Current Technologies in Diet Assessment & Intervention

Tech Summit: Innovative Tools for Assessing Diet & Physical Activity for Health Promotion

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Disclosure

President and stock holder in Viocare which developed and licenses several products described in the presentation, VioScreen, FIVR, and VioDine
Diet Assessment Problem

Need:
• Improve the accuracy of food intake assessments

Problem:
• Suffer from inaccurate recall
• Time-consuming, tedious, and/or intrusive
• Costly

Solution:
• Use of innovative technology has potential
  – Web/mobile systems to improve recall
  – Mobile devices to capture intake in real-time
Diet Assessment Techniques

• Questionnaires/Surveys – Food Frequency Questionnaires (FFQ)
• 24 hour diet recalls
• Food records
  – Estimated
  – Weighed
• Metabolic feeding study
Food Frequency Questionnaire
Diet Assessment System for Cancer Control Applications

aka: VioScreen

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Alan R. Kristal, Dr PH, Fred Hutchinson Cancer Research Center
Marci K. Campbell, PhD, Univ. of North Carolina, Chapel Hill
Electra D. Paskett, PhD, The Ohio State University
Phyllis J. Stumbo, PhD, University of Iowa

NCI Grant# R44 CA097560
VioScreen FFQ Dietary Assessment

• Browser based (PC, iPad, etc.)
• Individual runs assessment from home or office/research center
• HIPAA compliant
• Based on the Fred Hutchinson Cancer Research Center’s validated paper Food Frequency Questionnaire (Women’s Health Initiative)

Reduces response burden by collecting information only about those foods that are regularly consumed
• 400 Foods -> 125 Questions -> 19 Food Groupings
• Proprietary design enables capture of 90 day dietary history in ~25 minutes
The Science of Dietary Assessment

• Unique food intake presentation of portion size (1200+ images) dramatically increases user accuracy
• Images improve and standardize reporting portion sizes
• Context based on eating trends and behaviors of typical American diet (developed a Swiss FFQ with NIHS & SNS)

• Uses complex branching algorithms to collect details about selection and preparation of foods requiring additional specification to apply correct nutrient values
• Uses U of Minnesota’s NDSR food nutrient database
Select Foods Consumed at > Once Per Month

### Cereals and Breads

<table>
<thead>
<tr>
<th>Food Selection</th>
<th>Food Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cold breakfast cereals</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cooked breakfast cereals and grits</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pancakes, French toast and waffles</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Muffins, scones, croissants and biscuits</strong></td>
<td></td>
</tr>
<tr>
<td><strong>White breads, including bagels, rolls and English muffins</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Whole grain breads, including whole grain bagels, rolls and English muffins</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cornbread and corn muffins</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Corn tortillas</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Flour tortillas</strong></td>
<td></td>
</tr>
</tbody>
</table>
Branching: Immediate Adjustment Questions

Cereals and Breads

Section 1 of 29

Cold Cereals

Select those foods you eat at least once a month. Press the “Next” button if you did not eat any of these foods.

- Sweetened (such as Apple Jacks®, Cocoa Puffs®, Fruit Loops®, Lucky Charms®, Trix®)
- Highly-fortified (such as Total®, Product 19®, Smart Start®)
- Mostly or all whole grain (such as Cheerios®, Grape-Nuts®, Quaker Natural Granola®, Raisin Bran®, Shredded Wheat®)
- Standard (such as Corn Chex®, Corn Flakes®, Kellogg’s Crispix®, Quaker 100% Natural Granola®, Rice Krispies®)

Done
Frequency & Portion Size Questions

Cereals and Breads

Section 1 of 20

How often did you eat...

Mostly or all whole grain?
Include Cheerios®, Grape-Nuts®, Quaker Natural Granola®, Raisin Bran® and Shredded Wheat®.

1 per month
2-3 per month
1 per week
2 per week
3-4 per week
5-6 per week
1 per day
2+ per day

Usual portion size?

