AN ASSESSMENT OF THE VALIDITY AND ACCEPTABILITY OF A NOVEL, AUDIO-VIDEO FOOD JOURNALING METHOD, IN A FREE-LIVING SETTING

by

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Abstract

Introduction

A novel method of dietary assessment was introduced in a field study with wildland firefighters, published in 2017. The purpose of this thesis was to validate this novel, audio-video method of dietary assessment, and to determine whether it can be integrated into clinical practice, to replace written food journals. The validation process was completed in two phases and is presented as two manuscripts within this thesis.

Manuscript One

Phase one was designed to validate the audio-video method in comparison to the gold standard: weighed food assessment; in a free-living setting. With the exception of Vitamin E (mg) and total weight (g), kilocalories, macro and micronutrient values were highly correlated between the audio-video diary recorded estimations and weighed food items. We concluded that the novel method was able to make accurate estimations of energy and nutrient intake, and may therefore be a meaningful alternative to diary recording in a free-living setting.

Manuscript Two

Phase Two was designed to assess the application of the 3-day, audio-video method in a clinical setting, to replace the current method of 3-day, written food journaling. We found that the diet assessments, as performed by a Registered Dietitian for the same participants, were comparable between written and audio-video diaries. In consultation with the Registered Dietitian, we conclude that the audio-video method is acceptable for use in clinical practice.

Conclusion

The audio-video method is a suitable method for assessing food items, when the portion sizes from the video are estimated by persons with training on portion sizing (i.e. researchers or Registered Dietitians). In addition, the AV method was determined to be an acceptable method for use in clinical practice, to replace written food journals. Participants indicated that if the method was developed into a mobile phone application, for use on their personal device, they would be more likely to accept it as a food journaling method, when compared to the written method of food journaling.

Keywords

Nutrition, mobile health, energy balance, dietary assessment

Co-Authorship Statement

Chapters two and three are presented as two separate manuscripts for publication.

Manuscript 1 :
AN ASSESSMENT OF THE VALIDITY OF AN AUDIO-VIDEO METHOD OF FOOD JOURNALING FOR DIETARY QUANTITY AND QUALITY

Author Contributions:

Emily Jago completed data collection, statistical analysis and interpretation, as well as drafting and editing the manuscript.

Dr. Sandra Dorman assisted with the conceptualization and design of the study, interpretation of the results, and review of the manuscript.

Dr. Alain Gauthier assisted with the conceptualization and design of the study, interpretation of the results, and review of the manuscript.

Dr. Ann Pegoraro assisted with interpretation of results and reviewed the manuscript.

Prof. Ginette Michel assisted with the conceptualization and design of the study, interpretation of the results, and review of the manuscript.

Manuscript 2 :
A COMPARATIVE ASSESSMENT OF NUTRIENT OUTPUTS FOR CLINICAL INTERPRETATION BETWEEN WRITTEN AND AUDIO-VIDEO FOOD JOURNALING IN A FREE-LIVING SETTING

Emily Jago completed data collection, statistical analysis and interpretation, as well as drafting and editing the manuscript.

Dr. Sandra Dorman assisted with the conceptualization and design of the study, interpretation of the results, and reviewed the manuscript.

Dr Alain Gauthier assisted with the conceptualization and design of the study, interpretation of the results, and reviewed the manuscript.

Dr. Ann Pegoraro assisted with interpretation of results and reviewed the manuscript.

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List of Acronyms

AV: Audio-Video

Kcal: kilocalorie

CROSH: Centre for Research in Occupational Safety and Health

DLW: doubly-labelled water

EE: Energy Expenditure

EI: Energy Intake

g: grams

mL: millilitres

(μg): micrograms

Kcal: kilocalorie

LUNCH: Laurentian University Nutrition, physical activity and Community Health

PFI: Personal Food Items

RD: Registered Dietitian

TEE: Total Energy Expenditure

Chapter 1: Introduction

The proposed research is important in the field of clinical nutrition because it is widely recognized that current food data collection methods are either not a valid representation of what a person consumes on a daily basis, and/or linked to poor compliance amongst individuals who engage in food journaling. Diet analysis is critical because diet meaningfully impacts diseases contributing to the highest morbidity and mortality amongst Canadians (Johnson, Hayes, Brown, Hoo, & Ethier, 2014). Nutrient analysis allows health care providers, including Registered Dietitians, to provide counseling to improve and maintain health. Diet intervention is critical for many Canadians including those experiencing disordered eating (e.g. binge eating to anorexia nervosa), a desire for weight loss for health reasons (e.g. Type II Diabetes, Cardiovascular disease), and general health assessments (e.g. calcium needs). Globally, poor diet habits have a negative impact on personal health resulting in a worldwide health concern related to obesity (World Health Organization [WHO], 2016). Rates of obesity in Canada are on the rise, and in 2012, "one in four Canadians were considered obese in that year, marking a 17.5% increase in obesity since 2003" (Navaneelan & Janz, 2014, p. 1). More research is required to understand the physical and social impacts of the increasingly obese population in Canada, and in an effort to mitigate the results of malnutrition, how we can develop prevention and intervention practices to improve personal health. One current practice of prevention and intervention is documenting food consumption by way of food journaling.

There are two main causes identified for obesity and being overweight. The first, is an increase in sedentary behaviour as a result of our built environment, transportation, stationary work tasks, and proximity to and availability of non-nutrient dense foods (WHO, 2016). The second cause is

energy imbalance; an imbalance between calories expended and calories consumed (WHO, 2016). When we consume more calories than we expend, the caloric surplus results in overall weight gain. Therefore, when an individual tracks their meals, this can help them to understand how much food they are consuming in terms of calories, and inform their choices to modify caloric consumption to maintain a healthy weight.

Food journaling is utilized within the scope of clinical practice and consultation, and due to modern technology, non-prescribed food logging has expanded and increased to the general public. Downloadable applications for mobile devices, which feature or incorporate food journaling and diet-analysis, have become popular and cell phones/camera technology have inspired people to share photos of their food. In some cases where food items are not visible, diary recording is still required, negating the benefits of photography as a replacement for written journaling. When compared to traditional methods of Three-day Food Records, the use of digital photography for assessing food choices has already been shown to be preferred amongst participants (Swanson, 2008) and as accurate as real-time estimates of food (Williamson et al., 2003). There are however three inherent challenges to using this methodology: i) it is difficult/impossible to determine food contents when the food is not readily visible; ii) results may be biased by participant's awareness of food consumption assessment; and iii) nutrition analysis is more labour-intensive. A solution to this, developed in the Centre for Research in Occupational Safety and Health (CROSH) lab, is to ask participants to audio-video (AV) record their food in a free-living setting; that is, describe the food that cannot be seen using the audio feature while taking a video of the food. This method has not been validated to date.

The current gold standard for assessing an individual's food consumption patterns (e.g by a Registered Dietitian) is still accomplished via written, food journaling. However, participant

feedback demonstrates that patients find it too laborious and difficult to accurately estimate serving sizes, especially for unpackaged foods (e.g. chicken). A second consideration for this method of diet evaluation is that food journaling is also considered a strategy for weight-loss, as the research tells us that journaling impacts the food choices people make. Therefore, although journaling is still considered an important tool for Registered Dietitians, is still an imperfect method.

Therefore, given that written food journals are the current standard practice in dietetic counseling, the purpose of the current thesis was threefold:

i. To assess the validity of the audio-video (AV) method; by comparing nutrient outputs from estimated food items from the AV method with the gold standard method: weight-recorded food items (manuscript 1);

ii. To assess the application of the AV method to replace written food journaling in the clinical setting (manuscript 2); where written food journaling is the current standard in clinical practice; and,

iii. To consider the acceptability of the AV method amongst Registered Dietitians and participants (manuscript 2).

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Chapter 2: Literature Review

Understanding Food Behaviours

Nutrition research is fundamental to the health of the Canadian and global population. The challenges associated with understanding which food items support health and physical development in order to live optimally and which may be contributing to poor health outcomes are numerous. The *American Society for Nutrition* suggests that, "nutrition research holds the key to increasing our understanding of the underlying causes of obesity and its related comorbidities and thus holds promise to markedly influence global economies" (Ohlhorst et al., 2013, p.620). The goal of an intervention is the induction of a behaviour change, and an important tool for transforming one's diet is to incorporate a food diary. Shay, Seibert, Watts, Sbrocco, and Pagliara (2009), acknowledge a wide body of research and support this in saying that;

> "…maintaining detailed records on specific behaviours is considered one of the most essential features of behaviour therapy and consistent self-monitoring has been associated with improved dietary measures… although accuracy is generally poor… is it likely that accuracy is not as important as consistently focusing attention on that behaviour. The more consistently individuals self-monitor their daily energy balance the more weight they lose. (p.220)."

The food environment is exceptionally complicated. Individuals in a free-living condition develop an ever-evolving relationship with food that is impacted by their physical environment (Minaker et al., 2013). Minaker et al. (2013) suggested that there is a relationship between the objective food environment and a resident's diet quality and weight status. They identified the

direct effect of several objective factors of the food environment, comprising food access and relative food affordability with where money is spent on food. This includes proximity of grocery stores and quick service restaurants, how much money is spent on food, the environment in which they eat their food, and if they eat alone or with others (Minaker et al., 2013). Adding to this, Kong et al. (2012) discovered that there are several influencing factors that contribute to one's decision to select some foods and not others, as well as to restrict, control, or binge with food. Sociocultural factors including race, age, gender, religion, and geographic location all contribute to these choices (Kong et al., 2012). Addressing the socio-behavioural factors surrounding food consumption is an important part of understanding a client or patient's eating behaviour and can be done using food journals. Addressing food consumption in a controlled environment prevents participants from making independent food choices and recording their meals and intake as they conduct their daily routine since they are provided with weighed and recorded meals, and can only eat what is provided to them at specific times in a laboratory setting. As a result, this has the potential to change the presentation and choice of food behaviour to the Registered Dietitian or clinician. Zepeda & Deal (2008) studied consumer behaviour regarding food choices specific to food journaling methods and found that participants conceded that compared to written food diaries, photographic food diaries:

> "Revealed that both the act of taking the photos and the pictures themselves raised their awareness of their diets. For many, this visual form of self-monitoring resulted in the recognition of unhealthy aspects of their diet and change in their behaviour. The act of photographing altered behaviour for some because it forced them to think about their food choices. The extra effort of recording the snack or a second helping of food made

them think about whether they really should eat it, and reflect that perhaps it was not the healthy thing to do" (Zepeda & Deal, 2008, p.696).

Weight Management Practices and Behaviours

One of the main reasons that people engage in food journaling is to manage their weight and to develop a better understanding of what they are eating. Healthfully managing individual weight and body composition is critical for all people, with the potential to support individuals to live freely from disease, and it is understood that "proper nutrition offers one of the most effective and least costly ways to decrease the burden of chronic and non-communicable diseases (NCDs) and their risk factors, including obesity." (Ohlhorst et al., 2013, p.624). These nuances in diet indicate that it is important to validate food journaling methods in free-living setting. To be considered significant, it has been identified that a 30kJ average energy imbalance per day contributes to gradual weight gain (Hall et al., 2011). Furthermore, to sustain the increased weight, energy intake must rise to an average of approximated 0.9MJ per day. Additionally, Hall et al. (2011) suggest that "every change of energy intake of 100kJ per day will lead to an eventual bodyweight change of 1kg (equivalently, 10kcal per day, per pound of weight change), with half of the weight being achieved in about 1 year and 95% of the weight change in about 3 years" (p. 834). As such, the feedback provided from food journaling in consultation with a health care practitioner can allow a person to manage their weight through calorie balance or deficit, and eat healthfully by understanding their own needs and fulfilling them by consuming the correct balance of macro and micro nutrients in a day.

