

# Exploring the use of an iPhone App: a Novel Approach to Dietary Assessment

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## Abstract

Recent advancements in smartphone technology have provided new methods of dietary assessment. An iTunes application (app) called Meal Snap lets users take pictures of the meal they eat, and then estimates the calories of the food items eaten. We conducted a pilot study to explore the user-friendliness and calorie estimation functions of the Meal Snap app. Two female nutrition graduate students pilot-tested the Meal Snap app. Using the app, each student took pictures of foods and drinks consumed daily for two weeks. The data were analyzed using the Nutritionist Pro™ software, version 4.4.0. The mean daily caloric intake obtained from the Meal Snap was then compared with that of Nutritionist Pro™. Paired samples t-tests and correlations were carried out using SPSS, version 19. Results indicated there was no significant difference in mean daily caloric consumption between Meal Snap and Nutritionist Pro™ ( $p=0.706$ ). Additionally, there was a significant correlation between Meal Snap and Nutritionist Pro™ calorie counts (Spearman  $r=0.625$ ,  $p<0.001$ ). It took about 35 minutes per week (or 5 minutes/day) to snap pictures and edit descriptions, whereas entering data for calorie analysis with Nutritionist Pro™ took about 85-90 minutes per week (about 13 minutes/day). Findings suggest that Meal Snap may be a user-friendly tool to estimate dietary intake. Future research should include a larger sample and people of diverse ethnic backgrounds, dietary habits and age groups.

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## Introduction

Accurate, valid, and reliable dietary assessment tools are essential to tracking the diets of individuals for nutrition assessment, education and counseling, and furthering understanding of the relationship between diet and health in research. Accurate measures of what people eat over the course of a day can provide important insights for the prevention of chronic diseases related to diet<sup>1</sup>. Traditionally, dietary assessment has relied on self-reporting techniques, including the 24-hour dietary recall, food diaries, and food frequency questionnaires (FFQ). The latter has been used extensively in large epidemiologic studies, upon which many dietary recommendations are based. While FFQs have been extensively used in nutritional epidemiology, this method is not without its drawbacks.<sup>2</sup> Having data collected in slightly variable ways causes a limitation in interpretation of how results may best be compared and applied. Friedman et al.<sup>3</sup> point out the difficulty of translating data from self-reported intakes, with subjects estimating portion sizes, into specific nutrient intakes. Furthermore the use of food records of any kind requires literacy, a high level of user motivation, coding of intake by researchers, and the understanding that self-monitoring can influence intake.<sup>4</sup>

Recent advancements in technology have provided new methods of dietary assessment, using mobile devices and digital imaging of food in particular. Technology-based dietary assessment methods may reduce the cost of collecting data and the burden of recording foods eaten.<sup>5</sup> These new technologies may also increase compliance and validity.<sup>6</sup>

## Estimation of Intake by Digital Food Photography

Williamson et al.<sup>7</sup> compared digital photographs of foods to visual estimates and weighed portions. The estimated intakes based on digital photos correlated well with results from weighed food portions, supporting the validity of this new

methodology. Martin et al.<sup>8</sup> described their analysis of digital food images as "a semi-automatic process that relies on human raters and a custom-built computer program called *the Food Photography Application*." They subsequently validated this method as compared to estimates using doubly-labeled water and directly weighed portions in a metabolic unit,<sup>9</sup> and reviewed other studies utilizing this method with a variety of populations.<sup>10</sup>

## Applications in Personal Digital Assistants

In the mid 2000s, many studies compared traditional methods of dietary assessment with assessments utilizing personal digital assistant (PDA)-based technology. One study sought to assess the validity of DietMatePro (a PDA-based dietary assessment), using 24-hour recall data.<sup>4</sup> Results indicated that there were no significant differences in daily totals for calories and macronutrients between DietMatePro data and the comparison measurements, thus concluding that DietMatePro provides a method of assessing energy and macronutrient intakes comparable to the traditional 24-hour recall in individuals lacking dietary restrictions.