1/2 cup (small bowl)
1 cup (regular bowl)
1 1/2 cups (large bowl)
2 cups

Skip this question (didn’t really eat)
Additional Adjustment Questions: Got Milk?

Milk on cold cereal

Did you use milk on cold cereal?

Yes  No
Another Form of Adjustments
Number of Portion Size Images 3 to 6

Mixed Dishes and Pasta

How often did you eat...

Spaghetti, lasagna or other pasta with tomato sauce made without meat?

1 per month  2-3 per month  1 per week  2 per week  3-4 per week  5-6 per week  1 per day  2+ per day

Usual portion size?

1/2 cup (small bowl)  1 cup (medium bowl)  1 1/2 cups (large bowl)  2 cups

2 1/2 cups  3 cups

Skip this question (didn’t really eat)
Swiss FFQ

Developed with Nestlé Institute of Health Sciences, Swiss Society for Nutrition SGE & Viocare

Sélectionnez les aliments que vous avez mangés au moins une fois par mois

1. Sélectionnez les aliments, puis cliquez sur "Suivant". Si vous n'avez mangé aucun des ces aliments, cliquez sur "Suivant".

- Tomates
- Carottes crues
- Carottes cuites
- Légumes racine (sauf carottes et pommes de terre)
- Légumes "fruit" (sauf tomate) comme aubergine et poivron
- Légumes choux, comme le chou fleur ou brocoli
- Légumes feuille comme épinards ou bettes
- Légumes "oignons" tels que poireau, oignon, échalote
- Légumes "légumineux" tels que haricots verts et petits pois
- Autres légumes tels que asperges, céleri ou maïs
- Avocat
Audience Specific Reporting

- Reports create basis for dietary counseling
- Summary (patient/consumer)
- Educational/tutorial (patient/consumer)
- Diagnostic (physician/dietitian/clinician)
- Comparative (assessment 1 to assessment n)
- Custom situation (e.g., diabetes counseling)
- Healthy Eating Index (HEI) dietary scoring system
- Exports for researchers
Report Highlights

- Benchmarks dietary behaviors vs. recommended dietary guidelines
- Immediate analysis of over 160+ nutrient and food components
- Analysis by food types, e.g. sweets, for simplified planning
- 14 serving calculations including Alcohol, Calcium, Fried Food and Whole Grain Servings

- Suggests foods to overcome identified dietary deficiencies
- Guidance to achieve a healthy diet not just weight control
- BMI, EER, Energy Requirements
Validation Study Results

- 100% thought the VioScreen was easy to use
- 95% agreed that the food photos helped in selecting portion sizes
- 93% rated VioScreen as either great or excellent
- 99% agreed they would complete VioScreen if asked by a doctor
- Highly accurate
  - Correlation coefficients: macronutrient intake of two VioScreen sessions compared to six 24-hour recalls:

<table>
<thead>
<tr>
<th>Macronutrient</th>
<th>Correlation Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat</td>
<td>0.82</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>0.79</td>
</tr>
<tr>
<td>Alcohol</td>
<td>0.90</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>0.84</td>
</tr>
<tr>
<td>Protein</td>
<td>0.67</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>0.85</td>
</tr>
</tbody>
</table>

- The inter-method reliability was higher for VioScreen than for other paper FFQs currently used in major epidemiological research studies

Customized Assessment Portal

- Lifestyle data collection still uses a lot of paper forms
- Requests to automate, self-administer surveys, automatic analysis
- Make it easy to collect, store, and analyze data
- Combine VioScreen with physical activity questionnaire and custom surveys
- Built in protocol to customize order of questionnaires and timeframe
Dietary Intervention: Personalized Nutrition Counseling Using Dietary Patterns
**Healthy Eating Index (HEI)**

New method added to VioScreen to generate automated personalized nutrition counseling based on HEI dietary pattern analysis.