Current Food Journaling Practices

Benefits of Food Journaling

The need to measure nutritional input and eating habits as an indicator for future implications on health is recognized as an important strategy to mitigate disease (Bingham et al., 1994). However, the study of food and food choices have inherent challenges. Primary considerations for collecting nutrition information include: i) ensuring the assessment method is accurate; ii) achieving participant compliance; and iii) extending the assessment method to reach large populations of people (Thompson & Subar, 2001). Historically, the principal methods for assessing dietary intake include, but are not limited to: 24-Hour Recall, Food Frequency Questionnaires, and Three-Day Food Records. Twenty-Four Hour Recall and Food Frequency Questionnaires are notoriously flawed methods. In fact Dhurandhar et al. (2015) reported that self-reported intakes of energy intake are regularly used in health research, and yet collecting "data through self-reported diary recall, despite the fact that self-report questionnaires have been repeatedly shown to be seriously flawed" (Dhurandhar et al., 2015, p. 1110) and is a common practice. Three-day food records require participants to record, in detail, all foods and beverages consumed during a seventy-two-hour time period. Current recommendations suggest to record every second day; two days during the week and one day during the weekend to capture variability (Kolar et al., 2005). Yang et al. (2010) found that compared to a nine-day food record, three-day food records showed higher correlations and higher agreement proportions of quartile classification than did Food Frequency Questionnaires.

In the clinical setting, Registered Dietitians frequently ask patients to keep a food diary to assess their food behaviours and to help advise them about food choices or as a method of self-regulation or self-monitoring in an effort to improve eating patterns (Yang et al., 2010).

Understanding energy expenditure and energy intake is complicated for the average person, and so one goal of utilizing a food journal is to keep track of approximate portions of food, and more specifically kilocalories, fat, protein, and carbohydrate. However, food is also comprised of numerous micronutrients, which are often left out of food journals because they are more difficult to capture. In consultation with a Registered Dietitian, these nutrients can be estimated using nutrient software analysis and the Registered Dietitian can provide feedback to modify a patient's diet to improve micro- and macronutrient levels.

Challenges of Food Journals

Food journaling is considered a strategy for weight management, including weight-loss, because of its known impact on guiding food choice (Illner et al., 2012). Therefore, although journaling the intake of foods is an important tool for Registered Dietitians, it is still a faulty method. Feedback from written recall journaling indicates that some patients and clients find it too laborious and difficult to accurately estimate serving sizes, especially for unpackaged foods (e.g. chicken). In fact, some participants report eating packaged foods during the journaling process, because it is easier to record (Cordeiro et al., 2015).

Although written food journals provide a more realistic picture of the foods consumed by a person, three-day food records are limited to capturing food intake at a specific point in time and cannot capture the within-person variations of day-to-day dietary intake (Gersovitz, Madden, & Smiciklas-Wright, 1978). Considering that participants tend to tire of recording food diaries, particularly weighed food diaries, it is generally recommended not to exceed three days of collection because compliance rates diminish after this timeframe (Illner et al., 2012). Hollis et al. (2008) contend that, "[more] food records kept per week… provide additional evidence that standard behavioural strategies are key for successful weight loss" (p.7). Furthermore, they

argued that with a detailed food diary, “behavioural strategies to modify these health behaviours are important components of weight-loss interventions because they emphasize the ability to monitor and regulate behaviour” (Hollis et al., 2008, p.2). Exploring new platforms for recording food data will be beneficial to increase participant compliance and reduce perceived barriers as indicated in other similar studies (Cordeiro et al., 2015; Illner et al., 2012). Detailed food diaries that capture the exact food items or meals produce more valid and consistent results and shed light on behaviours that require a nutrition intervention.

One of the issues with written food journaling cited by Cordeiro et al. (2015), is that if one forgets to, or is unable to journal, it undermines the reliability of the journal reporting; that is, if a Registered Dietitian is able to use a person’s food diary knowing that they are able to consistently repeat the journaling process, including recording all meals and accurately estimating portion sizes. The authors also reported that missing entries lead participants to abandon journaling altogether. Additionally, participants in this study said that, “hard deadline[s], travel, [and] holiday season” (Cordeiro et al., 2015, p.1161) breaks the habit and makes it hard to start again. Research studies suggest that when integrating written food journaling methods, reporting portion-size estimation acts as a barrier for participants, suggesting that mistakes in estimating portion sizes can lead to under-estimation, and so portion-size estimation training and other methods of recording should be explored where appropriate (Carter, Burley, Nykjaer, & Cade, 2013).

Finally, it is critical to acknowledge the effects of health literacy, including linguistic and literacy barriers in nutrition. The ability to understand and process information is required to participate in food journaling. Health literacy can be defined as “the ability to access, understand, evaluate and communicate information as a way to promote, maintain, and improve health in a variety of

settings across the life course (Rootman & Gordon-El-Bihbety, 2008, p.11). Patients or persons working with a Registered Dietitian, health care practitioner, or who wish to make lifestyle choices are educated in food literacy skills which help them understand the foods consumed, read food labels, and understand the guidelines in Canada's Food Guide set by Health Canada in partnership with Dietitian of Canada. Canada has a large population of immigrants and individuals who do not speak or read English as a first language, which may impede their ability to consume healthy foods. One study reported by Fishman, Pearson, and Reicks (1999) discussed the barrier migrant workers and their families experienced living in a new country, where their children, "when asked what they needed to know to be healthy, few spoke of knowing about nutrition or healthful foods" (p.79).

Photographic Food Journaling

Given the pervasiveness of perceived barriers to prescribed food journaling, and due to modern technology, non-prescribed food logging practice has become more prevalent in the public domain. Applications, available on the Internet and easily downloaded, which feature or incorporate food journaling and diet-analysis have become popular, and tablets and mobile devices with camera technology have inspired people to share photos of their food on a variety of social media platforms.

A recent approach to assessing food has been the implementation of digital photography to capture food intake. Advantages of this method include its low cost, limited participant burden, and rapid data collection. Additionally, it is possible to extend the method to collect data on populations outside of a controlled laboratory setting (Martin et al., 2009). Continued research from Martin et al. (2014) have developed a software program using digital photographs to accurately estimate food volume consumed. Their Remote Food Photography Method (RFPM)

required subjects to capture pre- and post-meal images to compare with images of 'standard' portions of food using computer software. The amount of food selected and discarded is estimated based upon this comparison, and the application automatically calculates energy and nutrient intake. Participants must identify food in baseline photos for the software program such that kilocalorie and macronutrient estimates can be made. However, Martin et al. (2014) argues that this method allows estimation of food intake in near real-time in free-living conditions.

Several groups have experimented with photography and have found it to be valid for food assessment and preferred by participants in research studies (Higgins et al., 2009; Martin et al., 2007, 2014; Parent, Niezgoda, Keller, Chambers, & Daly, 2012; Small et al., 2009; Swanson, 2008; Williamson et al., 2003). Williamson et al. (2003) were the first to compare digital photography and visual estimation of portion size, and then compared both of these methods to weighed measures of food in university cafeterias. Sixty meals with ten different portion sizes were prepared and weighed. They found high correlations between portion sizes, for food selections, plate waste and food intake between both methods. They also found that both methods yielded small over- or under-estimates of weighed food. They concluded that digital photography would be useful for measuring food intake in settings that allow for the direct observation of food selections and plate waste. They also concluded that minimal disruption of the eating environment was important and might be better achieved with photography and that the photos allowed for unhurried estimates of portion size.

Small et al. (2009) examined meals (for 22 preschoolers) to assess the validity, reliability and acceptability of the addition of photography to traditional written diet diaries. They found strong correlations between visual estimates and actual values of calories and macronutrients for premeasured foods. They also stated that adding photographs to a traditional diet diary may

enhance the validity and reliability of prospective dietary intake recording and that parents and children enjoyed the photographic method, indicating effective compliance with this methodology in the public setting.

Martin et al. (2007) and Swanson (2008) measured the reliability of digital photography in assessing children's food. Martin et al. (2007) examined intake and the effects of second servings upon food intake in a school cafeteria. They reported the method to be reliable, but also demonstrated the utility of photography for studies of food intake and body weight. Swanson (2008) studied children's lunch trays, photographing them before and after eating periods; they concluded that the method was cost-effective, unobtrusive, accurate and reliable for measuring food consumption in a school setting for both comprehensive nutritional analysis and for simple counts of servings of food groups.

In 2009, Higgins et al. also performed a validation study comparing 3 days of meals assessed using a weighed diet and compared to digital photography in adolescents. There was no difference between the written diary and photographic estimates of total energy, carbohydrate, fat, protein, fiber, vitamins A, D and E, calcium, iron or zinc compared to actual intake. However, both participants and their parents reported that the photographic method was quicker, simpler and would be preferred if they were to record dietary intake in the future. In this study cohort, 36% of subjects accurately reported actual daily energy intake (±5% of actual intake), 29% under-reported energy intake and 35% over-reported energy intake.

More recently, Parent et al. (2012) also assessed visual estimation methods for regular and modified textures using real-time versus digital imaging and concluded that digital imaging was

a valid alternative to estimating regular and modified textured food waste for main meal plates when compared with real-time visual estimation.

To my knowledge, the only study to date that reported negative findings for the use of photography was Kikunaga, Tin, Ishibashi, Wang, and Kira (2007). This group used a handheld personal digital assistant (PDA) with camera and mobile phone card (Kikunaga et al., 2007). They concluded that this device required better resolution to adequately assess the photographs, however the photographic method they used was preferred by participants over the weighted diet record.

Taken together, the literature supports the use of digital photography, provided that the picture resolution is of good quality and under scenarios where the entire meal can be seen (Martin et al., 2014). However, in cases where visual estimation is insufficient to determine food choices, food diary data is still required (Gauthier et al., 2013; Martin et al., 2014). A Working Report on Nutrition Research by Ohlhorst et al. (2013) supports this in saying there should be a focus on improving current Nutrient Databases and that tools including, "… photographic food intake documentation, direct upload of food composition and sensory characteristics (if not proprietary) from food manufacturers, and biological sample collection" (p.624), which will improve the state of self-directed food and nutrition documentation.

