Nutrition and Oral Health in Aging

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Baby Boomers

• don't like hearing gingivitis and periodontitis applied to themselves

• Previous generations accepted tooth loss as a natural part of aging

• Boomers want to know what they can do to keep or restore their oral health,"

Kelly Kaplan, - Dental Concepts.
Over the past 10 years, the number of adults who are edentulous has declined from 31% to 25% for those ages 60+ years, from 9% to 5% for boomers- CDC
Prevalence of Common Diseases in 45–64 year olds

(Winn et al, 1996)
Average Annual/Patient Dental Spending by Age (ADA)

U.S. Dental Spending Remains Flat Through 2012

Authors: Thomas Wall, M.B.A.; Kamyar Nasseh, Ph.D.; Marko Vujicic, Ph.D.
Nutritional Status Survey
- N = 1016
- Mean Age 75 (60-101)
- 64% Female

Race
- 94% Caucasian
- 5% African American
- 1% Other

Education
- 65% High School or less
- 25% College
- 10% Graduate Education

62% Nonsmokers

Nutrition and Oral Health
- N = 392
- Mean Age = 66 (30-91)
- 57% Female

Race
- Caucasian 89.7%
- African American 8.4%
- Other 1.9%

Education 13.4 +/- 2.5

93% Nonsmokers

The NOHS recruited from the inner city to increase minority representation and included Oral Exams and Nutritional Studies
Calcium in 2 studies

Total Calcium Intake in NSS

Calcium Females in NOHS

p < .0001 MW

Dentures
no Dentures
Individuals (especially the elderly) who lack sufficient levels of Vitamin D (Food + supplements) are at a greater risk for developing osteoporosis.
Calcium and Vitamin D – Other studies

- Krall et al., Dietrich et al. have published several papers showing a relationship between Vitamin D, Calcium and Tooth Loss.

- Conversely, higher Calcium intake was associated with lower alveolar bone loss.
Bone Density Study-

As bone is lost at the Spine, Femoral neck and Radius, the Number of Teeth goes Down

BESS DAWSON HUGHES, RAUL GARCIA AND LIZ KRALL-COLABORATORS
Effects of Dentures (partial or full) on Mean Intakes

**Ratio of the Mean Intake of Denture Wearers to Mean Intake of Nonwearers**

<table>
<thead>
<tr>
<th>Vitamin/Element</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A</td>
<td>0.80</td>
</tr>
<tr>
<td>Ascorbic Acid</td>
<td>0.78</td>
</tr>
<tr>
<td>Vitamin B-6</td>
<td>0.76</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>0.74</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.72</td>
</tr>
<tr>
<td>Calories per kg (Cal/kg)</td>
<td>0.70</td>
</tr>
<tr>
<td>Protein per kg (Pro/kg)</td>
<td>0.70</td>
</tr>
</tbody>
</table>

All ratios are significant at the 0.05 level.
The diet of full or partial denture-wearers was lower in dairy, dark green and yellow vegetables, fiber, meat consumed than non-wearers resulting in significantly lower:

- **Cal, Pro, Fat intake 3 day diary** $p<0.0001$
- **CHO** $p<0.0005$
- **Total Intake diet + supplements**
  - Vit A $p<0.0001$
  - Vit C and Folate $p<0.017$
  - Vit B1 $p<0.005$, Vit B2 $p<0.002$, Vit B6 $p<0.0001$, Niacin $p<0.035$
  - Calcium $p<.0001$
  - Vitamin D $p<.0001$
  - Fe $p<.0001$
Dentate vs. Partial or Full Dentures

![Bar chart showing the comparison between dentures and no dentures in dark green and yellow vegetables 3 day kcal consumption.](chart.png)

- **Dentures**:
  - 95.1 kcal

- **No Dentures**:
  - 118.6 kcal

*P > 0.005*
Systematic reviews and meta-analyses of cohort studies indicate that small differences in Fruits and Vegetables intake are associated with reductions in the risk for cardiovascular events.

Increasing F and V consumption by around 100 to 150 g/day decreases:

- stroke by 11%,
- coronary heart disease by 4% to 7%
- diabetes by 10% to 14%

Refined CHO in NSS and NOHS

NSS

NOHS

Baked Desserts

Chips and Crackers

Dentures

no dentures

NSS

NOHS

SUGAR-HS

SUGAR-COL

RCO-HS

RCHO-COL
Crude Fiber, Number of Teeth and Education

![Bar Chart]

- **X-axis**: College and Up to 12
- **Y-axis**: Number of Teeth (0-6)
- **Categories**: <18, 18-24, 25+

NOHS
Weight and Blood values

- The weight of the denture wearer was lower $p > .002$
- The skinfold test of the denture wearer was lower $p > .0001$

Dentures Wearers have lower levels of:
- Plasma Albumin (G/DL) $p > .001$
- Plasma Carotenoids (UG/DL) $p > .0001$
- Plasma Vitamin B12 (PG/ML) $p > .0001$
Associations between the # Teeth and Metabolic Syndrome - NHANES n = 5511

Zhu and Hollis  J Clin. Perio. 2015
Finding in NHANES Study

- Tooth loss was significantly associated with metabolic syndrome ($p = 0.002$) adjusting for age, gender, race/ethnicity, ratio of family income to poverty, physical activity, smoking, and energy intake.