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### HEI-2010 Component Table

<table>
<thead>
<tr>
<th>Component</th>
<th>Maximum</th>
<th>Standard for maximum score</th>
<th>Standard for minimum score of zero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit</td>
<td>5</td>
<td>≥ 0.8 cup equiv./1,000 kcal</td>
<td>No fruit</td>
</tr>
<tr>
<td>Whole Fruit</td>
<td>5</td>
<td>≥ 0.4 cup equiv./1,000 kcal</td>
<td>No whole fruit</td>
</tr>
<tr>
<td>Total Vegetables</td>
<td>5</td>
<td>≥ 1.1 cup equiv./1,000 kcal</td>
<td>No vegetables</td>
</tr>
<tr>
<td>Greens and Beans</td>
<td>5</td>
<td>≥ 0.2 cup equiv./1,000 kcal</td>
<td>No dark-green vegetables, beans, or peas</td>
</tr>
<tr>
<td>Whole Grains</td>
<td>10</td>
<td>≥ 1.5 ounce equiv./1,000 kcal</td>
<td>No whole grains</td>
</tr>
<tr>
<td>Dairy</td>
<td>10</td>
<td>≥ 1.3 cup equiv./1,000 kcal</td>
<td>No dairy</td>
</tr>
<tr>
<td>Total Protein Foods</td>
<td>5</td>
<td>≥ 2.5 ounce equiv./1,000 kcal</td>
<td>No protein foods</td>
</tr>
<tr>
<td>Seafood and Plant Proteins</td>
<td>5</td>
<td>≥ 0.8 ounce equiv./1,000 kcal</td>
<td>No seafood or plant proteins</td>
</tr>
<tr>
<td>Fatty Acids</td>
<td>10</td>
<td>(PUFAs + MUFAs)/SFAs ≥ 2.5</td>
<td>(PUFAs + MUFAs)/SFAs ≤ 1.2</td>
</tr>
</tbody>
</table>

### Moderation (higher score indicates lower consumption)

<table>
<thead>
<tr>
<th>Component</th>
<th>Maximum</th>
<th>Standard for maximum score</th>
<th>Standard for minimum score of zero</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refined Grains</td>
<td>10</td>
<td>≤ 1.8 ounce equiv./1,000 kcal</td>
<td>≥ 4.3 ounce equiv./1,000 kcal</td>
</tr>
<tr>
<td>Sodium</td>
<td>10</td>
<td>≤ 1.1 gram/1,000 kcal</td>
<td>≥ 2.0 grams/1,000 kcal</td>
</tr>
<tr>
<td>Empty Calories</td>
<td>20</td>
<td>≤ 19% of energy</td>
<td>≥ 50% of energy</td>
</tr>
</tbody>
</table>

US HEI Scores

- Total score of more than 80 considered “good”*
- Scores of 51-80 indicate “needs improvement”
- Scores of less than 51 considered “poor”


USDA CNPP Nutrition Insight 51 February 2013 report – Diet Quality of Americans in 2001-02 and 2007-08 as Measured by the Healthy Eating Index-2010
Higher Diet Quality Is Associated with Decreased Risk of All-Cause, Cardiovascular Disease, and Cancer Mortality among Older Adults\textsuperscript{1,2}

Jill Reedy,\textsuperscript{3} Susan M. Krebs-Smith,\textsuperscript{3} Paige E. Miller,\textsuperscript{5} Angela D. Liese,\textsuperscript{6} Lisa L. Kahle,\textsuperscript{7} Yikyung Park,\textsuperscript{4} and Amy F. Subar\textsuperscript{3}

### TABLE 4
Multivariate HRs (95\% CIs) for mortality according to quintiles of diet quality indices for the HEI-2010, AHEI-2010, aMED, and DASH score among men (n = 242,321) in the NIH-AARP Diet and Health Study\textsuperscript{1}