Audio-Video Food Journaling

Three known studies have addressed food consumption challenges by using wearable video cameras, which directly observe individuals for an 'overall lifestyle evaluation,' (Arab, Estrin, Kim, Burke, & Goldman, 2011; Sun et al., 2010; Thomaz, Parnami, Essa, & Abowd, 2013). Methods implementing body-worn or wearable technology seek to understand how the person is

consuming food, where, when, and what they are consuming (Thomaz et al., 2013). First, the study by Thomaz et al. (2013) demonstrates that body-worn cameras used to capture food consumption provide interesting insight into a person's dietary consumption. However, some limitations were noted; specifically, since the video camera was worn around the neck, images only captured what was directly in front of the participant. Furthermore, the technology produced a large selection of video footage to be viewed and assessed by researchers (Thomaz et al., 2013). Whereas Arab et al. (2011), note that their participants reported no difficulty in using the technology, however 71% of participants did note that they felt uncomfortable wearing the technology in public, suggesting that smaller devices or alternative methods could be used in the future. Both studies acknowledge that automating images for the purpose of designing photo recognition will reduce the laborious nature of analyzing images after they are recorded to determine portion size and calorie nutrient information. Similar to the body-worn technology designed by Thomaz et al. (2013), Sun et al. (2010) developed wearable technology to be worn around the neck on a lanyard which captures the food directly in front of the participant. In this case, data is transferred directly to a Registered Dietitian's computer for processing and analysis to lessen the burden on the RD (Sun et al., 2010). Designed as a passive device, the technology also captures physical activity, behaviour and environmental exposure which all contribute to the over-all health of a person (Sun et al., 2010).

The Audio-Video Method

In 2017, Robertson and colleagues , published a study implementing a novel food journaling method with wildland firefighters, called the audio-video (AV) method. This method of food journaling asks participants to record their food using audio-video technology; that is, describe the food that cannot be seen using the audio feature while taking a video of the food. In the lab,

researchers examined the video footage to create a food diary, including the estimation of portion sizes. This method has not been validated to date.

Audio-Video (AV) appears to have the same benefits of photography: easy to use, fast, readily available, and potentially provides more accurate food information compared to written journaling (Robertson et al., 2017). However, audio-video recording may have additional benefits; namely, participants can describe their food while recording, solving the problem of literacy and 'hidden foods' identified with photographic journaling. For example, while recording the sandwich they are eating, participants can describe the ingredients within (e.g., mayonnaise, salt, pepper, and sliced cheese).

Mobile Technology

It has been suggested that mobile phone interventions designed to support specific components of evidence-based treatments could reduce barriers to treatment access and engagement (Luxton, McCann, Bush, Mishkind, & Reger, 2011). By the end of 2012, 91% of the global population was using mobile phone technology, with 4.3 billion unique mobile subscribers (Tregarthen, Lock, & Darcy, 2015). This statistic demonstrates that there is an available global market to develop a mobile phone application with the potential to engage people in various cultures representing several races and ethnicities. Such technology could change eating and food consumption behaviour to prevent chronic diseases including Type II diabetes, obesity, and cardiovascular disease. Portable and technologically savvy food journaling may allow people in a free-living environment to more readily track their food to understand their food consumption habits. Tracking food speaks to how accurately a person records their food choices, and so personal bias becomes an issue when considering the results of any food journal. Developing and implementing a food diary application using audio-video recording has the potential to solve

both indicated barriers: the need to *quickly* and *accurately* record food consumption may improve compliance with minimal effects on food choices.

To accurately assess and understand a person's dietary habits, it is important to study food intake by individuals in their own unique food environment. For example, in 2016, it was reported that in Canada, 76% of the population owned a smart phone (Statistics Canada, 2017), and mobile phone usage has been, "widely adopted across socioeconomic and demographic groups and appears greater among those populations most in need of these interventions" (Riley et al., 2011, p.1). In addition to the prevalence of mobile phone usage, the devices provide the potential for reduced burden on the user to record the meals, and users are more likely to report meals consumed using a mobile device than other dietary assessment methods, even when recording meals before and after eating (Boushey et al., 2009).

Diet Analysis

NutriBase Pro is a software program used by Registered Dietitians and researchers to analyze the contents of foods and provide an overview of the micro- and macronutrients consumed by a person. NutriBase Professional draw their nutrient profiles from the Canadian Nutrient Profile produced by Health Canada (Health Canada, 2015), and can be used in for clinical or commercial applications. Registered Dietitians can work with clients or patients, encouraging them to submit a food journal, after which a Registered Dietitian can develop a profile for the client including height, weight, gender and date of birth. The Registered Dietitian enters the food items and their listed quantities based on the food journal provided to them. The food items are selected from a search bar and dropdown menus, drawing from the food items listed in the Canadian Nutrient File. Once the food item has been selected, the Registered Dietitian enters the quantity of the food item provided by the patient. After all of the food items and their quantities

have been entered, the Registered Dietitian can produce a document which illustrates the nutrient profile from each day, and over three days. Using each program, a list of macro- and micronutrients, vitamins, and total calories are displayed. Based on the age, weight, height and gender of the patient, the program estimates the approximate caloric intake level, required macro- and micronutrients, and vitamins the person requires to maintain their current weight. A Registered Dietitian can then begin analyze the data provided by the patient and compare the outputs to the Recommended Daily Intake values prescribed by Health Canada, indicated in the personal client nutrient repost created with NutriBase Pro. At this point, the Registered Dietitian can recommend diet changes for individuals to optimize their food choices.

As demonstrated above, it is important to address the feasibility of incorporating the AV method into standard practice or nutrition counselling. To date related methods are laborious in nature for the participant and Registered Dietition, and as such, it is likely the participant compliance will drop. Additionally, from both a time and cost perspective, it would be necessary that any method developed could be easily and conveniently incorporated into standard practice to achieve high success in producing accurate results, at a low cost, and rapidly.

Current Research Thesis

The purpose of this study was: to validate the audio-video method of food journaling; to assess the use of the AV method in dietetic assessment and counselling, to replace food journaling; and to assess the acceptability of the method by a Registered Dietitian and participants. The thesis was conducted in two phases. Phase One was designed to validate the audio-video (AV) method in comparison to weighed food assessment, the gold standard. Phase Two was designed to compare nutrient assessments of diets recorded by both the audio-video method and traditional food journaling, by a Registered Dietitian. We also estimated the acceptability of using the AV

method by participants, in a free-living setting, through a survey. Furthermore, feedback was sought from the Registered Dietitian regarding whether or not this method of food journaling could be used in a clinical setting.

Research Questions and Hypothesis

This thesis was designed to address the following research questions:

1) Does the audio-video method produce micro- and macro- nutrient estimates that are comparable to the nutrient estimates produced when food items are individually weighed?

2) Does 3-day audio-video journaling produce nutrient data that is comparable to 3-day written food journaling; for clinical interpretation of diet?

3) Is the audio-video method acceptable for use by a Registered Dietitian as a means of clinically interpretation diet practice?

4) Is the audio-video method preferred by participants for use in a free-living setting?

Hypotheses

The research was partly undertaken due to discussions with local Registered Dietitians who describe difficulty achieving good patient compliance and therefore meaningful diet information from their patients.

We hypothesize that by integrating technology (which is easy-to-use and already accepted practice in North America) the following:

1) The nutrient output data produced as a result of weighing food items will correlate clinically, with the nutrient output data produced by the food items estimates in audio-video recordings.

2) The nutrient output data produced from the 3-day audio-video method will correlate clinically to the nutrient output data produced by the 3-day written food journals.

3) The Registered Dietitian will consider the audio-video method a potential replacement for food journaling.

4) The participants will be more accepting of the audio-video method of recording, compared to the written food journals in a free-living setting.

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Chapter 3

An assessment of the validity of an audio-video method of food journaling for dietary quantity and quality.

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ABSTRACT

OBJECTIVE
To validate an Audio-Video (AV) method of food journaling, in a free-living scenario, in comparison to direct, weighed food assessment: the gold standard.
DESIGN AND SETTING
Data were collected over one day, in a University cafeteria. Meals, selected by participants (n=30) from the cafeteria were documented by the participants using the AV method. Using an iPod Touch, participants video-recorded their tray while audio-recording a verbal description of the contents of their selected meal. After which the research team digitally weighed each food item and created an itemized diary record of the food.
VARIABLES MEASURED
Data from the AV food journals were transcribed and entered into a nutrition software analysis program (Nutribase Pro 10.0; Cybersoft, Inc, Phoenix, AZ, 2012). Data from the weighed food diaries were also entered into the program and nutrient outputs were compared between the two methods including: kilocalories, macronutrients, and selected micronutrients.
ANALYSES
Using mean scores for each variable, Wilcoxon Signed Ranks test and Spearman's Correlation Coefficients were conducted. Interclass Correlation Coefficient (ICC) was calculated for absolute agreement between the two methods to assess inter-rater reliability
RESULTS
With the exception of Vitamin E (mg) and total weight (g), nutrient values were highly correlated between AV diary record estimations and the actual weight of food items and were statistically significant given alpha=0.05, power =0.95, effect size of 0.70.
CONCLUSIONS
The AV method provided the researcher and Registered Dietitian with the audio and video information needed to make estimations of energy intake in a school cafeteria setting, and may be a meaningful alternative to diary recording in a free-living setting.

Introduction

Novel methods for assessing nutrient intake in the free-living setting are needed to manage food-related health challenges (Gorber et al., 2007). The most accurate measure of dietary intake is direct observation and prospective recording of weighed foods (Ptomey et al., 2015). This gold-standard method requires that each item of food be weighed and recorded prior to (pre-meal) and following consumption (post-meal), where the researcher weighs the plate with any leftover food items. This results in the valid and reliable quantification of dietary intake and permits retrospective calculation of nutritional intake (i.e., kilocalories, macro- and micronutrients). However, this method is time-consuming, and expensive to execute (e.g., participant/patient training) in research studies and in clinical settings. Furthermore, there is considerable participant burden, and the mere act of keeping such a detailed, weighed food record by participants/parents can become an intervention in and of itself (Small et al., 2009).

Historically, the principal methods for assessing dietary intake have included: 24-Hour Recall, Food Frequency Questionnaires (FFQs), and Twenty-four-hour Recall; but all have been deemed faulty (Dhurandhar et al., 2015). In fact, Dhurandhar et al. (2015) reported that self-reported intakes of energy intake are regularly used in health research, and yet collecting “data through self-reported diary recall, despite the fact the fact that self-report questionnaires have been repeatedly shown to be seriously flawed" (Dhurandhar et al., 2015, p. 1110) and is a common practice. Three-day food diaries, despite limitations, remain the best option. This method requires participants to record, in detail, all foods and beverages consumed during a three-day time period, ideally, every second day; two during the week and one day during the weekend to capture variability (Kolar et al., 2005). Limitations include: i) compliance; participants tire of recording food diaries (which is why people are generally recommended not to exceed three days

of collection because compliance rates diminish after this timeframe) (Illner et al., 2012); ii) self-reporting bias (Freedman et al., 2014); iii) poor ability to estimate serving sizes (Boehl, 2007); iv) the act of writing down one's food, fundamentally changes our eating patterns (Boehl, 2007); and v) the literacy of the person collecting the food data will also fundamentally affect the data provided (Boehl, 2007). The use of food journaling has become mainstream and studied at length in the last decade however, few advances in this methodology resolving these limitations have occurred. The exception is the use of photography, although this method still requires a written documentation of food items (Gauthier et al., 2013).

