate whether oral health-related behavioral modification intervention influences work performance or improves oral health behavior and oral health status among Japanese workers. We quasi-randomly separated participants into the intervention group or the control group at baseline. The intervention group received intensive oral health instruction at baseline and a self-assessment every three months. Both groups received oral examinations and answered the self-questionnaire at baseline and at one-year follow-up. At follow-up, the prevalence of subjects who use fluoride toothpastes and interdental brushes/dental floss were significantly higher in the intervention group than in the control group. Three variables (tooth brushing in workplace, using fluoride toothpaste, and experience of receiving tooth brushing instruction in a dental clinic) showed significant improvement only in the intervention group. Our intensive oral health-related behavioral modification intervention improved oral health behavior, but neither work performance and oral status, among Japanese workers.

Keywords: work performance; oral health; intervention study; behavioral modification

#### 1. Introduction

Health impairment influences work performance due to pain, absence for treatment and physical disability [1–4]. The World Health Organization states that protecting workers' health is important to household income, productivity, and economic development, and work-related health problems result in an economic loss of 4–6% of gross domestic product (GDP) for most countries [5].

Several chronic diseases, including oral diseases, were reported to cause economic loss due to impaired work performance [6]. In Japan, 34.8% of workers had problems with work due to oral diseases and impaired work performance [7]. Another study reported that oral diseases indirectly

impose an economic burden, costing US\$144 billion in terms of productivity losses due to absenteeism from work [8]. Thus, prevention and control of oral diseases is important for workers to avoid impaired work performance and subsequent economic loss.

Improving individual oral health behavior is effective for preventing oral diseases. Dentists or dental hygienists perform behavioral modification for improvement of patient oral health behavior [9–11]. Adopting methods for behavioral modification, such as "prompt self-monitoring of behavior", "prompt intention formation", "prompt specific goal setting", "provide feedback on performance", and "prompt review of behavioral goals", are effective [12,13]. However, there have been few studies investigating the effects of intervention for behavioral modification on work performance.

We hypothesize that oral health-related behavioral modification intervention will improve work performance by improving oral health behavior and oral health status. This study aims to investigate whether oral health-related behavioral modification intervention influences work performance or improves oral health behavior and oral health status among Japanese workers.

#### 2. Materials and Methods

#### 2.1. Study Population

We estimated the sample size using G\*Power and calculated minimum sample sizes for a chi-squared test. We set the effect size at 0.3, alpha at 0.05, and power  $(1 - \beta)$  at 0.80 [14]. The minimum sample size was 108 (chi-squared test). Assuming an attrition rate of 30% [15,16], the planned sample size was therefore a minimum of 308 participants (154 in each group).

Among central or branch offices in Okayama in Japan, we recruited companies that have never received oral examination in work places and agreed to participate in the study. A total of 14 companies in Okayama, Hiroshima, Osaka, and Kyoto cities in Japan agreed to participate in this study. Inclusion criteria for participant recruitment were to complete oral examinations and questionnaires, while exclusion criteria were participants who did not agree to participate. We enrolled 611 workers from April to December 2015 and performed re-examination from April to December 2016.

This study was an assessor-blinded, quasi-randomized trial (alternate allocation). All participants first received an oral examination and answered self-administered questionnaires, and were then divided into two groups in the order in which they came at baseline (2015). After alternate allocation (ratio; 1:1), participants were assigned to the intervention group or the control group. After oral examination, the intervention group received instructions for oral health-related behavioral modification. They were involved in further intervention by the mailing method, which was performed every three months. The control group received only oral examinations. After one year (follow-up) (2016), the two groups received re-examination and answered self-questionnaires.

All study protocols were approved by the Ethics Committees of Okayama University Graduate School of Medicine, Dentistry and Pharmaceutical Sciences and Okayama University Hospital (no. 1507-001). Written informed consent was obtained from all targeted participants. Moreover, this study was registered at the University Hospital Medical Information Network (no. 000023011) before commencing.

#### 2.2. Oral Examination

At baseline and follow-up, six dentists (M.M., T.I., H.M., A.T.-T., A.Y., D.F.) who did not know the allocation performed oral examinations (single blind). The dentists assessed oral health status based on community periodontal index (CPI) [17], debris index-simplified (DI-S) [18] and bleeding on probing (BOP) using a CPI probe (YDM, Tokyo, Japan). CPI, DI-S, and BOP were measured for 10 representative teeth (maxilla: right first and second molar, right central incisor, left first and second molar; mandible: right first and second molar, left central incisor, left first and second molar). CPI scores were binarized; 0–2 vs. 3, 4. DI-S was evaluated in 4 grades (0–3). BOP was expressed as percentage (%BOP). In addition, the number of present teeth, decayed teeth, and filling teeth were recorded [17]. For assessment, all dentists received training and calibration. Data of CPI score ( $\leq 2/>2$ ) were analyzed using a non-parametric kappa test. The kappa coefficients for intra- and inter-examiner reliability were 1.0 and 0.83, respectively.

#### 2.3. Self-Questionnaire

Before oral examination, participants answered self-questionnaires on sex, age, job category [19], work pattern (daytime/daytime and nighttime/flextime), and 10 questions about oral health [20], as presented below:

- (1) Do you have a family dental doctor? (Yes/No)
- (2) Does your work disturb you going to dental clinic? (Yes/No)
- (3) Do you brush your teeth in your workplace? (Always/Sometimes/No)
- (4) Do you eat snack food between meals? (Always/Sometimes/No)
- (5) Do you smoke tobacco? (Current smoking/Past smoking/Never)
- (6) Do you brush your teeth before going to bed? (Always/Sometimes/No)
- (7) Do you use fluoride toothpaste? (Yes/No/I don't know)
- (8) Do you use interdental brushes/dental floss? (Always/Sometimes/No)
- (9) Have you received tooth brushing instruction at a dental clinic? (Yes/No)
- (10) Have you received oral examination in the past year at a dental clinic? (Yes/No)

Furthermore, to assess whether oral status influences work performance, we asked "Have you had any problems with work performance because of oral diseases?" [7]. The answer was given in a "yes/no" format. If the answer was "yes", work performance was assessed as impaired.

#### 2.4. Intervention

The intervention group received individualized instruction for five minutes. During the study briefing, the participants set three goals for oral health behavioral modification to improve individual oral status and received advice on achieving the goals using a leaflet and a dental model. The instructors were dental hygienists or dentists who did not perform oral examinations. Moreover, we performed self-assessment questionnaires three times per year by mail (mailing method). In the mailing method, the intervention group evaluated the level of achievement of the goals, which were suggested at baseline intervention and reconsidered the direction. If the goals were achieved, new goals were established by participants.

#### 2.5. Statistical Analysis

SPSS version 20 software (IBM, Tokyo, Japan) was used for statistical analyses. Values of p < 0.05 were considered to indicate significant associations. Chi-squared tests or non-paired *t*-tests were used to assess whether there were significant differences between the intervention group and the control group at both baseline and follow-up. McNemar test, McNemar-Bowker tests or paired *t*-tests were used to assess whether there were significant changes between baseline and follow-up.

#### 3. Results

Figure 1 shows the flow chart for study participants. All participants agreed to participate in this study. As the participants who did not undergo re-examination or provided incomplete data were excluded, 371 workers out of 611 workers were included in the analysis (final follow-up rate; 60.7%).



**Figure 1.** Flow chart showing the protocols for selecting analyzed workers from among those who agreed to participate in this study.

Table 1 shows the distribution of participants' characteristics at baseline. Data were not significantly different between the two groups at baseline ( $p \ge 0.05$ , chi-squared tests, data not shown). The most common job category was professional and technical workers (36.9%). Daytime workers accounted for 85.4% of participants.

| Variables                               | Intervention ( <i>n</i> = 188) | Control ( <i>n</i> = 183) |
|---|--------------------------------|---------------------------|
| Sex                                     |                                |                           |
| Male                                    | 149 (79.3) <sup>1</sup>        | 148 (80.9)                |
| Female                                  | 39 (20.7)                      | 35 (19.1)                 |
| Age (y)                                 | $40.7 \pm 11.9^{\ 2}$          | $41.4\pm11.9$             |
| Job category                            |                                |                           |
| Administrative and managerial workers   | 16 (8.5)                       | 25 (13.7)                 |
| Professional and technical workers      | 67 (35.6)                      | 70 (38.3)                 |
| Clerical workers                        | 38 (20.2)                      | 23 (12.6)                 |
| Sales workers                           | 20 (10.6)                      | 15 (8.2)                  |
| Service workers                         | 3 (1.6)                        | 4 (2.2)                   |
| Security workers                        | 9 (4.8)                        | 7 (3.8)                   |
| Manufacturing process workers           | 28 (14.9)                      | 36 (19.7)                 |
| Transport and machine operation workers | 7 (3.7)                        | 3 (1.6)                   |
| Work schedule                           |                                |                           |
| Daytime work                            | 160 (85.1)                     | 157 (85.8)                |
| Daytime and nighttime work              | 8 (4.3)                        | 6 (3.3)                   |
| Flextime work                           | 20 (10.6)                      | 20 (10.9)                 |

Table 1. Characteristics of participants at baseline.

<sup>1</sup> *n* (%); <sup>2</sup> Mean  $\pm$  standard deviation.

In Table 2, we show a comparison of clinical variables between the two groups at baseline and at follow-up. All variables related to oral health status did not significantly differ between the two groups at baseline and follow-up ( $p \ge 0.05$ , non-paired *t*-tests or chi-squared tests, data not shown).

|           | Baseline                | e (2015)   | Follow-u  | р (2016)  |   |
|-----------|-------------------------|--|---|---|---|
| Variables |                         | Control<br>( <i>n</i> = 183)   | Intervention<br>( <i>n</i> = 188)   | Control<br>( <i>n</i> = 183)  | <i>p</i> -Value   |
|           | $0.36 \pm 0.34 \ ^4$    | $0.38\pm0.33$  | $0.35\pm0.36$   | $0.34\pm0.37$   | $0.784^{6}$   |
|           | $39.0\pm30.5$           | $40.5\pm28.4$  | $36.3\pm27.3$   | $37.4\pm26.3$   | 0.674   |
|           | $28.3\pm2.4$            | $28.5\pm1.8$   | $28.3\pm2.4$  | $28.6\pm1.9$  | 0.246   |
|           | $0.69 \pm 1.58$         | $0.77\pm2.06$  | $0.64 \pm 1.60$   | $0.60 \pm 1.56$   | 0.796   |
|           | $8.67 \pm 6.08$         | $9.06\pm5.73$  | $8.66\pm6.13$   | $9.20\pm5.64$   | 0.376   |
| $\leq 2$  | 113 (60.1) <sup>5</sup> | 110 (60.1)   | 121 (64.4)  | 116 (63.4)  | 0.845 <sup>7</sup>  |
|           | ≤2                      | Baseline           Intervention $(n = 188)$ $0.36 \pm 0.34^4$ $39.0 \pm 30.5$ $28.3 \pm 2.4$ $0.69 \pm 1.58$ $8.67 \pm 6.08$ $\leq 2$ $113 (60.1)^5$ | $\begin{tabular}{ c c c c } \hline Baseline (2015) \\ \hline Intervention (n = 188) (n = 183) \\ \hline (n = 188) (n = 183) \\ \hline 0.36 \pm 0.34 & 0.38 \pm 0.33 \\ 39.0 \pm 30.5 & 40.5 \pm 28.4 \\ 28.3 \pm 2.4 & 28.5 \pm 1.8 \\ 0.69 \pm 1.58 & 0.77 \pm 2.06 \\ 8.67 \pm 6.08 & 9.06 \pm 5.73 \\ \le 2 & 113 (60.1) & 110 (60.1) \\ \hline \end{tabular}$ | Baseline (2015)Follow-uInterventionControlIntervention $(n = 188)$ $(n = 183)$ $(n = 188)$ $0.36 \pm 0.34^4$ $0.38 \pm 0.33$ $0.35 \pm 0.36$ $39.0 \pm 30.5$ $40.5 \pm 28.4$ $36.3 \pm 27.3$ $28.3 \pm 2.4$ $28.5 \pm 1.8$ $28.3 \pm 2.4$ $0.69 \pm 1.58$ $0.77 \pm 2.06$ $0.64 \pm 1.60$ $8.67 \pm 6.08$ $9.06 \pm 5.73$ $8.66 \pm 6.13$ $\leq 2$ $113 (60.1)^5$ $110 (60.1)$ $121 (64.4)$ | $ \begin{array}{ c c c c c c } \hline Baseline (2015) & Follow-up (2016) \\ \hline Intervention & Control & Intervention & Control \\ (n = 188) & (n = 183) & (n = 188) & (n = 183) \\ \hline 0.36 \pm 0.34 & 0.38 \pm 0.33 & 0.35 \pm 0.36 & 0.34 \pm 0.37 \\ 39.0 \pm 30.5 & 40.5 \pm 28.4 & 36.3 \pm 27.3 & 37.4 \pm 26.3 \\ 28.3 \pm 2.4 & 28.5 \pm 1.8 & 28.3 \pm 2.4 & 28.6 \pm 1.9 \\ 0.69 \pm 1.58 & 0.77 \pm 2.06 & 0.64 \pm 1.60 & 0.60 \pm 1.56 \\ 8.67 \pm 6.08 & 9.06 \pm 5.73 & 8.66 \pm 6.13 & 9.20 \pm 5.64 \\ \leq 2 & 113 (60.1) & 110 (60.1) & 121 (64.4) & 116 (63.4) \\ \hline \end{array} $ |

**Table 2.** Comparison of clinical variables between the intervention group and the control group at follow-up.

<sup>1</sup> Debris index-simplified; <sup>2</sup> Percentage of bleeding on probing; <sup>3</sup> Community periodontal index; <sup>4</sup> Mean  $\pm$  standard deviation; <sup>5</sup> *n* (%); <sup>6</sup> Non-paired *t*-test at follow-up; <sup>7</sup> Chi-squared test at follow-up.

The distribution of self-questionnaire answers between the intervention group and the control group is shown in Table 3. At baseline, there were no significant differences between the two groups ( $p \ge 0.05$ , chi-squared tests, data not shown). After intervention, the frequency of fluoride toothpaste and interdental brushes/dental floss use was higher in the intervention group than in the control group (p < 0.05). There were no significant differences in work performance.

**Table 3.** Comparison of qualitative variables between the intervention group and the control groupat follow-up.

|                           | Baseline                             | e (2015)                             | Follow-u                             |                                      |   |
|---------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|---|
| Vriables                  | Intervention<br>( <i>n</i> = 188)    | Control<br>( <i>n</i> = 183)         | Intervention<br>( <i>n</i> = 188)    | Control<br>( <i>n</i> = 183)         | <sup>–</sup> <i>p</i> -Value <sup>1</sup> |
| Have you had any pro      | oblems with work perfo               | rmance because of                    | oral diseases?                       |                                      |   |
| Yes<br>No                 | 9 (4.8) <sup>2</sup><br>179 (95.2)   | 12 (6.6)<br>171 (93.4)               | 7 (3.7)<br>181 (96.3)                | 7 (3.8)<br>176 (96.2)                | 0.959                                     |
| Do you have a family      | dental doctor?                       |                                      |                                      |                                      |   |
| Yes<br>No                 | 118 (62.8)<br>70 (37.2)              | 116 (63.4)<br>67 (36.6)              | 126 (67.0)<br>62 (33.0)              | 122 (66.7)<br>61 (33.3)              | 0.942                                     |
| Does your work distu      | rb you going to dental               | clinic?                              |                                      |                                      |   |
| Yes<br>No                 | 91 (48.4)<br>97 (51.6)               | 76 (41.5)<br>107 (58.5)              | 83 (44.1)<br>105 (55.9)              | 71 (38.8)<br>112 (61.2)              | 0.296                                     |
| Do you brush your te      | eth in your workplace?               | ,                                    |                                      |                                      |   |
| Always<br>Sometimes<br>No | 56 (29.8)<br>38 (20.2)<br>94 (50.0)  | 46 (25.1)<br>43 (23.5)<br>94 (51.4)  | 51 (27.1)<br>62 (33.0)<br>75 (39.9)  | 50 (27.3)<br>42 (23.0)<br>91 (49.7)  | 0.07                                      |
| Do you eat snack food     | ! between meals?                     |                                      |                                      |                                      |   |
| Always<br>Sometimes<br>No | 43 (22.9)<br>115 (61.2)<br>30 (16.0) | 45 (24.6)<br>111 (60.7)<br>27 (14.8) | 43 (22.9)<br>114 (60.6)<br>31 (16.5) | 52 (28.4)<br>108 (59.0)<br>23 (12.6) | 0.344                                     |

| 6 of 10 |
|---------|
|         |

|                         | Baseline                          | e (2015)                     | Follow-u                          | р (2016)                     | _                            |
|-------------------------|-----------------------------------|------------------------------|-----------------------------------|------------------------------|------------------------------|
| Vriables                | Intervention<br>( <i>n</i> = 188) | Control<br>( <i>n</i> = 183) | Intervention<br>( <i>n</i> = 188) | Control<br>( <i>n</i> = 183) | <i>p</i> -Value <sup>1</sup> |
| Do you smoke tobacco?   |                                   |                              |                                   |                              |                              |
| Current smoking         | 43 (22.9)                         | 44 (24.0)                    | 45 (23.9)                         | 43 (23.5)                    | 0.994                        |
| Past smoking            | 33 (17.6)                         | 29 (15.8)                    | 31 (16.5)                         | 30 (16.4)                    |                              |
| Never                   | 112 (59.6)                        | 110 (60.1)                   | 112 (59.6)                        | 110 (60.1)                   |                              |
| Do you brush your teet  | h before going to bed             | ?                            |                                   |                              |                              |
| Always                  | 152 (80.9)                        | 137 (74.9)                   | 160 (85.1)                        | 140 (76.5)                   | 0.075                        |
| Sometimes               | 25 (13.3)                         | 28 (15.3)                    | 21 (11.2)                         | 28 (15.3)                    |                              |
| No                      | 11 (5.9)                          | 18 (9.8)                     | 7 (3.7)                           | 15 (8.2)                     |                              |
| Do you use fluoride too | thpaste?                          |                              |                                   |                              |                              |
| Yes                     | 95 (50.5)                         | 82 (44.8)                    | 124 (66.0)                        | 96 (52.5)                    | 0.029                        |
| No                      | 36 (19.1)                         | 46 (25.1)                    | 34 (18.1)                         | 44 (24.0)                    |                              |
| I don't know            | 57 (30.3)                         | 55 (30.1)                    | 30 (16.0)                         | 43 (23.5)                    |                              |
| Do you use interdental  | brushes/dental floss?             | >                            |                                   |                              |                              |
| Always                  | 26 (13.8)                         | 28 (15.3)                    | 43 (22.9)                         | 32 (17.5)                    | 0.021                        |
| Sometimes               | 74 (39.4)                         | 70 (38.3)                    | 88 (46.8)                         | 70 (38.3)                    |                              |
| No                      | 88 (46.8)                         | 85 (46.4)                    | 57 (30.3)                         | 81 (44.3)                    |                              |
| Have you received tooth | h brushing instructio             | n at a dental clinic         | ?                                 |                              |                              |
| Yes                     | 129 (68.6)                        | 129 (70.5)                   | 146 (77.7)                        | 135 (73.8)                   | 0.382                        |
| No                      | 59 (31.4)                         | 54 (29.5)                    | 42 (22.3)                         | 48 (26.2)                    |                              |
| Have you received an or | ral examination in th             | e past year at a dei         | ıtal clinic?                      |                              |                              |
| Yes                     | 72 (38.3)                         | 65 (35.5)                    | 89 (47.3)                         | 87 (47.5)                    | 0.969                        |
| No                      | 116 (61.7)                        | 118 (64.5)                   | 99 (52.7)                         | 96 (52.5)                    |                              |

Table 3. Cont.