- Compared to participants with full dentition, the odds were
  - 32% higher in those with 21–27 teeth,
  - 55% higher in those with 1–20 teeth
  - 79% higher in edentulous participants.

- The number of natural teeth was **inversely associated** with BMI, waist circumference, blood pressure, fasting plasma glucose and insulin concentrations ($p < 0.01$ for all);

- it was **positively associated** with serum HDL cholesterol concentration ($p = 0.003$).

Zhu and Hollis J Clin. Perio. 2015
Fiber Consumption from 3 Day Food Diaries

ANOVA p > 0.05

Periodontal Pocket Depth
Supplementation with Antioxidants Dental NSS and Periodontal Disease n=133

* Significant p≤0.05
B Vitamin intake and Periodontal Status at Baseline

- B Vitamin Intake (mg)
- Periodontal Disease
  - Healthy

<table>
<thead>
<tr>
<th>B Vitamin</th>
<th>Intake (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>0.91</td>
</tr>
<tr>
<td>B5</td>
<td>3.33</td>
</tr>
<tr>
<td>B6</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>8.36</td>
</tr>
</tbody>
</table>
Odds Ratio for Periodontal Disease by Level of Vitamin C Intake
## Association of Periodontal (mean AL≥1.5) with Vitamin C Intake, n= 12,419) NHANES III

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2.25</td>
<td>2.17-2.33</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Male sex</td>
<td>1.57</td>
<td>1.40-1.76</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current Tobacco User*</td>
<td>4.48</td>
<td>3.81-5.27</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Gingival Bleeding</td>
<td>11.59</td>
<td>7.72-17.39</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>1.19</td>
<td>1.05-1.33</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

*Tobacco user had a significantly lower Vit C consumption*
Conclusions of NOHS

- Those people who had one denture had a significantly lower consumption of 20 key nutrients than people with teeth.

- This represented a 20% decrease
CONCLUSION OF NSS

- The diet of full or partial denture-wearers was lower in dairy and vegetable consumption than that of individuals with their own teeth.

- Denture-wearers had a lower intake of key nutrients that are important to both oral and general health.

- With their insufficient nutrient consumption, denture-wearers may be at an increased risk for cancer, osteoporosis, and other diseases that are already common for elderly populations.
The Link between Oral Disease and Nutrition goes both ways
88%- 60+ take medications and the number will grow and so will side effects.

- 76% used two or more prescriptions,
- 36.7 % took five or more prescription

Demographics of Study Population
Inner City Boston n=1058

Number
- Meds 912
- No Meds 146

Mean Age
40-80
- Med 64
- No-med 62

Sex
- Med- 57% female
- No med 52% male

Meds
- Med 3.5
- No Med-0

Number of Teeth
- Med 23.1
- No-med 24.9

Freq of Dental Visits
- Med 1.9
- No-med 1.2

Smoking
- Med 8.4% current 33.4% past
- No- med 16.2% past 16.2%

Floss
- Med 2
- No- med 1
Single Calibrated Caries Examiner and Periodontal Examiner

- Training and Calibration were performed annually
- Repeatability was performed on 5% of the subjects with a 0.9 repeatability for the Examiner
Coronal Increment by Medication Class

Diabetes
NSAIDS
Blood Pressure
Chol
Psych
BP&P Psych

Tufts University
Multiple Medications Affect on Root Increments as Well
Metabolic Syndrome

Caries multiple linear regression model:
BMI (p=0.005)
African American (p=0.003)
Age (p=0.006)

Mean Age & DMFS in Metabolic Sx vs. Non-Metabolic Sx
Dietary Methods

- Patients completed modified Block food frequency questionnaire.
- Patients provided all dietary supplements taken.
- Analysis of data provided daily intake levels of patient’s vitamin A and beta-carotene quantified in activity retinol equivalents.
<table>
<thead>
<tr>
<th></th>
<th>Your Serving Size</th>
<th>How Often?</th>
<th>When?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Medium Serving</td>
<td>S</td>
<td>M</td>
</tr>
<tr>
<td>Cantaloupe (in season)</td>
<td>1/2 medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doughnuts, Cookies, Cake, Pastry</td>
<td>1/2 medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapefruit, grapefruit juice</td>
<td>6 oz.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweet potatoes, yams</td>
<td>1/2 cup</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hamburger, cheeseburger, meetloaf</td>
<td>1 medium</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Consumption of Sugars in Psychiatric vs. Healthy