A study by Yon et al., however, indicated that the use of PDAs for dietary self-monitoring did not improve the validity of self-reports of energy intake, especially among overweight and obese people.<sup>6</sup> Another study validated a PDA with a camera and a mobile phone card attachment.<sup>11</sup> The PDA, called Wellnavi, was compared to a 1-day weighed diet record. Median nutrient intakes estimated by the Wellnavi method and the traditional diet record were comparable, therefore implying that this mobile technology could measure individual dietary intakes for a variety of nutrients. However a subsequent study by Kikunaga et al.<sup>12</sup> found that Wellnavi underestimated intakes as compared to weighed diet records. They attributed this to quality issues with the digital photos. Additionally, while PDAs had been shown to be of some value in recording dietary intakes, their use has been

largely eclipsed by the exponential growth in the ownership and use of smartphones.

### Applications in Smartphones

Nearly two-thirds of American adults (64%) now own a smartphone of some kind, up from 58% in early 2014. Smartphone ownership has increased by 29 percentage points since Pew Research conducted its first survey of smartphone ownership in the spring of 2011, when 35% of Americans were smartphone owners.<sup>13</sup> The United States is one of the leading countries in the world with respect to adoption of smartphone technology. Based on figures from 2010 to 2013, it is estimated that there will be more than 196 million smartphone users in the U.S. by the year 2016.<sup>14</sup>

Among smartphones, the iPhone is significant because since its release in 2007, third parties have the ability to design applications, or “apps”, for the iPhone operating system and distribute them to the public through the Apple iTunes store.<sup>15</sup> iTunes provides users with access to many downloadable health apps, which have a wide range of functionality, including reference, tracking, and calculators.<sup>4</sup> As of August 2015, there were almost twenty thousand Health and Fitness Apps in the Apple iTunes store.<sup>15</sup>

The Pew Research Center, in association with the California Healthcare Foundation, conducted a research study on mobile health. They found that 17% of cell owners have used their phone to look up health or medical information, and 9% of cell owners have apps on their phones that help them track or manage their health.<sup>16</sup> Although these numbers may seem small, they are likely to increase as smartphones such as the iPhone become more popular. Significantly, they also found no significant differences in health app use between men and women, nor among income groups<sup>16</sup> suggesting that health apps are utilized by both genders and across socioeconomic groups. These trends continued to be seen in another PEW survey in 2011.<sup>17</sup> Even among those with a household income of \$30,000 or less, smartphone ownership rates for those ages 18-29 are equal to the national average. 44% of blacks and

Latinos are smartphone users. Urban and suburban residents are roughly twice as likely to own a smartphone as those living in rural areas. All of these trends imply that smartphone apps may be a viable means of addressing health disparities in these populations.

### Dietary Assessment via Cellphone

With the increasing popularity of smartphones, the uses of health-related apps will also increase.<sup>18</sup> As these mobile-based assessment methods are implemented, there is a need to validate their accuracy and reliability to compare these methods with current methods in relation to cost, convenience, participant burden, and completeness of measurements.<sup>19</sup> While several studies have examined dietary intake with proprietary software apps commercially available apps have received much less attention.<sup>20 - 26</sup>

To explore this area, we conducted a small-scale pilot study to examine the user-friendliness and accuracy of calorie estimation functions of one such app. We chose the “Meal Snap” app from the Apple iTunes store as a typical example of this category of apps. Meal Snap lets users take pictures of the meal they eat, and then identifies which foods are in the meal. It estimates the calories of the food items eaten by providing a range. Meal Snap also allows the users to keep track of foods eaten in a picture format, thus making food tracking easier.<sup>27</sup>

### Methods & Materials

#### Sample

Two Caucasian female nutrition graduate students agreed to pilot-tested the Meal Snap app.

#### Preparation / Training

The two graduate students were trained to use the Meal Snap app using the step-by-step directions provided by the app itself. The students had several days to practice using the app before beginning data collection. The students were trained to use Nutritionist

Pro prior to the start of the pilot study during a nutrition course as part of their graduate coursework.