 $^{1}$  Chi-squared test on differences between intervention and control groups at follow-up;  $^{2}$  *n* (%).

Changes in measured variables from baseline to follow-up in each group were also compared (Table 4). Use of interdental brushes/dental floss and dental examinations in the past year improved significantly in both groups. On the other hand, three variables (tooth brushing in workplace, using fluoride toothpastes, and experience of receiving tooth brushing instruction) showed significant improvement only in the intervention group. Work performance and oral status did not change significantly.

 Table 4. Changes in variables in intervention and control groups.

| Variables            | Inter                | rvention ( $n = 1$ | 88)                          | Control ( <i>n</i> = 183) |                 |                              |  |
|----------------------|----------------------|--------------------|------------------------------|---------------------------|-----------------|------------------------------|--|
| variables            | Baseline             | Follow-up          | <i>p</i> -Value <sup>6</sup> | Baseline                  | Follow-up       | <i>p</i> -Value <sup>6</sup> |  |
| Continuous variables |                      |                    |                              |                           |                 |                              |  |
| DI-S <sup>1</sup>    | $0.35 \pm 0.36$ $^4$ | $0.36\pm0.34$      | 0.913                        | $0.38\pm0.33$             | $0.34\pm0.37$   | 0.165                        |  |
| %BOP <sup>2</sup>    | $39.0\pm30.5$        | $36.3\pm27.3$      | 0.290                        | $40.5\pm28.4$             | $37.4\pm26.3$   | 0.179                        |  |
| Present teeth        | $28.3\pm2.36$        | $28.3\pm2.37$      | 0.381                        | $28.5\pm1.78$             | $28.6 \pm 1.90$ | 0.414                        |  |
| Decayed teeth        | $0.69 \pm 1.58$      | $0.64 \pm 1.60$    | 0.515                        | $0.77\pm2.06$             | $0.60\pm1.56$   | 0.062                        |  |
| Filling teeth        | $8.67\pm 6.08$       | $8.66\pm6.14$      | 0.969                        | $9.06\pm5.73$             | $9.21 \pm 5.64$ | 0.337                        |  |

| Variables                  | Inte                   | rvention ( $n = 1$ | .88)                         | Control ( <i>n</i> = 183) |           |                              |  |
|----------------------------|------------------------|--------------------|------------------------------|---------------------------|-----------|------------------------------|--|
| variables                  | Improved               | Worsened           | <i>p</i> -Value <sup>7</sup> | Improved                  | Worsened  | <i>p</i> -Value <sup>7</sup> |  |
| Categorical variables      |                        |                    |                              |                           |           |                              |  |
| CPI <sup>3</sup>           | 33 (17.6) <sup>5</sup> | 25 (13.3)          | 0.358                        | 32 (17.5)                 | 26 (14.2) | 0.512                        |  |
| Have you had any problem   | 1s with work perf      | formance becaus    | e of oral disease            | rs?                       |           |                              |  |
|                            | 9 (4.8)                | 7 (3.7)            | 0.804                        | 10 (5.5)                  | 5 (2.7)   | 0.302                        |  |
| Do you have a family dent  | al doctor?             |                    |                              |                           |           |                              |  |
|                            | 13 (6.9)               | 5 (2.7)            | 0.096                        | 18 (9.8)                  | 12 (6.6)  | 0.362                        |  |
| Does your work disturb yo  | ou going to denta      | el clinic?         |                              |                           |           |                              |  |
|                            | 26 (13.8)              | 18 (9.6)           | 0.291                        | 25 (13.7)                 | 20 (10.9) | 0.551                        |  |
| Do you brush your teeth i  | n your workplace       | ?                  |                              |                           |           |                              |  |
|                            | 30 (16.0)              | 16 (8.5)           | 0.003                        | 22 (12.1)                 | 19 (10.4) | 0.256                        |  |
| Do you eat snack food beta | ween meals?            |                    |                              |                           |           |                              |  |
|                            | 27 (14.4)              | 26 (13.8)          | 0.997                        | 18 (9.8)                  | 28 (15.3) | 0.403                        |  |
| Do you smoke tobacco?      |                        |                    |                              |                           |           |                              |  |
|                            | 4 (2.1)                | 7 (3.7)            | 0.392                        | 8 (4.3)                   | 7 (3.8)   | 0.978                        |  |
| Do you brush your teeth b  | efore going to be      | d?                 |                              |                           |           |                              |  |
|                            | 13 (6.9)               | 4 (2.1)            | 0.132                        | 13 (7.1)                  | 10 (5.4)  | 0.733                        |  |
| Do you use fluoride tooth  | paste?                 |                    |                              |                           |           |                              |  |
|                            | 53 (28.2)              | 7 (8.0)            | < 0.001                      | 35 (19.1)                 | 22 (12.0) | 0.076                        |  |
| Do you use interdental bri | ushes/dental floss     | ;?                 |                              |                           |           |                              |  |
|                            | 50 (26.6)              | 7 (3.7)            | < 0.001                      | 26 (14.2)                 | 15 (8.2)  | 0.049                        |  |
| Have you received tooth b  | rushing instructi      | ion at a dental cl | inic?                        |                           |           |                              |  |
|                            | 24 (12.8)              | 7 (3.7)            | 0.003                        | 16 (8.7)                  | 10 (5.5)  | 0.327                        |  |
| Have you received an oral  | examination in t       | he past year at a  | a dental clinic?             |                           |           |                              |  |
|                            | 28 (14.9)              | 11 (5.9)           | 0.009                        | 32 (17.5)                 | 10 (5.5)  | 0.001                        |  |

Table 4. Cont.

<sup>1</sup> Debris index-simplified; <sup>2</sup> Percentage of bleeding on probing; <sup>3</sup> Community periodontal index; <sup>4</sup> Mean  $\pm$  standard deviation; <sup>5</sup> n (%); <sup>6</sup> Paired *t*-test; <sup>7</sup> McNemar test or McNemar-Bowker test.

Oral health behavioral interventions are not invasive. Therefore, there were no study-related serious adverse events in this study. Furthermore, outcomes did not change after the trial commenced.

#### 4. Discussion

To the best of our knowledge, this was the first study to assess changes in work performance after oral health-related behavioral modification intervention. The study design was reliable as examinations were performed blinded, participants were quasi-randomly (alternate allocation) separated into either an intervention group or a control group, and the sample size was sufficiently large. Unfortunately, this intervention did not improve work performance, and there are several reasons for this. In a previous study [21], it was reported that work performance is mainly influenced by pain from oral diseases. In this study, there was a significant association between work performance and oral pain (baseline, p = 0.002; follow-up, p = 0.019; chi-squared tests; data not shown). However, there was no significant difference in the decrease in oral pain between the intervention and control groups ( $p \ge 0.05$ ). A previous study showed that a combination of professional oral hygiene treatment and oral hygiene instructions contributed to a decrease in gingival-related pain [22]. Thus, in the future, we should investigate whether a combination of professional oral hygiene treatment and oral health instruction improves work performance.

Oral health-related behavioral modification intervention improved oral health behavior but not oral health status. A systematic review showed that oral hygiene instruction had short-term and long-term effects [10]. The short-term effects were improving knowledge, attitudes, self-efficacy, oral health behavior, and theory constructs. The long-term effects included improving the number of decayed teeth, plaque score, BOP, and gingival condition [10]. The results of this study may be included in the short-term effects. Menegaz et al. suggested that a follow-up time of less than one year led to a lack of efficacy for educational intervention [23]. In addition, Oshikohji et al. reported that workers who had more participation time for oral examination and oral health instruction had better periodontal condition than those with less time [24]. If the duration of this study and/or the frequency of instruction was increased, oral health status might improve.

The intervention in this study was advantageous as it included some of the known factors that lead to behavioral modification. We explained why the workers should change their behavior (prompt intention formation), let the workers set goals independently (prompt specific goal setting), and checked their improvement and prompted them to reconsider their goals (prompt self-monitoring of behavior and prompt review of behavioral goals) [12,13]. Goals to improve oral status were also set based on individual situations in this study. These concepts were supported by a previous study [25]. Finally, the intervention time was short (5 min), a factor which may be effective in workplaces to improve oral health behavior.

There were 17 participants who had problems with work because of tooth or gum disease (4.6% of participants) at baseline. These conditions agree with the prevalence of poor work performance caused by oral pain in previous studies, which ranged between 1.0–7.6% [25–28]. The percentage in this study was within this range. However, the job sector of participants in this study was skewed. The percentage of workers who belonged to the tertiary industry sector was high (83%), and there were no workers from the primary industry sector. Therefore, we should exercise caution when applying our results more generally.

There were some limitations with regard to the interpretation of these results. First, although most of the participants visited a dental clinic during the study period, the type of dental health instruction they received was not confirmed. The intensity of instruction may have affected the results. Second, the follow up rate was not high (approximately 60.7%). As >20% loss would pose a serious threat [29], the high percentage of loss to follow-up may have affected our results. In the intervention group, the ratios of work performance, oral status, and oral health behavior were not significantly different between the analyzed and non-analyzed workers (188 vs. 85 workers, chi-squared test and non-paired *t*-test, *p* > 0.05). However, in the control group, the percentage of those using interdental brushes/dental floss was significantly different (183 vs. 90 workers, chi-squared test, *p* = 0.034). In the control group, use of interdental brushes or dental floss might have been improved because more workers who did not use these were not analyzed. Other limitations include the short-term scale of the study period and the fact that this was not a randomized trial.

#### 5. Conclusions

In conclusion, oral health-related behavioral modification intervention improved oral health behavior, but not work performance in Japanese workers.

**Author Contributions:** Conceptualization, A.T.-T., S.M., D.E. and M.M.; investigation, A.T.-T., N.S., Y.S., D.F., Y.U., H.M. and A.Y.; data curation, A.T.-T. and N.T.; writing—original draft preparation, N.T.; writing—review and editing, all authors; project administration, M.M.; funding acquisition, M.M.

**Funding:** The research was funded by the "Research Fund of Clinical Study for Industrial Accident and Disease" (14020101–01) from the Japanese Ministry of Health, Labour and Welfare.

Acknowledgments: The authors are grateful to Junko Emi (Animal Development and Reproductive Biotechnology, Okayama University Graduate School of Environmental and Life Science Okayama, Japan) for data entry and collection, Hirofumi Mizuno (Sasaki dental clinic, Aichi, Japan) for oral examination, and Yuko Kimura (International Dental Hygienist College, Okayama, Japan) for collaboration with regard to oral health behavioral modification intervention.

**Conflicts of Interest:** The authors declare no conflicts of interest.

#### References

- Pronk, N.P.; Martinson, B.; Kessler, R.C.; Beck, A.L.; Simon, G.E.; Wang, P. The Association Between Work Performance and Physical Activity, Cardiorespiratory Fitness, and Obesity. *J. Occup. Environ. Med.* 2004, 46, 19–25. [CrossRef] [PubMed]
- 2. Suvinen, T.I.; Ahlberg, J.; Rantala, M.; Nissinen, M.; Lindholm, H.; Könönen, M.; Savolainen, A. Perceived stress, pain and work performance among non-patient working personnel with clinical signs of temporomandibular or neck pain. *J. Oral Rehabil.* **2004**, *31*, 733–737. [CrossRef] [PubMed]
- 3. Khubchandani, J.; Price, J.H. Association of Job Insecurity with Health Risk Factors and Poorer Health in American Workers. *J. Community Health* **2017**, *42*, 242–251. [CrossRef] [PubMed]
- 4. Sigurdardottir, V.; Drivelegka, P.; Svärd, A.; Jacobsson, L.T.H.; Dehlin, M. Work disability in gout: A population-based case—Control study. *Ann. Rheum. Dis.* **2018**, *77*, 399–404. [CrossRef] [PubMed]
- 5. Protecting Workers' Health. Available online: http://www.who.int/news-room/fact-sheets/detail/ protecting-workers\T1\textquoteright-health (accessed on 26 October 2018).
- Fouad, A.M.; Waheed, A.; Gamal, A.; Amer, S.A.; Abdellah, R.F.; Shebl, F.M. Effect of Chronic Diseases on Work Productivity: A Propensity Score Analysis. *J. Occup. Environ. Med.* 2017, 59, 480–485. [CrossRef] [PubMed]
- 7. Ichihashi, T.; Mutou, T.; Shibuya, K. Influence of Dental Diseaseon Workers in Terms of Hours Lost from Work or Daily Life Activities. *Jpn. Soc. Dent. Health* **2002**, *52*, 141–149. [CrossRef]
- Listl, S.; Galloway, J.; Mossey, P.A.; Marcenes, W. Global Economic Impact of Dental Diseases. J. Dent. Res. 2015, 94, 1355–1361. [CrossRef] [PubMed]
- 9. Kay, E.; Vascott, D.; Hocking, A.; Nield, H.; Dorr, C.; Barrett, H. A review of approaches for dental practice teams for promoting oral health. *Community Dent. Oral Epidemiol.* **2016**, *44*, 313–330. [CrossRef] [PubMed]
- Ghaffari, M.; Rakhshanderou, S.; Ramezankhani, A.; Buunk-Werkhoven, Y.; Noroozi, M.; Armoon, B. Are educating and promoting interventions effective in oral health?: A systematic review. *Int. J. Dent. Hyg.* 2018, *16*, 48–58. [CrossRef] [PubMed]
- Haresaku, S.; Tsutsui, A.; Sakai, K.; Ryu, C.; Kanesaki, N.; Hanioka, T.; Kashiwagi, S.; Mishima, K.; Chinju, N.; Ogawa, K. Relationships of Dental Factors for Behavior Change with the Effects of an Intervention Program in the Workplace and Consciousness of the Oral Health of Workers. *Jpn. Soc. Dent. Health* 2004, 54, 122–131. [CrossRef]
- 12. Michie, S.; Abraham, C.; Whittington, C.; McAteer, J.; Gupta, S. Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychol.* **2009**, *28*, 690–701. [CrossRef] [PubMed]
- 13. Ishikawa, Y. Recent Global Trends in Standardized Reporting of Behavior Change Technique. *Jpn. J. Behav. Med.* **2014**, *20*, 41–46. [CrossRef]
- 14. Cohen, J. A power primer. Psychol. Bull. 1992, 112, 155–159. [CrossRef] [PubMed]
- 15. Davis, K.D.; Lawson, K.M.; Almeida, D.M.; Kelly, E.L.; King, R.B.; Hammer, L.; Casper, L.M.; Okechukwu, C.A.; Hanson, G.; McHale, S.M. Parents' Daily Time With Their Children: A Workplace Intervention. *Pediatrics* **2015**, *135*, 875–882. [CrossRef] [PubMed]
- 16. Yoshihara, A.; Yagi, M.; Sawamura, E.; Kanako, N.; Miyazaki, H. Evaluation of Personalized Oral Health Program with Mailing Pamphlets for Women. *Jpn. Soc. Dent. Health* **1999**, *49*, 809–815. [CrossRef]
- 17. World Health Organization. *Oral Health Surveys: Basic Methods;* World Health Organization: Geneva, Switzerland, 1997.
- 18. Greene, J.G.; Vermillion, J.R. The Simplified Oral Hygiene Index. J. Am. Dent. Assoc. 1964, 68, 7–13. [CrossRef] [PubMed]
- 19. Ministry of Internal Affairs and Communications. Japan Standard Industrial Classification 2013. Available online: http://www.soumu.go.jp/english/dgpp\_ss/seido/sangyo/san13-3.htm (accessed on 23 November 2018).
- 20. Japan Dental Association. Lifelong Teeth Support Program. Available online: http://www.jda.or.jp/dentist/ program/ (accessed on 23 November 2018).
- 21. Lawal, F.B.; Taiwo, J.O.; Oke, G.A. Impact of Oral Health on The Quality of Life of Elementary School Teachers. *Ethiop. J. Health Sci.* **2015**, *25*, 217–224. [CrossRef] [PubMed]

- 22. Arduino, P.G.; Lopetuso, E.; Carcieri, P.; Giacometti, S.; Carbone, M.; Tanteri, C.; Broccoletti, R. Professional oral hygiene treatment and detailed oral hygiene instructions in patients affected by mucous membrane pemphigoid with specific gingival localization: a pilot study in 12 patients. *Int. J. Dent. Hyg.* **2012**, *10*, 138–141. [CrossRef] [PubMed]
- 23. Menegaz, A.M.; Silva, A.E.R.; Cascaes, A.M. Educational interventions in health services and oral health: Systematic review. *Rev. Saúde Pública* **2018**, *52*. [CrossRef] [PubMed]
- 24. Oshikohji, T.; Shimazaki, Y.; Shinagawa, T.; Fukui, N.; Akifusa, S.; Yamashita, Y. Relationship between Receiving a Workplace Oral Health Examination Including Oral Health Instruction and Oral Health Status in the Japanese Adult Population. *J. Occup. Health* **2011**, *53*, 222–229. [CrossRef] [PubMed]
- 25. Abegg, C.; Fontanive, V.N.; Tsakos, G.; Davoglio, R.S.; de Oliveira, M.M.C. Adapting and testing the oral impacts on daily performances among adults and elderly in Brazil. *Gerodontology* **2015**, *32*, 46–52. [CrossRef] [PubMed]
- 26. Nagarajappa, R.; Batra, M.; Sanadhya, S.; Daryani, H.; Ramesh, G. Oral impacts on daily performance: Validity, reliability and prevalence estimates among Indian adolescents. *Int. J. Dent. Hyg.* **2018**, *16*, 279–285. [CrossRef] [PubMed]
- 27. Gülcan, F.; Nasir, E.; Ekbäck, G.; Ordell, S.; Åstrøm, A.N. Change in Oral Impacts on Daily Performances (OIDP) with increasing age: testing the evaluative properties of the OIDP frequency inventory using prospective data from Norway and Sweden. *BMC Oral Health* **2014**, *14*, 59. [CrossRef] [PubMed]
- 28. Peker, I.; Alkurt, M.T. Oral impacts on daily performance in Turkish adults attending a dental school. *J. Contemp. Dent. Pract.* **2014**, *15*, 92–98. [CrossRef] [PubMed]
- 29. Dettori, J.R. Loss to follow-up. Evid.-Based Spine-Care J. 2011, 2, 7–10. [CrossRef] [PubMed]



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).

