CHILDREN & YOUTH

Current Technologies in Diet Assessment & Intervention
30 November 2016
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Different approaches to enhance dietary assessment with images

• Passive
  – Wearable camera
  – Users do not need to be “engaged”
  – Lots of images collected
  – Need to detect eating events
  – Images can be used for other things
  – Privacy issues

• Active
  – Use mobile telephone
  – Better quality images
  – User is “engaged”
Is This Big Data?

- Passive Approach
  - 1 image/5 sec ➔ 400,000 images/day – most not related to food

- Active approach
  - 8-12 images/day
• Blank Slide
Reviews summarizing image methods

Covers:
January 1998 to November 2013

See J Acad Nutr Diet Dec 2015

Covers:
December 2013 to January 2016

See Proc Nutr Soc (in press)

Image-assisted and image-based
Examples using images for dietary assessment

Examples using images for dietary assessment

Assessment method
- Dietary record
  - Image-assisted
    - 24h dietary recall
      - Passive
        - Passive camera
      - Wearable camera
    - SenseCam (SC)
      - Worn around the neck
      - Automatic image every 20 seconds
      - Turned on manually, option for privacy button
  - Tablet
    - Micro-camera
      - Worn on the ear
      - Audiovisual recordings during meal times
      - Turned on by chewing sounds
  - Video camera

Mode of image taking
- Active
  - Tablet
    - Image food record for IDD
      - Before and after images eating occasions
      - Fiducial marker
  - Micro-camera
    - Worn on the ear
    - Audiovisual recordings during meal times
    - Turned on by chewing sounds
  - SenseCam (SC)
    - Worn around the neck
    - Automatic image every 20 seconds
    - Turned on manually, option for privacy button

Device
- Smartphone
  - Food Record App (Frapp)
    - Multiple input methods
    - Only before image of eating occasions
    - Automatic food identification, energy and nutrient estimation
  - Only before image of eating occasions
  - Voice recording of food details
  - Follow-up call the following day
  - No automatic identifications or estimations
- Wearable camera
  - Nutricam Dietary Assessment Method (NuDAM)
    - Only before image of eating occasions
    - Automatic image every 2 seconds, during eating occasions
    - Portion-size estimation
  - eButton
    - Worn on the chest
    - Automatic image every 2 seconds, during eating occasions
Brief Report

Digital photography improves estimates of dietary intake in adolescents with intellectual and developmental disabilities

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• Determine if the collection of digital images is a feasible method to improve estimates of energy and macronutrient intake of proxy-assisted 3-day food records in adolescents with intellectual and developmental disabilities.
Summary

• n=20, age 14.9 y ± 2.2
• 3 days proxy-assisted dietary records
• 3 days child took independent before and after images of eating occasions w/ iPad

<table>
<thead>
<tr>
<th></th>
<th>Original record</th>
<th>Photo-assisted record</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M ± SE</td>
<td>n</td>
</tr>
<tr>
<td>Energy (kcal)</td>
<td>130</td>
<td>429.4 ± 23.0</td>
<td>130</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>130</td>
<td>57.1 ± 3.2</td>
<td>130</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>130</td>
<td>16.0 ± 1.1</td>
<td>130</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>130</td>
<td>17.2 ± 1.1</td>
<td>130</td>
</tr>
</tbody>
</table>

<sup>a</sup> Denotes significance at 0.05 alpha level using mixed modeling for repeated measures.

20% higher energy per eating occasion.
Objective

- To investigate the dietary intake and physical activity patterns of adolescents and young adults with Down syndrome.
- Mobile food record x 4 days
Launching mFR App

Ahmad Z et al Proc IS&TISPIE 2014
Record View

- The user taps the *Before Eating* button to take an image of foods before eating.

- After eating, the user taps the *After Eating* button to take an image of the same scene after eating.
Record: Proper Angle Assistance

- Angle information is obtained from the phone
- Guide colors along with words assist the user in taking an image at preferred angles

Ahmad Z et al Proc IS&TISPIE 2014
Review: Viewing a Labeled Eating Occasion

- The before eating image is displayed in landscape view with colored pins and labels identifying the foods.