<table>
<thead>
<tr>
<th>Index and quintile</th>
<th>Range of index score$^2$</th>
<th>n</th>
<th>Any deaths</th>
<th>Follow-up</th>
<th>All-cause mortality (n, person-years)</th>
<th>CVD deaths</th>
<th>CVD mortality (n)</th>
<th>Cancer deaths</th>
<th>Cancer mortality (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>48,464</td>
<td>13,746</td>
<td>643,181</td>
<td>1.00 (1.00, 1.00)</td>
<td>3633</td>
<td>1.00 (1.00, 1.00)</td>
<td>4880</td>
<td>1.00 (1.00, 1.00)</td>
</tr>
<tr>
<td>HEI-2010 1</td>
<td>18.2–55.2</td>
<td>48,464</td>
<td>13,746</td>
<td>643,181</td>
<td>1.00 (1.00, 1.00)</td>
<td>3633</td>
<td>1.00 (1.00, 1.00)</td>
<td>4880</td>
<td>1.00 (1.00, 1.00)</td>
</tr>
<tr>
<td>2</td>
<td>55.2–62.6</td>
<td>48,464</td>
<td>11,449</td>
<td>656,332</td>
<td>0.91 (0.88, 0.93)</td>
<td>3250</td>
<td>0.95 (0.91, 1.00)</td>
<td>3936</td>
<td>0.90 (0.86, 0.94)</td>
</tr>
<tr>
<td>3</td>
<td>62.6–68.3</td>
<td>48,465</td>
<td>10,532</td>
<td>662,729</td>
<td>0.86 (0.83, 0.88)</td>
<td>3009</td>
<td>0.90 (0.86, 0.95)</td>
<td>3579</td>
<td>0.85 (0.82, 0.89)</td>
</tr>
<tr>
<td>4</td>
<td>68.3–74.1</td>
<td>48,464</td>
<td>9908</td>
<td>664,187</td>
<td>0.83 (0.81, 0.85)</td>
<td>2901</td>
<td>0.89 (0.85, 0.94)</td>
<td>3212</td>
<td>0.79 (0.75, 0.83)</td>
</tr>
<tr>
<td>5</td>
<td>74.1–96.1</td>
<td>48,465</td>
<td>9245</td>
<td>668,900</td>
<td>0.78 (0.76, 0.80)</td>
<td>2704</td>
<td>0.85 (0.80, 0.89)</td>
<td>3039</td>
<td>0.76 (0.72, 0.80)</td>
</tr>
</tbody>
</table>

### TABLE 5
Multivariate HRs (95\% CIs) for mortality according to quintiles of diet quality indices for the HEI-2010, AHEI-2010, aMED, and DASH scores among women (n = 182,342) in the NIH-AARP Diet and Health Study\textsuperscript{1}

<table>
<thead>
<tr>
<th>Index and quintile</th>
<th>Range of index score$^2$</th>
<th>n</th>
<th>Any deaths</th>
<th>Follow-up</th>
<th>All-cause mortality (n, person-years)</th>
<th>CVD deaths</th>
<th>CVD mortality (n)</th>
<th>Cancer deaths</th>
<th>Cancer mortality (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>36,468</td>
<td>8033</td>
<td>500,136</td>
<td>1.00 (1.00, 1.00)</td>
<td>1987</td>
<td>1.00 (1.00, 1.00)</td>
<td>2720</td>
<td>1.00 (1.00, 1.00)</td>
</tr>
<tr>
<td>HEI-2010 1</td>
<td>18.5–59.3</td>
<td>36,468</td>
<td>8033</td>
<td>500,136</td>
<td>1.00 (1.00, 1.00)</td>
<td>1987</td>
<td>1.00 (1.00, 1.00)</td>
<td>2720</td>
<td>1.00 (1.00, 1.00)</td>
</tr>
<tr>
<td>2</td>
<td>59.3–66.1</td>
<td>36,468</td>
<td>6481</td>
<td>508,788</td>
<td>0.88 (0.85, 0.91)</td>
<td>1669</td>
<td>0.90 (0.85, 0.97)</td>
<td>2159</td>
<td>0.89 (0.84, 0.94)</td>
</tr>
<tr>
<td>3</td>
<td>66.1–71.3</td>
<td>36,469</td>
<td>6141</td>
<td>509,665</td>
<td>0.88 (0.85, 0.91)</td>
<td>1506</td>
<td>0.87 (0.81, 0.93)</td>
<td>2113</td>
<td>0.92 (0.87, 0.98)</td>
</tr>
<tr>
<td>4</td>
<td>71.3–76.4</td>
<td>36,468</td>
<td>5633</td>
<td>513,007</td>
<td>0.82 (0.79, 0.85)</td>
<td>1439</td>
<td>0.82 (0.76, 0.88)</td>
<td>1922</td>
<td>0.85 (0.80, 0.90)</td>
</tr>
<tr>
<td>5</td>
<td>76.4–96.2</td>
<td>36,468</td>
<td>5249</td>
<td>514,258</td>
<td>0.77 (0.74, 0.80)</td>
<td>1374</td>
<td>0.79 (0.73, 0.85)</td>
<td>1837</td>
<td>0.82 (0.77, 0.87)</td>
</tr>
</tbody>
</table>
HEI Reporting – Overall & Subcomponent Scores