Nutritionist Pro is commonly used by nutritionists, dietitians, and health professionals in healthcare delivery, food service, and education settings to analyze food recalls and food diaries for patients. The software provides thorough nutrient analysis of diets, recipes, and menus with up-to-date food and nutrient data, diabetic exchanges, and My Plate servings.<sup>28</sup>

### Data Collection

Each student used the Meal Snap application to take pictures of whatever foods or drinks she consumed over the course of seven days. This was repeated a second time, resulting in two weeks of data for each participant.

When an individual took a picture of her meal, the app produced a description of the food, and calculated an estimated range of calories in the meal. Upon viewing the meal description, the individual had the option to rate the accuracy of the caption with a 'thumbs up' or 'thumbs down' and then if needed change the description to more accurately represent the meal. The participants were instructed to make the meal descriptions as accurate as possible.

Participants also constructed two 7-day food diaries from the pictures taken in the Meal Snap app. The food diaries were handwritten documents much like traditional food records, which included the food item, serving size, and time of day or mealtime the food was consumed. The food diaries were then entered into Nutritionist Pro™ Diet Analysis Software version 4.4.0.<sup>28</sup> The participants recorded the time it took to take daily food pictures using Meal Snap as well as the amount of time it took to enter the week's data into Nutritionist Pro.

To assess the accuracy of the Meal Snap app, daily range of the caloric intake obtained from the Meal Snap was averaged and then compared with the mean daily caloric intake calculated from the Nutritionist Pro. Paired samples t-tests and Spearman rank correlation

coefficients were carried out using SPSS Statistics, version 19. Statistical significance was set a-priori at  $\alpha = 0.05$  level. To assess whether mean daily calorie intakes estimated by Meal Snap were consistent with those derived from analysis through Nutritionist Pro, a Spearman rank correlation coefficient was calculated. The results showed that there was a significant correlation between Meal Snap and Nutritionist Pro™ calorie counts (Spearman  $r = 0.625$ ,  $p < 0.001$ ).

### Results

There were no statistically significant differences between the Meal Snap calorie counts and the calorie counts obtained through weeklong food diaries analyzed using Nutritionist Pro™ Software ( $p = 0.706$ , Table 1). When the overall intakes were broken down into different meal types (breakfast, lunch, dinner, and snacks & drinks) no differences were found. Lastly, there was a significant correlation between Meal Snap and Nutritionist Pro™ calorie counts (Spearman  $r = 0.625$ ,  $p < 0.001$ ).

It took users about 35 minutes per week (or 5 minutes a day) to snap pictures and edit descriptions, whereas calorie analysis with Nutritionist Pro™ took about 85-90 minutes per week (about 13 minutes a day).

### Discussion

#### Limitations of Apps

Several previous review articles focused on the uses of apps for diet and nutrition. While they are widely believed to be a promising new method of measuring dietary intakes, not all evaluations have been favorable. It has been noted that most apps focus on weight loss, with inconsistent outcomes.<sup>29</sup> In a systematic literature review on mobile dietary apps and management of chronic renal disease, among the studies they examined, none found significant changes in nutrient intake, biochemical markers or intradialytic weight gain.<sup>30</sup>

Table 1: Comparison of caloric intake by meal type<sup>a</sup>

Meal Type	Nutritionist Pro Mean ± SD	MealSnap <sup>b</sup> Mean ± SD	P value
Breakfast	418.13 ± 83.97	399.52 ± 91.16	0.058
Lunch	397.32 ± 186.24	419.30 ± 247.02	0.183
Dinner	528.36 ± 207.36	528.02 ± 228.77	0.993
Snacks + Drinks	235.68 ± 254.90	193.50 ± 198.08	0.234
Overall	1561.46 ± 247.59	1540.93 ± 277.89	0.706