The advent of digital photography has provided advantages that include its low cost, limited participant burden, and rapid data collection (Dorman, Gauthier, Laurence, Thirkill, & Kabaroff, 2013). Additionally, it is possible to extend the method to collect data on populations (Martin et al., 2009). Significantly, people have already incorporated this application into their lives as photographing and sharing food photos has become commonplace (Patrick, Griswold, Raab, & Intille, 2008). Several groups have tested the photographic method and found it to be reliable for food assessment; and *preferred* by participants in research studies (Higgins et al., 2009; Martin et al., 2007, 2014; Parent et al., 2012; Swanson, 2008; Williamson et al., 2003). Taken together, the literature supports the use of digital photography, provided that the picture resolution is of good quality and under scenarios where the entire meal can be seen (Martin et al., 2014). However, in cases where visual estimation was insufficient to determine food choices, food diary data was still required (Martin et al., 2014).

In 2017, a novel method of assessing food intake in a free-living setting was reported; which removed the requirement of written journaling, specifically, they used audio-video (AV) food recording (Robertson et al., 2017). This AV method was employed amongst wildland firefighters

with the goal to understand food consumption patterns during fire deployment, while eliminating barriers in food data collection. In particular, to achieve compliance amongst participants, it was critical that the food data collection not be overly laborious or time consuming, (i.e. written journal records), or rely on participant memory (Olafsdottir et al., 2016). Robertson et al. (2017) reported that the AV method was beneficial because it could be completed at any time, in any location, and did not impede participant work tasks; written journaling would have been difficult given the nature of their work and the inclement weather and field conditions. The AV method employed by Robertson et al. (2017) builds on the principle of the photographic dietary record, that is, that the video image provides (presumably) equivalent data to a digital photo but with the benefit that the written journal is no longer required; since participants instead included an audio dictation of the meal and any hidden, or un-seen ingredients while video-recording. Given that previous research has validated the photographic method for measuring food intake, compared to visual estimation (Dorman et al., 2013; Gauthier et al., 2013), it suggests that video-recording would provide similar results and that the AV method may be a novel, alternative method to estimating food intake via direct observation (Williamson et al., 2004). However, to our knowledge the AV method has not yet been validated in the literature. Doing so is meaningful, given the potential applications for this method; specifically, since 91% of the global population has access to portable, personal devices, capable of AV (i.e. cell phones) (Tregarthen et al., 2015). Audio-Video food journaling could therefore allow people, globally, in a free-living environment, to readily track their food and better understand their food consumption habits. In addition, written journaling also requires a level of literacy; the AV method removes this constraint, increasing participant pools and potentially reaching people, previously unable to contribute food data to the research literature (March et al., 2015). Given the technological

advancement in these devices, including high-resolution video capabilities, we are poised for rapid increases in available, personal food data for analysis, leading to broad-based opportunities for mobile phone interventions designed to support specific components of evidence-based treatments relating to food and health (Luxton et al., 2011; Mohr, Schueller, Montague, Burns, & Rashidi, 2014).

Therefore, the purpose of this paper was to assess the AV method of recording meals in a free-living scenario, in comparison to direct, weighed food assessment, the gold standard.

Methods

Participants

Participants were recruited, at random, from a University-based cafeteria. After selecting their meal choices, participants were approached by researchers until a total of n=30 participants (female: 18; male: 12) agreed to participate. Forty-seven people were approached and 17 chose not to participate. Thirty (30) participant meals, including a mix of lunch and breakfast, were documented over a four-hour period, in one day. All meals were included in the data analysis.

Each participant received an incentive of $10.00 for agreeing to participate. Results of this study are solely based on the foods selected, and so no personal data was collected; participant food data were assigned a participant ID number. All participants provided written, informed consent prior to participation and this study was approved by the Institutional Research Ethics Board of the authors. (Appendix A)

Study Design

Data were collected in January 2017, in a cafeteria setting in a medium sized University in Canada. Each meal was selected by the participant prior to study recruitment, resulting in a range of portion sizes and items chosen per meal.

AV Method

Participants were provided with an iPod touch© (3rd generation), and were asked to AV record the food they selected for their meal, i.e. while video-recording their tray, they provided a verbal description of their food, including a listing of contents (e.g. mustard). Thirty meals were AV recorded in the form of .mp4 files. Afterward, in the laboratory, a researcher and a Registered Dietitian, independently, reviewed the AV recordings and created a diary listing of food items for each meal, and estimated portion sizes per item indicated in the recording.

Weighted Method

The research assistants digitally weighed participant meals, using sanitary methods. Specifically, the participant was asked to place their food on a clean plate resting on a weigh scale (plate type and weight was pre-measured to subtract from the total weight). Each food item was listed and given a weighed value.

Nutrient Analysis

Participant meals were entered into NutriBase Pro; a software program used by Registered Dietitians and researchers to analyze the contents of foods and provide an overview of the micro and macronutrients contained within the meals-selected by the participants. Each participant meal was coded, and entered into the program three times: 1) AV estimates from Researcher; 2) AV estimates from Registered Dietitian; and 3) weighed food items (gold standard).

Audio-Video Method

A researcher explained the AV method using a script and once a participant understood the method, they moved forward in the protocol. Participants selected the video option under the camera setting on the iPod touch©; pressing ‘start’ to begin taking a video of the meal they had selected, while speaking directly into the device, participants dictated the quantities and name of each item on their plate (e.g. one apple), or by volume (e.g. one cup of white rice). In the case of complex items, such as a breakfast sandwich, individual components were listed. Participants would dictate that the sandwich included: one fried egg, one white English muffin, one slice of cheddar cheese and one tablespoon ketchup.

Weighted Method

One lead researcher and two research assistants completed all of the data collection, and were trained prior to interacting with participants, including sanitary methods of weighing food items. Researchers weighed individual food items on a StarFrit© food scale. Each item was recorded on a coded log sheet, which included a list of items for each selected meal, the weight in grams (g), subject ID and date and time for the AV recording and weighing. Two research assistants confirmed the weight of each item before it was recorded, and then recorded it. The item identified on the coded log sheet, the same as identified by the AV method, was used for data entry.

Nutrient Analysis

All items recorded were entered into the Nutribase Pro nutrition software program. NutriBase draws its nutrient data from the Canadian Nutrient Profile produced by Health Canada (*NutriBase Pro*, 2012). First, the researcher created ‘client profiles’ for each of the video recordings, using AV subject ID coding to identify each profile. Next, the researcher searched

for food items using the ‘food item search’ function, and selected the food item from a list of Canadian foods available on Nutribase Pro. At this point, the researcher entered the serving size, and repeated this for each food item listed in the AV recording. This develops a nutrient profile with macro and micro nutrient values per food item, and for the meal as a whole. This procedure was repeated with estimates provided by: 1) the researcher; and 2) the Registered Dietitian. There were no discrepancies between item lists.

Next, the researcher followed the same procedure as above, but for the weighed food items. Since the researcher recorded weights during data collection, and completed data entry, participant information was coded, and the researcher waited seven days to enter the data in an attempt to prevent recall bias (Hassan, 2005). Again, the researcher developed individual ‘client profiles’ for each of the participants, coded by subject ID. The researcher searched for food items using the ‘food item search’ function and selected the measured serving size. None of the items included in data collection were pre-packaged and so the researcher relied solely on developing tailored Personal Food Items (PFI) from the Nutribase Pro 10.0 software.

Statistical Analysis

Prior to data collection, a sample size calculation was performed with the following inputs (type 1 error: 5%; type II error: 90%; effect size: 100kcal; 2-sided test). All data are shown as mean ± standard error of the mean (SE). The Shapiro-Wilk test for normality was conducted and outputs indicated that variables were not normally distributed, thus, nonparametric tests were used to compare the weighing methods.

Spearman’s correlation coefficient was calculated to determine the strength of the relationship between: actual weight of the meals, and the averaged, AV-estimations from the Researcher and the Registered Dietitian. Variable averages were computed for the Researcher and Registered

Dietitian in order to best capture the weight of each variable given the large amount of variance between each participant. Spearman's correlation coefficient was used to compare the Researcher and Registered Dietitian data. Data was expressed as mean ± standard error of the mean (SE), calculated for continuous variables, and compared using Wilcoxon match-pairs signed ranks test. The Wilcoxon match-pairs signed test was used to compare both the weighed, and AV recorded methods of dietary measurement. This was followed with the Interclass Correlation Coefficient (ICC) for absolute agreement between the two methods to assess inter-rater reliability. SPSS statistical package version 20 (SPSS Inc, Chicago, IL) was used for all statistical analysis, reporting significance levels at alpha=0.05, power =0.95, and effect size of 0.70.

Results

Table I indicates the mean +/- standard deviation for the selected meals estimated by the Registered Dietitian and Researcher from the AV recordings; Spearman correlations were calculated. We chose to average these values, since the correlation between them were high. Averaged estimates from the Registered Dietitian and Researcher are compared to the actual weight of the meals in Table II.

The ICC estimates and their 95% confidence intervals were calculated based on a mean-rating (*k* = 3), consistency, 2-way mixed-effects model. Table II represents the weight measured in grams for each variable compared to the average weight, calculated using weighed and Registered Dietitian suggested weight. The results indicate that the Researcher and Registered Dietitians ICC scores were highly correlated for macronutrients and kilocalories, and some micronutrients including, sodium, potassium, calcium, zinc, and iron.

From the analysis computed it was consistently noted that throughout all analyses both total weight and vitamin E did not yield significant results. However, all other variables analyzed provided statistically significant results (alpha=0.05, power =0.95, effect size of 0.70).

As seen in Figure 1, the Researcher and Registered Dietitian both overestimated portion sizes, resulting in higher macronutrient and kilocalorie outputs per meal, compared to the macronutrient and kilocalorie outputs from the actual weight of the food items.

