


Leveraging Technology to Enhance Dietary Assessment

Carol J Boushey

Epidemiology Program, University of Hawaii Cancer Center
Nutrition Science Department, Purdue University



e-tools and
social networks
for epidemiology

DAY OF EXCHANGES BETWEEN
ACADEMIC AND INDUSTRIAL ACTORS
ON THE EMERGENCE
OF INNOVATIVE TECHNOLOGIES

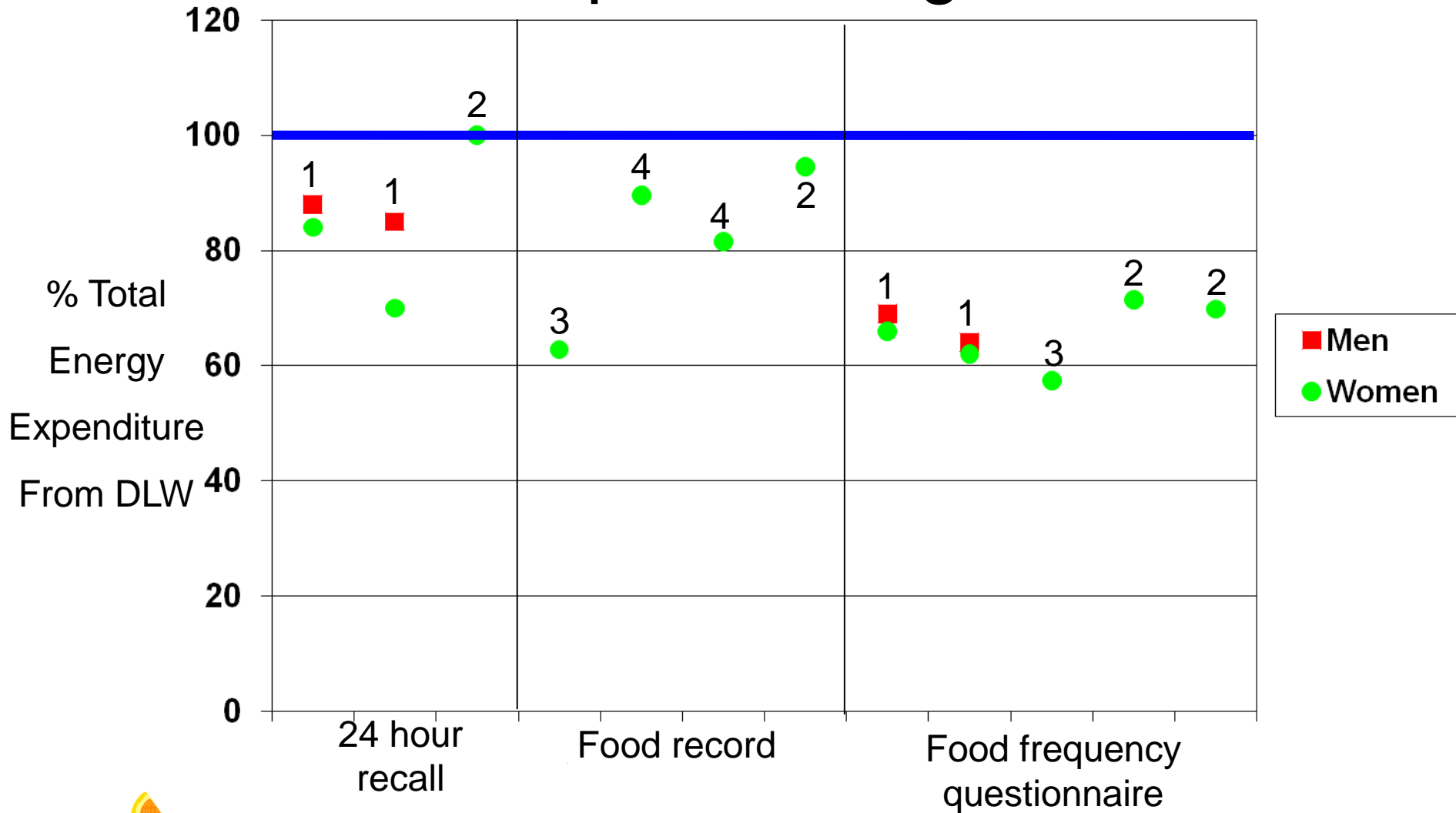
INTERNATIONAL CONFERENCE
Tuesday, 21 May 2013 from 9:00 to 18:00
Auditorium Adenauer, Cité Internationale Universitaire, Paris 14, France



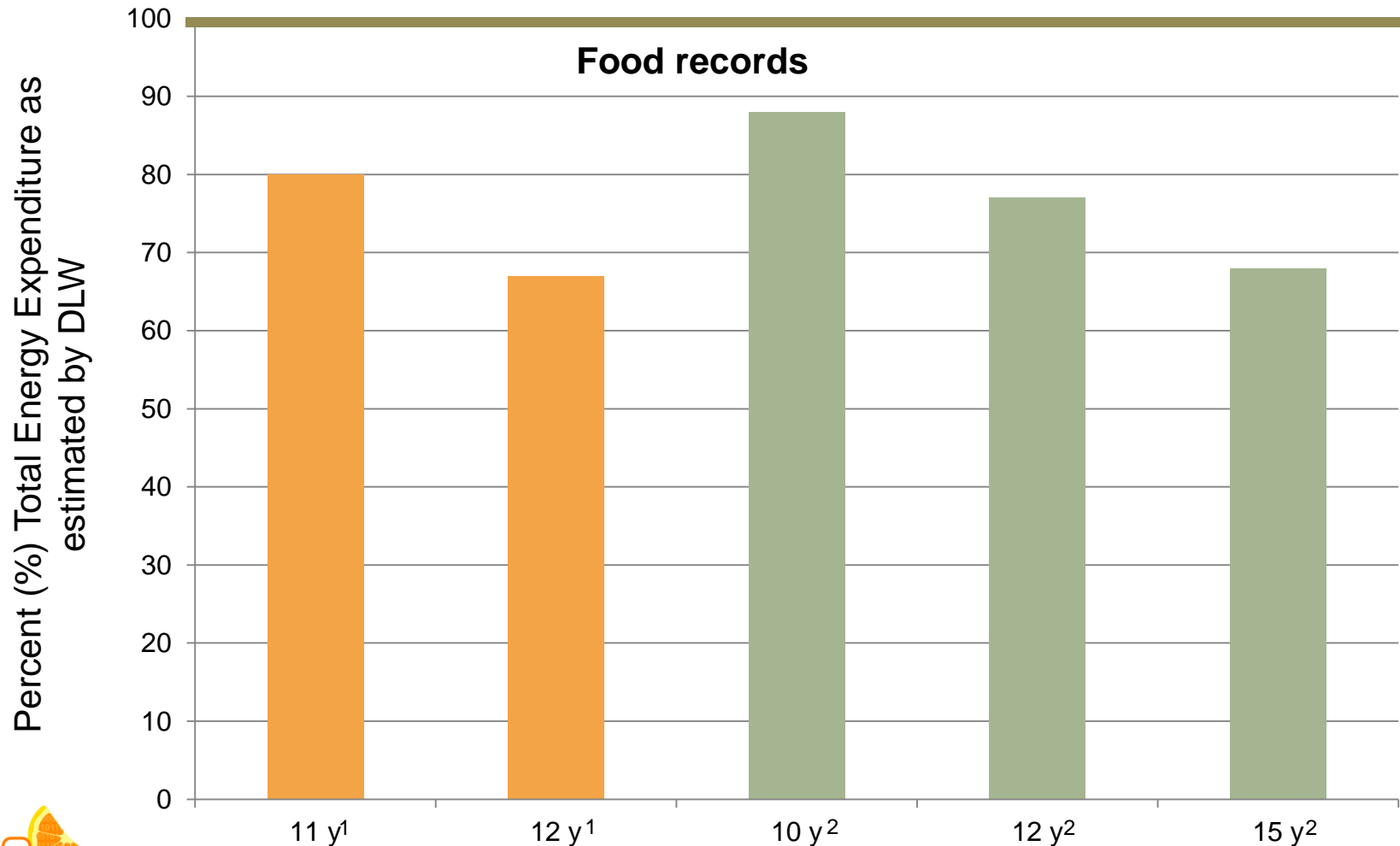
Outline

- Introduction – Why we have to do things better
- Image-based dietary assessment
- Usability testing
- Progress in automated food identification & volume estimation
- Distribution challenges
- Adaptability advantages