Ahmad Z et al Proc IS&TISPIE 2014
Review: Confirm/Remove/Change Food Label

• Users confirm, remove or change labels on food identification pins.
• To correct the food, the user can choose an item from *Suggested Food* or *Complete Food List*.
Imitation is the best form of flattery
The company has developed image recognition software that is able to guess what’s in the photo and match it to items in the app’s database. If it’s not able to find a corresponding entry, you can manually enter one yourself.
Color Fiducial Marker

Reference Illumination

New Illumination #1

New Illumination #2

Color Correction

Xu et al. Proceedings IS&T/SPIE, 2012
Examples using images for dietary assessment

To determine the amenability of community dwelling adolescents, with minimal parental input, to use the FRapp to record their dietary intake.
Using the mFR

Brief instructions for children:
- Researcher demonstrated mFR use
- Distributed mFR, FM, & wristband
- Children (3-10 y) asked to demonstrate taking a usable image pair

Images uploaded to TADA website

Aflague TF et al Nutrients 2015
Examples

**Before eating**

**After eating**

---

How old is this participant?

9 years old!
Methods: unique to each sample

Sample 1

Children possessed mFR for 6 to 8 hours

- 1-4 opportunities to take image pairs:
  - Practice, AM snack, lunch, and PM snack
- Brief questionnaire:
  1. Usability of mFR
  2. Acceptability of mFR
  3. Carry the FM

Sample 2

- Carrying case and charger
- Reviewed images with trained analyst

Day 1 → Day 2

~4 weeks

Aflague TF et al Nutrients 2015
Sample 1 Results: usable image

Percent of children that captured a usable image (n=57)

- Included FM: 74% Before, 70% After
- Included all food: 95% Before, 97% After
- Included both: 72% Before, 70% After

Aflague TF et al Nutrients 2015
Sample 1 Results: Return undamaged

- All children (n=63) returned the mFR undamaged!
Sample 1 Results: Feedback

Children’s feedback on using the mFR (n=62)

- mFR easy to use: 89%
- Borrow & use mFR: 87%
- Carry FM: 94%

Aflague TF et al Nutrients 2015
## Sample 2 Results (n=63)

<table>
<thead>
<tr>
<th>Number of children</th>
<th>Age Mean (years)</th>
<th>Length of time mFR used (days)</th>
<th>Number of image pairs per day Median (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 (6)</td>
<td>5.5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8 (13)</td>
<td>7.7</td>
<td>1</td>
<td>1.00 (1.00-4.00)</td>
</tr>
<tr>
<td>20 (32)</td>
<td>8.2</td>
<td>2</td>
<td>2.00 (1.00-4.00)</td>
</tr>
<tr>
<td>20 (32)</td>
<td>8.2</td>
<td>3</td>
<td>2.42 (1.33-6.00)</td>
</tr>
<tr>
<td>11 (17)</td>
<td>9.8</td>
<td>4+</td>
<td>2.67 (1.33-4.25)</td>
</tr>
<tr>
<td><strong>Time 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 (22)</td>
<td>7.8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 (8)</td>
<td>7.8</td>
<td>1</td>
<td>1.00 (1.00-2.00)</td>
</tr>
<tr>
<td>16 (25)</td>
<td>8.3</td>
<td>2</td>
<td>2.00 (1.00-5.00)</td>
</tr>
<tr>
<td>18 (29)</td>
<td>8.3</td>
<td>3</td>
<td>1.83 (1.00-3.33)</td>
</tr>
<tr>
<td>10 (16)</td>
<td>8.0</td>
<td>4+</td>
<td>1.75 (1.20-3.75)</td>
</tr>
</tbody>
</table>
Conclusion & Next Steps

- Given instructions, children 3-10 year olds can use the mFR to record their dietary intake.
- Results support the need to include parents to help with reminders that are tailored by child’s age.

Aflague TF et al Nutrients 2015
Examples using images for dietary assessment

- **Image-assisted**
  - **Assessment method**
    - **Mode of image taking**
      - **Device**
        - **Method**
          - **Image food record for IDD**
            - Before and after images eating occasions
            - Fiducial marker
          - **Micro-camera**
            - Worn on the ear
            - Audiostream recordings during meal times
            - Turned on by chewing sounds
          - **SenseCam (SC)**
            - Worn around the neck
            - Automatic image every 20 seconds
            - Turned on manually, option for privacy button
          - **Mobile Food Record (mFR)**
            - Before and after images eating occasions
            - Fiducial marker
            - Automatic food identification, energy and nutrient estimation
          - **Food Record App (Frapp)**
            - Multiple input methods
            - Only before image of eating occasions
            - No automatic identifications or estimations
          - **Nutricam Dietary Assessment Method (NuDAM)**
            - Only before image of eating occasions
            - Voice recording of food details
            - Follow-up call the following day
            - No automatic identifications or estimations
  - **Image-based**
    - **Assessment method**
      - **Mode of image taking**
        - **Device**
          - **Method**
            - **Passive camera**