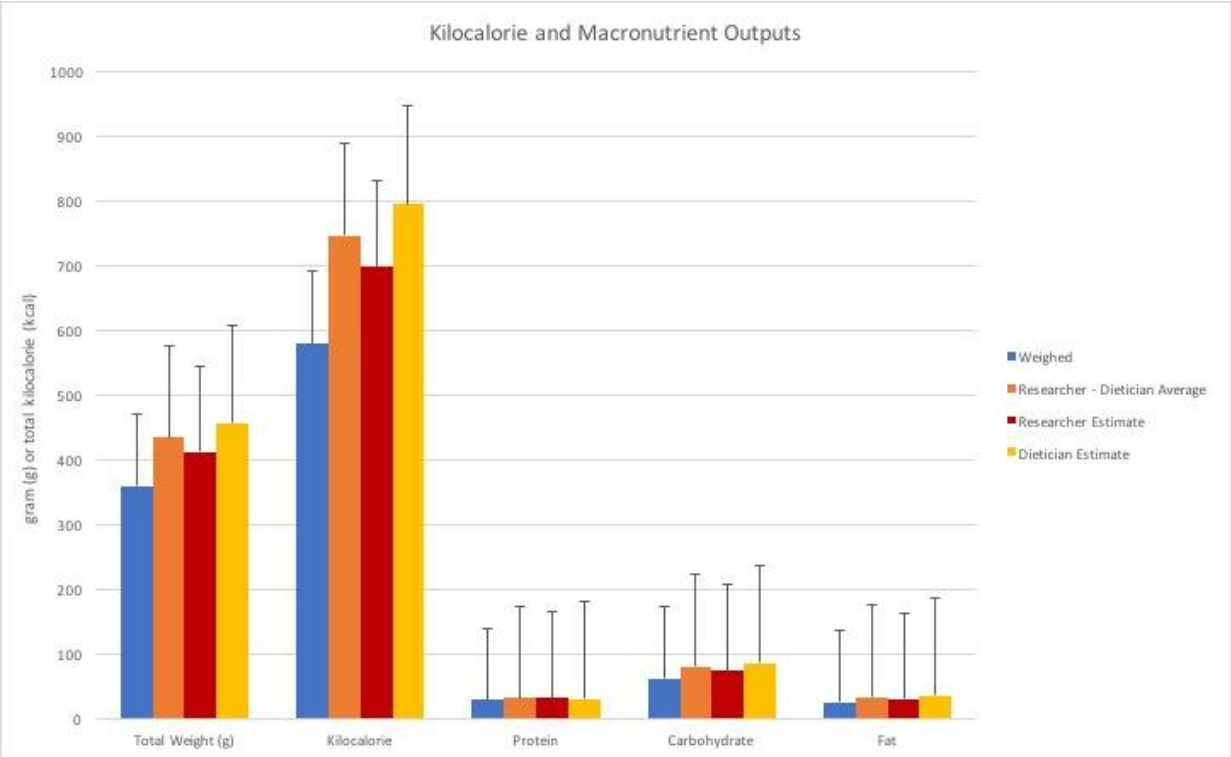

Figure I. Kilocalorie and Macronutrient Outputs

Table I. Researcher and Registered Dietitians mean +/- STD, with Spearman Correlation

	Researcher mean +/- SD	**Registered Dietitian mean +/- STD**	**Spearman Correlation**
Total Weight (g)	411.6 +/- 139.05	456.5+/- 195.68	0.599
Calories (kcal)	697.5 +/- 352.64	794.5 +/- 388.88	0.774
Energy (kJ)	2823.4 +/- 1314.16	3255.0 +/- 1689.37	0.781
Protein (g)	31.5 +/- 15.30	30.8 +/- 14.79	0.667
Carbohydrates (g)	74.4 +/- 44.09	85.5 +/- 54.33	0.803
Fiber (g)	5.8 +/- 4.75	7.0 +/- 5.78	0.798
Fat (g)	29.8 +/- 19.52	35.1 +/- 19.25	0.675
Saturated Fat (g)	7.7 +/- 5.01	8.1 +/- 3.67	0.731
Trans Fat (g)	2.9 +/- 9.46	0.7 +/- .749	0.513
Vitamin A (μg)	230.7 +/- 220.19	239.9 +/- 204.65	0.551
Vitamin C (mg)	20.7 +/- 19.20	23.9 +/- 27.21	0.453
Vitamin D (mg)	52.3 +/- 72.59	57.4 +/- 69.62	0.533
Vitamin E (mg)	5.2 +/- 3.84	5.1 +/- 3.52	0.596
Calcium (mg)	215.7 +/- 228.16	215.7 +/- 174.19	0.778
Magnesium (mg)	83.0 +/- 51.71	83.2 +/- 48.57	0.670
Potassium (mg)	916.4 +/- 551.26	978.3 +/- 700.62	0.769
Sodium (mg)	1355.8 +/- 893.43	1203.2 +/- 695.19	0.817
Iron (mg)	4.3 +/- 1.82	4.7 +/- 2.15	0.745
Zinc (mg)	3.4 +/- 2.10	3.6 +/- 1.95	0.818
Folate (μg)	114.0 +/- 71.15	124.7 +/- 81.12	0.671

Table II. Comparing values of the Actual Weighed mean (+/- Standard Deviation), and the Researcher/Registered Dietitian mean (+/- Standard Deviation) and showing calculated Interclass Correlation Coefficients, and statistical significance.

	Weighed mean +/- STD	**R/RD mean +/- STD**	**ICC**	**Wilcoxon Signed Ranks**
Total Weight (g)	359.3 +/- 121.79	434.1 +/- 167.36	0.793	(Z=-3.013, p=0.003)
Calories (kcal)	593.2 +/- 265.74	746.0 +/- 370.76	0.813	(Z=-3.198, p=0.001)
Energy (kJ)	2477.8 +/- 1110.64	3039.2 +/- 1501.76	0.808	(Z=-2.900, p=0.004)
Protein (g)	29.4 +/- 14.49	31.2 +/- 15.04	0.891	(Z=-1.386, p=0.166)
Carbohydrates (g)	63.2 +/- 30.07	79.9 +/- 49.21	0.793	(Z=-2.865, p=0.004)
Fiber (g)	5.0 +/- 2.89	6.4 +/- 5.27	0.851	(Z=-2.779, p=0.005)
Fat (g)	25.4 +/- 14.81	32.5 +/- 19.39	0.808	(Z=-2.922, p=0.003)
Saturated Fat (g)	6.4 +/- 4.23	7.9 +/- 4.34	0.900	(Z=-2.916, p=0.004)
Trans Fat (g)	1.6 +/- 6.25	1.8 +/- 5.10	0.804	(Z=-0.743, p=0.457)
Vitamin A (μg)	229.1 +/- 216.03	235.3 +/- 212.42	0.875	(Z=-0.761, p=0.447)
Vitamin C (mg)	17.7 +/- 18.04	22.3 +/- 23.21	0.823	(Z=-1.395, p=0.163)
Vitamin D (mg)	48.7 +/- 66.92	54.9 +/- 71.11	0.859	(Z=-2.847, p=0.004)
Vitamin E (mg)	3.1 +/- 2.76	5.1 +/- 3.68	0.586	(Z=-2.392, p=0.017)
Calcium (mg)	202.1 +/- 223.47	215.7 +/- 201.18	0.911	(Z=-2.222, p=0.026)
Magnesium (mg)	68.9 +/- 24.05	83.1 +/- 50.14	0.778	(Z=-1.564, p=0.118)
Potassium (mg)	785.2 +/- 350.49	947.3 +/- 625.94	0.821	(Z=-1.224, p=0.221)
Sodium (mg)	1114.8 +/- 627.64	1279.5 +/- 794.31	0.880	(Z=-1.142, p=0.254)
Iron (mg)	3.8 +/-1.85	4.5 +/- 1.99	0.885	(Z=-2.596, p=0.009)
Zinc (mg)	3.3 +/- 2.08	3.5 +/- 2.03	0.976	(Z=-2.147, p=0.032)
Folate (μg)	105.9 +/- 68.35	119.4 +/- 76.16	0.933	(Z=-2.006, p=0.045)

R: Researcher; RD: Registered Dietitian.

Discussion

This validation study was aimed at assessing a novel method of calculating dietary intake in a free-living setting, which is more practical than previous methods. The results from this study suggest that the audio-video method is a valid method for providing accurate visual and audio information of food selection, allowing a researcher or RD to make accurate estimations of food to determine energy consumption; replacing the laborious nature of food journaling, since it is correlated to precise weights of food items.

Total Weight

The AV videos were assessed after data were collected to provide serving size estimates of the items recorded for each meal. After the data were entered to Nutribase Pro from both the researcher and the Registered Dietitian, outputs were averaged and then descriptive statistics were run on those averages values.

Kilocalories and Nutrients

Unlike other cafeteria-based studies (Olafsdottir et al., 2016), participants in the present study served their own meals, none of which were pre-portioned by trained cafeteria staff. Likewise, a list of ingredients and cooking methods was not provided by the cafeteria management company, and each meal was presented to the researchers after selection by the participant. Given that the normal application of the gold standard method would not have access to these conditions, we wanted to compare the nutrient values produced from assessing the AV method to the use of the weighed method. While the spearman correlation demonstrates a moderate to very good level (r values ranging from 0.50 to 0.75 indicate moderate to good correlation, and r values from 0.75 to 1 point to very good to excellent correlation between the variables) of correlation between the two diary methods, suggesting that the nutrient values produced from assessing AV method are

valid, the mean standard deviation reflects that participants selected varying levels of total calories per meal. This is critical because it demonstrates that the AV method is able to capture differences in portion size resulting in a range of caloric values per meal, even in a free-living setting.

The ability to accurately estimate portion sizes is critical to understanding actual calories consumed, reducing the margin of error in a food journal. The Researcher and Registered Dietitian estimated portion sizes in this study because it is known that trained persons can more accurately estimate portion sizes when compared to non-trained persons (Trucil, Vladescu, Reeve, DeBar, & Schnell, 2015), and in the present study, participants inaccurately estimated portion sizes, or commented in their recordings that they did not know how to assess portion sizes, saying “I’m not exactly sure, maybe 1 cup, could be more though”. Some researchers have recommended portion size training methods for participants to help them accurately estimate portion sizes, resulting in improved portion size estimation accuracy (Hausman, Borrero, Fisher, & Kahng, 2014; Trucil et al., 2015). Since weight gain is directly attributed to an overconsumption of calories compared to energy expenditure, it is critical to improve current methods of portion size estimate for the general public, in a free-living setting. One solution to this problem is the introduction of computer-based estimation using image recognition software. In this study, both the Researcher and Registered Dietitian overestimated portion sizes, reinforcing the need for unbiased, computer-based estimation in the free-living setting, where weighing individual food items is not an option.

Some aspects of the present study could be considered limitations and merit future methodological modifications. First, since participants tend to inaccurately estimate portion sizes, we did not rely on, nor ask for participant estimates. Since one aim of the study was to

validate the AV method, the Researcher and Registered Dietitian estimated portion sizes because they are known to be more accurate estimations (Trucil et al., 2015). Second, the food captured in the present study was done so in a cafeteria setting, which is different from the home or other free-living environments. In a cafeteria, participants can only select foods that are made available to them, and signage related to, and presentation of food items may influence a participants' food selection which may not reflect "typical" foods in their diet.

Implications for Future Research and Practice

In the clinical setting, Registered Dietitians frequently ask patients to keep a food diary to assess their food behaviours, to help advise them about food choices (Yang et al., 2010), or as a method of self-regulation or self-monitoring in an effort to improve eating patterns. Understanding energy expenditure and energy intake is complicated for the average person, and so one goal of utilizing a food journal is to keep track of approximate portions of food, and more specifically calories, fat, protein, and carbohydrate; however multiple challenges are experienced with this approach. First, patient tire of recording food diaries (Illner et al., 2012); the AV method reduces participant burden and therefore may improve extended food collections. Second, patients tend to be biased when self-reporting (Freedman et al., 2014); the AV method reduces the capacity to do this, as it is literally 'showing' the foods selected. Third, patients are poor at estimating their serving sizes (Boehl, 2007); although this study demonstrates that even the experts are not perfect at estimating size given the discrepancy in estimations made, it is more likely that the Registered Dietitian or researcher would generally estimate serving sizes better than the untrained client. Fourth, given that food journaling is one method for weight loss, we know that writing down one's food, fundamentally changes our eating patterns (Boehl, 2007); we do not know whether this is true for AV journaling. Lastly the AV method bypasses literacy problems

in food data collection (Boehl, 2007). Overall, this method provides significant advantages over written food journals and should be considered for future research, with the potential for additional research projects to assess the application in a clinical setting.