Examples of energy estimate error based on self-report among adults



Examples of energy estimate error based on self-report among adolescents

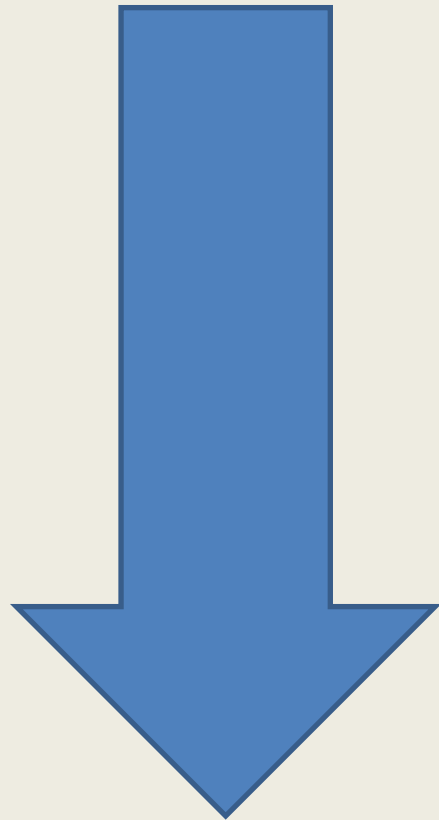


May 21, 2013

Slide 4

¹Champagne et al J Am Diet Assoc 1998; ²Bandini et al Am J Clin Nutr 2003

Commonly underreported foods



- Pancakes
- Desserts
- Pizza
- Milk on cereal
- Frozen dairy
- Meat mixtures
- Condiments
- Beer
- Salty snacks



Issues with paper-based methods?

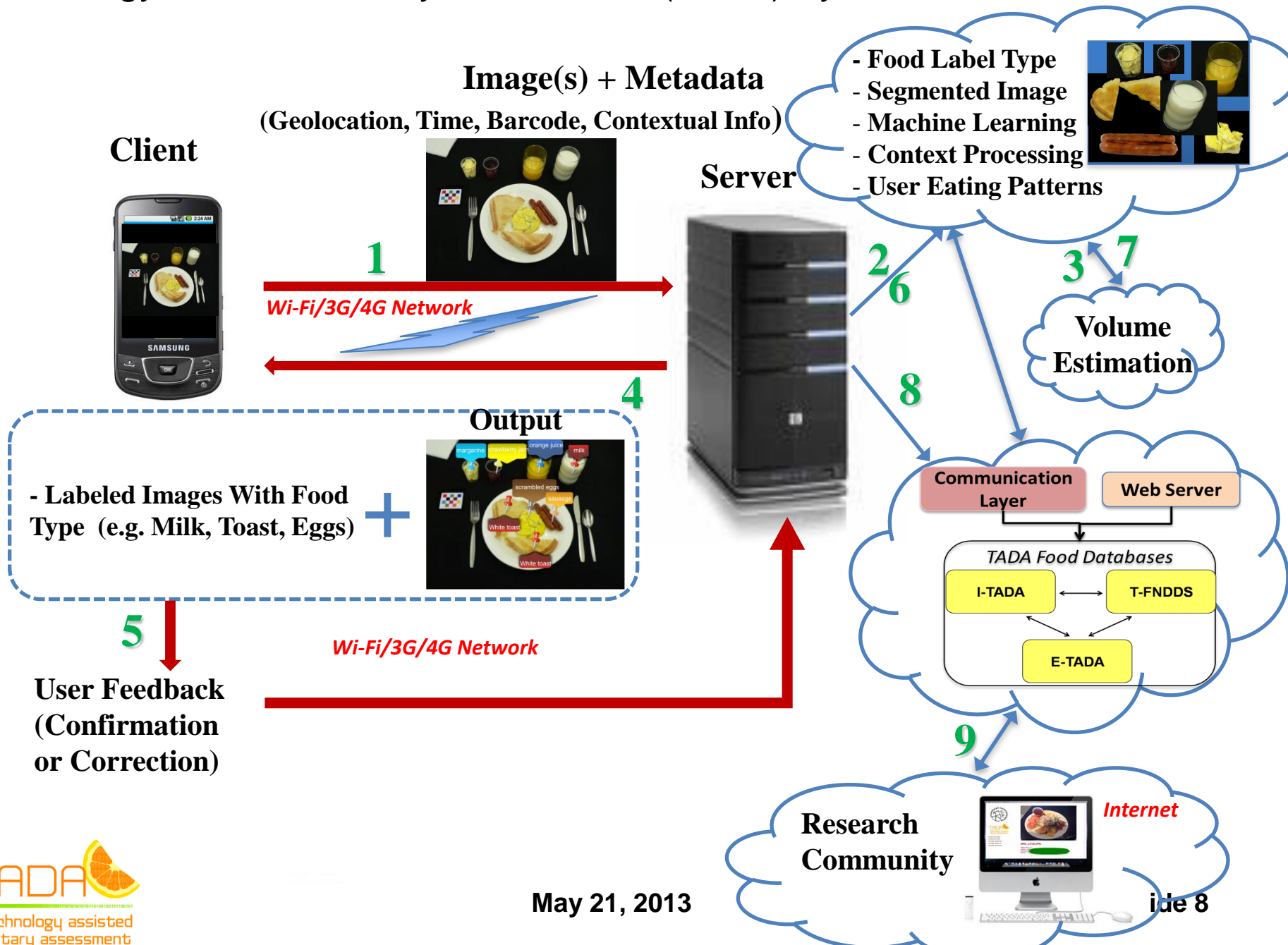


- Burden on the client
- Analysis time for the researcher
- Measurement error

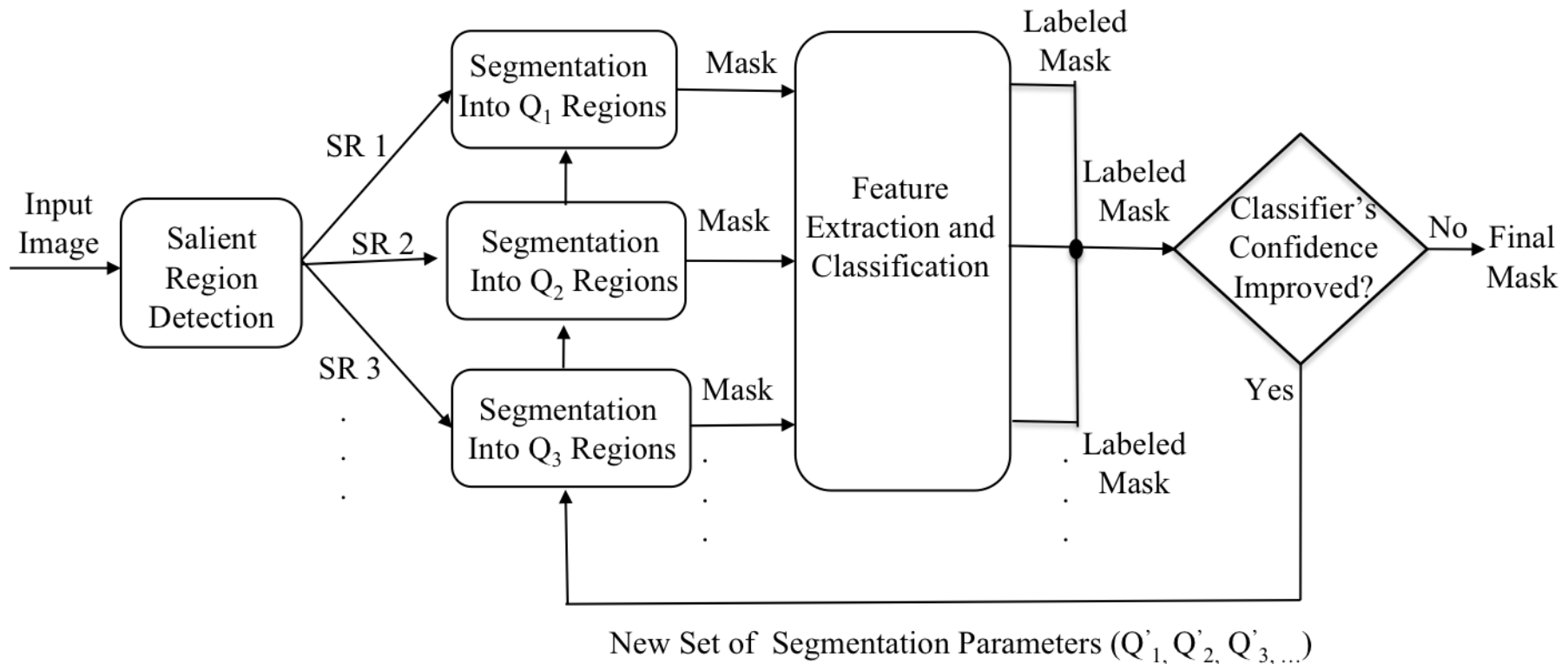
Image-Based Dietary Assessment

- Convenient & reduced burden
 - study participants
 - researchers
- Richer source of information
 - a repository of images
 - images for future research and analysis
- A tool that will connect with study participants
- Improve accuracy