- **Active**
  - **Tablet**
  - **Wearable camera**
  - **Video camera**

- **Passive**
  - **Passive camera**
  - **Smartphone**
  - **Passive camera**
  - **eButton**
    - Worn on the chest
    - Automatic image every 2 seconds, during eating occasions
    - Portion-size estimation
To adapt the eButton for use by children requires understanding of its acceptance and procedural use. Two formative studies were conducted for using the eButton with children.

Figure 3. eButton location below the collar bone.
• Study 1
  – 21 children, 8-13 years
  – Tested 2 eButton weights
  – Used the eButton with a meal seated at a dining table (freely selected foods from 18 menu items)
  – Each child was asked:
    • Would you wear the eButton for 2-3 days at a time
    • Any concerns (Parent asked this, also)
<table>
<thead>
<tr>
<th>Child (n=21)</th>
<th>n</th>
<th>Parent (n=16)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undesirable Aspects Identified</strong></td>
<td></td>
<td><strong>Parents Concerns for using the eButton</strong></td>
<td></td>
</tr>
<tr>
<td>Uncomfortable while wearing it, for example:</td>
<td>6</td>
<td>May fall or interfere while playing or during sports</td>
<td>10</td>
</tr>
<tr>
<td>- <em>Straight pin on back was uncomfortable</em></td>
<td></td>
<td>Concern about attracting negative public’s attention and kids asking about it</td>
<td>8</td>
</tr>
<tr>
<td>- <em>Magnet feels on body</em></td>
<td></td>
<td>Privacy concerns while at home or school</td>
<td>8</td>
</tr>
<tr>
<td>- <em>Weight pulled the t-shirt down</em></td>
<td></td>
<td>Concern about loss or damage</td>
<td>7</td>
</tr>
<tr>
<td>- <em>Strap felt rough, itchy, tight around neck</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- <em>Strap didn’t match school uniform</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>eButton bounced when running or skipping</strong></td>
<td>4</td>
<td><strong>Desirable Aspects</strong></td>
<td></td>
</tr>
<tr>
<td>Uncomfortable while wearing it during the meal:</td>
<td>9</td>
<td>Parent not having problem charging eButton or uploading pictures for 2-3 days</td>
<td>15</td>
</tr>
<tr>
<td>- <em>Worry it’ll be damaged or get dirty while eating</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- <em>Restricted movement while eating or come in way</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Desirable Aspects</strong></td>
<td></td>
<td><strong>Suggestions to improve eButton and overcome concerns</strong></td>
<td></td>
</tr>
<tr>
<td>Wearing the eButton during a meal was comfortable and had no problems</td>
<td>14</td>
<td>Reduce size of eButton</td>
<td>7</td>
</tr>
<tr>
<td>Fine to wear the eButton for 2-3 days at a time</td>
<td>15</td>
<td>Have clear instructions of the process using the eButton</td>
<td>5</td>
</tr>
<tr>
<td><strong>Suggestions to improve eButton</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduce size of eButton</td>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Beltran A et al PMB 2016
• Study 2
  – 10 children, 8-13 years
  – No siblings
  – Each child was asked:
    • Wear eButton one day at home & school
<table>
<thead>
<tr>
<th></th>
<th>Counts</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total food items</strong></td>
<td>140</td>
<td>100</td>
</tr>
<tr>
<td>Total of food items before food verification</td>
<td>118</td>
<td>84.3</td>
</tr>
<tr>
<td>Total of food items added from food verification</td>
<td>22</td>
<td>15.7</td>
</tr>
<tr>
<td><strong>Before meal pictures available (numbers of food items)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>114</td>
<td>81.4</td>
</tr>
<tr>
<td>No</td>
<td>26</td>
<td>18.6</td>
</tr>
<tr>
<td><strong>Adequate placement of foods in the images (numbers of food items)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct placement to obtain image</td>
<td>85</td>
<td>60.7</td>
</tr>
<tr>
<td>Not correct placement</td>
<td>47</td>
<td>33.6</td>
</tr>
<tr>
<td>Images not available</td>
<td>7</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Meals recorded for the day (numbers of children)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete meals (three meals + snacks)</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Meals missing dinner pictures</td>
<td>4</td>
<td>40</td>
</tr>
<tr>
<td>Meals missing lunch &amp; dinner pictures</td>
<td>1</td>
<td>10</td>
</tr>
</tbody>
</table>