Accurate diet analysis of macro- and micro-nutrient intake allows healthcare providers, including Registered Dietitians, to provide accurate counselling to improve and maintain health. In fact, AV journaling could may provide the clinician additional information which could be used to help counsel the patient (e.g. time-of day when the meal is consumed).

Conclusion

Diet intervention is a critical community issue for many Canadians; a new method of food journaling, which includes an easy to use application for the general public to use in a free-living environment and enhances communication between clients and health care providers, is needed. The AV method allows participants with limited health literacy and language and literacy barriers to participate in meal recording for diet analysis for the purpose of Dietetic consultation and is comparable to the gold standard – weighed method. How the AV method compares to written journaling is not yet known and should be explored in future research, given that this is the most common type of diet recording used in practice (Johnson, 2002).

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Chapter 4

A comparative assessment of nutrient outputs for clinical interpretation between written and audio-video food journaling in a free-living setting.

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ABSTRACT

OBJECTIVES
The objective are twofold; first, to determine whether the diet assessments, as performed by a Registered Dietitian, are comparable for the same participant using 3 days of journaling with the audio-video (AV) method and 3 days of journaling with the traditional, written method; second, to comment on whether the AV method could be used in a clinical setting to replace the written method of journaling.

DESIGN AND SETTING
In this random, cross-over design, participants recorded their food consumption using both the written and AV method of journaling for three consecutive days, separated by a seven-day washout. The A/V method used an iPod Touch© (3rd generation), to video-record meals while participant's audio-recorded a verbal description of the contents of their meal. The researcher and Registered Dietitian created an itemized diary record of the food for each participant for each of the six days of food recordings.

VARIABLES MEASURED
Using the itemized food records, data from the AV and written food journals were entered into a nutrition software analysis program (Nutribase Pro 10.0; Cybersoft, Inc, Phoenix, AZ, 2012) to create three-day food averages. These averages were coded and analyzed by a Registered Dietitian, using a Dietetic Assessment (DA) form, based on Canadian RDIs. The Registered Dietitian provided individual diet analysis, based on their assessment of the 3-day food averages. Food journal methods were assessed for clinical use by comparing the matching diet analysis forms. That is: did the Registered Dietitian made similar nutrient and diet modifications/recommendations for each participant, using the different journaling methods (AV and written method)?

RESULTS
Nutrient outputs correlated significantly between methods for: total kcal, protein, carbohydrate, fat, fibre, and some micronutrients between methods. Based on sufficient and insufficient categorization of foods consumed, the RD recommended similar diet modifications for each participant where Cronbach's α for fruits and vegetables was 0.94, for processed foods was 0.64, and for healthy fats was 0.88 between diary methods.

CONCLUSIONS
The AV method is comparable to the written method in terms of nutrient outputs for clinical interpretation such that, in consultation with the RD, the AV method could be integrated into clinical practice. Participants indicated that they would prefer a method of food journaling that includes the AV method with a written component, developed in a mobile application for use on a personal cellular/mobile device.

Introduction

Dietary intervention practices are important in a clinical setting to support the adoption of healthy lifestyles among patients/clients (Raine, 2005). Dietary records are used in clinical practice to help clinicians understand a person's typical food consumption pattern and to address health issues in a population health framework (Raine, 2005). With the current global epidemic of obesity and malnourishment, we know that diet and healthy eating patterns have significant public health implications (Raine, 2005). A person's dietary choices are influenced by a number of socio-economic factors, lived experience, and personal preferences (Raine, 2005); this complicates successful change strategies for a person's diet. Therefore, clinicians also ask that clients/patients record their meals for the purpose of dietary counselling and to develop strategies for changing food behaviours. As such, the standard practice requires participants to record, in detail, all foods and beverages consumed over a three-day time period, (two weekdays and one weekend day). Patients are instructed to select days that reflect typical days for their eating habits; to provide the clinician with a sense of 'what, when, and how much' they are eating on average (Yang et al., 2010). Although this provides a more realistic picture of the foods consumed by a person, three-day food diaries do not capture the within-person variations of day-to-day dietary intake (Gersovitz et al., 1978) and do not provide visual representations for the foods listed. One solution to this problem would be to extend the number of diary-days; however, the literature shows that participants tire of written food diaries, particularly weighed food diaries, and therefore currently, it is recommended not to exceed three days of collection because compliance rates diminish after this timeframe (Illner et al., 2012).

Researchers contend that when implementing a diet intervention, keeping food records is a significant predictor of intervention adherence (Hollis et al., 2008). In a large cohort study by

Hollis et al. (2008), “two thirds of all participants achieved clinically significant weight loss of 4kg or more” (Hollis et al., 2008, p. 8) and the researchers noted that food record adherence played an important role in achieving this result. In fact, researchers have identified written food journals as an important strategy for weight loss, and for maintaining a new weight (Kong et al., 2012). This creates a challenge in using food journals for diet analysis, in that, we recognize that the act of keeping a food journal can change the patient’s normal food behaviour. Exploring new platforms for recording food data will be beneficial to increase participant compliance, and reduce perceived barriers as indicated in other studies (Cordeiro et al., 2015; Mohr et al., 2014)(Mohr et al., 2014; Cordeiro, 2015)**.** Detailed food diaries that capture the exact food items or meals produce more reliable results and shed light on behaviours that require a nutrition intervention.

Conversely, as a result of the perceived barriers to prescribed food journaling, and due to modern technology, non-prescribed food logging has increased in the public domain (Griffin, 2012; Thomaz et al., 2013). Downloadable applications, which feature or incorporate food journaling and diet-analysis have become popular, and tablets and mobile devices with camera technology have inspired people to share photos of their food on a variety of social media platforms. In an effort to improve current written food journaling practices, research has demonstrated that food photos are comparable to written food journals when all of the food is visible in the photo (Gauthier et al., 2013). Otherwise, written diary recording is still required to capture these items, which reduces the benefits of photography as a replacement for written journaling. A solution to this is to ask participants to audio-video (AV) record their food; that is, describe the food that cannot be seen using the audio feature while taking a video of the food. If Physicians and Registered Dietitians can incorporate this technology in their clinical practice, they can view the

videos with the client and have meaningful conversations about portion size, eating behaviour, timing of meal consumption, and the contents of each meal from a holistic perspective. Furthermore, by asking clients and patients to utilise the AV method, it may provide an opportunity to: a) increase compliance; b) increase 'real' representation of food behaviours through the recordings; and c) provide more accurate data on serving sizes (i.e. inability for subjects to accurately assess their food) (Martin et al., 2014; Williamson et al., 2003; Yang et al., 2010). The AV method was validated (Paper 1) in a cafeteria setting, and has demonstrated that people can AV record their meals and develop a comprehensive, nutrient output, statistically comparable to weighing food items individually.

Linking these concepts, we hypothesize that patients would more readily record their diet and more realistically record their dietary habits for secondary assessment if they were asked to do so using audio-video recordings rather than written journaling. We expect that by integrating technology that is easy to use and already accepted in North America, we will see a higher rate of methodological acceptance compared to the three-day written food journaling method and participants will be more willing to provide true images of all of their meals. This should provide health care professionals with better data to make meaningful dietary recommendations.

Therefore the purpose of this study was twofold: i) to compare and correlate three-day mean scores for: kilocalories, macro-, and micronutrients; between written and AV food journaling methods; and ii) to clinically evaluate the AV method by comparing the diet analyses performed on the three-day food data for both journaling methods; to determine whether or not this novel technology would be acceptable, and/or replace the use of the three-day written food journal in clinical practice for lifestyle and diet counselling.

Methods

Participants

Thirty-six participants were recruited from a medium sized University in Canada by way of email, advertising posters, and in-class recruitment presentations. Participants' ages ranged from 18 to 60 years of age, and included participants whom identified and male or female on their birth certificate. Participants signed consent forms and were asked to exclude themselves if they had current or previous disordered eating or known eating disorders; one participant removed themselves based on this criterion. Participants were informed that they could opt out of the study at any time for any reason. Researchers provided crisis intervention and eating disorder counseling contact information at the time of consent and upon completion of participation, however researchers did not intervene at any time since they are not qualified to do so. A total of n= (18) participants completed all components of the research project (female: 10; male: 8). Participants were coded to protect individual identity. This study was approved by the University's Research Ethics Board. (Appendix A)

Study Design

This randomized, crossover study design consisted of two experimental units within each unit, participants were asked to diary record their food consumption for three consecutive days, including one weekend and two week days, using either a written diary template (Appendix B), or A/V record their food consumption using an iPod touch© (3rd generation); each arm was separated by a 7-day washout period so that data collection for each method would occur on the same days of the week.

Participants completed a Pre-Participation and Demographic Questionnaire including: age, height, weight, activity level, and history of eating disorders. Following this, participants were

randomly assigned a food journaling method, beginning with either the A/V or written journal method. At the end of each three-day journaling method, participants completed a questionnaire about that method and after completing both arms of the study, participants completed an exit survey. Prior to starting the data collection for the study, a 15-minute information session, outlining the procedures for each method of food diary keeping, were explained. This included scripted explanations, the reasoning behind the 7-day wash-out period, and the importance of maintaining consistent or normal eating habits. At this time, participants were also given an iPod touch© (3rd generation) touch to complete the A/V diary recording, and a paper journal for the written diary recording (Appendix B).

Survey Questionnaires

The Pre-Participation and Demographic Questionnaire (Appendix E) was used to gather general information about a participant's knowledge of and (potential) previous use of food journaling. The survey included questions to determine a participant's level and frequency of physical activity, and previous use or understanding of food journals as a method for tracking food consumption.

After each data collection arm, participants were asked to complete a survey asking them questions about the methodology used (e.g. perceptions of time required, personal compliance etc.) measured using a 5-point Likert scale. The post-method questionnaire was used to determine a participant's perceived compliance with each food journaling method, how tracking food made them aware of their consumption, and if that changed their behavior, and if they completed the food journals in a reasonable amount of time. Upon completion of the journaling process, an Exit survey (Appendix C) was given, which, consisted of five questions on a Likert Scale from: 1-Strongly Disagree, to: 5- Strongly Agree. The questions asked participants about

their experience recording their meals with both methods and asked participants to compare their experience of food journaling with each method; written or AV. The Exit survey was used to determine which method of diary recording participants preferred, if they would prefer a combination of both methods, and if they would choose to diary record their meals in the future.

The food data collected for both diary methods was entered into NutriBase Pro, a diet analysis software program. Researchers calculated a 3-day-average for kilocalories, macronutrients (fat, protein, carbohydrates), and micronutrients (vitamins, minerals) for each participant. This information was provided to a Registered Dietitian who blindly analysed all three-day diets using a Diet Assessment Form (Appendix C).

Written Method

Participants were required to record their meals using a 3-day food journal, over two weekdays and one weekend-day, consecutively. The participants were provided with a 3-day food log and instructed to record food item, brand name if provided, calories (kcal) if provided, quantity, and time of day (Appendix A). Following this they were required to indicate if the food recorded represented a “typical day” of food intake. The written 3-day food journaling method is used in nutrition counselling practice, instead of food frequency questionnaires, because they do not rely on memory and are inexpensive to administer, and found that compared to 9-day or FFQs, 3-day food journals showed higher validity when characterizing an individual’s diet (Yang et al., 2010). As a result of day-to-day variation in food consumption, it is recommended that participants complete at least three days (including one weekend day) of food diary recording, and researchers and Registered Dietitians can average the data collected to develop 3-day mean energy intake to assess on an individual basis (Johnson, 2002).