原 著

# 職域における歯科健診と個別保健指導による行動変容

| 金子 | 昇  | 葭原              | 明弘2) | 濃野   | 要  | 山賀                 | 孝之1) |
|----|----|-----------------|------|------|----|--------------------|------|
|    | 財津 | 祟 <sup>3)</sup> | 川口   | 陽子3) | 宮﨑 | 秀夫 <sup>1,4)</sup> |      |

概要:職域における歯科保健事業として,疾病の早期発見を目的とした歯科健診が主に行われてきた.こうした従来型 の歯科健診から,行動・環境リスク発見型・行動変容支援型歯科健診への転換を目的として,日本歯科医師会で「標準的 な成人健診プログラム・保健指導マニュアル」(生活歯援プログラム)が策定された.本調査ではこのプログラムに基づ いた歯科健診と保健指導が,歯科健診単独に比べてどの程度優れているのか検討を行った.新潟市内の3企業の従業員 129名(44.6±11.5歳)を対象としてランダムに2群に分け,介入群には生活歯援プログラムに準じた歯科健診と保健指 導を,対照群には歯科健診のみを行った.保健行動を把握するための質問紙調査をベースライン時,3カ月後,6カ月後 および1年後に行い,この間の行動変容を調べた.その結果,介入群と対照群のいずれにおいても「職場や外出先での歯 磨き」や「フッ素入りの歯磨剤の使用」,「歯間ブラシ・フロスの使用」が有意に改善していた.ただ,介入群では1年後 まですべての時点でベースライン時に比べ有意に改善していたのに対し,対照群では一部の時点で有意な改善がみられた のみであった.したがって,従来型の歯科健診でも保健行動の変容がある程度期待できるが,その期間は限定的であるこ と,歯科健診に加え生活歯援プログラムに準じた保健指導を行うことで行動変容はより確実となり,効果が少なくとも1 年間持続することが明らかとなった.

#### 索引用語:成人歯科保健、保健指導、行動変容

#### 緒 言

職域において、歯科疾患は欠勤や仕事の能率低下を引き起こす原因となり、労働損失をもたらす大きな問題である<sup>1)</sup>. さらに、歯周病は糖尿病<sup>2)</sup> や心疾患<sup>3,4)</sup>、腎臓疾患<sup>5,6)</sup> などの全身疾患との関連性が指摘されており、フロスや歯間ブラシの不使用は、心血管系イベントのリスク上昇<sup>7)</sup> やメタボリックシンドローム<sup>8)</sup> と関連していることが報告されるなど、成人における歯科保健活動の重要性は増加している.

こうした中,日本歯科医師会は平成21年に「標準的 な成人歯科健診プログラム・保健指導マニュアル」(生 活歯援プログラム)を策定した\*1.これは歯科健診を, 単に疾患を発見する場としてではなく,受診者の口腔内 状態の改善と行動変容に繋がるような指導・支援の場と 位置づけることで,従来型の歯科健診から行動・環境リ

#### 口腔衛生会誌 69:27-33,2019 (受付:平成 30 年 6 月 12 日/受理:平成 30 年 10 月 2 日)

スク発見型・行動変容支援型歯科健診への転換を目指し たものである.このプログラムでは、まず質問紙により 受診者の環境・行動診断を行う.この結果に基づいて受 診者を類型化し、受診者に必要と考えられる情報提供・ 保健指導を行うというプロセスを取る.従来型の歯科健 診がスクリーニングを主な目的としているのに対し、生 活歯援プログラムは受診者の行動変容を主な目的として いるといえる.

これまでに生活歯援プログラムに準拠した歯科健診と 保健指導を行った調査がいくつか実施されている. 佐々 木らは北海道内の29の事業所においてこのプログラム に準拠した成人歯科健診を行い, 10項目の保健行動の うち6項目で望ましい方向への変化がみられたことを報 告している<sup>9-11)</sup>. また, 岩本らは4都県の事業所・団体 でこのプログラムに基づいた成人歯科健診を行い, 同様 に8項目の保健行動のうち6項目で有意な改善がみられ

<sup>1)</sup> 新潟大学大学院医歯学総合研究科予防歯科学分野

<sup>2)</sup> 新潟大学大学院医歯学総合研究科口腔保健学分野

<sup>3)</sup> 東京医科歯科大学大学院医歯学総合研究科健康推進歯学分野

<sup>4)</sup> 明倫短期大学歯科衛生士学科

<sup>\*1</sup>日本歯科医師会:標準的な成人歯科健診プログラム・保健指導マニュアル、https://www.jda.or.jp/program/main.pdf(2018年5月29日アクセス).

たことを報告している<sup>12)</sup>.しかしこれまでのところ,対 照群として従来型の歯科健診のみを行った群を設定した 調査は行われておらず,生活歯援プログラムに準拠した 歯科健診が従来型の歯科健診に比べてどの程度優れてい るのかは明らかでない.また,保健指導を行った後,行 動変容がどの程度持続するかは不明であった.

そこで本研究では、従来型の歯科健診単独の場合に比 べて生活歯援プログラムがどの程度優れているのか、ま たそれによる行動変容がどの程度持続するのか調査する ことを目的とした.

#### 対象および方法

#### 1. 対象者

新潟市内の製造業,飲食業,建設業から各1企業を任 意に選出し、その従業員を対象とした、各企業におけ る対象人数は、製造業 59 名 (参加率 100%)、飲食業 32 名 (参加率 100%), 建設業 38 名 (参加率 90.5%)の合 計 129 名 (男性 100 名,女性 29 名)であった. 各企業 の従業員を介入群 65 名と対照群 64 名に振り分けた.そ の際、年齢が偏らないようにするため、各企業の従業員 を年齢順にソートした後、ランダムに2群に振り分け た。介入群に対しては口腔内診査と質問紙調査の後に保 健指導を,対照群に対しては口腔内診査と質問紙調査の みを行った.なお、口腔内診査で治療が必要とされた者 には、介入群と対照群とも歯科医師による治療勧告が行 われた、本研究は新潟大学歯学部倫理委員会の承認を受 けて行われ(承認番号: 27-R17-9-14),対象者には事前 に十分な説明を行ったうえで同意の書面を得た.また. 本研究には利益相反は存在しない.

#### 2. 質問紙調査

日本歯科医師会が作成した生活歯援プログラム質問 紙<sup>\*1</sup>を用いて、口腔清掃習慣やかかりつけ歯科医院の有 無など、対象者の保健行動に関する情報を得た.また3 カ月後、6カ月後、1年後にも同じ質問紙を用いて保健 行動の変化を把握した.

#### 3. 保健指導

介入群に対しては、口腔内診査と質問紙調査を行った 後、事前に研修を受けた歯科衛生士が「標準的な成人歯 科健診プログラム・保健指導マニュアル」<sup>\*1</sup>に準拠して 保健指導を行った.すなわち、まず質問紙の回答内容か ら受診者を類型化し、「知識提供・気づき支援型」指導、 「相談・カウンセリング型」指導、「環境・受け皿整備 型」指導、「実技指導型」指導のうち受診者に必要と考 えられる保健指導を行った.まず「知識提供・気づき支 援型」指導として、う蝕や歯周病に関する基本的な知識 とセルフケアの方法, 喫煙および食生活等についての情 報提供を質問紙の情報を基に行い, もし「QOL, 口腔 内の状態・機能」についての質問 Q1~6のうち2項目 以上該当したらさらに「相談・カウンセリング型」の指 導としてセルフケアの改善に必要な実践的な指導を, ま た「支援的環境」についての質問 Q7~12のうち3項目 以上該当したら, さらに「環境・受け皿整備型」の指導 として歯科医院への受診を勧め, 職場での環境整備のた めのアドバイスを行った. Q13~20の「保健行動」の うち3項目以上該当する者はさらに保健指導の必要性が 高いことから, これらすべての指導に加えて「実技指導 型」の指導も行った.

また,保健指導の最後に対象者自身によって実現可能 と考えられる行動目標を設定させ,紙に記入してもらっ た.3カ月後,6カ月後および1年後に質問紙調査票を 郵送する際,保健指導のパンフレットに加えてこの自筆 の行動目標のコピーも同封して,目標の再認識を促した.

#### 4. 統計

ベースライン時における介入群と対照群の対象者特性 を、質的変数に対しては $\chi^2$ 検定、量的変数に対しては t 検定を用いて比較した.また、介入群と対照群のそれぞ れで、ベースライン時と追跡調査時(3カ月後、6カ月 後、1年後)の比較を行う際、2×2表データの比較に は McNemer 検定を、それ以外の比較には Wilcoxon の 符号付き順位検定を用い、それぞれ Bonferroni 補正を 行った.すべての統計的分析には STATA SE 14 (USA STATA Corporation)を用い、p<0.05を有意とした.

#### 結 果

#### 1. 対象者の特性

3カ月後,6カ月後,1年後の質問紙調査および1年 後の歯科健診にすべて参加した者は111名(86%,介入 群52名,対照群59名)であり,以降,この111名につ いて解析を行った.

表1に対象者の特性を示す.介入群と対照群におけ る男性の割合はそれぞれ78.8%と79.7%,年齢は45.6± 10.8 歳と44.3±12.0 歳であり、2 群間で有意差は認めら れなかった.また,各群の所属企業構成についても有意 差はなかった.ベースライン時の質問紙調査の項目中, 保健行動に関する質問項目Q12~20のいずれの項目に おいても,介入群と対照群とで有意差は認められなかっ た(表2).

#### 2. 保健行動の変容

次に介入群と対照群のそれぞれで、質問紙の回答がど のように変化したかを表3に示す.介入群ではQ12「職 場や外出先での歯磨き」が、ベースライン時(毎回9.6%, 時々34.6%)と比較して、3カ月後(毎回21.6%, 時々 33.3%; *p*=0.007), 6カ月後(毎回19.2%, 時々40.4%; *p*=0.004), 1年後(毎回19.2%, 時々40.4%; *p*=0.014)と, いずれの時点でも有意に改善していた.対照群ではベー スライン時(毎回18.6%, 時々16.9%)と比較して、3カ

|                         |                | 介入群<br>(N=52)   | 対照群<br>(N=59) | ⊉値    |
|-------------------------|----------------|-----------------|---------------|-------|
| 性別 N (%) <sup>†</sup>   | 男              | 41 (78.8)       | 47 (79.7)     | 0.016 |
|                         | 女              | 11 (21.2)       | 12 (20.3)     | 0.910 |
| 年齡 平均±S.D. <sup>‡</sup> |                | $45.6 \pm 10.8$ | 44.3±12.0     | 0.546 |
| N (%) <sup>†</sup>      | ~ 29 歳         | 4 (7.7)         | 7 (12.1)      |       |
|                         | $30 \sim 39$ 歳 | 10 (19.2)       | 13 (22.4)     |       |
|                         | $40\sim\!49$ 歳 | 17 (32.7)       | 14 (24.1)     | 0.841 |
|                         | $50\sim59$ 歳   | 17 (32.7)       | 20 (34.5)     |       |
|                         | 60 歳~          | 4 (7.7)         | 4 (6.9)       |       |
| 企業 N (%) <sup>†</sup>   | 製造業            | 26 (50.0)       | 29 (49.2)     |       |
|                         | 飲食業            | 10 (19.2)       | 13 (22.0)     | 0.930 |
|                         | 建設業            | 16 (30.8)       | 17 (28.8)     |       |

表1 対象者の特性

<sup>†</sup>:χ<sup>2</sup> 検定, <sup>‡</sup>:t 検定

月後(毎回 22.0%, 時々 16.9%; *p*=0.309), 6カ月後(毎回 16.9%, 時々 27.1%; *p*=0.309)では有意な改善を認めなかったが,徐々に「いいえ」の回答が減少し,1年後(毎回 22.0%, 時々 27.1%; *p*=0.030)には有意な改善を示した.

また Q16「フッ素入り歯磨剤の使用」についても, 介入群はベースライン時(30.8%)と比較して,3カ月 後(63.5%; *p*=0.005),6カ月後(75.0%; *p*<0.001),1年 後(69.2%; *p*<0.001)のいずれの時点でも「はい」の割 合が有意に増加していた.対照群ではベースライン時 (25.4%)と比較して,3カ月後(40.7%; *p*=0.087)と1 年後(32.2%; *p*=1.000)の時点では有意な変化を認めな かったが,6カ月後(44.1%; *p*=0.024)の時点では「は い」の割合が有意に増加していた.

Q17「歯間ブラシ・フロスの使用」についても,介入 群ではベースライン時(毎日17.3%,時々28.8%)と比 ベて3カ月後(毎日25.0%,時々34.6%;*p*=0.022),6カ 月後(毎日17.3%,時々51.9%;*p*=0.027),1年後(毎日 19.2%,時々48.1%;*p*=0.010)のいずれの時点でも使用 習慣が有意に改善していた.対照群ではベースライン時 (毎日6.8%,時々40.7%)に比べて3カ月後(毎日8.5%, 時々44.1%;*p*=0.745)は有意な変化は認めなかったが,

表2 ベースライン時における口腔保健行動に関する質問紙調査結果

| 質問項目                                 | 回答    | 介入群<br>(N=52)              | 対照群<br>(N=50)          | <i>p</i> 値 |
|--------------------------------------|-------|----------------------------|------------------------|------------|
|                                      |       | $\frac{(N-32)}{5(0.6)}$    | (10-39)                |            |
| ○19 並四 弾担わが山上で火毒な麻きますか N (0/)        | 毎回    | 3(9.0)<br>18(24.6)         | 11 (10.0)<br>10 (16.0) | 0.070      |
| Q12. 百权, 戦物で外山儿くも困て居さよりが N (%)       | 時で    | 10(34.0)                   | 10 (10.9)<br>28 (64.4) | 0.070      |
|                                      |       | $\frac{29(33.6)}{0(17.2)}$ | <u> </u>               |            |
| O12 明合 (甘い合べ物の始万物) なしますか N $(0/)$    | 世口    | 9(17.3)<br>20(57.7)        | 13 (22.0)<br>25 (50.2) | 0.657      |
| Q13. 同長(日い長べ物や臥み物)をしより2, N (%)       | 時々    | 30(37.7)<br>12(25.0)       | 33 (39.3)              | 0.037      |
|                                      | V+V+Z | $\frac{13}{23.0}$          | 11 (18.0)              |            |
| 014 $413 > 410$ $-11 + 44$ $N(0/)$   | はい    | 22 (42.3)                  | 18(30.5)               | 0.422      |
| Q14. にはこを吸っていますが N (%)               | ~0/2  | 0 (11.3)                   | 8 (13.0)               | 0.433      |
|                                      |       | 24 (46.2)                  | 33 (55.9)              |            |
|                                      | 毎日    | 33 (63.5)                  | 35 (59.3)              | 0.400      |
| Q15. 夜, 寝る前に歯をみかさますか N (%)           | 時々    | 7 (13.5)                   | 13 (22.0)              | 0.480      |
|                                      | いいえ   | 12 (23.1)                  | 11 (18.6)              |            |
|                                      | はい    | 22 (42.3)                  | 22 (37.3)              |            |
| Q16. フッ素人り歯磨剤(ハミガキ)を使っていますか N(%)     | いいえ   | 14 (26.9)                  | 22 (37.3)              | 0.503      |
|                                      | わからない | 16 (30.8)                  | 15 (25.4)              |            |
|                                      | 毎日    | 9 (17.3)                   | 4 (6.8)                |            |
| Q17. 歯間ブラシまたはフロスを使っていますか N(%)        | 時々    | 15 (28.8)                  | 24 (40.7)              | 0.155      |
|                                      | いいえ   | 28 (53.8)                  | 31 (52.5)              |            |
|                                      | 毎日    | 10 (19.2)                  | 9 (15.3)               |            |
| Q18. ゆっくりよく嚙んで食事をしますか N(%)           | 時々    | 20 (38.5)                  | 21 (35.6)              | 0.741      |
|                                      | いいえ   | 22 (42.3)                  | 29 (49.2)              |            |
| ○10 歩利圧院笙で歩るがき指定尽けたことけなりませか。N (0/)   | はい    | 33 (63.5)                  | 41 (69.5)              | 0.501      |
| Q19. 困性医院寺で困みがさ拍導を文りたことはのりますが IN (物) | いいえ   | 19 (36.5)                  | 18 (30.5)              | 0.301      |
| 090 年に1回11上は歩利医院で会期値珍な感はアレナナム N (0/) | はい    | 11 (21.2)                  | 14 (23.7)              | 0.746      |
| Q20. 平に1回以上は圏科医院で走期運衫を支けていますか N(%)   | いいえ   | 41 (78.8)                  | 45 (76.3)              | 0.740      |
|                                      |       |                            | $\gamma^2$ 検定          |            |

表3 介入群・対照群における口腔保健行動の変化

| が田省日   | 同次    |           | 5          | 介入群            |              |           | 対照        | <u></u> 飛群 |             |
|--|-------|-----------|------------|----------------|--------------|-----------|-----------|------------|-------------|
| 頁回項日   | 凹谷    | ベースライン    | 3M 後       | 6M 後           | 1Y 後         | ベースライン    | 3M 後      | 6M 後       | 1Y 後        |
| 並の 弾視の対山生でくまた  | 毎回    | 5 (9.6)   | 11 (21.6)* | * 10 (19.2)**  | 10 (19.2)*   | 11 (18.6) | 13 (22.0) | 10 (16.9)  | 13 (22.0)*  |
| Q12. 産きますか N(%)  | 時々    | 18 (34.6) | 17 (33.3)  | 21 (40.4)      | 21 (40.4)    | 10 (16.9) | 10 (16.9) | 16 (27.1)  | 16(27.1)    |
|  | いいえ   | 29 (55.8) | 23 (45.1)  | 21 (40.4)      | 21 (40.4)    | 38 (64.4) | 36 (61.0) | 33 (55.9)  | 30 (50.8)   |
| <b>問合</b> (甘い合べ物の始ろ物)  | 毎日    | 9 (17.3)  | 11 (22.0)  | 6 (11.5)       | 9 (17.3)     | 13 (22.0) | 8 (13.6)  | 12 (20.7)  | 13 (22.0)   |
| Q13. $p_{13}$ $p_{13$     | 時々    | 30 (57.7) | 27 (54.0)  | 37 (71.2)      | 32 (61.5)    | 35 (59.3) | 45 (76.3) | 33 (56.9)  | 36 (61.0)   |
|  | いいえ   | 13 (25.0) | 12 (24.0)  | 9 (17.3)       | 11 (21.2)    | 11 (18.6) | 6 (10.2)  | 13 (22.4)  | 10 (16.9)   |
| たげこを吸っていますか  | はい    | 22 (42.3) | 20 (40.0)  | 21 (40.4)      | 21 (40.4)    | 18 (30.5) | 16 (27.6) | 17 (28.8)  | 16 (27.1)   |
| Q14. $N(\%)$   | やめた   | 6 (11.5)  | 6 (12.0)   | 8 (15.4)       | 4 (7.7)      | 8 (13.6)  | 11 (19.0) | 9 (15.3)   | 11 (18.6)   |
|  | いいえ   | 24 (46.2) | 24 (48.0)  | 23 (44.2)      | 27 (51.9)    | 33 (55.9) | 31 (53.4) | 33 (55.9)  | 32 (54.2)   |
| <b>夜</b> 喧ス前に歯をみがきます   | 毎日    | 33 (63.5) | 32 (62.7)  | 31 (59.6)      | 34 (65.4)    | 35 (59.3) | 40 (67.8) | 36 (62.1)  | 33 (55.9)   |
| Q15. $\psi$ , $\chi$ in $(\%)$   | 時々    | 7 (13.5)  | 13 (25.5)  | 13 (25.0)      | 10 (19.2)    | 13 (22.0) | 9 (15.3)  | 11 (19.0)  | 16 (27.1)   |
|  | いいえ   | 12 (23.1) | 6 (11.8)   | 8 (15.4)       | 8 (15.4)     | 11 (18.6) | 10 (16.9) | 11 (19.0)  | 10 (16.9)   |
| フッ麦入り歯磨剤 (ハミガキ)  | はい    | 16 (30.8) | 33 (63.5)* | * 39 (75.0)*** | 36 (69.2)*** | 15 (25.4) | 24 (40.7) | 26 (44.1)* | 19 (32.2)   |
| Q16. を使っていますか N(%)   | いいえ   | 14 (26.9) | 7 (13.5)   | 7 (13.5)       | 4 (7.7)      | 22 (37.3) | 18 (30.5) | 18 (30.5)  | 19 (32.2)   |
|  | わからない | 22 (42.3) | 12 (23.1)  | 6 (11.5)       | 12 (23.1)    | 22 (37.3) | 17 (28.8) | 15 (25.4)  | 21 (35.6)   |
| 歯間ブラシキたはフロスを使  | 毎日    | 9 (17.3)  | 13 (25.0)* | 9 (17.3)*      | 10 (19.2)*   | 4 (6.8)   | 5 (8.5)   | 6 (10.2)*  | * 8 (13.6)* |
| Q17. $\alpha$ The second se | 時々    | 15 (28.8) | 18 (34.6)  | 27 (51.9)      | 25 (48.1)    | 24 (40.7) | 26 (44.1) | 30 (50.8)  | 28 (47.5)   |
|  | いいえ   | 28 (53.8) | 21 (40.4)  | 16 (30.8)      | 17 (32.7)    | 31 (52.5) | 28 (47.5) | 23 (39.0)  | 23 (39.0)   |
| ゆっくりよく噛んで食事をし  | 毎日    | 10 (19.2) | 12 (23.1)  | 10 (19.2)      | 12 (23.1)    | 9 (15.3)  | 9 (15.3)  | 10 (16.9)  | 9 (15.3)    |
| Q18. $\pm \pm \pm m$ N (%)   | 時々    | 20 (38.5) | 22 (42.3)  | 27 (51.9)      | 24 (46.2)    | 21 (35.6) | 22 (37.3) | 21 (35.6)  | 21 (35.6)   |
|  | いいえ   | 22 (42.3) | 18 (34.6)  | 15 (28.8)      | 16 (30.8)    | 29 (49.2) | 28 (47.5) | 28 (47.5)  | 29 (49.2)   |
| Q19 歯科医院等で歯みがき指導を受   | はい    | 33 (63.5) | 39 (75.0)  | 36 (69.2)      | 36 (69.2)    | 41 (69.5) | 40 (67.8) | 39 (66.1)  | 40 (67.8)   |
| (%)  | いいえ   | 19 (36.5) | 13 (25.0)  | 16 (30.8)      | 16 (30.8)    | 18 (30.5) | 19 (32.2) | 20 (33.9)  | 19 (32.2)   |
| Q20. 年に1回以上は歯科医院で定期  | はい    | 11 (21.2) | 17 (33.3)  | 17 (32.7)      | 14 (26.9)    | 14 (23.7) | 21 (36.2) | 20 (34.5)  | 22 (37.3)   |
| <u>****</u> 健診を受けていますか N(%)  | いいえ   | 41 (78.8) | 34 (66.7)  | 35 (67.3)      | 38 (73.1)    | 45 (76.3) | 37 (63.8) | 38 (65.5)  | 37 (62.7)   |