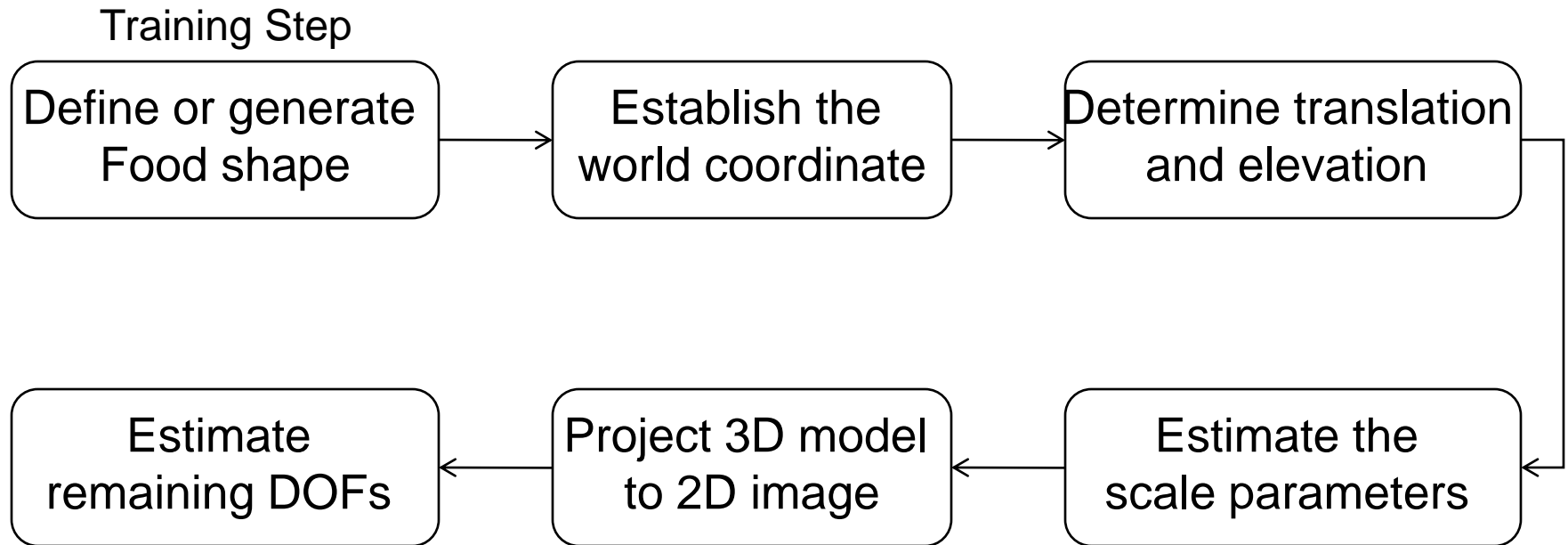
Technology Assisted Dietary Assessment (TADA) System Overview



Multiple Hypothesis Segmentation and Classification (MHSC)



Overview of Volume Estimation Method



DOF = degrees of freedom

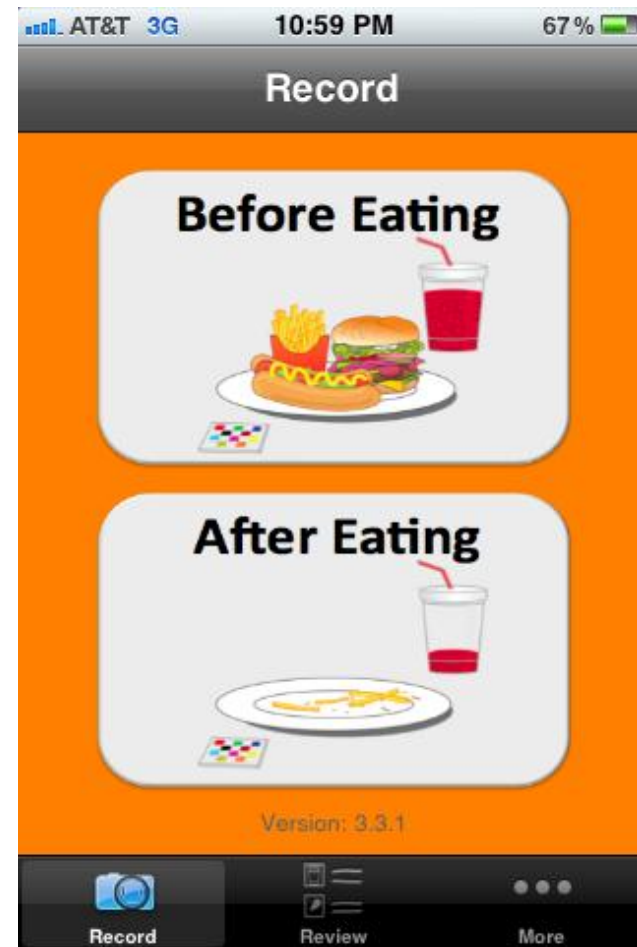
Usability Testing Launching TADA App

- To launch the TADA app, the user can tap on the TADA app icon located on the home screen



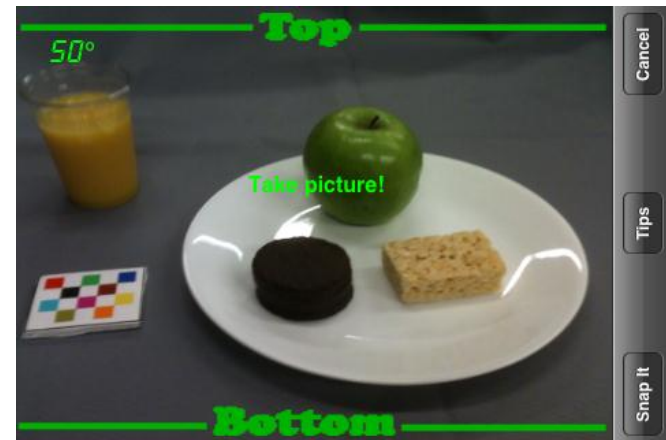
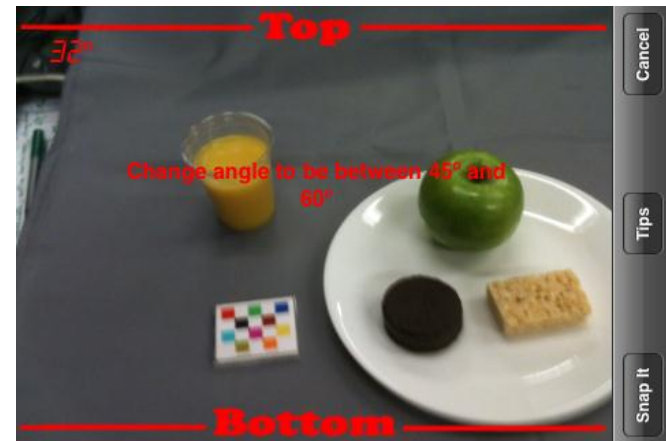
Record View

- To start recording an eating occasion, the user taps on the *Before Eating* button to take an image of foods before eating
- After eating, the user taps on *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



Examples of studies using TADA system

- TADA Café

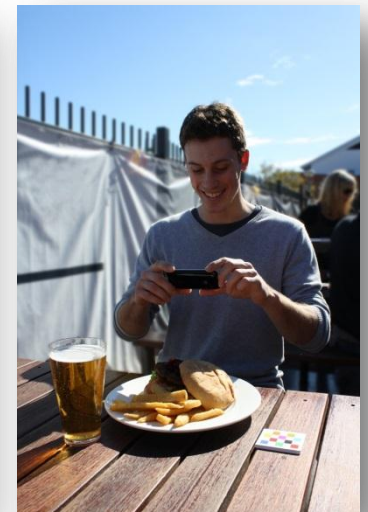
- Controlled conditions
- Men & women, 21-65 y
- 1 to 2 meals
- n = 57

- Food in Focus

- Community dwelling
- Men & women, 21-63 y
- 7 days
- n = 45

- Connecting Health and Technology (CHAT)

- Community dwelling
- Men & women, 18-30 y
- 4 days
- n = 86 (of 247)



Remembering to take an image BEFORE or AFTER MEALS was easy.