Audio-Video Method

Participants were instructed to AV record the contents of their meals using an iPod Touch; dictating approximate portion sizes and hidden or unseen ingredients that are undetectable from the use of video recording alone. The participants were instructed to verbally state the day and time of recording, and if the recording represented a 'typical' meal. After three days of recording, the researcher obtained the iPod touch and assessed the videos for item type and portion size. In order to provide a complete AV journal, the researchers estimated portion sizes for each food item recorded. This was done because several participants did not dictate portion sizes consistently, or suggested they did not feel they could accurately estimate portion sizes. This method was adapted from Dorman et al, (2013) and Gauthier et al. (2013) where participants recorded their meals using annotated photography; photographic methods have been deemed more reliable than other methods of self-report journaling, including written food journals (Illner et al., 2012; Martin et al., 2009, 2014; W illiamson et al., 2003).

Diet Analysis by a Registered Dietitian

A Dietary Assessment Form was developed, in consultation with a Registered Dietitian, to allow the Registered Dietitian to assess both written and AV food journals, in a blinded manner for comparison regarding clinical recommendations. This form used a 3-point Likert scale, assessing 22 macro/micronutrients, and kilocalories (kcal) using: "low," "neutral," and "high;" as categories based on Health Canada's Recommended Daily Intakes (RDIs) for each nutrient (Appendix D). The Registered Dietitian used the software-computed 3-day averages for each participant to categorize them individually as meeting nutrient criteria, using the Likert scale. The Registered Dietitian was blinded to the method of recording, with the intention of determining whether they could provide the same or similar recommendations for each

participant, regardless of the method of journaling used. The Registered Dietitian scored the values based on the following percentages, in order to categorize them as “low”, “good”, or “high”: 75%-100%- good, >100%=high, <75%=low. The Registered Dietitian also assessed each participants’ food journals to determine if they were consuming sufficient or insufficient numbers of 1) fruits and vegetables, 2) processed foods, and 3) healthy fats based on Health Canada recommendations found in Canada’s Food Guide.

Data Entry Procedure

Two groups of fifty-four (54) participant meals (total = 108), including breakfast, lunch, dinner, snacks, and caloric beverages were documented over two, three-day time frames, separated by a 7-day washout period. The first group includes all data from written food journals, and the second group included all data from the AV food journals. All meals were included in the data analysis, since all videos were recorded according to procedure and were recorded with clarity of voice and image. All items consumed were entered into the Nutribase Pro 10.0 (*NutriBase Pro*, 2012) nutrition software program. This software enables the user to create menus, track food intake, and manage individual dietary needs.

First, the researcher created “client profiles” for each of the video recordings, using AV subject ID coding to identify each profile. Next, the researcher searched for food items using the “food item search” function, and selected the food item from a list of Canadian foods available on Nutribase Pro. At this point, the researcher input the serving size, and completed this for each food item recorded in the AV recording. This develops a nutrient profile with macro and micro nutrient values per food item, and for the meal as a whole. This procedure was repeated for each of the 18 AV participant recordings. Next, the researcher followed the same procedure for the written food journals. Again, the researcher developed individual “client profiles” for each of the

participants and were coded by subject ID. The researcher searched for food items using the "food item search" function, selecting the exact food options as were selected for the AV meal recordings, to eliminate variances in nutrient outputs. "Generic" food items were selected, avoiding brand name items unless specified in the AV recordings or written food journals.

Statistical Analysis

Since the data was non-parametric, Cronbach's Alpha was calculated to determine the level of internal consistency to assess the relationship between the AV method and the written journal methods, between 3-day averages of kilocalories, macro- and select micronutrients (Vitamins: A, B1, B3, B12, C, D, E, and Folate, Ca, Mg, P, K, Na, Fe, and Zn), from the AV and written food journals (Table I). This was followed with the Interclass Correlation Coefficient (ICC) for absolute agreement between the two methods to assess inter-rater reliability. The SPSS statistical package version 20 (SPSS Inc, Chicago, IL) was used for all statistical analysis, reporting significance levels at alpha=0.05, power =0.95, and effect size of 0.70.

Results

Nutrient Output Comparisons

Table I lists the average kilocalories, macro and micronutrients consumed by participants when using the AV and Written journaling methods, showing the correlations computed. Nutrient outputs correlated significantly for: total kilocalories, protein, carbohydrate, fat, fibre, and some micronutrients between methods.

Table I. Comparing outputs of Three-day Averages for AV and Written Methodologies

	AV Average (±SE)	**Written Average (±SE)**	**Cronbach's α**	**P Value**
Kilocalories (kcal)	2192 ± 243.30	2363 ± 226.87	0.882	0.000
Protein (g)	101 ± 12.99	114 ± 12.16	0.712	0.007
Carbohydrate (g)	277 ± 26.66	281 ± 27.16	0.945	0.000
Fibre (g)	27 ±3.41	31 ± 2.69	0.859	0.000
Fat (g)	75 ± 11.50	88 ± 9.42	0.766	0.002
Sat Fat (g)	27 ± 4.29	29 ± 3.82	0.804	0.001
Cholesterol (mg)	338 ± 52.94	407 ± 51.37	0.809	0.001
Vit A (µg)	510 ± 111.14	510 ± 85.87	0.084	0.429
B1 (mg)	1 ± 0.21	1 ± 0.21	0.899	0.000
Niacin (mg)	15 ± 2.28	11 ± 1.85	0.576	0.043
Folate (µg)	263 ± 60.35	235 ± 36.06	0.752	0.003
B12 (µg)	2630 ± 501.19	3296 ± 690.68	-.050	0.539
Vit C (mg)	96 ± 10.02	92 ± 15.35	0.595	0.035
Vit D (mg)	152 ± 37.31	126 ± 21.97	0.349	0.193
Vit E (mg)	7 ± 1.48	11 ± 2.97	0.129	0.389

Magnesium (mg)	963 ± 27.14	944 ± 21.45	0.624	0.026
Phosphorous (mg)	192 ± 127.71	177 ± 83.31	0.686	0.011
Potassium (mg)	757 ± 266.49	647 ± 151.69	0.678	0.012
Sodium (mg)	1844 ± 571.52	1427 ± 496.63	0.839	0.000
Iron (mg)	20 ± 3.09	18 ± 2.30	0.554	0.053
Zinc (mg)	20 ±1.08	19 ± 0.60	0.521	0.069
Calcium (mg)	6 ± 146.05	6 ± 114.73	0.711	0.007

Vit: Vitamin

Registered Dietitian Comparisons

Table II shows the classification made by the Registered Dietitian for each nutrient, for each of the participant's food journals (i.e. Written and AV method), indicating whether the nutrient was considered to be: 1) low; 2) good; or 3) high; according to the Recommended Daily Intakes (RDI) value, by age and sex, for each nutrient. The Registered Dietitian categorized kilocalories, and the macronutrients protein and fat 'the same' for 72% of participants, with carbohydrates categorized 'the same' for 78% of participants. Congruency in allocating micronutrients was highest for potassium, sodium and vitamin E, and lowest for calcium, phosphorus and Vitamin C.

Table II. Categorization of nutrients into: "low", "good", "high," by the Registered Dietitian (n=18).

	AV Low	**Written Low**	**Categorized the Same**	**AV Good**	**Written Good**	**Categorized the Same**	**AV High**	**Written High**	**Categorized the Same**	**Categorized the Same (% total)**
Kcal	12	8	7	5	7	5	1	3	1	72%
Protein	6	3	3	8	12	7	4	3	3	72%

CHO	11	6	6	7	8	7	1	4	1	78%
Fat	4	3	2	7	10	6	7	5	5	72%
Fiber	7	6	5	10	11	9	1	1	1	83%
Sat Fat	0	0	0	9	8	8	9	10	9	94%
Vit A	11	14	11	1	1	0	6	3	2	72%
Vit B	14	14	11	1	1	1	3	3	3	83%
Vit C	7	8	5	4	5	2	7	5	4	61%
Vit D	14	13	12	0	2	1	4	3	3	89%
Vit E	16	16	16	1	1	0	1	1	1	94%
Calcium	8	8	5	7	6	4	3	4	1	56%
Phos	8	8	5	4	5	3	6	5	2	56%
Mag	12	12	10	4	5	3	2	1	1	78%
Pot	16	16	16	0	0	0	2	2	2	100%
Sodium	0	0	0	3	2	2	15	16	15	94%
Iron	4	5	4	5	4	4	9	9	8	89%
Zinc	12	12	11	5	5	4	1	1	1	89%
Folate	10	10	9	7	7	6	1	1	1	89%

Kcal: Kilocalories; CHO: Carbohydrate; Sat: Saturated; Vit: Vitamin; Phos: Phosphorus; Pot: Potassium

Registered Dietitian Assessment of Diet

Table III shows the classification made by the Registered Dietitian for each nutrient, for each of the participant's food journals (i.e. Written and AV method), indicating whether the diary showed that the participant was consuming sufficient or insufficient quantities of fruits and vegetables, processed or "non-foods", and healthy fats; based on the number servings recommended in Canada's Food Guide. Sufficient means they were consuming the correct amount of each of those denoted food items, whereas insufficient meant they were eating too little, or too much of the categorized food items (e.g. too much processed food would be

recorded as “insufficient”). Fruit and Vegetable and Healthy Fats were statistically correlated between methods. Cronbach’s Alpha tests indicated that there is a high level of consistency between methods when the Registered Dietitian assessed participants’ written and AV journals to provide feedback of food consumption for “fruits and vegetables” and for “healthy fats”, whereas “processed foods” did not display a high level of consistency between methods, although the consistency was statistically significant.

Table III. Diet Classification Analysis, Cronbach’s Alpha (n=18)

	AV Sufficient	**AV Insufficient**	**Written Sufficient**	**Written Insufficient**	**Cronbach’s α**	**95% Confidence Interval**	**p-value**
Fruit and Vegetable	7	11	6	12	0.94	0.727-0.995	0.000
Processed Foods	9	9	6	12	0.64	0.028-0.752	0.021
Healthy Fats	6	12	8	10	0.88	0.510-0.911	0.000

Post Method and Exit Questionnaires

The Exit Survey and Post Participation Questionnaire were completed using a Likert scale, from 1-5. Participants were asked to rate their answers by level of agreement, including: strongly disagree (SD), disagree (D), neutral (N), agree (A), and strongly agree (SA).

All (n=18) participants felt that tracking their meals made them more aware of their diet choices, regardless of method. Participants also (n=11: strongly agree/disagree, n=4: neutral) found that tracking meals made them more aware of the nutrients associated with the foods they were eating

and the quantity of food they were eating (n=13: strongly agree/disagree, n=2: neutral) and most (n=11: strongly agree/agree, n=4: neutral) participants found that they were consistently compliant in recording their meals. See Figure 1. Thirty-three percent of participants preferred (agree) the AV method to the written method, while 56% agreed and 1% strongly agreed that a combination of both would be appropriate. Whereas a total of 7 (39%) participants disagreed or strongly agreed that they would prefer a combination of methods, 11 (61%) total participants agreed or strongly agreed that they would prefer a combination of methods. Sixteen participants (89%) felt that they would use food journals in the future for health reasons.