• Provide the user a report with an overall “grade” of their diet based on HEI score:
  • Good > 80
  • Needs Improvement 50 – 80
  • Poor < 50
• List details of the user’s 12 HEI subcomponent scores that make up the overall score

<table>
<thead>
<tr>
<th>Food Group</th>
<th>Your Score/Max</th>
<th>Your Results</th>
<th>Food Group Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fruit</td>
<td>(8/10)</td>
<td>Poor. You are well below the recommended amount of this type of food. Work with your Practitioner to learn how to get more of this in your diet.</td>
<td>All forms of fruit including fruit juice.</td>
</tr>
<tr>
<td>Whole Fruit</td>
<td>(1/5)</td>
<td>GOOD! You are eating the recommended amount of the best type of foods. Keep up the good work!</td>
<td>All forms of vegetables except fruit juice.</td>
</tr>
<tr>
<td>Total Vegetables</td>
<td>(3/5)</td>
<td>Needs Improvement. Not so good, you are not eating enough of these foods, even less than average. Ask your Practitioner to suggest ways to get more variety and just more.</td>
<td>All forms of vegetables or vegetable juice.</td>
</tr>
</tbody>
</table>
HEI Automated Feedback

- Report based on FFQ food selections and HEI subcomponent scores
- Use HEI subcomponents to recommend up to 3 very personalized food behavior changes
- Suggest a new food or an increase in either portion size or frequency of current food
- List the HEI improvement based on change. Goal raise user’s HEI score by 5 pts. in 6 months