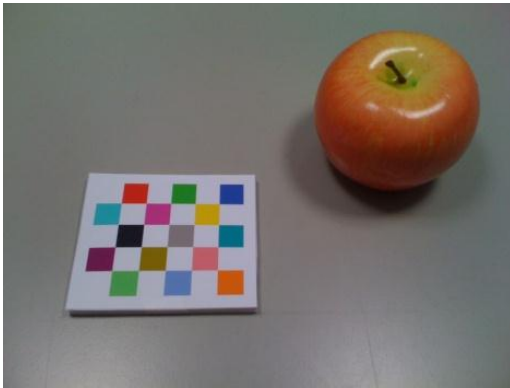
Study	Agree	Disagree	Total
	← n (%) →		
TADA Café			
Before meals	52 (91)	5 (9)	57
TADA Café			
After meals	50 (88)	7 (12)	57

Remembering to take an image BEFORE or AFTER SNACKS was easy.

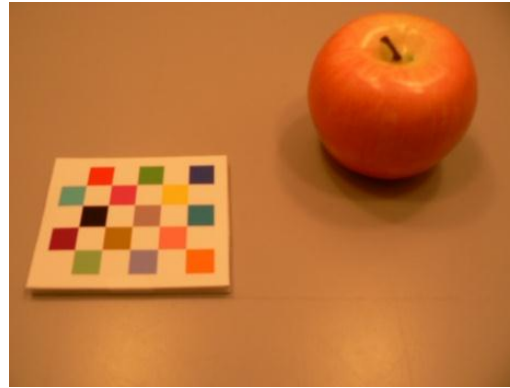
Study	Agree	Disagree	Total
	← n (%) →		
TADA Café			
Before snacks	27 (47)	30 (53)	57
TADA Café			
After snacks	32 (56)	25 (44)	57

Fiducial Maker: Size and Color Correction

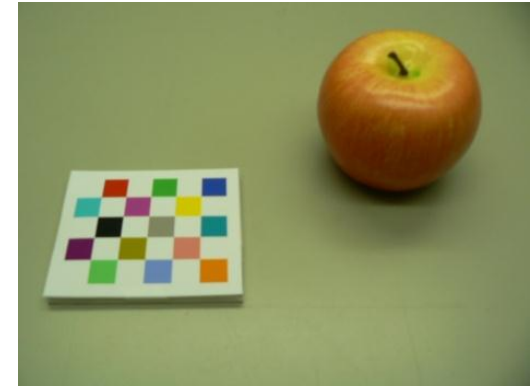
Daylight



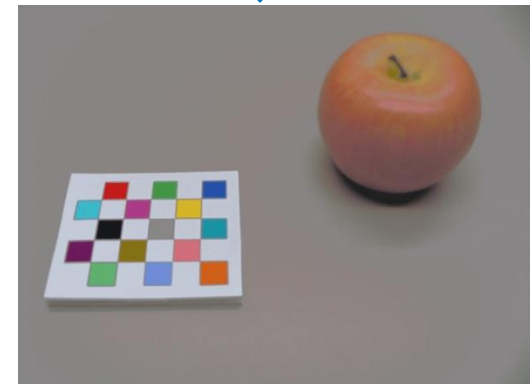
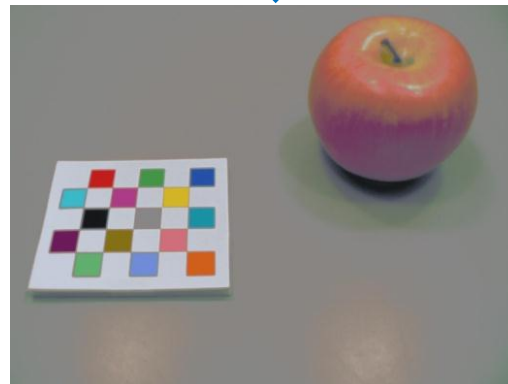
Horizon



Cool White



Color Correction



May 21, 2013

Slide 17

I think it would be easy to carry and use the fiducial marker.

Study	Agree	Disagree	Total
	← n (%) →		
TADA Café*			
After use	56 (98)	1 (2)	57

rEI across time of day quadrants

Image Pairs Captured Across Time Quadrants

Time Quadrant	
A	06:00-10:59
B	11:00-16:59
C	17:00-21:59
D	22:00-05:59

Proportion of rEI Across Time Quadrants

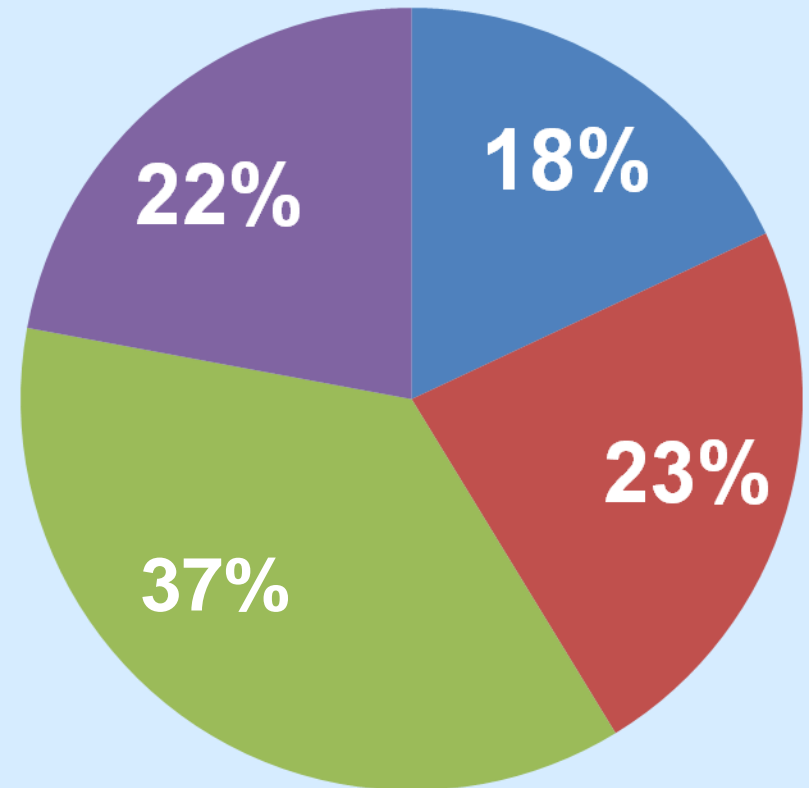


Image pairs containing commonly under-reported foods

Alcoholic beverages*

Coffee*

Cola drink*

Candy

Desserts

“Midnight snacks”