Beltran A et al PMB 2016
<table>
<thead>
<tr>
<th>Child (n=12)</th>
<th>n</th>
<th>Parent (n=12)</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Undesirable Aspects</strong></td>
<td></td>
<td><strong>Parents experience with eButton picture process</strong></td>
<td></td>
</tr>
<tr>
<td>Attracted attention from other people (3 children felt uncomfortable about it and 3 didn’t mind the attention, they liked it)</td>
<td>6</td>
<td>Instructions for uploading pictures easy to follow</td>
<td>9</td>
</tr>
<tr>
<td>Battery ran out or suddenly stopped</td>
<td>5</td>
<td>Average time to upload pictures = 30 min</td>
<td>8</td>
</tr>
<tr>
<td>Forgot to turn eButton back on</td>
<td>5</td>
<td>Parent thought the process for uploading was easy</td>
<td>8</td>
</tr>
<tr>
<td>Difficult to wear it in school</td>
<td>4</td>
<td><strong>Desirable Aspects</strong></td>
<td></td>
</tr>
<tr>
<td>Not secure enough</td>
<td>4</td>
<td>Willing to do the upload process of pictures for 2-3 days</td>
<td>7</td>
</tr>
<tr>
<td>Uncomfortable to wear</td>
<td>3</td>
<td>No concerns wearing for 2-3 days</td>
<td>5</td>
</tr>
<tr>
<td><strong>Desirable Aspects</strong></td>
<td></td>
<td><strong>Concerns for wearing the eButton</strong></td>
<td></td>
</tr>
<tr>
<td>Comfortable to wear during the day and meals</td>
<td>7</td>
<td>Each concern mentioned by only one parent (unwanted attention, approval from school, size too big, child distraction, find appropriate clothes to wear eButton)</td>
<td></td>
</tr>
<tr>
<td>No anticipated problems for wearing it 2-3 days</td>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Beltran A et al PMB 2016
• The eButton was able to be used by these children, but some children turned off the camera and forgot to turn it back on;

• the lighting made it challenging to see some of the images;

• some children ate standing up which did not allow a clear image;

• minimal necessary heights were identified to obtain images from a camera placed on a child’s chest; and

• The battery lasted only 9 hours, so some of the meals were missed.

• Smartphones requires that picture taking be volitionally initiated before and after the meal,

• the camera be at a certain angle with proper lighting,

• and a fiducial marker be properly displayed in the image, all of which may pose problems for children.

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• Smartphones requires that picture taking be volitionally initiated before and after the meal,
The promise of all day image taking cameras has been that the non-volitional nature of all day recording of images would identify all foods consumed; portion size estimation procedures could be applied to the images taken; and thereby lead to minimal error in diet assessment.

At this time, children’s input is essential especially on opaque cups for drinks and assembled foods, identification of missing foods (e.g. snacks), and portion estimation, especially for opaque packaged foods where volume can’t be estimated from images.
Review Process

- Review
  - Trained Analyst
    - Without participant
    - With participant
  - Automated
    - Participant review
      - Trained Analyst
        - Optional
        - Without participant
        - With participant

Boushey CJ et al Proc Nutr Soc, in press
Trained analyst reviews images and enters foods/beverages & serves

Trained analyst confirms with study participant

The approximate duration for the staff processing of the images for one day for one child was about 9 hours.
Children & youth friendly methods for using images for dietary assessment

Assessment method
- Dietary record
  - Image-assisted
  - 24h dietary recall

Mode of image taking
- Active
  - Tablet
  - Video camera
- Passive
  - wearable camera
  - Passive camera

Device
- Micro-camera
  - Before and after images eating occasions
  - Audiovisual recordings during meal times
  - Turned on by chewing sounds
- SenseCam (SC)
  - Worn around the neck
  - Automatic image every 20 seconds
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  - Worn on the chest
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  - Automatic food identification, energy and nutrient estimation
- eButton
  - Portion-size estimation

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University of Hawaii Cancer Center
  Kim Yonemori, RD

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