### Food Groups to Reduce – Dietary Recommendations

<table>
<thead>
<tr>
<th>Refined Grains</th>
<th>Asian-style (stir-fried) noodles and rice, such as chow mein, fried rice and pad Thai</th>
<th>Chicken and turkey (roasted, stewed, grilled or broiled), with skin</th>
<th>Peaches, nectarines and plums</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRENT:</td>
<td>1 1/2 cups (large bowl) (2+ per day)</td>
<td>3 pieces (1/2 chicken), 6 slices (8 oz) (5-6 per week)</td>
<td>2 peaches, 1 cup (1 per day)</td>
</tr>
<tr>
<td>RECOMMENDED:</td>
<td>1/2 cup (small bowl) OR 1 per day bowl</td>
<td>1 piece (1/4 chicken), 3 slices (4 oz) OR N/A</td>
<td>1 peaches, 1/2 cup OR 3-4 per week</td>
</tr>
<tr>
<td>HEI IMPACT:</td>
<td>.5 or .7</td>
<td>.3 or .4</td>
<td>.2 or .1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sodium</th>
<th>All other cheese, such as American, cheddar or cream cheese, including cheese used in cooking</th>
<th>Chicken and turkey (roasted, stewed, grilled or broiled), with skin</th>
<th>Bacon and breakfast sausage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRENT:</td>
<td>2 slices (2 oz), 1/2 cup shredded, 4 tablespoons soy cream cheese (2-3 per month)</td>
<td>3 pieces (1/2 chicken), 6 slices (8 oz) (5-6 per week)</td>
<td>3-4 strips bacon, 2 links sausage (3-4 per week)</td>
</tr>
<tr>
<td>RECOMMENDED:</td>
<td>1 slice (1 oz), 1/4 cup shredded, 2 tablespoons soy cream cheese</td>
<td>1 piece (1/4 chicken), 3 slices (4 oz) OR N/A</td>
<td>2 strips bacon, 1 links sausage OR 1 per day</td>
</tr>
<tr>
<td>HEI IMPACT:</td>
<td>.5 or .7</td>
<td>.3 or .4</td>
<td>.2 or .1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Empty Calories</th>
<th>Asian-style (stir-fried) noodles and rice, such as chow mein, fried rice and pad Thai</th>
<th>Chicken and turke (roasted, stewed, grilled or broiled), with skin</th>
<th>Peaches, nectarines and plums</th>
</tr>
</thead>
<tbody>
<tr>
<td>CURRENT:</td>
<td>1 1/2 cups (large bowl) (2+ per day)</td>
<td>3 pieces (1/2 chicken), 6 slices (8 oz)</td>
<td>2 peaches, 1 cup (1 per day)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 peaches, 1 cup (1 per day)</td>
<td></td>
</tr>
</tbody>
</table>
24 Hour Dietary Recall
What is ASA24?

• Fully automated, web-based, self-administered 24-hour dietary assessment tool
  • Web-based system for probing, coding, and calculation of intakes
• Developed by NCI and Westat
  • Format based on Automated Multiple-Pass Method (AMPM) interviewer-administered recalls collected in NHANES
• Publicly available at no cost to researchers
• Allows researchers to collect multiple recalls or records in large scale nutrition research
How it’s being used and how to gain access

• Since June 2009:
  • Number of studies registered to use ASA24: >2800
  • Number of recalls/records collected: >265,000

• Number of studies registered to use ASA24-2016: >500
Overview of the ASA24 system

Investigators can:
- monitor status of respondents' responses
- request data files
- utilize resources for computing HEI scores and nutrient/food group analyses

Respondents report:
- meals and snacks
- times of meals and snacks
- supplements consumed
- foods consumed
- amounts consumed
Details pass
Mobile Based Food Intake Records
Mobile Food Intake Tracking

- Consumer oriented mobile apps
- Mobile handheld spectrometer devices
- Research/clinical quality mobile trackers
### Mobile Consumer Phone App – MyFitnessPal

#### Lunch
- **Penne Pasta With Vodka Sauce**
  - Homemade, 1 cup
  - 367 cal

#### Dinner
- **Puddings, chocolate, ready-to-eat**
  - 1 container refrigerated, 4 oz container
  - 153 cal

#### Snacks
- **Toast With Peanut Butter and Jelly**
  - Homemade, 1 sandwich
  - 280 cal

#### Search Results: Eggs
- **Egg**
  - Egg, 1 large egg (50g), 70 calories
- **Egg, whole, cooked, fried**
  - 1 large, 90 calories
- **Egg, whole, cooked, poached**
  - 1 large, 72 calories
- **Egg, Boiled**
  - Egg, 1 large egg (50 g), 70 calories
- **Poached Egg**
  - Egg, 1 Large Egg (50g), 78 calories
- **Bagels, egg**
  - 1 oz, 79 calories
Mobile Phone App – MealSnap (Mechanical Turk)
Mobile Device – Airo Wristband
Mobile Device – Healbe GoBe

GoBe™
The Original 100% Automatic Body Manager™
The only way to automatically measure calorie intake.
Mobile Device – TellSpec
A spectrometer can determine the nutritional value and caloric content of single piece of fruit. (Target)
Here we see the nutritional values of scanned cheese. The numbers reported by SCiO were within about 10 percent of the nutritional information on the cheese packaging. It's a margin of error that's considerably less than the FDA's own requirements.
**Hypothesis:** By reducing the total number of chews per meal (without participant’s knowledge) with Just-in-Time (JIT) feedback from the sensor, the mass ingested and energy intake can be reduced.