Condiments

7:54:51 PM



8:10:01 PM



10:08:41 PM



10:42:22 PM



Before

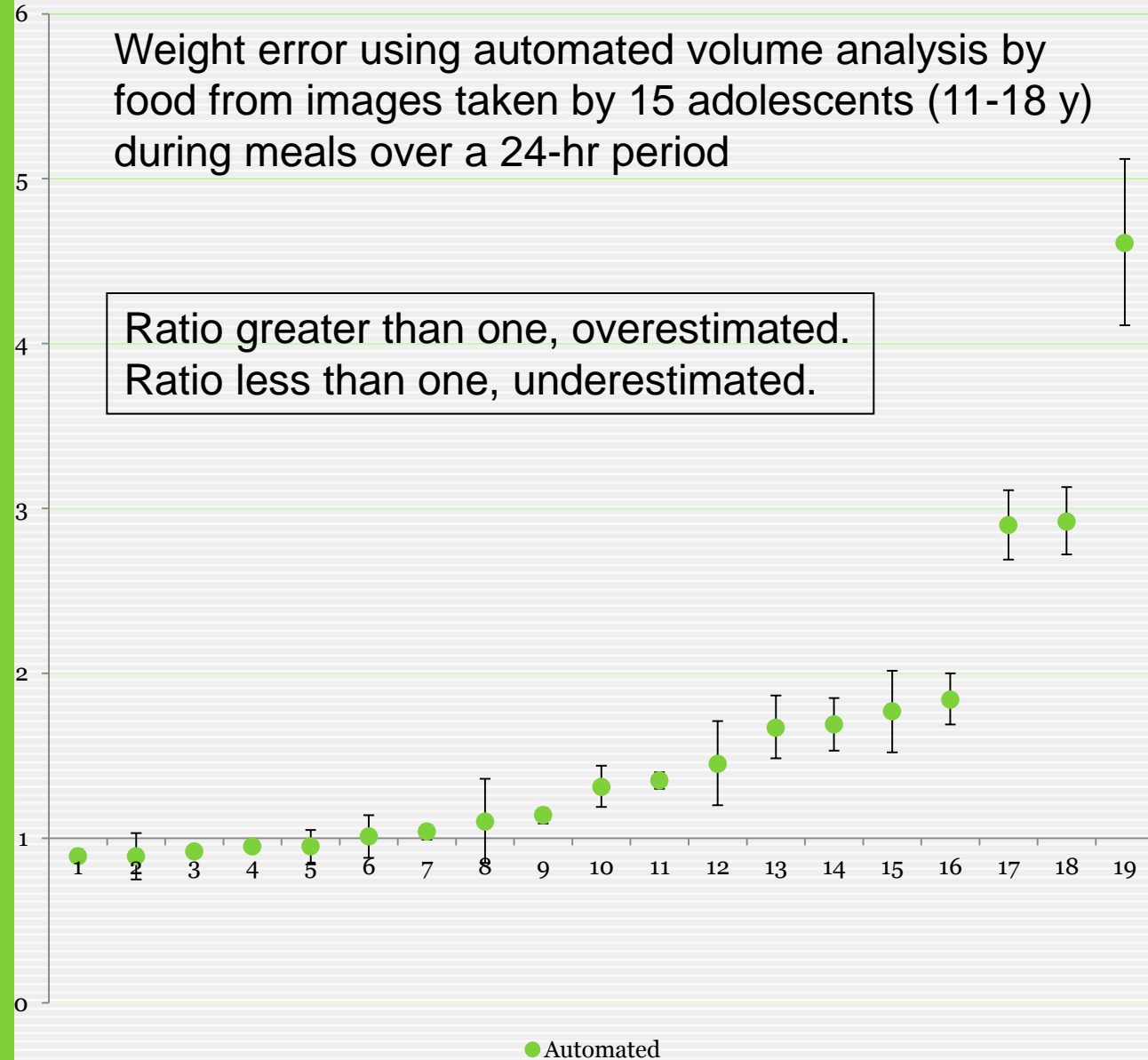
After

Food Items

1. Sausage Links
2. Spaghetti w/ sauce, cheese
3. French dressing
4. Milk, 2%
5. Cheeseburger sandwich
6. Strawberry jam
7. Orange juice
8. Ketchup
9. Sugar cookie
10. Chocolate cake w/ icing
11. Coke
12. Margarine
13. Toast
14. Sliced peaches
15. Scrambled eggs
16. Pear halves
17. French fries
18. Garlic bread
19. Lettuce salad

Weight error using automated volume analysis by food from images taken by 15 adolescents (11-18 y) during meals over a 24-hr period

Ratio greater than one, overestimated.
Ratio less than one, underestimated.

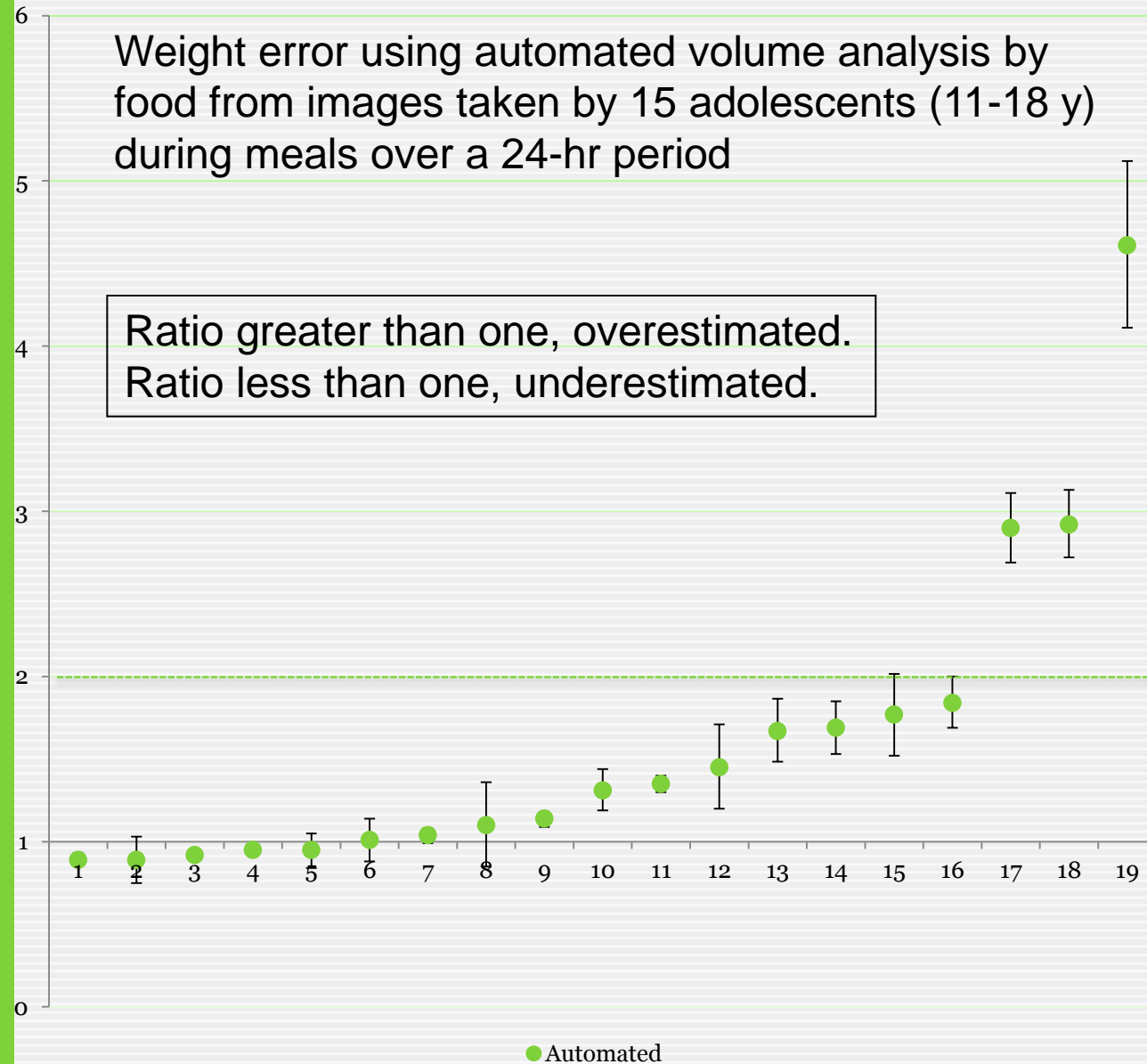


Food Items

1. Sausage Links
2. Spaghetti w/ sauce, cheese
3. French dressing
4. Milk, 2%
5. Cheeseburger sandwich
6. Strawberry jam
7. Orange juice
8. Ketchup
9. Sugar cookie
10. Chocolate cake w/ icing
11. Coke
12. Margarine
13. Toast
14. Sliced peaches
15. Scrambled eggs
16. Pear halves
17. French fries
18. Garlic bread
19. Lettuce salad

Weight error using automated volume analysis by food from images taken by 15 adolescents (11-18 y) during meals over a 24-hr period

Ratio greater than one, overestimated.
Ratio less than one, underestimated.