\*: p<0.05, \*\*: p<0.01, \*\*\*: p<0.001 (Q19, Q20 は McNemar 検定, それ以外は Wilcoxon の符号付き順位検定 (いずれも Bonferroni 補正))

徐々に改善する傾向がみられ、6カ月後(毎日 10.2%, 時々 50.8%; p=0.037),1年後(毎日 13.6%,時々 47.5%; p=0.033)に使用習慣が有意に改善していた.

その他 Q13「間食習慣」や Q14「喫煙習慣」, Q15「就 寝前の歯磨き」, Q18「ゆっくりよく噛む」, Q19「歯磨 き指導の経験」, Q20「年1回以上の歯科医院での定期 健診」については, 介入群と対照群共にいずれの時点で もベースライン時と比べて有意差は認められなかった.

#### 考 察

本研究では、生活歯援プログラムに準拠した歯科健診 を行った場合と従来型の歯科健診を行った場合のそれぞ れで行動変容が生じるかどうか、またそれぞれの歯科健 診で行動変容の持続期間に差がみられるかどうか検討を 行った.まず、ベースライン時とその後の質問紙の回 答結果に注目したところ、介入群と対照群のそれぞれで 「職場や外出先での歯磨き」や「フッ素入り歯磨剤の使 用」、「歯間ブラシ・フロスの使用」の項目で保健行動の 改善が認められた.ただ、介入群では3カ月後、6カ月 後および1年後のいずれの時点においてもベースライン 時と比べて改善が認められたのに対し、対照群ではベー スライン時と比べて有意な改善が認められた時期は限定 的であった.したがって従来型の口腔内診査主体の歯科 健診であっても、一部の項目で行動変容が期待できるこ と、また口腔内診査に加えて「標準的な成人歯科健診プ ログラム」に準じた保健指導を行うことで、1年以上の 長期間にわたっての行動変容が期待できることが示唆さ れた.

これまでに生活歯援プログラムに準拠した成人歯科 検診による行動変容について調べた調査はいくつかあ る. 佐々木らは北海道内の29の事業所においてこのプ ログラムに準拠した成人歯科健診を行ったところ,受診 者の「1日の歯磨き回数」,「歯間ブラシ・フロスの使用 頻度」,「職場や外出先での歯磨き」,「フッ素入り歯磨剤 の使用」,「ゆっくり良く噛んで食事する」,「歯科医院等 で歯磨き指導を受けたことがある」の項目が有意に改善 したことを報告している<sup>9-11</sup>. また,岩本らは4都県の 事業所・団体でこのプログラムに基づいた成人歯科健診 を行ったところ,「間食を毎日する」,「フッ素入り歯磨 剤の使用」,「歯間ブラシ・フロスの毎日の使用」,「ゆっ くり良く噛んで食事する」,「歯科医院で歯磨き指導を受 けたことがある」,「年1回以上の歯科医院での定期健

診|の項目が望ましい方向に有意に改善したことを報告 している<sup>12)</sup>.これらの調査では口腔内診査は行わずに質 間紙のみで受診者の行動把握を行っていた. また佐々木 らの調査では、保健指導を初回は歯科衛生士が直接行っ たが、2回目は95%が通信(レターまたは電子メール) により行われていた. 岩本らの調査では初回の保健指導 はスタッフが直接行ったが、その後は月に1,2回の頻度 で2カ月程度、直接指導・電話での指導・メールでの指 導のいずれかが行われた.本研究においては、質問紙に 加えて口腔内診査結果からも受診者の状態把握を行い, 保健指導を初回は歯科衛生士が直接行ったが、その後 は3カ月後,6カ月後,1年後に保健指導のパンフレッ トと共に対象者自身が設定した自筆の行動目標のコピー を郵送することで行った. その結果, 本研究においても これら先行研究と共通する項目で有意な改善が認められ た、このことから、口腔内診査の有無に関わらず、受診 者の状態を把握したうえでそれに応じた個別指導とその 後の行動変容を維持するための指導を繰り返すスタイル の生活歯援プログラムは、多くの保健行動を良い方向に 改善する効果があることが確認された.

行動変容の持続期間についてみると、生活歯援プログ ラムに準拠した保健指導を行った介入群において、1年 間にわたり行動変容が持続していた.過去の調査では、 歯科衛生士が個別に保健指導を行った後、1年後にフロ ス使用者の割合が有意に増加していたという葭原らの報 告<sup>13)</sup> や1カ月後は歯間部清掃器具を使用している者が 有意に増加したが、1年後にはその差が有意でなくなっ ていたという晴佐久らの報告<sup>14)</sup>等,行動変容の持続期 間にはばらつきがみられる<sup>15,16)</sup>. 葭原らの調査では口腔 内診査を行わず、ペリオスクリーンと咀嚼能力試験の結 果を受診者の状態把握に利用して歯科衛生士が個別に保 健指導を行い. またモチベーションの維持を目的として 3カ月後に保健指導のパンフレットを郵送していた.一 方,晴佐久らの調査では,口腔内診査と質問紙により受 診者の状態を把握したうえで保健指導を行っていたが. 受診者3人を1グループとして歯科衛生士が保健指導を 行っていることから個別指導とまではいえず、また、保 健指導は1回のみであった。晴佐久らは2014年、歯科 衛生士が個別保健指導を複数回行った調査についても報 告している<sup>17)</sup>.これはブラッシング行動自己管理スキル 尺度<sup>18)</sup>により受診者の状態を把握したうえで、歯科衛 生士による個別保健指導を3カ月おきに3回行った調査 であり、最初の保健指導から1年後の時点で歯間部清掃 用器具を使用する者の割合が有意に増加していた. 個別 指導・集団指導の違いや、モチベーションを維持するた めのその後の保健指導の有無が,行動変容の持続時間に 大きく影響を与えていると考えられる.

トランスセオレティカル・モデル(行動変容ステージ モデル)によると、行動変容に至るまでの過程には無関 心期、関心期、準備期、実行期、維持期があり、これら 細かく分かれたステージに応じた働きかけを行うこと で、次のステージへと進んでいく19). 各ステージで受診 者の行動や心理等が異なるため、ステージに応じてア プローチを変える必要がある.集団指導では、さまざま なステージにある受診者に対して画一的な指導を行うこ とになるため、保健に関する知識の習得には有効である が<sup>20)</sup>、行動変容はそれほど期待できない<sup>13)</sup>、明確なメッ セージ性のある個別指導を行うことにより、必ずしも口 腔内診査を行わなくても行動変容を引き起こすことも可 能である<sup>21)</sup>. 生活歯援プログラムでは、質問紙により受 診者の環境・行動診断を行って受診者を類型化し、受診 者の行動ステージに合わせた情報提供・保健指導を行っ ており、このことが長期間に渡って行動変容をもたらし ていると考えられた.

一方で今回の調査では、保健指導を伴わない従来型の 歯科健診のみでも、一時的ではあるが保健行動の変容が 認められ、3カ月後、6カ月後、1年後と歯科健診から 時間が経つにつれて「職場や外出先での歯磨き」、「歯間 ブラシ・フロスの使用」が徐々に改善する傾向が認めら れた.この理由としては、今回の調査では各企業それぞ れで従業員を介入群と対照群に分けたことで同じ職場に 介入群と対照群が働いており、介入群の保健行動が、対 照群の保健行動に影響を及ぼしたためではないかと考え られた<sup>17)</sup>.「職場や外出先での歯磨き」は、保健行動に ついての質問項目であるとともに職場環境についての 質問項目でもある.職場で口腔清掃を行う者が増えれ ば、それまで他の人の目を気にして口腔清掃を行ってい なかった者が口腔清掃を行いやすくなったり、職場の中 で口腔清掃を行う場所や時間が整備されたりという環境 要因の改善が期待できる.「歯間ブラシ・フロスの使用」 についても同様の傾向が認められたが、同様のことがい えるかもしれない、また本研究においては、対照群に対 しても口腔内診査とその結果に基づいた治療勧告が行わ れた. 治療勧告によって受診した歯科医院で保健指導を 受けた可能性や、3カ月後、6カ月後、1年後に保健行 動に関する質問紙が郵送されたこと等も、対照群におけ る保健行動の変容に影響していた可能性が考えられる.

「間食(甘い食べ物や飲み物)」,「喫煙」のような嗜好 に関わる項目や「就寝前の歯磨き」については,介入群 と対照群のいずれにおいてもベースライン時と比べて有 意な変化は認められなかった.間食や喫煙のような嗜好 に関わる生活習慣については,保健指導を行っても行動 変容が得られなかったことが過去の研究でも報告されて いる<sup>9,12)</sup>.本研究においても先行研究と同様の傾向が認 められ,これらの項目について行動変容を生じさせる ような保健指導方法を今後考えていく必要がある.ま た,就寝前の歯磨きは介入群においてベースライン時に 76.9% だったのが3カ月後に88.2% と若干の改善は認め られたが統計学的には有意ではなかった.これは,元々 行っている者が多いために効果がみえにくくなる「天井 効果」の影響と考えられた<sup>12)</sup>.

最後に本研究の限界について述べる.本研究では,新 潟県内の一部業種の従業員を対象としており,それ以外 の業種の従業員についての検討が不十分であった.職種 によって保健行動が異なることから<sup>22,23)</sup>,保健指導に対 する反応が業種や職種によって異なる傾向を示す可能性 があり,今後,他業種や職種別の調査を行う必要がある と考えられる.また,本研究では,対象者自身により設 定された保健行動目標の内容,およびそれが達成された かどうか検討を行わなかった.これは保健行動目標が対 象者によって千差万別であり,集計と解析が困難であっ たためである.とはいえ,そこには対象者自身が実行可 能で優先度が高いと考えている内容が含まれており,今 後検討を行っていく必要があると考えられる.

#### 謝 辞

本研究の一部は厚生労働省労災疾病臨床研究事業費補助金 (14020101-01 および 170501-01)の助成を受けて行われた.

#### 文 献

- 市橋 透,武藤孝司,渋谷耕司:勤労者における仕事及び日 常生活への歯科疾患による影響の実態. 口腔衛生会誌 52: 141-149, 2002.
- Teeuw WJ, Kosho MX, Poland DC et al.: Periodontitis as a possible early sign of diabetes mellitus. BMJ Open Diabetes Res Care 5: e000326, 2017.
- Humphrey LL, Fu R, Buckley DI et al.: Periodontal disease and coronary heart disease incidence: A systematic review and meta-analysis. J Gen Intern Med 23: 2079–2086, 2008.
- Beck J, Garcia R, Heiss G et al.: Periodontal disease and cardiovascular disease. J Periodontol 67: 1123–1137, 1996.
- Iwasaki M, Taylor GW, Manz MC et al.: Serum antibody to *Porphyromonas gingivalis* in chronic kidney disease. J Dent Res 91: 828–833, 2012.
- Iwasaki M, Taylor GW, Nesse W et al.: Periodontal disease and decreased kidney function in Japanese elderly. Am J Kidney Dis 59: 202–209, 2012.
- 7) Reichert S, Schlitt A, Beschow V et al.: Use of floss/ interdental brushes is associated with lower risk for new cardiovascular events among patients with coronary heart

disease. J Periodontal Res 50: 180-188, 2015.

- Kim YH, Kim DH, Lim KS et al.: Oral health behaviors and metabolic syndrome: the 2008-2010 Korean National Health and Nutrition Examination Survey. Clin Oral Investig 18: 1517-1524, 2014.
- 9) 佐々木 健:対象者の主体性を引き出す歯科保健プログラムの効果 「標準的な成人歯科健診プログラム・保健指導マニュアル」を適用した成人歯科保健事業の展開例.ヘルスサイエンス・ヘルスケア 10:63-69, 2010.
- 10) 佐々木 健, 高橋 収, 三上和恵ほか:職域における新しい 成人歯科健診プログラムの効果. ヘルスサイエンス・ヘルス ケア 11:64-71, 2011.
- 11) 佐々木 健:新しい成人歯科健診プログラムの活用事例と歯 科保健指導の課題. 日健教会誌 21:77-83, 2013.
- 12) 岩本 彩,石川裕子,八木 稔ほか:リスク発見・保健指導重 視型の成人歯科健診プログラムにおける口腔保健行動の変化. 口腔衛生会誌 62:33-40, 2012.
- 13) 葭原明弘,八木 稔,澤村恵美子ほか:個別保健指導及びパンフレット郵送の成人歯科保健に対する有効性 成人女性を対象として. 口腔衛生会誌 49:809-815, 1999.
- 14) 晴佐久 悟,筒井昭仁,境 憲治ほか:職域における口腔健 康教育の効果及び歯科保健意識と行動変容因子との関連性の 検討.口腔衛生会誌54:122-131,2004.
- 15)森 智恵子:職域における定期歯科健診と事後措置に関する 評価. 口病誌 69:162-170, 2002.
- 16) 尾崎哲則,小山圭子,三澤麻衣子ほか:成人集団における定期的歯科保健指導と口腔保健状況 3年間の口腔保健行動の 変容と口腔保健状況の差異.日歯医療管理誌 49:145-148, 2014.
- 17) 晴佐久 悟、山本未陶、三島公彦ほか:歯周病予防のための 健康教育は生活習慣病の予防能力に影響するか? 口腔衛生会 誌 64:382-391, 2014.
- 18) 山本未陶,今里憲弘,筒井昭仁ほか:自己管理スキルを応用 したブラッシング行動スキル尺度の開発. 口腔衛生会誌 59: 51-57, 2009.
- Prochaska JO, Velicer WF: The transtheoretical model of health behavior change. Am J Health Promot 12: 38-48, 1997.
- 20) 影山 淳,小田切圭一,鈴木直子ほか:職域における集団健 康教育の教育効果および行動変容につながる教育方法の検討. 産業衛誌 56:141-151, 2014.
- 21) 葭原明弘,金子 昇,杉本智子ほか:乳幼児健診に併設し実施する簡易スクリーニング検査および個別指導が行動変容に及ぼす影響. 口腔衛生会誌 60:11-16, 2010.
- 22) 深井穫博,眞木吉信,吉野浩一ほか:成人の口腔保健行動におよぼす年齢および職域特性. 口腔衛生会誌 45:522-523, 1995.
- 23) 深井穫博, 眞木吉信, 高江洲義矩:成人の口腔保健行動と職 種との関連. 口腔衛生会誌 47:89-97, 1997.

著者への連絡先:金子 昇 〒 951-8514 新潟市中央区学校町通 2-5274 新潟大学大学院医歯学総合研究科予防歯科学分野

TEL: 025-227-2858 FAX: 025-227-0807 E-mail: nkaneko@dent.niigata-u.ac.jp

## Changes in Health-promoting Behavior Due to Dental Examination and Individualized Health Instruction in Workplace

Noboru KANEKO<sup>1</sup>, Akihiro YOSHIHARA<sup>2</sup>, Kaname NOHNO<sup>1</sup>, Takayuki YAMAGA<sup>1</sup>, Takashi ZAITSU<sup>3</sup>, Yoko KAWAGUCHI<sup>3</sup> and Hideo MIYAZAKI<sup>1.4</sup>

<sup>1)</sup>Division of Preventive Dentistry, Niigata University Graduate School of Medical and Dental Sciences <sup>2)</sup>Division of Oral Science for Health Promotion, Niigata University Graduate School of Medical and Dental Sciences <sup>3)</sup>Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University <sup>4)</sup>Department of Dental Hygiene and Welfare, Meirin College

**Abstract:** For oral health in the workplace, dental examinations for the early detection of oral diseases have been mainly conducted. In order to shift from conventional dental examination programs to those for investigating environmental risks and promoting behavioral changes, the Japan Dental Association developed a new oral health examination, assessment, and health instruction program for adults.

The aim of this study was to evaluate how dental examination and health instruction based on this program improved health-promoting behavior compared with the traditional dental examination program.

Subjects were recruited from employees of three companies in Niigata City (n=129; 44.6±11.5 years old). They were randomly divided into an intervention group and a control group. For the intervention group, dental examination and health instruction, based on the program newly developed by the Japan Dental Association, were conducted, whereas only a dental examination was conducted for the control group. Questionnaire surveys were performed at the baseline and 3 months, 6 months, and 1 year later to evaluate behavioral changes.