<sup>a</sup>Daily average of two 7-day food records

<sup>b</sup>Values were calculated by taking the mean of high and low ranges

### Evaluation of the Meal Snap App

Our findings indicate that Meal Snap is nearly as good at estimating calories as the Nutritionist Pro™ software, and could be a potentially useful tool in estimating dietary intake of free-living individuals with smartphones. Results indicate that overall, Meal Snap can be used to provide similar calorie counts as traditional dietary assessment methods, including food diaries. Meal Snap has potential applications for use by health professionals and by the general public. Dietary assessment methods using Meal Snap offer a number of advantages in both the collection and analysis of user data. A significant strength of the Meal Snap app is that it saves time. It took more than 2.5 times longer to complete calorie analysis with Nutritionist Pro™ than with the Meal Snap application. Meal Snap is more accessible, less expensive and less time-consuming, therefore reducing user burden and enabling the app to be more user-friendly.

Results of the Meal Snap assessment are similar to evaluation of PDA-based dietary assessment. Technology-based dietary assessment is more convenient and provides calorie estimates comparable to traditional dietary assessment methods. The Meal Snap app actually reduces user burden even more than PDA-based technology, because users do not have to search or scroll to find each food eaten.<sup>4</sup> An additional benefit of the Meal Snap app is that it retains memory of what the user has recorded in the past. The individual is able

to personally monitor his/her calorie trends using those saved records. Dietary self-monitoring is frequently referred to as the “cornerstone” of all behavioral weight control programs.<sup>31</sup> More recent findings have confirmed these original results.<sup>32</sup> The specific addition of systematic calorie self-monitoring may increase weight loss and reduce attrition rates.<sup>33</sup>

Despite these advantages, it is important to note the limitations and areas of improvement for dietary assessment using Meal Snap. Sometimes, Meal Snap is unable to detect what type of food it is rating; stating “Not Food” when is the item is in fact a food. Calorie counts can also change with the specificity of the food description, such as eggs versus egg whites. Meal Snap relies on the individual to take a picture before they begin eating their meal, and to remember to take a picture of each of their meals in order to obtain an accurate daily calorie count. The client must also check the accuracy of the food description after it is given. Akin to PDA-based methods, the incorporation of iPhone apps including Meal Snap into dietary assessment cannot correct errors such as failure to report all foods eaten.<sup>6</sup>

We report here the results of a pilot study evaluating the accuracy and utility of a commercially available smartphone app. Because of the small number of subjects, interpretation and generalization of these findings is limited. However, because of the dearth of studies of any kind evaluating commercially available



smartphone apps, we believe that there is value in examining the results we obtained.

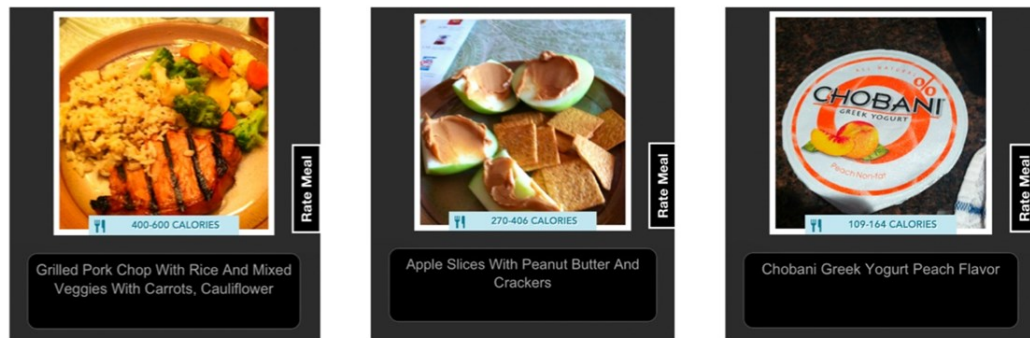
Meal Snap seems to be more accurate when dealing with simpler foods, such as packaged foods or whole fruits. Its precision seems to decrease when describing more complex foods, such as an entire meal with multiple ingredients on a plate. **Figure 1** shows examples of food items that Meal Snap was able to describe accurately vs. those with poor/inaccurate descriptions.