**Methods:** Three meals: (1) Baseline measurement of total mass ingested and required total chew counts (from sensor), (2) meal with same target chews (100% target visit) and (3) meal with target chews reduced by 25% of the baseline.

**Results:** The JIT feedback from the wearable system towards a lower goal (25% reduction) was successful in the reduction of the amount ingested (by 10%), compared to the baseline and 100% target visits.
Genes, Environment, and Health Initiative (GEI)

• NIH-wide, 4 year program
• Aims to better understand the genetic and environmental contributions to health and disease
• $40M/y in FY07- FY10
• Exposure Biology Program Areas
  – Chemical Exposures (NIEHS)
  – Diet and Physical Activity (NCI/NHLBI)
  – Psychosocial Stress and Addictive Substances (NIDA)
  – Biological Response Indicators of Environmental Stress (NIEHS)
The eButton

The device is unobstructive

Food portion size measurement using virtual reality

Advanced electronic design

Summary of major activity during a day
Technology Assisted Dietary Assessment (TADA) End-to-End System

1. User + TADA app
2. Images + Metadata
3. Food Identification Results
4. Review and Confirmation
5. Server
6. Researcher + Web app

- Image Analysis
  - Preprocessing
  - Segmentation
  - Food Identification

- Image Analysis Refinement
  - Volume Estimation

- Database Indexing
  - Energy & Nutrient Analysis

Example represents architecture of the TADA image-based system.


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DDMP: A System for Automated Collection, Storage, Analysis, and Reporting of Annotated Dietary Data

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(206) 501-2151

4/17/2016
DDMP System – Data Collection

- Uses newest tablet hardware and infrared 3D scanner for capturing food items’ size and volume
- Quickest way to capture accurate food volume data, 5 seconds per scan, no special training to produce accurate scans, just like taking a photo
DDMP System – Data Collection

- DDMP Survey mobile app allow user to capture 3D scan of the meal, seconds, and leftovers, enter text and voice food notes, fill in customizable questionnaires, and ability to review data.
- The system is ideal for research studies and accurately tracking individual’s intake over a period of time.

Study participant using DDMP scanner  High accuracy 3d scan of food plate
DDMP System – Data Processing

- Trained nutritional coders use DDMP Desktop Coder Interface software to review user collected data and process the 3D scan data.
- Coder Interface has an array of functions for getting size and volume of food items, correcting volume estimates for plate shapes, manually segmenting food items.
- After processing user-collected data with the Coder Interface, standardized food descriptions can be entered into nutrient analysis programs.
DDMP Coder Interface

- Infrared 3d scanner records data at proper scale without fiducial markers.
DDMP Coder Interface

- Coder Interface software is designed to integrate user-reported food descriptions with calculated volume estimates.
Viocare – The FIVR Project

Food Intake Visual and Voice Recognizer

- **Goal**
  
  Develop a software platform for capturing, storing, analyzing, and reporting on objective dietary behavioral measures.
Viocare Initial PDA Work with USDA
Weighed Food Record Technique - NESSy
Mobile Food Intake Tracking (FIVR)

- Need: Remove barrier to food tracking
- Goal: Make food tracking, accurate, simple, easy, fun and low burden
- Method: Create an image and speech recognition integrated with a comprehensive food database to accurately determine, food, portion size and nutrition information