As a result, "tooth brushing at the workplace and outside home", "use of fluoride-containing dentifrice", and "use of interdental brush or dental floss" were significantly improved in both groups. In the intervention group, changes were noted at all time points until 1 year later, but changes were limited and only seen at some time-points in the control group.

This study revealed that the conventional dental examination program only marginally improves health behavior, but the new dental examination and health instruction program more markedly improves such behavior and its effects persist for at least 1 year.

J Dent Hlth 69: 27-33, 2019

#### Key words: Oral health in adults, Health instruction, Behavioral change

*Reprint requests to* N. KANEKO, Division of Preventive Dentistry, Niigata University Graduate School of Medical and Dental Sciences, 2-5274 Gakkocho-Dori, Chuo-Ku, Niigata, 951-8514, Japan TEL: 025-227-2858/FAX: 025-227-0807/E-mail: nkaneko@dent.niigata-u.ac.jp

ISSN (Print) 1738-8546 · ISSN (Online) 2287-6197

# Masticatory Performance Measured with a Chewing Gum Containing Spherical Resinous Microparticles

Toshiya Kanazawa, Takashi Zaitsu, Masayuki Ueno, Yoko Kawaguchi

Department of Oral Health Promotion, Tokyo Medical and Dental University, Tokyo, Japan

**Objective:** This study aimed to investigate the factors associated with masticatory performance, as measured with a chewing gum containing spherical resinous microparticles, and to evaluate the method by examining the relationship with self-reported masticatory status.

**Methods:** The participants in this study comprised 903 industrial workers (mean age,  $42.2\pm11.6$  years). A questionnaire was administered to assess self-reported masticatory status. The masticatory performance score was calculated by counting the number of particles in the chewing gum. Clinical oral examinations were administered. Multiple linear regression analysis was conducted on the masticatory performance scores to examine the related factors. Analysis of covariance was conducted to investigate the association between the masticatory performance score and the self-reported masticatory status.

**Results:** Significant predictors of the masticatory performance score were sex (p < 0.001), age (p < 0.001), decayed teeth (p=0.009), total-functional tooth units (p < 0.001), periodontitis (p=0.003), and malocclusion (p=0.011). The relationship between the masticatory performance score and the self-reported masticatory status was attenuated after controlling for confounding factors.

**Conclusion:** The masticatory performance increased with age and decreased as the oral health status worsened. Using this chewing gum method partly, but not comprehensively, reflects masticatory performance. Therefore, various masticatory performance-related indexes should be employed to measure masticatory performance accurately.

Keywords: masticatory performance, measurement, oral health status, self-reported masticatory status, chewing gum

# Introduction

Mastication is the first step in a series of physiological food digestion processes which include cutting the food, mixing it

#### Corresponding author Takashi Zaitsu

Department of Oral Health Promotion, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549, Japan. Tel: +81-3-5803-5476, Fax: +81-3-5803-0194, E-mail: zaitsu.ohp@tmd.ac.jp

https://orcid.org/0000-0001-5786-4879

Received October 22, 2018, Accepted November 2, 2018

with saliva, and preparing the food bolus for swallowing. This process is complex, and stomatognathic organs and structures, such as teeth, periodontal tissue, tongue, maxillofacial muscle, gnathic bone, and nervous system work in concert.

The main role of mastication is to reduce the particle of ingested food and to support digestion, absorption, and nutrition intake [1]. Furthermore, mastication prevents overeating by stimulating the satiety center of the brain [2]. Previous studies report that the proportion of metabolic syndrome [3] or diabetes [4] or hypertension [5] was higher in individuals with poor mastication than in healthy individuals. Another study demonstrated that good masticatory performance decreased stress [6].

Copyright © 2018. Korean Academy of Preventive Dentistry. All rights reserved.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (http://creativecommons.org/licenses/ by-nc/4.0) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited. Mastication affects physical health and mental health; therefore, it is important to maintain and to improve masticatory performance for a lifetime.

As a method to subjectively assess masticatory performance, self-reported questionnaires have been employed to inquire about masticable food [7,8] or masticatory status [9]. However, a sieving method that measures the percentage or distribution of masticated particles of peanuts or silicon tablets [10-19] and a mixing test that evaluates color change or the amount of dissolved glucose from a chewing gum or gummy jelly [3,4,6,11,20-25] have been used to estimate masticatory performance objectively. The sieving method and mixing test have been applied to estimate the improvement in mastication after prosthetic treatment [16], periodontitis treatment [17], or malocclusion treatment [10].

However, the aforementioned methods evaluate only a portion of mastication rather than the whole masticatory performance [26,27]. Thus, it is preferable to use a technique or a method that can more comprehensively estimate masticatory performance.

A chewing gum containing spherical resinous microparticles has been developed to measure masticatory performance. By calculating the proportion of broken particles in the chewing gum after mastication, masticatory performance can be measured. Very few studies have examined masticatory performance by using this chewing gum; therefore, the applicability of the gum has not been fully assessed. Therefore, the current study aimed to investigate the factors associated with masticatory performance, as measured with the chewing gum, and to evaluate the method by examining the relationship between masticatory performance and self-reported masticatory status.

# Materials and Methods

#### 1. Study participants

The study participants were industrial workers from 10 companies in Japan. Among 948 participants (741 men and 207 women) who participated in the study, 903 (709 men and 194 women) were used in the final analysis, after excluding edentate participants and workers with missing information about study variables. A self-administered questionnaire, masticatory performance measurement, and clinical oral examinations were conducted from 2015 to 2016.

All participants agreed to participate in the study and signed an informed consent form after the research investigators explained the study procedure. This study protocol was approved by the Ethical Review Board of Tokyo Medical and Dental

#### University (N0.D2014-139-01).

#### 2. Questionnaire

A self-administered questionnaire asked the participants about sex, age, and masticatory status. The self-reported masticatory status was assessed by using the question "Can you bite tightly with your back teeth or dentures?", and the participants responded with one of the following three answers: "I can bite on both sides" (good mastication), "I can bite on only one side" (fair mastication), and "I can't bite on either side" (poor mastication).

#### 3. Objective masticatory performance

The masticatory performance was evaluated using 1.0 g of chewing gum measuring  $20.0 \times 12.0 \times 5.0$  mm (Welcome Gum; Examastica Co., Tokyo, Japan). The gum contains 2,159±28 spherical carnauba wax microparticles of 250-300 µm in diameter.

The participants were instructed to freely chew the gum 25 times in 25 seconds. The particles in the chewing gum were crushed into small pieces when pressed under a weight of >50 g. After chewing, the gum was stretched by a specific compressor and the number of remaining particles in an arbitrary area was counted with dedicated software (Examastica Co.). The number of remaining particles in the whole gum was estimated by the proportion of the area counted to the whole area. A masticatory performance score, based on the proportion of broken particles induced by one-time chewing, was calculated by comparing the number of particles before and after chewing 25 times.

The algorithm for the masticatory performance score calculation was as follows. The number of broken particles after one-time chewing is exponential; therefore, the proportion of remaining particles after chewing 25 times, p (%), is presented as  $(1-p/100)^{25}$ . Assuming K is the mean number of particles in a counted area before chewing, and X is the mean number of remaining particles in the counted area after chewing 25 times, then X/K is  $(1-p/100)^{25}$ , and p is  $[1-(X/K)^{1/25}] \times 100$ .

#### 4. Oral examination

Clinical oral examinations were conducted by six dentists, who were calibrated regarding the examination criteria before the study. The dentition status, excluding the third molars, was determined using a dental mirror and a World Health Organization-type periodontal probe under an artificial light. Functional tooth units (FTUs) were calculated as an indicator of the posterior occlusal condition.

The FTUs were defined as the number of pairs of opposing premolars and molars. Two opposing premolars were defined

as one FTU and two opposing molars as two FTUs. Therefore, FTUs ranged from 0 to 12.

In this study, three types of FTUs were computed. Natural FTUs (n-FTUs) were calculated only from natural teeth and included sound, restored, and carious teeth with occluding function. FTUs consisting of natural teeth, implanted teeth, and fixed prosthetic pontics were called nif-FTUs. Total-FTUs comprised natural teeth, implanted teeth, fixed prosthetic pontics, and removable prosthetic teeth.

Periodontal status was assessed with the modified Community Periodontal Index (CPI). Six index teeth (17 or 16, 11, 26 or 27, 36 or 37, 31, and 46 or 47) were examined by using the following codes: Code 0, periodontal pocket depth <4 mm; Code 1, periodontal pocket depth of 4-5 mm; and Code 2, periodontal pocket depth  $\geq 6$  mm. The highest CPI code among the six index teeth was recorded as the representative value. Individuals with CPI code 0 were classified as having no periodontitis and individuals with CPI code 1 or 2, as having periodontitis.

Malocclusion and temporomandibular disorders (TMDs) were assessed by visual and palpatory examinations. Malocclusion or TMDs was present if the dentist indicated the necessity for a detailed examination or treatment.

#### 5. Statistical analysis

Descriptive statistics of age and clinical oral health status were computed, based on sex and the self-reported masticatory status. The mean difference by age or self-reported masticatory status was analyzed using the independent t-test, and distributional differences were analyzed using the chi-square test. One-way analysis of variance and the Jonkheere-Terpstra trend test were used to analyze the association between the masticatory performance score and the self-reported masticatory status. The relationship of the masticatory performance score with age and with clinical oral health status were analyzed using Pearson's correlation coefficient and the independent t-test.

Multiple linear regression analysis was conducted on the masticatory performance scores to examine the scores' relationship with sex, age, and clinical oral health status. After controlling for confounding variables, an analysis of covariance was employed to investigate the association between the masticatory performance score and self-reported masticatory status.

PASW Statistics ver. 18.0 (IBM Japan, Tokyo, Japan) was used for all statistical analyses. The significance level was set at 5%.

# Results

#### 1. Characteristics of the study participants

Table 1 shows participants' age and the clinical oral health status by sex. The mean ages were  $42.9\pm11.7$  years in men and  $39.8\pm10.9$  years in women. The mean age was significantly higher in men than in women (p<0.001).

The mean number of teeth was  $26.7\pm2.7$  teeth in men and  $27.0\pm2.1$  teeth in women. There was no significant difference

## Table 1. Characteristics of the study participants

| Characteristic | Total (n = 903)    | Men (n = 709)  | Women (n = 194)   | p-value |
|----------------|--------------------|----------------|-------------------|---------|
| Age (yr)       | 42.2 <u>+</u> 11.6 | 42.9±11.7      | $39.8 \pm 10.9$   | < 0.001 |
| No. of teeth   | $26.7 \pm 2.6$     | $26.7 \pm 2.7$ | $27.0 \pm 2.1$    | 0.065   |
| DT             | $0.7 \pm 1.7$      | $0.8 \pm 1.8$  | $0.4 \pm 1.3$     | 0.004   |
| n-FTUs         | $10.5 \pm 2.6$     | $10.4 \pm 2.6$ | $10.8 \pm 2.3$    | 0.033   |
| nif-FTUs       | $10.9 \pm 2.3$     | $10.8 \pm 2.4$ | $11.2 \pm 1.6$    | 0.003   |
| Total-FTUs     | $11.0 \pm 2.0$     | $10.9 \pm 2.1$ | 11.2 <u>+</u> 1.6 | 0.030   |
| Periodontitis  |                    |                |                   |         |
| (+)            | 113 (12.5)         | 100 (14.1)     | 13 (6.7)          | 0.005   |
| (—)            | 790 (87.5)         | 609 (85.9)     | 181 (93.3)        |         |
| Malocclusion   |                    |                |                   |         |
| (+)            | 75 (8.3)           | 56 (7.9)       | 19 (9.8)          | 0.382   |
| (—)            | 828 (91.7)         | 653 (92.1)     | 175 (90.2)        |         |
| TMDs           |                    |                |                   |         |
| (+)            | 18 (2.0)           | 11 (1.6)       | 7 (3.6)           | 0.082   |
| (—)            | 885 (98.0)         | 698 (98.4)     | 187 (96.4)        |         |

Values are presented as mean  $\pm$  standard deviation or number (%). DT: decayed teeth, n-FTUs: natural teeth functional tooth units, nif-FTUs: natural, implanted and fixed prosthetic pontic teeth functional tooth units, Total-FTUs: total teeth functional tooth units, TMDs: temporomandibular disorders.

in the mean number of teeth between men and women. The mean number of decayed teeth (DT) was  $0.8\pm1.8$  teeth in men and  $0.4\pm1.3$  teeth in women, and significantly higher in men than in women (p=0.004).

The mean number of n-FTUs, nif-FTUs, and total-FTUs was  $10.4\pm2.6$ ,  $10.8\pm2.4$ , and  $10.9\pm2.1$ , respectively, in men and  $10.8\pm2.3$ ,  $11.2\pm1.6$ , and  $11.2\pm1.6$ , respectively, in women. For each type of FTUs, women had significantly higher numbers than men (n-FTUs, p=0.033; nif-FTUs, p=0.003; and total-FTUs, p=0.030).

The proportion of individuals with periodontitis were 14.1% in men and 6.7% in women; the proportion was significantly higher in men than in women (p=0.005). The overall proportion of participants with malocclusion and TMDs was 8.3% and 2.0%, respectively, and there were no significant distributional differences by sex.

## Self-reported masticatory status and related factors

Table 2 shows the relationship of the self-reported masticatory status with age and with clinical oral health status by sex. The mean ages of participants with 'good', 'fair', and 'poor' self-reported masticatory status were  $41.6\pm11.5$  years,  $45.3\pm$ 11.5 years, and  $46.3\pm11.7$  years, respectively. The mean age of participants with a good self-reported masticatory status was significantly lower than that of participants with a self-reported masticatory status of fair (p=0.010) or poor (p=0.049).

The mean number of teeth in participants with good, fair, and poor self-reported masticatory statuses was  $27.0\pm 2.3$  teeth,  $25.6\pm 3.1$  teeth, and  $24.0\pm 4.0$  teeth, respectively. The mean number of teeth was significantly higher in participants with a self-reported masticatory status of good than in participants with a self-reported masticatory status of fair (p<0.001) or poor (p<0.001). The mean number of DT in participants with good, fair, and poor self-reported masticatory statuses were  $0.6\pm 1.4$ teeth,  $1.3\pm 2.3$  teeth, and  $2.2\pm 3.0$  teeth, respectively. The mean number of DT was significantly lower in participants with a self-reported masticatory status of good than in participants with a self-reported masticatory status of good than in participants with a self-reported masticatory status of fair (p<0.001) or poor (p<0.001).

All FTUs showed a similar trend in that the mean number of FTUs was significantly higher in participants with a good self-reported masticatory status (n-FTUs,  $10.9\pm2.2$ ; nif-FTUs,  $11.2\pm1.8$ ; and total-FTUs,  $11.3\pm1.5$ ) than in patients with a fair self-reported masticatory status (n-FTUs,  $8.7\pm3.3$ ; nif-FTUs,  $9.2\pm3.1$ ; and total-FTUs,  $9.5\pm2.9$ ; p<0.001, p<0.001, and p<0.001, respectively) or a poor self-reported masticatory status (n-FTUs,  $7.5\pm3.8$ ; nif-FTUs,  $7.8\pm3.9$ ; and total-FTUs,  $7.9\pm3.9$ ; p<0.001, p<0.001, net p<0.001, p<0.001, net p<0.001, net p<0.001, p<0.001, net p<0.001, net p<0.001, p<0.001, net p<0.001, net p<0.001, net p<0.001, p<0.001, net p<0.001, ne

|   |  | Tota                                  |                                   |                            |                                   | Mer                         |                  |                |                   | Wome             | en              |            |
|---|--|---------------------------------------|-----------------------------------|----------------------------|-----------------------------------|-----------------------------|------------------|----------------|-------------------|------------------|-----------------|------------|
| Variable  | Self-reporte                             | ed masticatory p                      | erformance                        |                            | Self-reporte                      | d masticatory p             | oerformance      |                | Self-reported     | d masticatory μ  | berformance     |            |
|   | Good $(n = 767)$                         | Fair<br>(n = 99)                      | Poor $(n = 37)$                   | p-value                    | Good $(n = 595)$                  | Fair<br>(n=86)              | Poor $(n = 28)$  | -<br>p-value   | Good $(n = 172)$  | Fair<br>(n = 13) | Poor<br>(n = 9) | p-value    |
| Age (yr)  | $41.6 \pm 11.5$                          | $45.3 \pm 11.5$                       | 46.3±11.7                         | 0.001                      | 42.2±11.6                         | $45.5 \pm 11.7$             | $49.6 \pm 10.0$  | < 0.001        | $39.7 \pm 10.9$   | $43.4 \pm 10.3$  | $36.0 \pm 11.0$ | 0.286      |
| No. of teeth                                      | $27.0 \pm 2.3$                           | $25.6 \pm 3.1$                        | $24.0 \pm 4.0$                    | < 0.001                    | $27.0 \pm 2.3$                    | $25.5 \pm 3.2$              | $23.0\pm4.0$     | < 0.001        | $27.0 \pm 2.1$    | $26.5 \pm 1.6$   | $27.0 \pm 1.6$  | 0.635      |
| DT  | $0.6 \pm 1.4$                            | $1.3 \pm 2.3$                         | $2.2 \pm 3.0$                     | < 0.001                    | $0.6 \pm 1.5$                     | $1.3 \pm 2.5$               | $2.5 \pm 3.3$    | < 0.001        | $0.4 \pm 1.3$     | $0.7 \pm 1.2$    | $1.2 \pm 1.6$   | 0.137      |
| n-FTUs  | $10.9 \pm 2.2$                           | $8.7 \pm 3.3$                         | $7.5 \pm 3.8$                     | < 0.001                    | $10.9 \pm 2.2$                    | $8.6 \pm 3.3$               | $6.6 \pm 3.8$    | < 0.001        | $10.9 \pm 2.3$    | $9.6 \pm 2.7$    | $10.4 \pm 2.1$  | 0.122      |
| nif-FTUs  | $11.2 \pm 1.8$                           | $9.2 \pm 3.1$                         | $7.8 \pm 3.9$                     | < 0.001                    | $11.2 \pm 1.8$                    | $9.0 \pm 3.2$               | $7.0 \pm 4.0$    | < 0.001        | $11.3 \pm 1.5$    | $10.4 \pm 2.1$   | $10.4 \pm 2.1$  | 0.046      |
| Total-FTUs  | $11.3 \pm 1.5$                           | $9.5 \pm 2.9$                         | $7.9 \pm 3.9$                     | < 0.001                    | $11.3 \pm 1.5$                    | $9.3 \pm 3.0$               | $7.0 \pm 4.0$    | < 0.001        | $11.3 \pm 1.5$    | $10.6 \pm 1.9$   | $10.4 \pm 2.1$  | 0.098      |
| Periodontitis (+)                                 | 83 (10.8)                                | 20 (20.2)                             | 10 (27.0)                         | < 0.001                    | 73 (12.3)                         | 18 (20.9)                   | 9 (32.1)         | 0.002          | 10 (5.8)          | 2 (15.4)         | 1 (11.1)        | 0.356      |
| Malocclusion (+)                                  | 62 (8.1)                                 | 9 (9.1)                               | 4 (10.8)                          | 0.805                      | 49 (8.2)                          | 6 (7.0)                     | 1 (3.6)          | 0.633          | 13 (7.6)          | 3 (23.1)         | 3 (33.3)        | 0.010      |
| TMDs (+)  | 16 (2.1)                                 | 1 (1.0)                               | 1 (2.7)                           | 0.734                      | 10 (1.7)                          | 0 (0)                       | 1 (3.6)          | 0.338          | 6 (3.5)           | 1 (7.7)          | 0 (0)           | 0.616      |
| Values are presented a:<br>unctional tooth units. | s mean ± standarc<br>Fotal-FTUs: total t | d deviation or ni<br>teeth functional | umber (%). DT:<br>tooth units. TM | decayed tee<br>Ds: temporo | th, n-FTUs: nai<br>mandibular dis | tural teeth func<br>sorder. | tional tooth ur. | iits, nif-FTUs | s: natural, impla | anted and fixe   | d prosthetic po | ntic teeth |

Table 2. Self-reported masticatory status and related factors

The proportion of participants with periodontitis who reported good, fair, and poor masticatory status was 10.8%, 20.2%, and 27.0%, respectively. The proportion of periodontitis was significantly lower in participants reporting a good masticatory status than in participants reporting a poor masticatory status (p<0.001). There were no significant distributional differences in malocclusion and TMDs, based on the self-reported masticatory status. Similar results regarding the association of self-reported masticatory status with age and clinical oral health status were also observed in men.