Having pilot tested the Meal Snap App, we have considered some potential improvements to increase accuracy of the results it generates. The Meal Snap app could provide more detailed nutrition information, such as grams of protein, fat, and carbohydrates, as well as the Daily Values of various vitamins and minerals. A notification system through the Meal Snap app would be

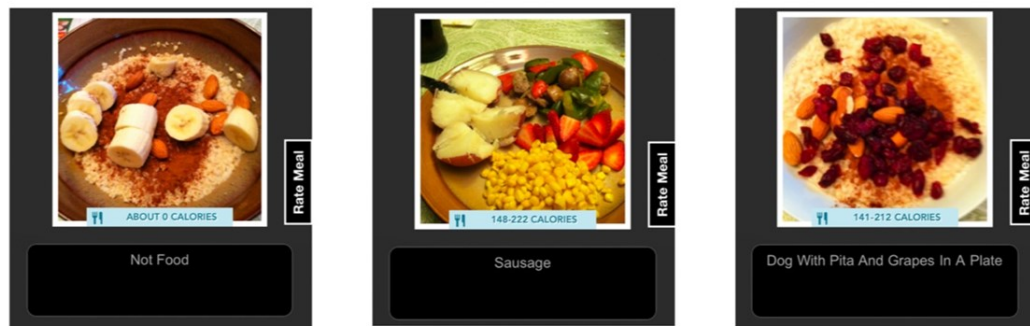
helpful to remind users to snap a picture of their food before each meal. Meal Snap could present a short questionnaire that includes prompts such as "Did you add sugar to your coffee?" and "What kind of salad dressing did you use, oily or oil-less?" that are often seen in studies using PDA technology.<sup>11</sup> Incorporation of this information would aid in calculating the more complex details of the meal. Finally, one potential way to make Meal Snap more useful would be to provide a connection to apps such as DailyBurn, an application made by the same company that allows the user to track calories through their food intake and workouts.<sup>34</sup> Food tracking can be completed using a simple search through the food database provided by DailyBurn, and doesn't need a picture to determine calories.

Figure 1: Examples of good versus poor descriptions of Meal Snap images.

Good Descriptions



Poor or Incorrect Descriptions



Correct Descriptions

- A. Oatmeal with Cinnamon, Banana, and Almonds
- B. Chicken sausage with Peppers & Onions, a Baked Potato, Strawberries, and Corn
- C. Oatmeal with Cinnamon, Craisins, and Almonds

Figure 1. Examples of food items that Meal Snap was able to describe accurately vs. incorrectly

## Conclusions

The Meal Snap app has potentially useful applications both to everyday users and to a clinical setting. Meal Snap allows its users to track calories and meals over a period of time. The app is convenient, portable, and user friendly.

It has been recognized that when energy intake is self-reported using traditional dietary assessment methods, food and nutrient consumption is often underestimated.<sup>35</sup> Meal Snap could potentially be an alternative dietary assessment method to traditional approaches including dietary recalls, food diaries, and FFQs. Meal Snap could aid nutritionists and dietitians in tracking food consumption of their patients. By using photos, they could estimate calorie counts more accurately for patients. With the advent of food blogging and photo-sharing websites such as *Instagram*, snapping a photo of one's plate of food in public before beginning to eat is not likely to make an individual feel self-conscious, as it once may have done. This may reduce a potential barrier to collecting this type of data in larger studies of free living populations.

With the rising popularity of smartphones such as the iPhone, the need for a valid and reliable dietary assessment app will become more critical. Meal Snap may be a potentially accurate and user-friendly tool to estimate dietary intake. Future research on Meal Snap should include a larger sample and include people of diverse ethnic backgrounds, dietary habits and age groups. Further studies should also explore other commercially available apps as research tools to facilitate collection of dietary data.

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