- Cakes & Cookies: Psych 22.2 vs. Healthy 5.88
- Candy: Psych 11.3 vs. Healthy 4.54

Healthy average is 37.4, Psychiatric average is 56.8.
## Predictors of Caries Incidence

<table>
<thead>
<tr>
<th>Variable</th>
<th>$t$</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychiatric Medications</td>
<td>3.157</td>
<td>0.002</td>
</tr>
<tr>
<td>Previous caries</td>
<td>4.952</td>
<td>0.0001</td>
</tr>
<tr>
<td>Sugar</td>
<td>3.124</td>
<td>0.002</td>
</tr>
</tbody>
</table>

Age, sex, flossing, frequency of visits, unstimulated salivary flow, smoking and HBP not significant in the model.
1 year increments in Attachment Loss

Chart Title

- Psychiatric
- Blood Pressure
- Diabetes

Loss of Attachment

- 1.23
- 1.33
- 1.47
- 1.1
- 1.15
- 1.2
- 1.25
- 1.3
- 1.35
- 1.4
- 1.45
- 1.5

Loss of Attachment
Intervention Studies have shown TX-debridement, antimicrobial solution, doxycycline -- chosen for its anticollagenase activity -- resulted in significant short-term improvement in glucose.

A control group receiving only debridement did not share the gains in periodontal health, or reduced hyperglycemia that the treatment group experienced.
Medication Induced Xerostomia Study (n=980) Two Sub- groups Were Identified

- **Group NS** - was not taking any supplementation n= 195
  - Mean age 65
  - 64% female, 46% male

- **Group S** – was taking 1 multivitamin a day n=372
  - Mean age 65
  - 61% female, 39% male
Percent of Sites with Severe Periodontal Disease at 1 year

MW p ≤ 0.021
On comparing, the group not supplementing with calcium showed a statistically significant increase in the percentage of sites with PD ≥ 5 mm (p=0.005, MW)
The mean (SE) increase for the group not supplementing with calcium was 1.51 (0.29) % and for calcium supplementing group was 0.70 (0.31) %
Vitamin A & β-carotene in Food + Supplements affect on Periodontal Disease Increments

Group Food and Vitamin + Beta carotene
Consequences of Salivary Hypofunction

Reduced Salivary Flow

Increased Infection
- Salivary Gland Infections
- Swelling
- Sialoliths
- Candidiasis
- Periodontal Disease

Loss of Remineralization
- Dental Caries
- Erosion

Decreased Lubrication
- Trouble Speaking
- Trouble Swallowing
A chronic, autoimmune inflammatory disorder of exocrine glands, characterized by diminished lacrimal and salivary gland secretion ("sicca syndrome") in association with autoantibody production or another connective tissue disorder.

Sjögren’s Syndrome
One of the most common autoimmune rheumatic diseases

- 9:1 ratio of women : men
- 1-4 million individuals affected in USA

Typical diagnosed patient is perimenopausal or postmenopausal female

Documented pediatric cases exist
Increased Dryness & Erythema
Consumption of Sugars in Radiation, Medication and Healthy Control

- Radiation: 50.0
- Medication: 48.8
- Healthy: 35.1

Categories:
- liquid
- semisolid
- solid
- sticky
- SDS
DNA Count of Oral Microbiome

DNA probe counts x100,000

- Sjogren's
- Healthy
- Periodontitis
MEAN % (± SEM) OF 40 BACTERIAL SPECIES IN SUBGINGIVAL PLAQUE SAMPLES

<table>
<thead>
<tr>
<th>% DNA probe count</th>
<th>Health</th>
<th>Periodontitis</th>
<th>Sjogren's</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Health**
- **Periodontitis**
- **Sjogren's**

- Actinos
- Purple
- Yellow
- Green
- Orange
- Red
- Other

**Note:** The chart shows the mean percentage of DNA probe count for each bacterial species in subgingival plaque samples across different conditions (Health, Periodontitis, Sjogren's). The bars are color-coded to represent different conditions and bacterial species. The significance levels (***, **) indicate statistical differences between conditions.
Mean (± SEM) Total DNA Probe Counts in Supragingival Plaque Samples from Sjogren’s and Control Subjects

Funded by NIDCR DE14368
Mean (+ SEM) % DNA probe count in Supragingival Sjögren's and Control Plaque Samples

Control (n = 53)
Sjogren's (n = 57)