#### Masticatory performance score, based on the self-reported masticatory status

Table 3 presents the mean masticatory performance scores, based on self-reported masticatory status. The overall mean masticatory performance scores in participants reporting good, fair and poor masticatory statuses were  $1.38\pm0.47$ ,  $1.30\pm0.53$ , and  $1.10\pm0.42$ , respectively. The masticatory performance scores showed a significant positive linear trend with the self-reported masticatory status (p=0.002). A similar sig-

nificant positive linear trend was also found in men (p=0.003).

# 4. Masticatory performance score and related factors

Table 4 presents the relationship of masticatory performance score with age and clinical oral health status. Overall, the masticatory performance score had a significant positive correlation with age (r=0.184, p<0.001), number of teeth (r=0.100, p=0.003), n-FTUs (r=0.122, p<0.001), nif-FTUs (r=0.156, p<0.001), and total-FTUs (r=0.144, p<0.001). There was a significant negative correlation between the masticatory performance score and DT (r=-0.138, p<0.001).

The masticatory performance score was significantly lower in participants with malocclusion  $(1.22\pm0.37)$  than in participants without malocclusion  $(1.37\pm0.49; p=0.002)$ . There were no significant relationship of the masticatory performance score with periodontitis or with TMDs. Similar results regarding the association of the masticatory performance score with age and clinical oral health status were also obtained in men.

Table 3. Masticatory performance score, based on the self-reported masticatory status

| Variable | Total (n=       | = 903)      | Men (n=         | 709)        | Women (n        | = 194)      |
|----------|-----------------|-------------|-----------------|-------------|-----------------|-------------|
| Vanable  | Mean $\pm$ SD   | p for trend | $Mean\pm SD$    | p for trend | $Mean\pm SD$    | p for trend |
| Good     | $1.38 \pm 0.47$ | 0.002       | $1.41 \pm 0.48$ | 0.003       | $1.25 \pm 0.43$ | 0.312       |
| Fair     | $1.30 \pm 0.53$ |             | $1.32 \pm 0.55$ |             | $1.17 \pm 0.39$ |             |
| Poor     | $1.10 \pm 0.42$ |             | $1.12 \pm 0.45$ |             | $1.06 \pm 0.33$ |             |

SD: standard deviation.

Table 4. Masticatory performance score and related factors

| Variable                      | Total (n = 903) | p-value | Men (n=709)     | p-value | Women (n = 194) | p-value |
|-------------------------------|-----------------|---------|-----------------|---------|-----------------|---------|
| Age (r)                       | 0.184           | < 0.001 | 0.175           | < 0.001 | 0.155           | 0.031   |
| No. of teeth (r)              | 0.100           | 0.003   | 0.119           | 0.001   | 0.046           | 0.525   |
| DT (r)                        | -0.138          | < 0.001 | -0.159          | < 0.001 | -0.106          | 0.140   |
| n-FTUs (r)                    | 0.122           | < 0.001 | 0.141           | < 0.001 | 0.087           | 0.226   |
| nif-FTUs (r)                  | 0.156           | < 0.001 | 0.184           | < 0.001 | 0.082           | 0.255   |
| Total-FTUs (r)                | 0.144           | < 0.001 | 0.169           | < 0.001 | 0.074           | 0.308   |
| Periodontitis (mean $\pm$ SD) |                 |         |                 |         |                 |         |
| (+)                           | $1.28 \pm 0.46$ | 0.058   | $1.28 \pm 0.47$ | 0.018   | $1.23 \pm 0.37$ | 0.954   |
| (—)                           | $1.37 \pm 0.48$ |         | $1.41 \pm 0.49$ |         | $1.24 \pm 0.43$ |         |
| Malocclusion (mean $\pm$ SD)  |                 |         |                 |         |                 |         |
| (+)                           | $1.22 \pm 0.37$ | 0.002   | $1.21 \pm 0.38$ | < 0.001 | $1.24 \pm 0.32$ | 0.945   |
| (—)                           | $1.37 \pm 0.49$ |         | $1.41 \pm 0.49$ |         | $1.24 \pm 0.44$ |         |
| TMDs (mean $\pm$ SD)          |                 |         |                 |         |                 |         |
| (+)                           | $1.39 \pm 0.45$ | 0.762   | $1.40 \pm 0.50$ | 0.928   | $1.37 \pm 0.40$ | 0.392   |
| (—)                           | $1.36 \pm 0.48$ |         | $1.39 \pm 0.49$ |         | $1.23 \pm 0.43$ |         |

r: correlation coefficient, DT: decayed teeth, n-FTUs: natural teeth functional tooth units, nif-FTUs: natural, implanted and fixed prosthetic pontic teeth functional tooth units, Total-FTUs: total teeth functional tooth units, SD: standard deviation, TMDs: temporomandibular disorder.

Table 5. Predictors of the masticatory performance score

| Variable      | В      | SE    | p-value |
|---------------|--------|-------|---------|
| Sex           | -0.155 | 0.037 | < 0.001 |
| Age           | 0.010  | 0.001 | < 0.001 |
| DT            | -0.025 | 0.010 | 0.009   |
| Total-FTUs    | 0.045  | 0.008 | < 0.001 |
| Periodontitis | -0.140 | 0.047 | 0.003   |
| Malocclusion  | -0.139 | 0.055 | 0.011   |
| TMDs          | 0.101  | 0.108 | 0.350   |

Multiple R=0.340, adjusted  $R^2$ =0.109. SE: standard error of the mean, DT: decayed teeth, Total-FTUs: total teeth functional tooth units, TMDs: temporomandibular disorder.

# 5. Predictors of the masticatory performance score

There were multicollinearities among the number of teeth, n-FTUs, nif-FTUs, and total-FTUs. Therefore, in a multiple linear regression on the masticatory performance scores, the total-FTUs was chosen as an independent variable, as well as sex, age, DT, periodontitis, malocclusion, and TMDs.

Table 5 presents the results of the analysis, which showed that sex (B=-0.155, p<0.001), age (B=0.010, p<0.001), DT (B=-0.025, p=0.009), total-FTUs (B=0.045, p<0.001), periodontitis (B=-0.140, p=0.003), and malocclusion (B=-0.139, p=0.011) were significant predictors of the masticatory performance score. However, TMDs was not a significant contributor of the masticatory performance score.

#### Adjusted masticatory performance score, based on the self-reported masticatory status

Table 6 shows the relationship between the adjusted mean masticatory performance scores and the self-reported masticatory status. The scores were adjusted for sex, age, DT, to-tal-FTUs, periodontitis, and malocclusion, all of which were significant predictors of the masticatory performance score, based on the multiple linear regression. The adjusted mean masticatory performance scores for the good, fair, and poor self-reported masticatory statuses were  $1.37\pm0.02$ ,  $1.35\pm0.05$ , and  $1.26\pm0.08$ , respectively. There was no significant linear relationship between the adjusted masticatory performance scores and the self-reported masticatory status.

# Discussion

This study evaluated a chewing gum containing spherical resinous microparticles for measuring masticatory performance among Japanese industrial workers. The masticatory performance was measured by calculating the number of particles

 Table 6. Adjusted masticatory performance score, based on the self-reported masticatory status

| Variable             | $Mean \pm SE$  | p for trend |
|----------------------|--|-------------|
| Good<br>Fair<br>Poor | $\begin{array}{c} 1.37 \pm 0.02 \\ 1.35 \pm 0.05 \\ 1.26 \pm 0.08 \end{array}$ | 0.182       |

Adjusted for sex, age, decayed teeth, total teeth functional tooth units, periodontitis, malocclusion. SE: standard error of the mean.

in the chewing gum. The diameter of the particles was determined to assume that teeth move approximately 100 mm during mastication.

Since an existing material used in the sieving test is an ordinary food, its quality is not uniform in case of using natural food [27]. It is also possible that a one-time measurement is of low quality; however, acquiring several measurements takes a long time [19]. The mixing test is affected by mastication and by saliva flow [20]. However, the current gum-based material is homogeneous and is not influenced by saliva. Chewing a gum is not a special activity for most people; therefore, they could produce the performance measurement with little consciousness of mastication [24]. Thus, it is possible to use the method to estimate the masticatory performance in a standardized condition and in a state that is close to natural mastication.

The masticatory performance using the current gum was associated with the clinical oral health status such as the number of teeth, DT, FTUs, periodontitis, and malocclusion. Many studies have demonstrated a positive association between masticatory performance and the number of teeth and occlusal units such as FTUs [12,13,21,22]. These results suggest that the number of teeth and the functional occlusal support of teeth are fundamental elements in mastication.

The number of DT negatively affected masticatory performance. A broken occlusal surface due to dental caries and pain-contingent with dental caries may prevent normal mastication. One study using a carrot or gummy jelly as the sieve food also reported that masticatory function decreased if an individual had dental caries [11]. The authors of that study conjectured that the participant may have reflexively avoided the pain that arose from dental caries.

A reason for the relationship between periodontitis and masticatory performance could be tooth mobility caused by advanced periodontitis. It has been reported that the occlusal force and occlusal surface area in patients with periodontitis are smaller than those of healthy individuals [28]. The decrease in occlusal force and surface area may deteriorate masticatory performance.

The masticatory performance of the participants with maloc-

clusion was poorer than that of healthy individuals. Malocclusion could aggravate the occlusal condition and reduce the occlusal surface area. One study using a silicon tablet as the sieve material showed that the masticatory performance of individuals with malocclusion was lower than that of healthy individuals because of the reduction of the occlusal surface area and alteration of jaw movement due to the malocclusion [18].

In the current study, masticatory performance increased with age, which could be related to a unique characteristic of the currently used chewing gum. The diameter of the particles in the chewing gum is very small so that a tooth with a flat occlusal surface is more favorable in crushing the particles, compared with a pointed occlusal surface. The proportion or area of a worn occlusal surface of the teeth increases with age because of the progression of abrasion and attrition [29]. The occlusal contact surface area increases accordingly [30,31]. Therefore, particles in the chewing gum were more likely to be crushed by a flat occlusal surface, and the masticatory performance consequently increased with age.

In this study, the question "Can you bite tightly with your back teeth or dentures?" was used to represent the self-reported masticatory status. The validity of this question has been demonstrated, and the response to the question was strongly associated with Yamamoto's chewing test results and with the clinical oral health conditions. Participants reporting a good masticatory status could chew all 15 test foods and had a higher number of present teeth, molars, and FTUs [7].

The validity of the self-reported masticatory status was reconfirmed in this study. The self-reported masticatory status worsened as the number of teeth or three types of FTUs decreased and as the number of DT increased. A similar trend was also observed for the periodontal condition. As the self-reported masticatory status worsened, the proportion of participants with periodontitis increased.

The relationship between masticatory performance and self-reported masticatory status, as indicated with bivariate analysis, disappeared after adjusting for confounding factors. This finding suggested that, as with other existing methods, the masticatory performance measured with the chewing gum reflected only a portion of the masticatory performance. Other factors had a substantial effect on masticatory performance.

There were several limitations to this study. This study was conducted as a part of a regular health check-up at each company site; thus, the content of the oral examinations was limited. Other mastication-related information such as occlusal contact area, occlusal force, jaw movement, and mastication pattern were therefore not collected. Furthermore, current industrial workers were not necessarily the representative of the general adult. However, the oral health status of the participants, whose mean age was approximately 43 years, was similar to that of 40to 44-year-old individuals in the national oral health survey in Japan [32].

# Conclusion

A gum containing microparticles for measuring masticatory performance was evaluated. The measurements revealed that the masticatory performance increased with age and decreased as the oral health status worsened. The association between masticatory performance and the self-reported masticatory status was attenuated after controlling for confounding factors. These results indicated that, as with other existing methods, the measurement method using this gum can partly, but not comprehensively, reflect masticatory performance. Therefore, to measure the masticatory performance accurately, various mastication-related indexes and chewing gum should be employed simultaneously.

# Acknowledgements

This study was partly supported by the "Research Fund of Clinical Study for Industrial Accident and Disease" by Ministry of Health, Labor and Welfare, Japan (14020101-01, 170501-01).

# References

- 1. Hollis JH. The effect of mastication on food intake, satiety and body weight. Physiol Behav 2018;193:242-5.
- Miquel-Kergoat S, Azais-Braesco V, Burton-Freeman B, Hetherington MM. Effects of chewing on appetite, food intake and gut hormones: a systematic review and meta-analysis. Physiol Behav 2015;151:88-96.
- Kikui M, Ono T, Kokubo Y, Kida M, Kosaka T, Yamamoto M, et al. Relationship between metabolic syndrome and objective masticatory performance in a Japanese general population: the Suita study. J Dent 2017;56:53-7.
- Yamazaki T, Yamori M, Asai K, Nakano-Araki I, Yamaguchi A, Takahashi K, et al. Mastication and risk for diabetes in a Japanese population: a cross-sectional study. PLoS One 2013;8:e64113.
- Heo SY, Lee EH. The correlation among systemic health, hypertension and oral health of Korean adults. Int J Clin Prev Dent 2018;14:112-8.
- Nishigawa K, Suzuki Y, Matsuka Y. Masticatory performance alters stress relief effect of gum chewing. J Prosthodont Res 2015;59:262-7.
- Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Masticatory ability and functional tooth units in Japanese adults. J Oral Rehabil 2008;35:337-44.
- 8. Ueno M, Yanagisawa T, Shinada K, Ohara S, Kawaguchi Y. Category of functional tooth units in relation to the number of

teeth and masticatory ability in Japanese adults. Clin Oral Investig 2010;14:113-9.

- Ueno M, Shimazu T, Sawada N, Tsugane S, Kawaguchi Y. Validity of self-reported tooth counts and masticatory status study of a Japanese adult population. J Oral Rehabil 2018;45: 393-8.
- Abrahamsson C, Henrikson T, Bondemark L, Ekberg E. Masticatory function in patients with dentofacial deformities before and after orthognathic treatment: a prospective, longitudinal, and controlled study. Eur J Orthod 2015;37:67-72.
- Decerle N, Nicolas E, Hennequin M. Chewing deficiencies in adults with multiple untreated carious lesions. Caries Res 2013; 47:330-7.
- Fontijn-Tekamp FA, van der Bilt A, Abbink JH, Bosman F. Swallowing threshold and masticatory performance in dentate adults. Physiol Behav 2004;83:431-6.
- Hatch JP, Shinkai RS, Sakai S, Rugh JD, Paunovich ED. Determinants of masticatory performance in dentate adults. Arch Oral Biol 2001;46:641-8.
- Laird MF, Vogel ER, Pontzer H. Chewing efficiency and occlusal functional morphology in modern humans. J Hum Evol 2016;93:1-11.
- 15. Lepley C, Throckmorton G, Parker S, Buschang PH. Masticatory performance and chewing cycle kinematics-are they related? Angle Orthod 2010;80:295-301.
- Omo JO, Sede MA, Esan TA. Masticatory efficiency of shortened dental arch subjects with removable partial denture: a comparative study. Niger J Clin Pract 2017;20:459-63.
- Pereira LJ, Gazolla CM, Magalhães IB, Dominguete MH, Vilela GR, Castelo PM, et al. Influence of periodontal treatment on objective measurement of masticatory performance. J Oral Sci 2012;54:151-7.
- Rios-Vera V, Sánchez-Ayala A, Senna PM, Watanabe-Kanno G, Cury AA, Garcia RC. Relationship among malocclusion, number of occlusal pairs and mastication. Braz Oral Res 2010;24: 419-24.
- van der Bilt A, Fontijn-Tekamp FA. Comparison of single and multiple sieve methods for the determination of masticatory performance. Arch Oral Biol 2004;49:193-8.
- Anastassiadou V, Heath MR. The development of a simple objective test of mastication suitable for older people, using chew-

ing gums. Gerodontology 2001;18:79-86.

- Ikebe K, Matsuda K, Kagawa R, Enoki K, Okada T, Yoshida M, et al. Masticatory performance in older subjects with varying degrees of tooth loss. J Dent 2012;40:71-6.
- 22. Ikebe K, Matsuda K, Kagawa R, Enoki K, Yoshida M, Maeda Y, et al. Association of masticatory performance with age, gender, number of teeth, occlusal force and salivary flow in Japanese older adults: is ageing a risk factor for masticatory dysfunction? Arch Oral Biol 2011;56:991-6.
- Kosaka T, Ono T, Kida M, Kikui M, Yamamoto M, Yasui S, et al. A multifactorial model of masticatory performance: the Suita study. J Oral Rehabil 2016;43:340-7.
- Schimmel M, Christou P, Miyazaki H, Halazonetis D, Herrmann FR, Müller F. A novel colourimetric technique to assess chewing function using two-coloured specimens: validation and application. J Dent 2015;43:955-64.
- Uesugi H, Shiga H. Relationship between masticatory performance using a gummy jelly and masticatory movement. J Prosthodont Res 2017;61:419-25.
- Elgestad Stjernfeldt P, Wårdh I, Trulsson M, Faxén Irving G, Boström AM. Methods for objectively assessing clinical masticatory performance: protocol for a systematic review. Syst Rev 2017;6:20.
- 27. van der Bilt A. Assessment of mastication with implications for oral rehabilitation: a review. J Oral Rehabil 2011;38:754-80.
- Alkan A, Keskiner I, Arici S, Sato S. The effect of periodontitis on biting abilities. J Periodontol 2006;77:1442-5.
- Van't Spijker A, Rodriguez JM, Kreulen CM, Bronkhorst EM, Bartlett DW, Creugers NH. Prevalence of tooth wear in adults. Int J Prosthodont 2009;22:35-42.
- Bourdiol P, Abou El Karam S, Martin JF, Nicolas E, Mioche L. Age and gender-related differences in premolar and molar functional areas. J Oral Rehabil 2007;34:251-8.
- Kim SK, Kim KN, Chang IT, Heo SJ. A study of the effects of chewing patterns on occlusal wear. J Oral Rehabil 2001;28: 1048-55.
- 32. Japan Ministry of Health, Labour and Welfare. Report on the survey of dental diseases 2016 [Internet]. Tokyo: Ministry of Health, Labour and Welfare, Japan [cited 2018 Oct 19]. Available from: https://www.mhlw.go.jp/toukei/list/62-17.html.