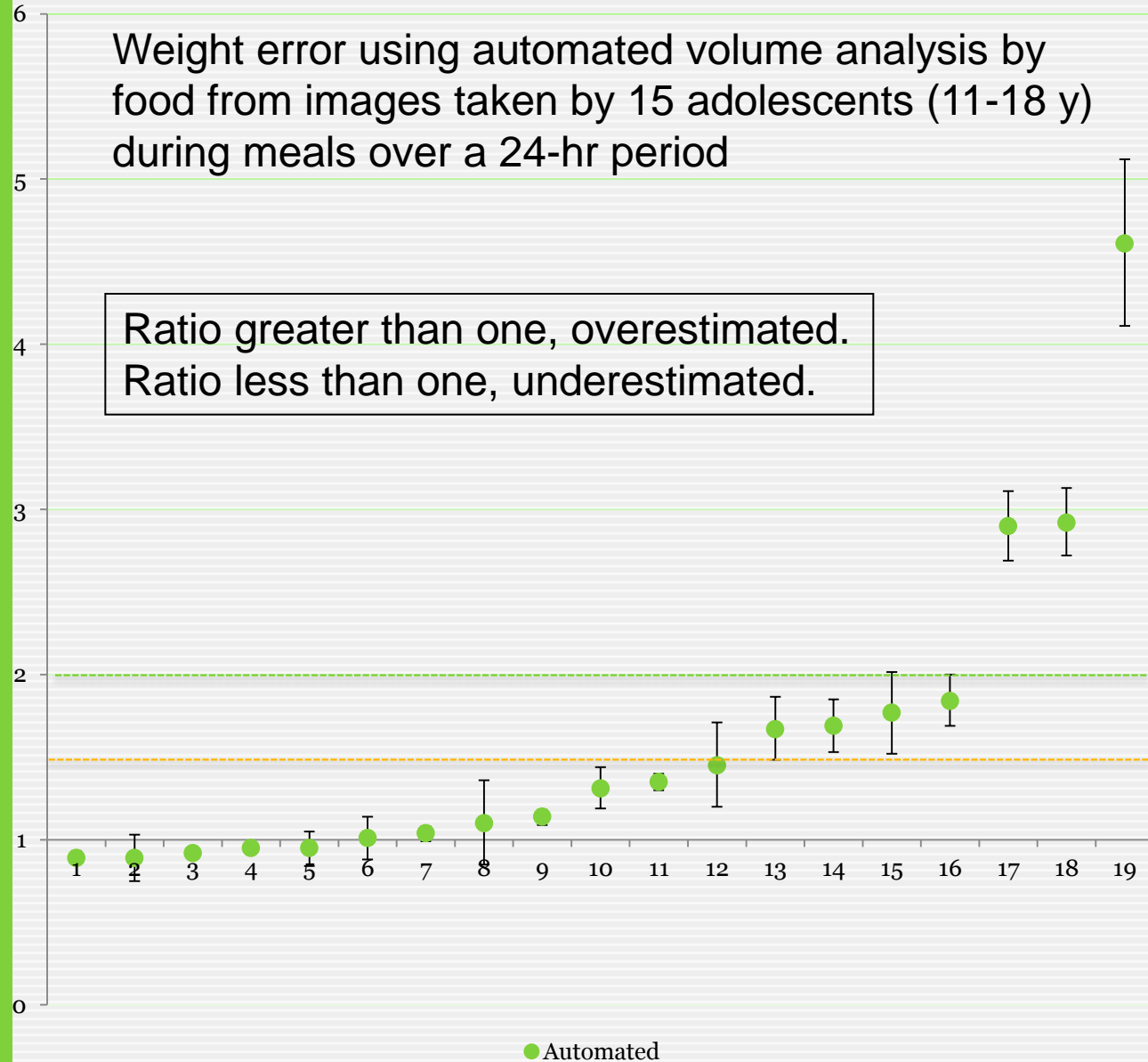


Food Items

1. Sausage Links
2. Spaghetti w/ sauce, cheese
3. French dressing
4. Milk, 2%
5. Cheeseburger sandwich
6. Strawberry jam
7. Orange juice
8. Ketchup
9. Sugar cookie
10. Chocolate cake w/ icing
11. Coke
12. Margarine
13. Toast
14. Sliced peaches
15. Scrambled eggs
16. Pear halves
17. French fries
18. Garlic bread
19. Lettuce salad

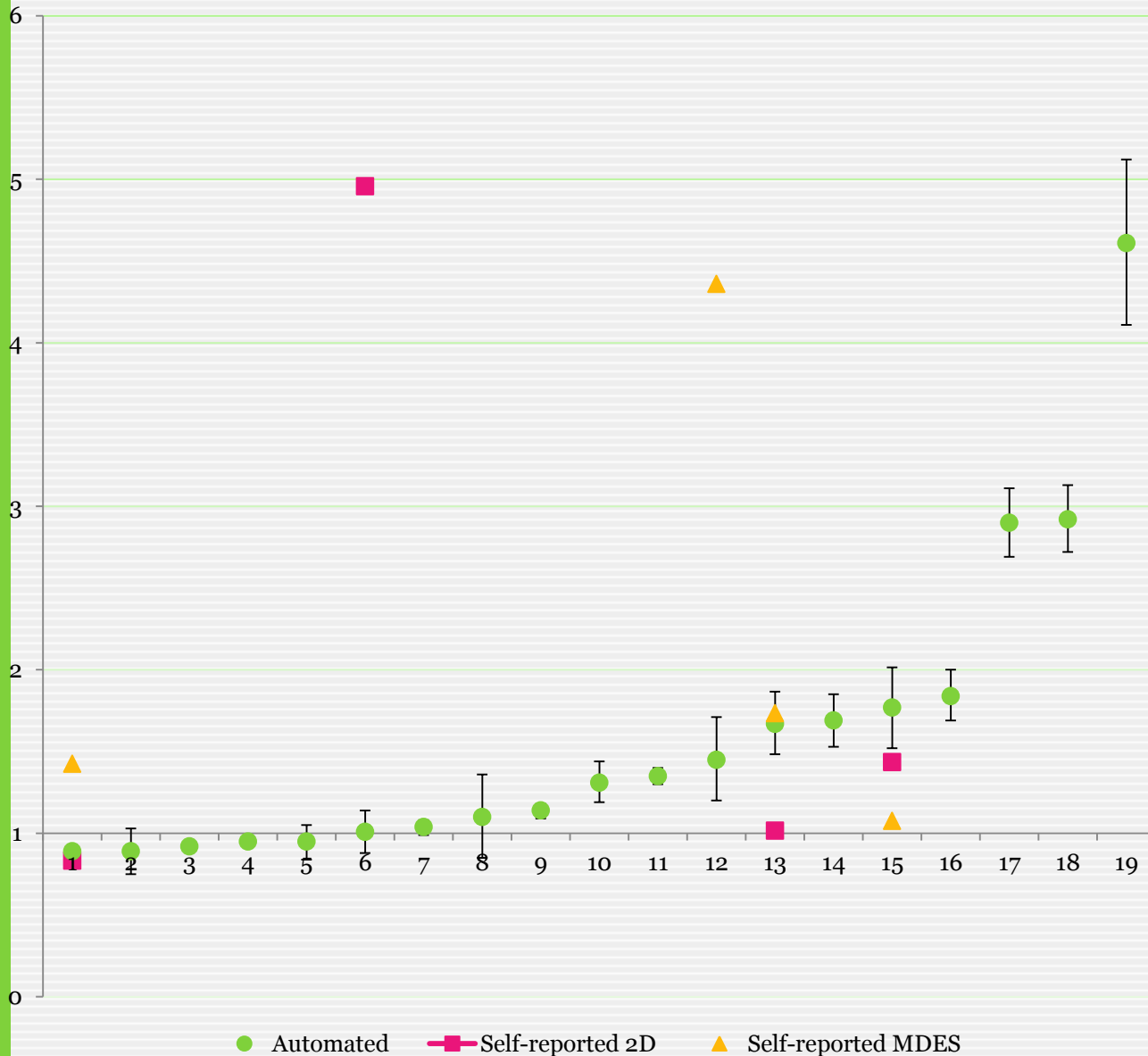
Weight error using automated volume analysis by food from images taken by 15 adolescents (11-18 y) during meals over a 24-hr period

Ratio greater than one, overestimated.
Ratio less than one, underestimated.