Funded by NIDCR DE14368
Dietary Findings for Sjögren's Patients

- Consumed less Omega 3 fatty acids
- Consumed more carbohydrates
- Consumed more sodium
- Consumed more tryptophan
- Consumed more caffeine (204mg/116mg)

Caffeine has an antinociceptive, stimulatory effect on secretion (amplifies cholinergic transmission)

With David Sullivan
Intervention with Omega 3 supplements

- Omega 3 fatty acids
- Block the gene expression of the pro-inflammatory cytokines tumor necrosis factor alpha (TNF-a), interleukin-1a (IL-1a), interleukin-1b (IL-1b), and cyclooxygenase (COX-2).
- It is proposed that the consumption of omega-3s reduce inflammation and block cytokine production which interferes with lacrimal and salivary gland secretion.
Periodontal Pockets improved

* p<0.002
Effect of Omega 3 on Unstimulated Salivary Flow

Mean US flow significantly increased for the omega-3-treated group [0.0777 ± 0.014 ml/min at baseline vs. 0.117 ± 0.02 ml/min at 3 months (p<0.01)] but not for placebo treatment [0.063 ± 0.017 ml/min at baseline vs. 0.094 ± 0.023 ml/min at 3 months (p=0.132)].
Dry-Eye Symptoms

- Flaxseed/Fish Oil Omega-3: 50%
- Placebo: 50%

Dry Mouth Symptoms

- Flaxseed/Fish Oil Omega-3: 60%
- Placebo: 40%

* p<0.0002
OR=2.9

Tufts University
Vitamins A and E may influence the autoimmune processes

- Fat-soluble vitamins possess immunoregulatory properties and have been implicated in the development of autoimmune diseases.
- The levels of vitamins A and E are different in patients with SS.
- There is a positive correlation between NK, Th1 cells and the plasma levels of vitamin E.
- Th1/Th2 ratio showed a positive correlation with.
- The levels of vitamins A and E.
Follow-up Mortality Studies were conducted at the Tufts – NSS and NOHS
NSS Methods for Survival Analysis

- Death Records were obtained using the National Death Index and Obtaining copies of death Certificates, with IRB approval,
  - to determine cause of death of the volunteers
  - To determine factors affecting Survival
## NSS Survival using Proportional Hazzard Regression N=602

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Error</th>
<th>Chi-Square</th>
<th>Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.19638</td>
<td>0.01786</td>
<td>120.8353</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Sex</td>
<td>0.23527</td>
<td>0.13555</td>
<td>3.0126</td>
<td>0.0826</td>
</tr>
<tr>
<td>Dentures</td>
<td>0.33423</td>
<td>0.15808</td>
<td>4.4703</td>
<td>0.0345</td>
</tr>
<tr>
<td>Wine years</td>
<td>-0.00958</td>
<td>0.00401</td>
<td>5.720</td>
<td>0.0168</td>
</tr>
<tr>
<td>Income*</td>
<td>0.0000221</td>
<td>9.45913E-6</td>
<td>5.4568</td>
<td>0.0195</td>
</tr>
<tr>
<td>Smoking years</td>
<td>0.00697</td>
<td>0.00335</td>
<td>4.3220</td>
<td>0.0376</td>
</tr>
</tbody>
</table>
NOHS Methods

- Death Records were searched, with IRB approval,
  - to determine cause of death of the volunteers.

- This data was compared for baseline data on:
  - Number of teeth present,
  - Number of root tips present,
  - Number of surfaces with pocket depth ≥4 mm.
Data was obtained after 30 years from National Death Index & Massachusetts Death Registry

Deceased 82.76

- Race -
  - 90.9% Caucasian
  - 8.5% African Americans
  - .6% Asians
- 51.2% were females
- Had an average of 12.9 years of education

Survivors 84.01

- Race
  - 88% - Caucasian,
  - 9%-African Americans
  - 3% Asian
- 61.1% were females
- Had an average of 13.8 years of education
The People that Survived Had More Teeth - Dental NOHS Study

$p \leq 0.0001$
<table>
<thead>
<tr>
<th></th>
<th>Mean # teeth</th>
<th>Education</th>
<th>Dead</th>
</tr>
</thead>
<tbody>
<tr>
<td>23+</td>
<td>25.71</td>
<td>13.68 year</td>
<td>46%</td>
</tr>
<tr>
<td>&gt;23</td>
<td>15.12</td>
<td>12.65 years</td>
<td>54%</td>
</tr>
</tbody>
</table>

African American had fewer teeth and were less well educated  p > .040
Survival and Number of Teeth N 7684 (20-89-12 year survival- Sweden)

Holmlund et al J Perio 2010 81:870-876
Conclusions

- Loss of Dentition may lead to poorer nutritional quality of the diet and can ultimately affect survival.

- This was found to be true based on mortality data from 2 Nutritional Studies.