# Review The Oral Healthcare System in Japan

## Takashi Zaitsu<sup>D</sup>, Tomoya Saito and Yoko Kawaguchi \*

Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo 113-8510, Japan; zaitsu.ohp@tmd.ac.jp (T.Z.); saito.ohp@tmd.ac.jp (T.S.)

\* Correspondence: yoko.ohp@tmd.ac.jp; Tel.: +81-3-5803-5475

Received: 15 June 2018; Accepted: 6 July 2018; Published: 10 July 2018



Abstract: This paper describes the present Japanese oral healthcare system and outlines the future challenges and perspectives for Japan. Japan has developed a system for providing high-quality and appropriate health care efficiently through a universal health insurance system which has been in operation since 1961. This health insurance covers most restorative, prosthetic and oral surgery treatment. Therefore, all people can receive dental treatment at a relatively low cost, with the same fees applying throughout the nation. In Japan, public oral health services are provided by the local governments according to the life stage of their populations. These services are mainly conducted by private dental practitioners under contracts with local governments. National oral health data shows that the oral health of the Japanese population has improved over the last several decades. Future challenges and perspectives for Japanese dentistry include: tackling the regional differences in oral health, decreasing the cost of health expenditure, establishment of sustainable emergency oral healthcare services in times of disaster, and the development a new tele-dental system for remote areas without access to dental professionals.

**Keywords:** oral health; healthcare system; dental workforce; public health insurance; oral health status; Japan

#### 1. Characteristics of Japan

Japan is located in Northeast Asia and is composed of four main islands and 6848 smaller islands. The land area is 378,000 km<sup>2</sup> and the capital city is Tokyo [1]. Japan's population is over 126 million and most Japanese reside in densely populated urban areas [2]. In 2016, the national gross domestic product (GDP) was 4.937 trillion United States dollars (US\$) and it is the world's third largest economy [3]. Health expenditure is around 10% of GDP. Japan has developed a system for providing high quality and appropriate healthcare efficiently in its communities through a universal health insurance system which has been in operation for more than 50 years.

#### 2. Dental Workforce

Three regulatory professional dental licenses are issued in Japan: dentists, dental hygienists, and dental technicians. For each profession, independent legislation exists: the "Dentists Act", the "Dental Hygienists Act", and the "Dental Technicians Act". These acts describe and regulate the professions' duties, roles, and ethics. There is no licensing system for dental chairside assistants. A survey of practicing healthcare professionals is conducted every two years by the Ministry of Health, Labor and Welfare (MHLW).

#### 2.1. Dentists

In 2016, the total number of dentists was 104,533 [4]. The number of female dentists was 24,344, 23.3% of the dental workforce. The dentist ratio per 100,000 people is 82.4 practitioners, and, as in

many nations, the distribution is unequal. The highest dentist to population ratio is in Tokyo (118.2), and the lowest is Fukui Prefecture (54.7); more than twice the regional difference of dentist distribution is observed. There are 68,730 dental facilities (mainly private dental clinics) in total throughout Japan.

Table 1 shows the number and proportion of dentists according to their roles or places of practice. More than 97% of the dentists (n = 101,551) engage in providing dental treatment at private or public dental institutions. The number of public dentists who engage in full-time administration work is only 348 (0.3%). Therefore, in Japan, most of the public dental activities are conducted by private dentists on a part-time basis. The "Dentists Act" describes the duties of dentist as follows: "Dentists shall take charge of dental treatment, provide oral health guidance, and contribute to the improvement and the promotion of public health in order to secure a healthy life for the people".

| Practicing Places             | Number   | %       |
|-------------------------------|----------|---------|
| Dental practice               | 101,551  | 97.1%   |
| Private office (employer)     | (59,482) | (56.9%) |
| Private office (employed)     | (29,684) | (28.4%) |
| Hospital                      | (3,077)  | (2.9%)  |
| Education institute           | (9,308)  | (8.9%)  |
| Research institute            | 1195     | 1.2%    |
| Administration/public service | 348      | 0.3%    |
| Others                        | 1430     | 1.4%    |
| Total                         | 104,533  | 100.0%  |

Table 1. Numbers of dentists in Japan (2016).

For example, a local government municipality contracts with a private dental practitioner to carry out the role of a school dentist. Local government pays the contracting dentist as a school dentist, and the dentist is responsible for the performance of school oral health activities, usually in a part-time capacity. This public and private mixed dental performance is one of the unique characteristics of the Japanese oral healthcare system.

In Japan, there are 29 dental educational institutions: eleven national, one local governmental, and seventeen private universities. The total enrolment in the 29 dental schools in 2017 was 2720 [5]. Dental education is based on a model core curriculum. For quality assurance of the education conducted in each dental school, computer based tests (CBTs) and objective structured clinical examinations (OSCEs) are performed during the undergraduate course before dental students start clinical training. After six years of education, all students have to take a national board dental examination. The MHLW manages this national board examination and regulates the issuing of dental licenses. The pass rate of this national board examination is relatively low, around 65–70%. In 2018, 3159 dental students took the examination and 2039 passed (64.5%) [6].

Without passing this examination, a dental graduate cannot get a dental license. Further, after successfully getting a dental license, all new graduates participate in the compulsory residency clinical training program for more than one year. Following completion of a residency program, the graduate is free to choose the career path to follow as a dentist. Most prefer further study through postgraduate university courses, or to work at hospitals to improve their academic knowledge and technical skills for several years before entering private practice.

#### 2.2. Dental Hygienists

The number of active dental hygienists in Japan in 2016 was 123,831 [7]. The roles of dental hygienists are prevention of oral diseases, oral health education, and chairside treatment assistance. About 90% of dental hygienists (n = 112,211) work in largely private dental clinics, and about 5% (n = 6259) work in hospitals. The number of dental hygienists working in public sectors (i.e., prefectures,

municipalities, and health centers) is 2754 (2.2%), and teaching staff in education institutes is 873 (0.7%).

In total there are 166 dental hygienist education institutes. Most of these are 3-year-period vocational schools. Eleven schools however provide a 4-year-period university bachelor degree programs in the universities. Hygienists also need a national license, and the proportion of dental hygienists who pass the national examination is high and around 95%. Every year around 6500 new dental hygienists are produced.

#### 2.3. Dental Technicians

In 2016, the total number of active dental technicians was 34,640 [7]. Dental technicians make dental prostheses, based on dentists' prescriptions. They are not allowed to take impressions directly from the patients. The number of dental technicians working in dental laboratory offices is 24,972 (72.1%) and working in hospitals or dental clinics is 9166 (26.5%).

There are 54 dental technicians' schools. Most of the schools provide 2-year-period education. Three universities have 4-year-period bachelor degree programs for dental technicians. After graduation, a pass in the national board examination is necessary to get a license to practice as a dental technician.

#### 3. Public Health Insurance System in Japan

Japan is called a welfare country and public healthcare systems are well developed. Japan introduced a universal health insurance system for the entire population in 1961. It covers almost all medical and dental treatment and pharmacy care required by the population [8]. People can receive treatment at a relatively low cost, and the same fee is applied throughout the nation. In 2000, in response to the increasing aging of the population, Japan initiated a "long-term care insurance" to deliver health and welfare services for the elderly.

#### 3.1. Health Insurance

Almost all practicing doctors and dentists are registered in the public national health insurance scheme as insured doctors, and provide treatment according to a fee-for-service system. In general, after receiving treatment by an insured doctor or dentist, patients pay 30% of the total cost to the clinic or hospital. The remaining 70% of the cost is paid to the clinical institutions by the insurance agency approximately two or three months later, based on the submitted fee claims. Therefore, the cost of insurance treatment provided is the same, throughout the nation, fixed by the fee schedule. There is no price difference between private and public institutions.

There are certain exemptions. Low income earners do not necessarily have to pay the cost directly to the clinic. In addition, elderly persons may pay directly but at a reduced rate (10–20% of the cost) according to their income. Moreover, the Japanese health insurance system has a reimbursement scheme for patients who receive costly treatment services such as cardiac surgery, where the patient's payment over a certain amount is refunded later. Under this health insurance system, Japanese people can receive high-quality health services at a relatively low cost, both in public and private institutions. The fee schedule is reviewed every two years and inclusions/exclusions of each treatment option within the insurance scheme is reviewed by an expert committee established through the MHLW.

Dental services under the national health insurance system are available for most restorative, prosthetic, and oral surgery treatment. They include services such as fillings, endodontic treatment, crowns, bridges, dentures, and extractions. Higher cost items (e.g., gold crowns and bridges, metal plate dentures, implants, and orthodontic treatment) are excluded. Preventive services are also excluded, as the current health insurance system only covers treatments for existing diseases. Delivery of dental treatment services to bed-ridden people at home or in aged care centers by dentists are also covered in this public health insurance scheme.

#### 3.2. Long-Term Care Insurance

To deal with the rapidly increasing aging population, in April 2000 Japan introduced the "long-term care insurance system". This system provides various long-term care services in a comprehensive and uniform way for all eligible persons, so that they can lead independently as long as possible. The managing insurer of the long-term care insurance system is the municipality (local government), and the main eligibility criterion for those covered by the scheme is that they are aged 65 years or over.

Based on the care plan established by a patient's care manager, the patient contracts the service provider to make necessary arrangements so that the individual can use in-home care services or community-based preventive services. Facilities are also available for those in the aged care institutions. To use long-term care services, the long-term care insurance covers 90% of the service-related costs, while the remaining 10% of costs are paid by the user.

The services provided under this scheme include home visit nursing, day-care or short-stay medical service, etc. In-home healthcare guidance, doctors, nurses, dentists, dental hygienists, or other medical professionals visit the homes of users who have difficulty in making a hospital visit and provide health maintenance instruction and care according to the patient's medical and physical condition or environment.

After its launch, there was a rapid increase in the use of the long-term care scheme, especially the home care service. The long-term care insurance system has now come to have an important role as a system designed to assure an affordable and comfortable life for elderly people and their family members.

#### 4. Life Course Oral Healthcare System

According to each life stage of the population, many policies regulate the regional health services and describe the accountability of governments, related organizations and populations in Japan. Therefore, oral health services are provided as a part of the general health service, and the programs are based on the health related laws and acts (Table 2).

| Law/Act  | Main Target Population                      |
|--|---|
| Maternal and Child Health Act (1965)                   | Infants, preschool children, pregnant women |
| School Health and Safety Act (1958)                    | Schoolchildren                              |
| Industrial Safety and Health Act (1972)                | Workers                                     |
| Act on Securing Medical Care for Elderly People (2008) | Elderly                                     |
| Community Health Act (1947)                            | All population                              |
| Health Promotion Law (2003)                            | All population                              |
| Act on the Promotion of Dental and Oral Health (2011)  | All population                              |

Table 2. Health related law and acts in Japan.

In 2017, there were a total of 479 health centers throughout Japan. Among them, 363 centers were established in 47 prefectures, 93 centers in 74 designated cities, and 23 centers within the 23 special Tokyo wards. These health centers take the role of the central administrative management office for the regional public health services.

In 2000, a National Health Promotion Campaign for the 21st century, "Healthy Japan 21", was proposed to prevent lifestyle-related diseases (non-communicable diseases (NCDs) such as cancers, cardiovascular diseases, diabetes, and chronic obstructive pulmonary disease). "Healthy Japan 21" set up national goals for the year 2010 in nine specific fields for improving lifestyles, reducing risk factors, and decreasing diseases. Oral health is one of the NCD conditions identified, and specific goals were set up to prevent tooth loss. The "Health Promotion Act" was enacted in 2003 and it supported the development of health promotion activities throughout the nation.

After evaluation of the achievements on "Healthy Japan 21", the second term of "Healthy Japan 21" was initiated from 2013. Its basic goals were as follows:

- Extension of healthy life expectancy and reduction of health disparities
- Prevention of onset and progression of life-style related diseases
- Maintenance and improvement of mental and physical functions necessary for social life
- Establishment of a healthy and supportive social environment

Specific goals for the year 2022 are indicated in these six fields, and include; (1) nutrition and dietary habits; (2) physical activity and exercise; (3) rest; (4) alcohol use; (5) tobacco use; and (6) oral health. Table 3 shows the oral health goals set out in the second "Healthy Japan 21".

|    | Indicators   | <b>Baseline</b> Data | Goals                 |
|----|--|----------------------|-----------------------|
| 1. | Maintenance and improvement of oral function   |                      |                       |
|    | Increase in proportion of persons aged 60–69 years with good mastication function  | 73.4% (2009)         | 80% (2022)            |
| 2. | Prevention of tooth loss   |                      |                       |
|    | A. Increase in the proportion of 80-year-old persons with 20 or more teeth   | 25% (2005)           | 50% (2022)            |
|    | B. Increase in the proportion of 60-year-old persons with 24 or more teeth   | 60.2% (2005)         | 70% (2022)            |
|    | C. Increase in the proportion of 40-year-old persons with no missing teeth   | 54.1% (2005)         | 75% (2022)            |
| 3. | Prevention of periodontal disease  |                      |                       |
|    | A. Decrease in the proportion of persons in their 20s with gingivitis  | 31.7% (2009)         | 25% (2022)            |
|    | B. Decrease in the proportion of persons in their 40s with progressive periodontitis   | 37.3% (2005)         | 25% (2022)            |
|    | C. Decrease in the proportion of persons in their 60s with progressive periodontitis   | 54.7% (2005)         | 45% (2022)            |
| 4. | Prevention of dental caries  |                      |                       |
|    | A. Increase in the number of prefectures where >80% of 3-year-old children are caries free   | 6 prefectures (2009) | 23 prefectures (2022) |
|    | B. Increase in the number of prefectures where 12-year-old children have fewer than 1 DMFT (decayed, missing and filled permanent teeth) | 7 prefectures (2011) | 28 prefectures (2022) |
| 5. | Regular dental check-up  |                      |                       |
|    | Increase in the proportion of persons who received a dental check-up during the past year  | 34.1% (2009)         | 65% (2022)            |

Table 3. Goals related to oral health in the second "Healthy Japan 21".

#### 4.1. Preschool Children

Pregnant women receive a "maternal and child health handbook" from the municipal government for each child. Health care professionals record the health check-up data during pregnancy and after the child is born and up to six years of age. The handbook covers the child's health condition and immunization records. Mothers also record the child's growth and health concerns in the handbook by themselves. Therefore, healthcare professionals in hospitals or health centers can refer to the records within this book, as mothers always carry this book with the child.

In Japan, national programs for preschool children are conducted by local government free of charge. They include physical, medical, and dental examinations of all children. The collected data are sent to the MHLW and published every year.

- (1) Health check-ups for 3-year-old children (since 1961)
- (2) Health check-ups for 18-month-old children (since 1977)

Private practitioners (i.e., doctors and dentists) contribute to the conduct of these examinations in turns at the community health centers. This means they become part-time "public doctors/dentists". Medical or dental treatment is not provided at the health centers and only preventive services are

available. After the oral examination, oral health education is offered to mothers and children by dental hygienists, either in a small group or individually. Education covers oral health related habits, nutritional consultation, and brushing instructions. Topical fluoride application for caries prevention and silver diamine fluoride application for caries arrest is also provided to those who require this care, at a reasonable fee.

#### 4.2. Schoolchildren

In Japan, every public primary, junior, and senior high school has an appointed school dentist. In 2014 the total number of school dentists holding such positions was 44,600. The school dentist is responsible for the performance of school-based oral health activities, usually in a part-time capacity, because s/he may work also as a dental practitioner in the area.

The roles of school dentists are described in the "School Health and Safety Act" and include the conduct of an oral health examination at least once a year on each child at school, and contributing to implementing the school's oral health education. According to the standard procedures and guidelines, school dentists check the oral health status of all the students for conditions such as dental caries, malocclusion, gingival status, dental plaque, and temporomandibular disorders.

If oral health problems are detected in schoolchildren, the school dentist recommends to the child and parents that they should seek dental treatment under the public health insurance scheme, described before. School dentists do not provide dental treatment in the schools at all. Schoolchildren can receive comprehensive dental care at any public or private dental offices.

In addition, oral health education is conducted by the school dentist, or the dental hygienist, in cooperation with the nursing teachers and the classroom teachers. Oral health education programs usually include prevention of dental caries and gingivitis, but the content of oral health education program depends on the individual school's curriculum and timetable.

School health surveys are conducted every year, and the data are published by the Ministry of Education.

#### 4.3. Adulthood

According to the "Industrial Safety and Health Act", employers have to provide annual medical check-ups for all the employees in any company which has more than 50 workers. On the other hand, the Act does not include a duty for dental check-ups for employees. Only the workers who engage in jobs in acid-producing environments have to receive special dental check-ups every six months for the prevention and early detection of tooth erosion. Some companies provide good oral health promotion programs for their employees, but the number of these companies is very small.

According to the "Health Promotion Law", local governments (municipalities) are to provide free or low-cost "periodontal disease examination programs" for their adult population by way of contracts with private dental practitioners. However, the rate of participation for the eligible persons in these programs is very low, about 10–15%.

Therefore, in Japan, the oral health program for the adult population is based on an individual's personal responsibility for care, self-support and self-motivation. Many dental facilities and a public insurance system contribute to easy access for dental treatment for adults, but the proportion of regular (check-up or preventive) visits to dental clinics is not high. This adult population group should be encouraged to visit a dentist and dental clinic regularly for prevention of dental diseases.

#### 4.4. Elderly

Japan is known as a "super aging society". The age structure (2016) shows that 12.4% of the population is aged 0–14 years, 60.3% is aged between 15 and 64 years, and just over a quarter of the population, 27.3%, is aged 65 years and older [9]. Life expectancy at birth (2016) is 81.0 years for males, 87.1 years for females, and 84.2 years for all [10].

This figure shows that Japan is one of the longest life expectancy countries in the world. Therefore, over the past several decades, Japan has become increasingly concerned at the pace of population aging and the challenges this brings to dealing with changing social systems.

Dentistry is no exception. In 1989, the Ministry of Health and the Japan Dental Association advocated a national oral health campaign, "8020 (Eighty-Twenty) campaign". The first part "80" signifies the average life expectancy for Japanese people at that time, and the second part "20" indicates the critical number of natural teeth to maintain eating and chewing function for life. Previous studies in Japan show that keeping 20 or more natural teeth is considered to be a simple and adequate threshold for maintaining good masticatory ability for eating almost any kinds of Japanese food items, which vary from soft texture food to hard texture food [11].

The objective of this campaign is to inform the general population of the importance of retaining 20 or more natural teeth until 80 years of age to maintain satisfactory masticatory abilities. The number of missing teeth increases as people get older. The concept of "8020" is to ensure all Japanese people are able to enjoy a healthy diet and a good social life by preventing tooth loss that leads to masticatory dysfunction.

This national campaign has led to many projects and research studies regarding the impact of oral health on general health and quality of life. Many studies report that improvements in oral health and masticatory function contribute to the prevention of aspiration pneumonia and to the maintenance or recovery of activities of daily living [12]. In March 2015, the Japan Dental Association hosted the world congress with co-sponsorship by the World Health Organization (WHO), and the "Tokyo Declaration on Dental Care and Oral Health for Healthy Longevity" was drafted [13].

The "8020" campaign, a community and clinic-based initiative started in 1989, has contributed to a dramatic improvement in the oral health of older people in Japan. This was followed by an accumulation of evidence, culminating in oral health being integrated into health policy in the form of the "Act on the Promotion of Dental and Oral Health" in 2011, for the purpose of oral disease prevention and general health improvement.