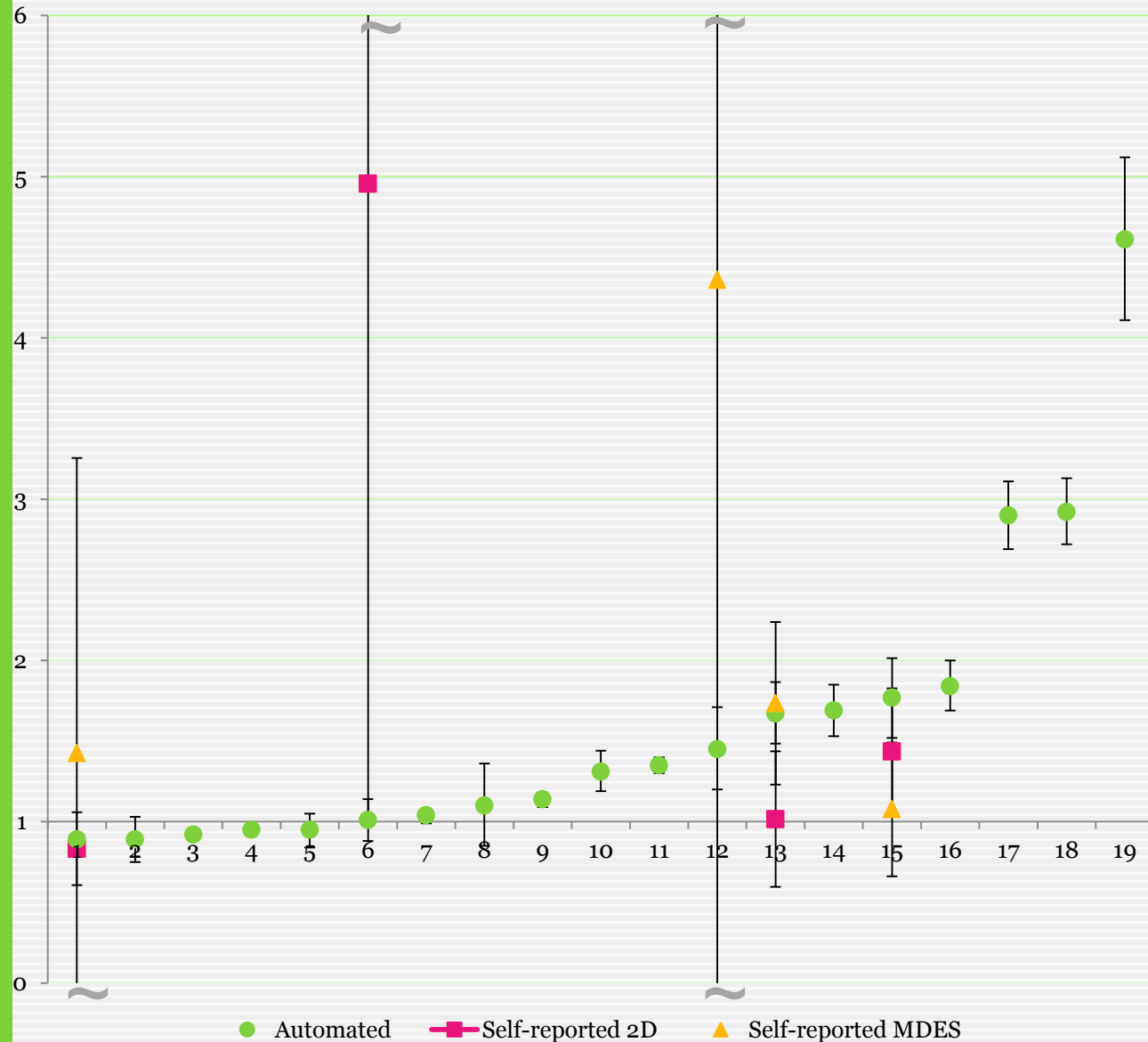
Food Items

1. Sausage Links
2. Spaghetti w/ sauce, cheese
3. French dressing
4. Milk, 2%
5. Cheeseburger sandwich
6. Strawberry jam
7. Orange juice
8. Ketchup
9. Sugar cookie
10. Chocolate cake w/ icing
11. Coke
12. Margarine
13. Toast
14. Sliced peaches
15. Scrambled eggs
16. Pear halves
17. French fries
18. Garlic bread
19. Lettuce salad



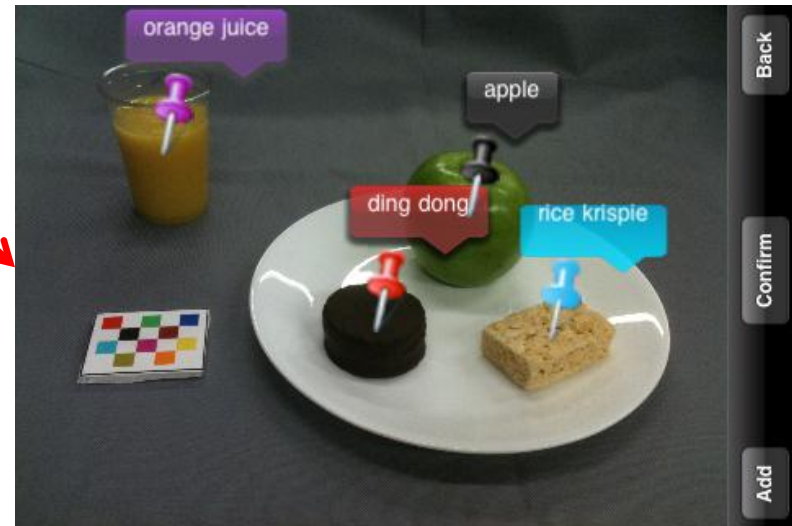
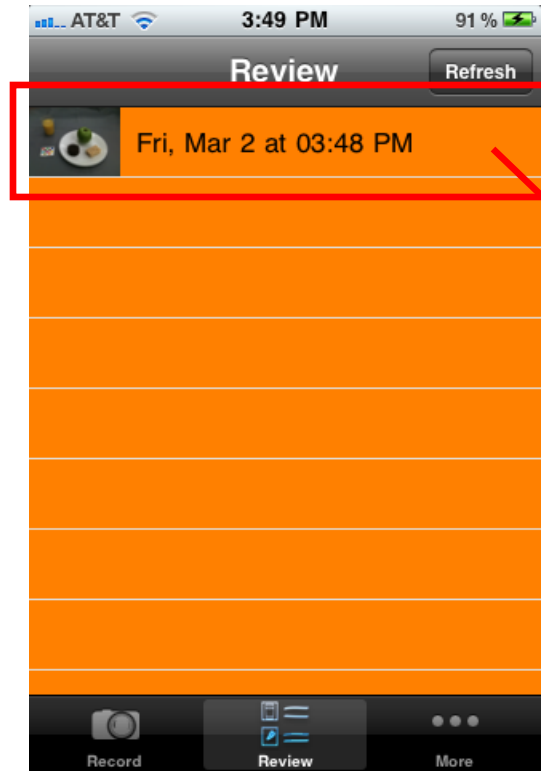
Food Items

1. Sausage Links
2. Spaghetti w/ sauce, cheese
3. French dressing
4. Milk, 2%
5. Cheeseburger sandwich
6. Strawberry jam
7. Orange juice
8. Ketchup
9. Sugar cookie
10. Chocolate cake w/ icing
11. Coke
12. Margarine
13. Toast
14. Sliced peaches
15. Scrambled eggs
16. Pear halves
17. French fries
18. Garlic bread
19. Lettuce salad