Classification-driven Segmentation

Input Image

Classification Output

Minimize data cost + smoothness cost

Segmentation output
Food Volumes Estimated

Food Item Masks

Broccoli 124.3 ml
Chicken patties 182.3 ml
Orange 232.6 ml
Mobile App – Food Capture

- User records audio of food and uses camera to capture short video of plate
- System converts to accurate food record, option to display info to user
- Other recording options including simple photo log (2 clicks), text entry of foods, easy notes, and backend coding option
- Cafeteria system concept for easy and accurate capture of food intake (including leftovers)
VioCenter Food Tracking Tools

Nutritional Information

<table>
<thead>
<tr>
<th>Lunch</th>
<th>Food Database</th>
<th>Food Code</th>
<th>Amount</th>
<th>Measure</th>
<th>Kcal</th>
<th>Fat(g)</th>
<th>Carbohydrate(g)</th>
<th>Protein(g)</th>
<th>Fiber(g)</th>
<th>Entry Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretzels</td>
<td>FNOD0G</td>
<td>54408000</td>
<td>393</td>
<td>1 gram</td>
<td>1486</td>
<td>10</td>
<td>311</td>
<td>41</td>
<td>12</td>
<td>Photo</td>
</tr>
</tbody>
</table>

Notes:

Click here to edit this food.

Originally received from a mobile device

Pre/Post Serving Amount: 393 / 0
Pre/Post Serving: /
Density: 1

Pre/Post Serving Grams: 393 / 0

Food Information

Food Code: 54408000
Food Name: Pretzels
Food Alias: No Alias Name
Favorite Food: N

Capture Information

Pre/Post Entry Mode: Photo / Photo
Device OS: Android
Device Hardware: Samsung
Location: 145
Lat/Long: 40.353494620000006 / -74.6611823
Date of entry: 9/7/2013 12:00:00 AM

Media

Image Note: N/A

Pre Images

Audio Note: N/A
Is Audio Used For Search: Y

Post Images
Session Export

Protocol Export - Default Protocol for Your Research Organization

Search / Filter
- Visit Number:
- Finished Date Range: (mm/dd/yyyy) through (mm/dd/yyyy)

Note: Hit the 'Search' button after you change search / filter criteria.

Search | Clear Search

Export Data
- Database: NDSR - v3.0
- Key Field: Subject Id

Action: Nutrient Vector Export | Do Action

<table>
<thead>
<tr>
<th>Description</th>
<th>SubjectId</th>
<th>Time</th>
<th>Created</th>
<th>Started</th>
<th>Finished</th>
<th>Report</th>
</tr>
</thead>
</table>

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Internal Test Results – Strawberries/Pineapple

- 60 test cases captured
- 5% error

<table>
<thead>
<tr>
<th></th>
<th>Video Food Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strawberry</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>134</td>
</tr>
<tr>
<td><strong>Ground Truth</strong></td>
<td>140</td>
</tr>
<tr>
<td><strong>% Error</strong></td>
<td>3.9</td>
</tr>
<tr>
<td><strong>Standard Deviation</strong></td>
<td>8.3</td>
</tr>
</tbody>
</table>

Video Food Test (Extracted Frames)
VioDine Healthy Dining Locator

- **Need**: Dietary decision support tools for consumers when eating in a free living environment
- **Goal**: Provide personalized and easily accessible decision support where it is most difficult for them to make healthy decisions, restaurant dining
- **Method**: Mobile application that makes personalized menu item recommendations based on consumer dietary needs (driven by VioScreen)
- **Status**: Completed NIH Phase II contract $1M, Philly pilot in November 2013
Takeaways

• Dietary assessment technology is getting better
• Identifying previously unknown issues and learning how to handle them
• Some big issues remaining for lowering burden of using mobile diet trackers include handling foods that have hidden ingredients, soups, casseroles, and items like sandwiches
• Dietary patterns are useful to generate personalized dietary feedback recommendations
WELLNESS THROUGH SCIENCE

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Chief Wellness Engineer

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