Oral functional impairments reduce chewing efficiency, influence nutritional deficiencies, and deter the elderly from the pleasure of eating and communication. Oral functional enhancement, along with dental prostheses and better oral hygiene has been reported to be effective in preventing swallowing difficulties in the dependent elderly. From the perspective of prevention and health promotion, it is considered to be more effective to implement interventions before health problems and functional disturbances have occurred. Therefore, at community health centers, dental professionals educate the independent elderly about the importance of oral function promotion and provide oral function promotion programs such as "tongue exercise" or "salivary grand massages".

#### 5. Oral Health Status

In Japan, national oral health surveys have been conducted every six years from 1957 to 2011 by the MHLW. Recently, the eleventh survey was conducted in 2016, the interval between surveys being changed from six to five years. According to data from these surveys, the changing patterns of oral health status of Japanese population can be well described.

#### 5.1. Oral Health Status of Children

For deciduous teeth, improvement is obvious. Figure 1 shows the trends in prevalence of dental caries in deciduous teeth for one- to five-year-old children. In 1957, the prevalence of dental caries in 5-year-olds and 3-year olds were 94.5% and 81.8%, respectively. In 2016, these values decreased to 39.0% and 8.6%, respectively. Figure 2 shows the changing pattern of the status of deciduous teeth from 1957 to 2016 for one- to 14-years-old children. In 1957, most carious teeth were untreated, and 5-year-olds had on average 8.7 decayed teeth (dt). As time went on, children could access and receive dental treatment, and the number of filled teeth (ft) increased. Also the number of healthy teeth increased remarkably in all ages. These figures show the dental caries status of deciduous teeth

in Japanese children improved rapidly. Figure 3 shows the changing pattern of decayed, missing and filled permanent teeth (DMFT) of 12-year-olds from national School Oral Health Survey data. In 1985, 12-year-olds had on average 4.6 DMFT, and this gradually decreased year by year and it became 0.8 DMFT in 2016 [14].



Figure 1. Trends in prevalence of dental caries, deciduous teeth (1957–2016) [15].



Figure 2. Changing pattern of deciduous teeth (1957–2016) [15].

Teeth

9 of 17



Figure 3. DMFT of in 12-year-olds (1985–2016) [14].

#### 5.2. Oral Health Status of Adults

Figure 4 shows the mean number of teeth present for adults (35–44 years age group) and older persons (65–75 years age group) over a 60-year period from 1957 to 2016. For the 35–44-year age group, the number of natural teeth present increased from a mean of 25.1 to 28.2, a difference of more than three teeth. For the 65–74-year age group, the increase in the number of natural teeth was more remarkable, from 10.1 to 20.8 teeth. That is by a factor of ten teeth or twice the number of natural teeth present over this time period. This implies that recent Japanese populations, especially elderly people, are keeping more natural teeth than the past [15].

On the other hand, the proportion of edentulous persons decreased each year in all age groups (Figure 5). In 1957, the proportion of those with no natural teeth was about one-third in the 65–74 year-old age group (35.5%), and more than half of those 75 years and over (57.2%). In 2016, these proportions had changed to 4.1% and 14.3%, respectively. Figure 6 shows the changing pattern of the proportion of persons with 20 or more teeth. In all age groups, the proportion of those retaining 20 or more natural teeth had increased, with a substantial increase observed, especially in older age groups. This might be attributed to the national "8020" campaign which was initiated in 1989, and people's awareness for oral health which has been improving and changing oral health behaviors.



**Figure 4.** Changing pattern of mean number of present teeth for 35–44 and 65–74-year old groups (1957–2016) [15].



Figure 5. Trends in proportion of edentulous persons by age group (1975–2016) [15].



Figure 6. Proportions of persons with 20 or more teeth by age group [15].

Figure 7 shows the prosthetic status of those 15 years and over in the Japanese population in 2016. In total, the proportion without missing teeth (not needing prosthetic treatment) was 34.0%, and those who completed prosthetic treatment was 28.3%. In Japan, the public insurance covers most prosthetic treatments, such as dentures and bridges. Therefore, people can receive the prosthetic treatment they require also at a reasonable price.

Figure 8 shows the changing pattern of the status of permanent teeth. In 1957, the number of decayed teeth was greater than the number of filled teeth in all age groups. In those days, the whole Japanese population was not covered by public health insurance. In 1961, all the population entered the public health insurance system and access to dental treatment improved. The number of decayed teeth on average decreased as time went on and the average number of decayed teeth (DT) was low at 0.8 teeth in the total population aged five years and over, in 2016. The number of healthy teeth in adults also decreased, and the number of filled teeth increased. Japanese health insurance is based on the fee-for-service system, so the more filled teeth, the more fees dentists can get. It is necessary


therefore to consider the inclusion of prevention in the insurance schemes. As people keep more teeth than before, a preventive approach to dental care is more important.

Source: National Oral Health Survey in Japan

Figure 7. Prosthetic status (2016) [15].



Figure 8. Changing patterns of permanent teeth (1957–2016) [15].

# 5.3. Data on Oral Health Related Factors

Many factors are thought to be involved in the caries reduction of both deciduous teeth and permanent teeth in Japanese children. They include increased usage of different fluoride strategies, improvement of tooth brushing behavior, reduced sugar consumption as well as improved awareness of oral health through the public oral health check-up system for preschool and school children.

In Japan there is no systemic fluoride use, and only topical fluorides are available. Figure 9 shows the trends in the proportion of persons (1–14 years of age) who received topical fluoride application. In 1969, only 6% of children received topical fluoride application. Recent data shows that this increased to about 60% and indicated a 10 times increase in exposure [15].

The market share of fluoride toothpaste has also increased dramatically from 12% (1985) to 91% in 2015 (Figure 10). According to the National Oral Health Survey, tooth brushing behavior also improved for the whole population (Figure 11). Sugar consumption per person per year decreased from on average 27.5 kg per person in 1970 to16.1 kg in 2015, a difference of 11.4 kg (Figure 12) [16].

These factors, as well as the sufficient numbers in the dental workforce and the universal coverage of the public health insurance system have contributed to the improved oral health of all Japanese people.



Figure 9. Proportions of persons (1-14 years of age) who had received topical fluoride application [15].



Figure 10. Market share of fluoride dentifrice (1985–2015).



□Once/day □Twice/day □3 times and more/day □Sometimes ■No brushing □Unknown

Figure 11. Reported tooth brushing habit (1969–2016) (1 year of age and over) [15].



Figure 12. Sugar consumption per person per year [16].

#### 6. Future Challenges for Japanese Dentistry

Although the oral health status of Japanese people has improved, there still remain many problems to be solved. These include: regional disparities in oral health and the total cost of health care, especially in the elderly. Further, as Japan is subject to many natural disasters, we have to establish an emergency oral healthcare system to cope in times of disaster and to train dental personnel to manage suitable intervention programs. It appears also important technologically to develop a new tele-dental system which can be used in the rural and remote areas of Japan without easy access to dental professionals to access diagnostic and preventive care—this is also one of our challenges for the future.

# 6.1. To Reduce the Regional Difference

Japan consists of 47 prefectures. Figure 13 shows the regional differences in caries prevalence of three-year-olds according to the data from nationwide health examinations of three-year-old children. Caries prevalence in Japanese three-year-old decreased from 77.2% in 1963 to 17.0% in 2015 [17]. However, there remain substantial regional differences. In 2015, the caries prevalence in Okinawa

prefecture (28.9%) was more than twice as high as Aich prefecture (11.2%). The number of carious deciduous teeth (dft) shows the same tendency. At present public dental services are offered based on the same rules and procedures throughout Japan. It might be advisable to develop special intensive preventive programs for high-risk persons or regions.



Figure 13. Regional differences of caries prevalence in 3-year-olds by year [17].

### 6.2. To Decrease the Cost of Health Expenditure

Figure 14 shows the total health expenditure per capita by age group in 2015 [18]. This figure is based on the total fee of both medical and dental public insurance schemes, and excludes the patients' private contribution fees. According to the Survey on Economic Conditions in Health Care in 2015 [19], the proportion of dental expenses provided by the public health insurance scheme is about 85.8% of total dental health expenditure. The proportion of medical expenses borne by private fees was only 1.2% in 2015. So this figure can explain the general outline of Japanese health expenditure between the medical and dental components of the insurance scheme. Personal contributions for dental services are far higher than for medical care.



**Figure 14.** Total health expenditure and dental expenditure per capita by age group (Japan, 2015) (110 yen = 1 US\$) [18].

Total health expenditure per capita is 333,300 yen (3030 US\$), and dental expenditure per capita is 22,300 yen (203 US\$). Dental expenditure occupies 6.7% of total expenditure in general. It is amazing that those aged 65 years and older use 60% of the total health expenditure. There is considerable evidence showing the relationship between oral health and general health. Effective oral health promotion programs targeting younger generations can therefore be expected to contribute to the escalation of medical health expenditure for the elderly population.

# 6.3. Emergency Oral Health Systems in Times of Disaster

As Japan has one of the highest frequencies of natural disaster in the world, it is recognized that special systems in the field of health are necessary as risk management tools [20]. In times of disaster, the ordinary health care system may not function. In March 2011, Japan experienced its strongest-ever recorded earthquake and tsunami disaster, and a nuclear power plant accident in Tohoku area. From this catastrophic experience, we realized that not only is medical support necessary for the population affected, but also that dental support is important to allow the people to maintain health and comfort in times of disaster.

The roles of dental professionals in such times should include the following:

For victims: Identification of victims at the request of police

For survivors: Provision of emergency dental treatment

Oral healthcare for vulnerable people (especially older citizens) Oral health education and oral health promotion materials

In the first stage of disaster, the first dental assessment at a shelter house was conducted by non-dental personnel. Based on their assessment for the need of dental services, dental professionals were sent to the affected area to deliver adequate dental care. An example of dental assessment items at an emergency situation was developed and is shown in Table 4.

To make sure every type of dental personnel could respond appropriately to such an emergency situation, training programs are being provided for the members of Japan Dental Association and Japan Dental Hygienists' Association. Disaster dentistry is now included in the undergraduate dental curriculum in Japan.

| Dental | Checklist Items  | Contents  |  |  |  |  |  |  |  |
|--------|--|---|--|--|--|--|--|--|--|
| D      | Dental high-risk population  | To know the number of the dental high-risk population is<br>important in the affected area. In the shelter house, to check<br>the number of elderly, disabled persons, and<br>pre-schoolchildren and to report them to the emergency<br>disaster office is a high priority. Then the manager of the office<br>can ask for dental support from an unaffected area. |  |  |  |  |  |  |  |
| E      | Environmental settings   | To keep good oral health, it is necessary to check the<br>availability of water and water-supply facilities, not only for<br>drinking but also for mouth-rinsing.   |  |  |  |  |  |  |  |
| N      | Necessary support for oral hygiene behavior                                    | Check people's oral hygiene behavior (brushing).<br>Can they brush by themselves or do they need special care to<br>clean their teeth and mouth?  |  |  |  |  |  |  |  |
| Т      | Tool materials for oral hygiene<br>behavior                                    | Are there enough oral hygiene tool materials in the<br>shelter house?<br>(e.g., toothbrush, toothpaste, dental floss, interdental brush,<br>mouth wash, denture cleaning tablets etc.)  |  |  |  |  |  |  |  |
| A      | Acute dental treatment needs   | Do they need acute dental treatment?<br>Is emergency dental treatment necessary, such as acute pain<br>and loss of dentures?  |  |  |  |  |  |  |  |
| L      | Limitation: Obstacles to receiving<br>dental treatment in the affected<br>area | How much damage to dental facilities (i.e., clinics and hospitals) is there in the affected area?<br>Is a mobile dental service necessary?  |  |  |  |  |  |  |  |

| Fable 4. | Dental | checklist | items fo | r the | peop | ple a | tas | helter | house | in | times | of | disaste | r |
|----------|--------|-----------|----------|-------|------|-------|-----|--------|-------|----|-------|----|---------|---|
|          |        |           |          |       |      |       |     |        |       |    |       |    |         |   |

### 6.4. Tele-Dental Systems in the Remote Areas without Dental Professionals

At present, there are six astronauts working in the International Space Station (ISS). These members are special crews trained to live in the space environment with no access to a dental facility. But in the near future, space technology will develop so ordinary people will also have the chance to travel or live in space.

For the purpose of the astronauts' oral health promotion, the Faculty of Dentistry, Tokyo Medical and Dental University (TMDU) and the Japan Aerospace Exploration Agency (JAXA) cooperated to develop the "Space Oral Health Promotion Project" to tackle the current and the possible dental or oral problems in future long-term space flight [21]. It is a new challenge for us to develop "space dentistry".

In Antarctica, Japan has the Showa Station. The Japanese Antarctic Research Expedition (JARE) team has been engaging in research for more than one year in circumstances without access to a dentist. At present, TMDU conducts tele-dental conferences with doctors in the Antarctica for dental support of JARE members. Real-time diagnosis and adequate advice for dental troubles of JARE members can be provided using an intraoral camera and a TV system.

We believe that the tele-dental system could be expanded for other remote or rural areas with limited or no access to dental professionals. In such situations, oral self-care and prevention of dental diseases are the most important strategies. By giving adequate advice using recent advanced technologies, dentists can help these isolated population groups. Dentistry in the future may contribute to oral health promotion for people everywhere on earth and also in space.

### 7. Conclusions

Japan has developed a system for providing high-quality and appropriate oral health care efficiently. Therefore, the oral health status of the Japanese population has improved markedly. Dental caries in children decreased remarkably. In adults and older populations, untreated decayed teeth decreased and people are keeping more natural teeth than ever before.

Many factors are thought to contribute to these changes. Public oral health services are provided according to the life stage of their populations and these services are mainly conducted by private dental practitioners under contracts with local governments. The number of dental facilities increased and the health insurance system helps by providing easy access to receiving dental treatment at reasonable price. Fluoride usage has increased, and sugar consumption has decreased. People's awareness and behavior toward oral health have also improved. Japanese dentistry is now challenging to solve the newly emerged oral health problems.

Author Contributions: T.Z. prepared the manuscript; T.S. critically reviewed the manuscript; Y.K. supervised and critically reviewed the manuscript. All authors approved the final version of the manuscript.

**Funding:** This paper was partly supported by the "Research Fund of Clinical Study for Industrial Accident and Disease" by Ministry of Health, Labor and Welfare, Japan (170501-01) and the Sciences Research Grant by Ministry of Health, Labor and Welfare, Japan (201315006B).

**Acknowledgments:** We thank the staff at the Department of Oral Health Promotion, Tokyo Medical and Dental University for providing information related to this article.

Conflicts of Interest: The authors declare no conflict of interest.

### References

- 1. Ministry of Foreign Affairs of Japan. Japanese Territory. Available online: https://www.mofa.go.jp/ territory/index.html (accessed on 6 June 2018).
- 2. Ministry of Internal Affairs and Communications. Statistics Japan. Available online: http://www.stat.go.jp/english/index.html (accessed on 6 June 2018).
- 3. Cabinet Office, Government of Japan, GDP 2018. Available online: http://www.esri.cao.go.jp/jp/sna/menu. html (accessed on 6 June 2018).

- 4. Ministry of Health, Labour and Welfare. Survey of Physicians, Dentists and Pharmacists in 2016. Available online: http://www.mhlw.go.jp/english/database/db-hss/dl/spdp\_2016.pdf (accessed on 6 June 2018).
- 5. Ministry of Education, Culture, Sports, Science and Technology. Dental University Admission Quota in 2017. Available online: http://www.mext.go.jp/component/a\_menu/education/detail/\_\_icsFiles/afieldfile/ 2017/11/02/1324090\_4.pdf (accessed on 6 June 2018).
- Ministry of Health, Labour and Welfare. The pass rate of National Board Dental Examination in 2018. Available online: http://www.mhlw.go.jp/general/sikaku/successlist/2018/siken02/about.html (accessed on 6 June 2018).
- Ministry of Health, Labour and Welfare. The Number of Employed Dental Hygienest and Dental Technician in 2016. Available online: http://www.mhlw.go.jp/toukei/saikin/hw/eisei/16/dl/kekka2.pdf (accessed on 6 June 2018).
- 8. Ikegami, N.; Yoo, B.K.; Hashimoto, H.; Matsumoto, M.; Ogata, H.; Babazono, A.; Watanabe, R.; Shibuya, K.; Yang, B.M.; Reich, M.R.; et al. Japanese universal health coverage: Evolution, achievements, and challenges. *Lancet* **2011**, *378*, 1106–1115. [CrossRef]
- 9. Ministry of Health, Labour and Welfare. Vital statistics in Japan—Trends up to 2016. Available online: http://www.mhlw.go.jp/english/database/db-hw/dl/81-1a2en.pdf (accessed on 6 June 2018).
- 10. World Health Organization. Life Expectancy and Healthy Life Expecancy Data. Available online: http://apps.who.int/gho/data/view.main.SDG2016LEXREGv?lang=en (accessed on 6 June 2018).
- 11. Ueno, M.; Yanagisawa, T.; Shinada, K.; Ohara, S.; Kawaguchi, Y. Masticatory ability and functional tooth units in Japanese adults. *J. Oral Rehabil.* **2008**, *35*, 337–344. [CrossRef] [PubMed]
- 12. The Japan Dental Association. The Current Evidence of Dental Care and Oral Health for Achieving Healthy Longevity in an Aging Society: 2015. Available online: https://www.jda.or.jp/pdf/ebm2015En.pdf (accessed on 6 June 2018).
- 13. Fukai, K. Oral Health for Achieving Healthy Longevity in an Aging Society: Evidence and policy. *Int. J. Oral Health* **2017**, *13*, 52–57.
- 14. Ministry of Education, Culture, Sports, Science and Technology. School Oral Health Survey. Available online: http://www.nichigakushi.or.jp/dentist/material/investigation.html (accessed on 6 June 2018).
- 15. Ministry of Health, Labour and Welfare. Report on the Survey of Dental Diseases in Japan 2016. Available online: http://www.mhlw.go.jp/toukei/list/62-17b.html (accessed on 6 June 2018).
- 16. Japan Sugar Refiner's Association. *Year Book of Sugar Statistics;* Japan Sugar Refiners' Association: Tokyo, Japan, 2015.
- 17. Ministry of Health, Labour and Welfare. The Report of Community Health and Health Promotion Services in 2015. Available online: http://www.mhlw.go.jp/toukei/saikin/hw/c-hoken/15/index.html (accessed on 6 June 2018).
- 18. Ministry of Health, Labour and Welfare. National Health Expenditures in Fiscal Year 2015. Available online: https://www.mhlw.go.jp/toukei/saikin/hw/k-iryohi/15/index.html (accessed on 6 June 2018).
- 19. Ministry of Health, Labour and Welfare. Survey on Economic Conditions in Health Care in 2015. Available online: http://www.mhlw.go.jp/bunya/iryouhoken/database/zenpan/jittaityousa/dl/20\_ houkoku\_iryoukikan.pdf (accessed on 6 June 2018).
- 20. Nakakuki, K. Disaster Dentistry–Management of Oral Infectious Diseases to Prevent Aspiration Pneumonia. *Int. J. Oral Health* **2017**, *13*, 5–12.
- 21. Zaitsu, T.; Kawaguchi, Y. Perspectives for Tele-dental System in Space and Antarctic Environments. *Int. J. Oral Health* **2017**, *13*, 13–16.



© 2018 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).