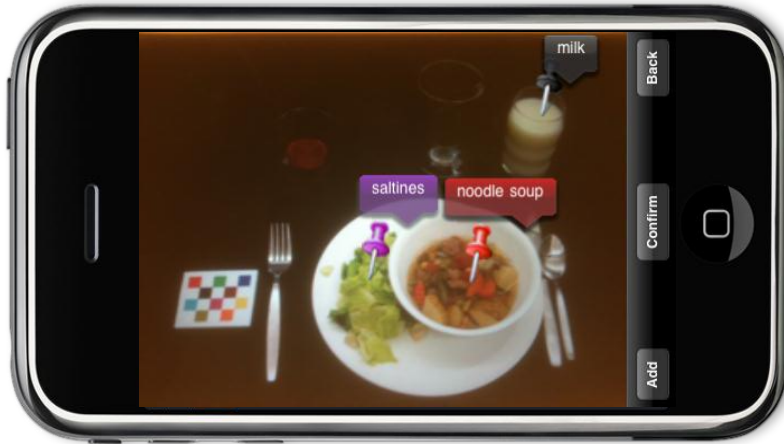
Distribution Challenges

Review: Viewing a Labeled Eating Occasion

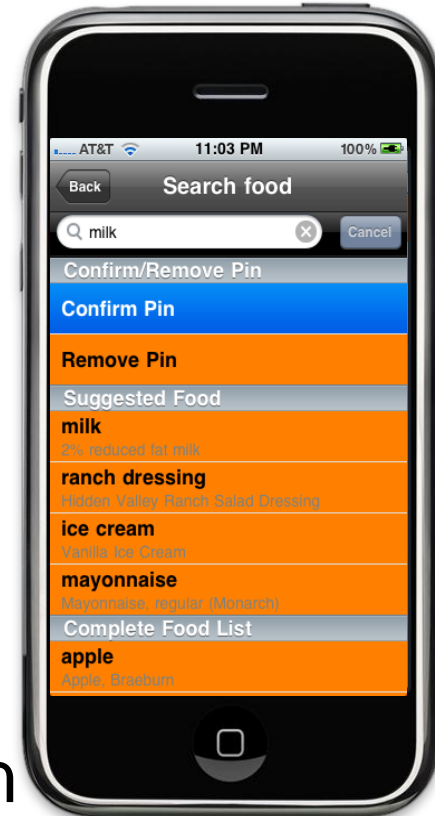


- The before eating image is displayed in landscape view with colored pins and labels identifying the foods

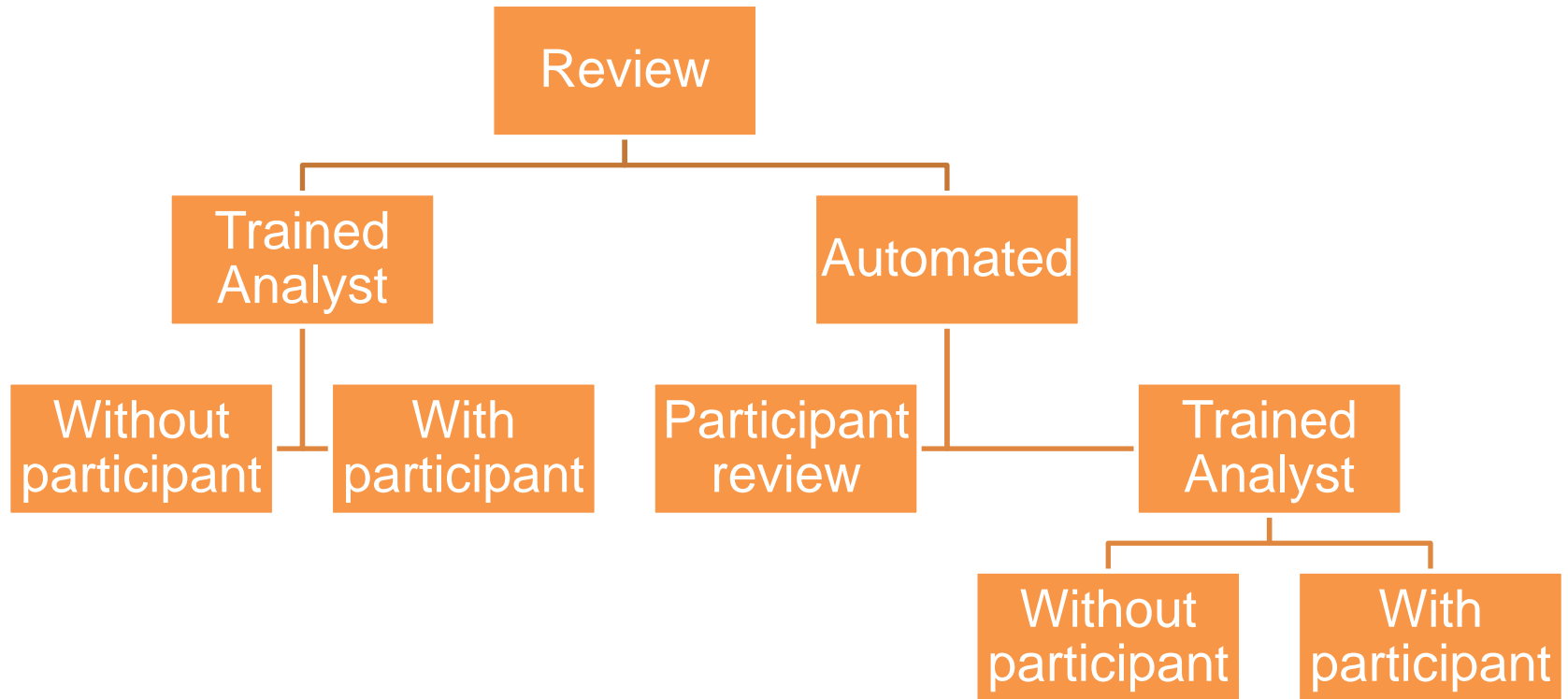
Review: Confirm/Remove/Change Food Label



- 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*



Review Process



MOBILE TELEPHONE TIMELINE

1992 1994 1996 1997 1999



Motorola MicroTac Motorola StarTac Nokia 1610 Qualcomm QCP2700 Ericsson A1228d

2000 2001 2002 2003 2004 2005



Palm Treo 600 Motorola V60c Motorola V770 Sony Ericsson T616 Motorola RAZRv3 Sony Ericsson W810i

2006 2007 2008 2010 **Today**



AT&T 8525 AT&T 8925 Blackberry 8830 BlackBerry Bold 9700 Apple iPhone 3G Apple iPhone 5

May 21, 2013

Slide 30

Mailing devices



May 21, 2013

Slide 31

Cost Considerations

32

- Mobile telephone

- Data service plans

- Purchase phones

- Device cost

- Monthly voice cost

- Data cost

- Text cost

~\$40
/phone

~\$5
/phone

- Distribute and return, or

- Give telephones to participants

- Mobile devices, such as an Apple iPod

- No service plan

- One time device cost

- ✦ \$275/device +

- ✦ \$25/protectors =

- ✦ \$300 total/device

Acknowledgement of TADA team

PI: Carol Boushey, PhD, MPH, RD

Purdue University

Department of Nutrition Science

TusaRebecca Schap, PhD, MS, RD

Heather Eicher-Miller, PhD

Bethany Daughtery, MS, RD

Elisa Bastian, MS

YuJin Lee

Ashley Chambers, RD

Department of Agricultural & Biological
Engineering

Martin Okos, PhD

Shivangi Kelkar

Scott Stella

Curtin University, Perth, Western
Australia

Deb Kerr, PhD

Purdue University

School of Electrical & Computer Engineering

Edward Delp, PhD

David Ebert, PhD

Nitin Khanna, PhD

Marc Bosch

Junghoon Chae

Ye He

Fengqing Zhu

Xu Chang

Ziad Ahmad



Support for this work comes from the National Cancer Institute (1U01CA130784-01) and National Institute of Diabetes, Digestive, and Kidney Disorders (1R01-DK073711-01A1). TusaRebecca was an Indiana Clinical and Translational Sciences Institute TL1 Pre-doctoral Trainee supported by TL1 RR025759 (A. Shekhar, PI).