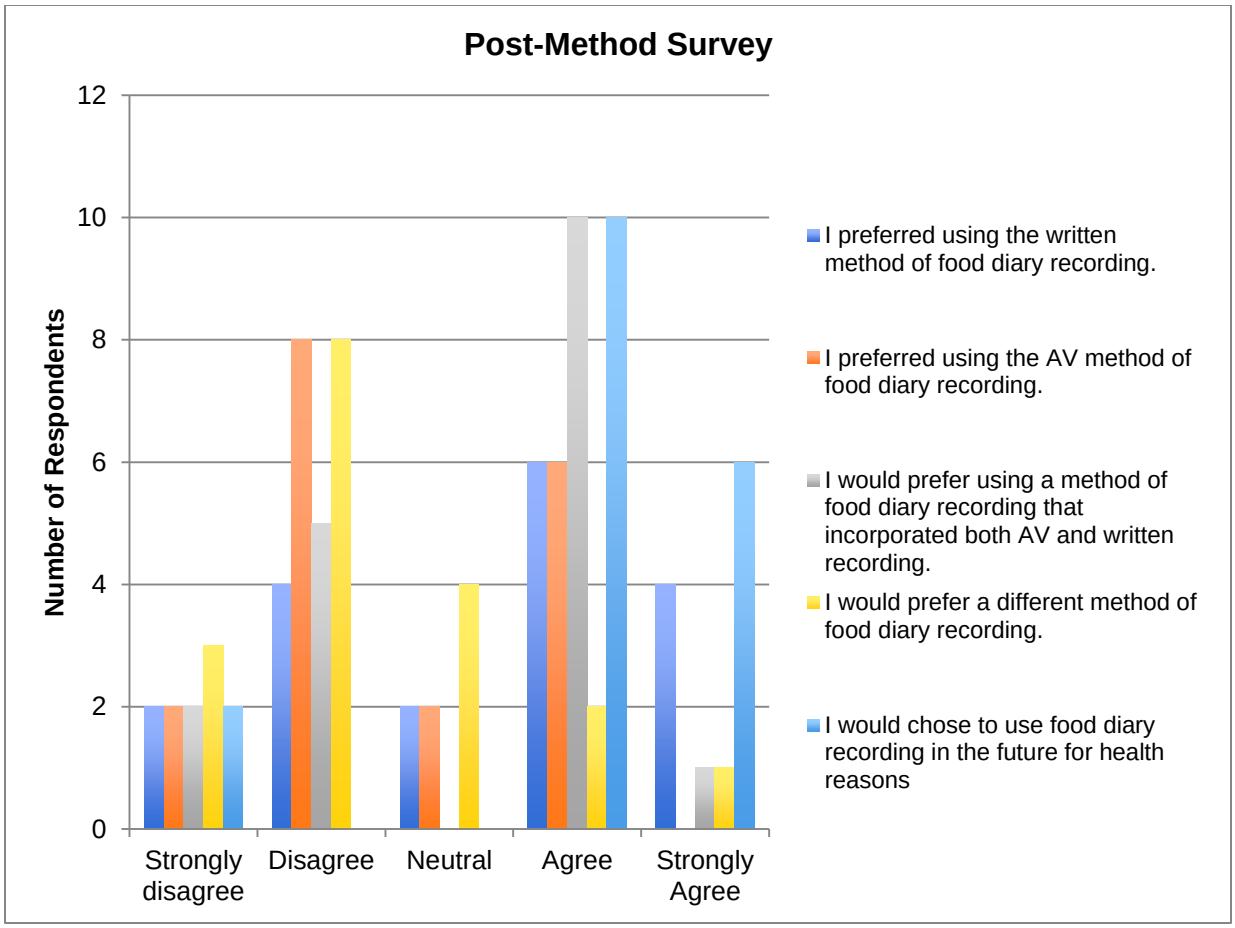

Figure I. Post Method Survey

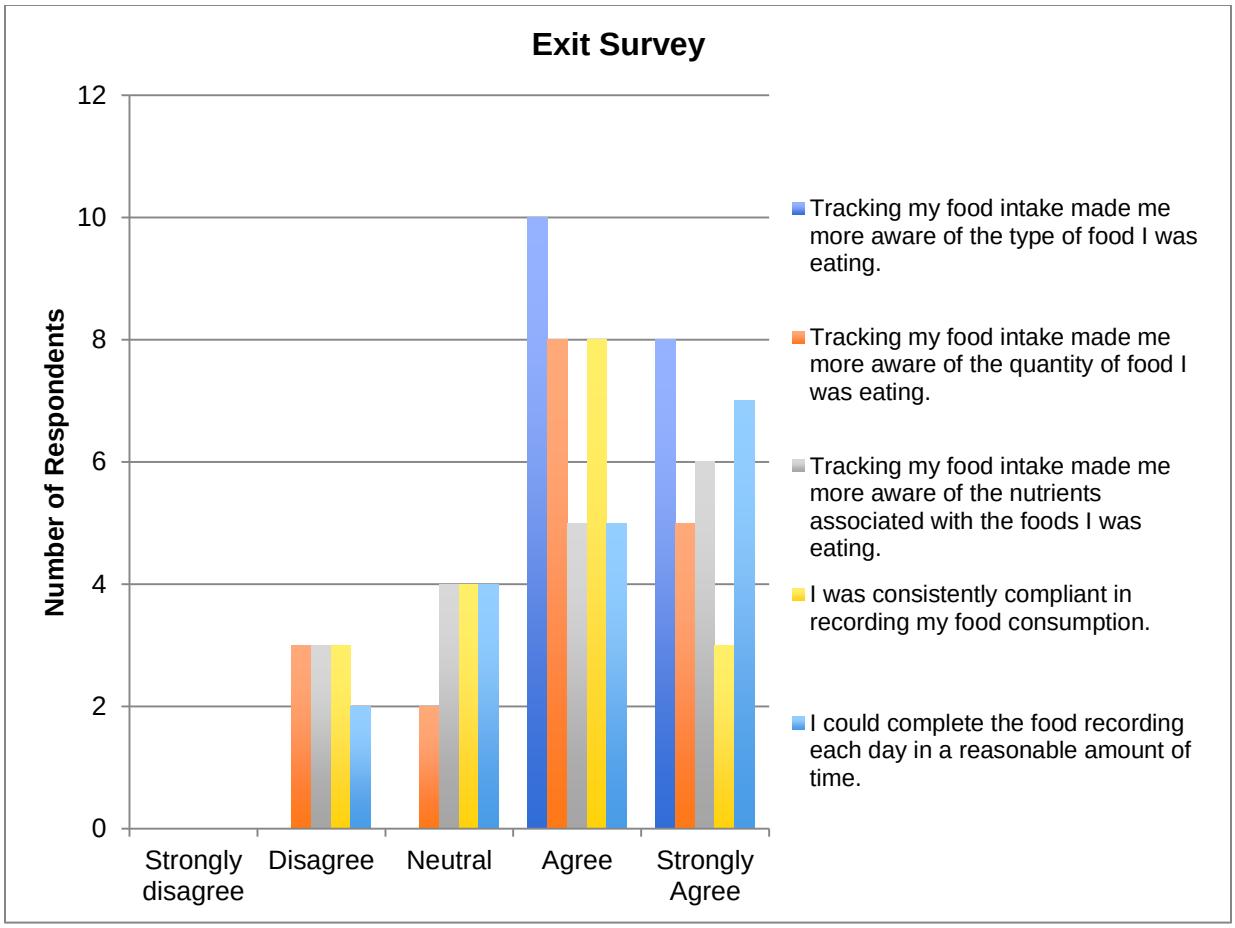

Figure II. Exit Survey

Discussion

The present study was designed to address the clinical implications of utilizing the AV method in dietetic and nutrition counseling. A primary goal was to determine whether or not a Registered Dietitian would recommend similar or identical changes to a participant's food behaviour and energy consumption based on food journaling from either the audio-video method or written food journals; in both journaling occasions participants were required to record meals on the same three days on either side of the 7-day washout period, and meals could be eaten without restriction of time or type of foods consumed. We conclude that the Registered Dietitian was able to assess adequacy similarly between methods when comparing them to RDI (ie. similar suggestions after blindly assessing both the AV and written journal recordings). Likewise, visual examination of the average nutrient outputs (Table I) show congruency between methods.

The following are key outcomes:

1) AV and Written outputs are comparable for clinical use, 2) nutrient assessment between methods were statistically significant, 3) the Registered Dietitian was able to clinically categorize health outcomes, which were comparable for the choice of foods and the categorization of food types, 4) there will be a higher rate of methodological acceptance from participants.

Nutrient Assessment

The AV method of food journaling has been validated (see chapter 3 above); for nutrient outputs using diet analysis software (NutriBase Pro); macronutrients were strongly correlated with the actual weighed food items; and micronutrients correlated moderately, depending on the micronutrient of interest. This paper extends this research; to determine whether using the AV

method would be interpreted the same as the traditional method of written journaling under diet counselling conditions; that is to say, would a health care professional make the same dietary recommendations for a client/patient using this method as they would after assessing a written diary?

In designing this study to answer this question, we assumed two things: i) that people tend to eat a limited range of food items (Burke, Wang, & Sevick, 2011); and ii) that three days of food consumption; regardless of the exact foods consumed within this food range; would still provide a general representation of the dietary habits of the individual. For example, a vegetarian would predominantly eat plants over a two-week span; even if the plant types varied; as an omnivore would predominantly include meats in daily meals etc. Since participants were not required to consume the same foods for each 3-day recording period, we expected to see variance in food items selected within the two participant reports; however, we thought that overall eating patterns would remain stable, allowing a clinician to make the same dietary recommendations for both, if the AV method was interpreted the same as the written method. From examining Table I; we can see that the three-day averages between methods correlated strongly for total kilocalories consumed and for all of the macronutrients, suggesting that a clinician would make the same dietary recommendations regardless of method for these nutrients.

Micronutrient correlations were less consistently correlated. This variability is likely explained in part by the diet analysis software program. Previous research has shown variability in micronutrients, but not macronutrients. Gauthier et al. (2013) assessed intra and inter-rater variability in diet analysis software outputs and found inter-rater variability for select micronutrients. They concluded that the variability was dependent on the food item selected by the software user; specifically, different brands of food had varying amounts of micronutrients.

Based on this, we would suggest that all micronutrient data be interpreted with caution; regardless of the journaling method used.

Categorization of Nutrient Outputs of AV and Written Methods

To assess this aspect of the method, the Dietetic Assessment Form was developed to allow the Registered Dietitian to categorize the average 3-day food data From Table I into three categories reflecting whether or not the participant's diet matched the corresponding Recommended Daily Intake as indicated by Health Canada. These categories were "low", "good", or "high." The Registered Dietitian was blinded to the methods during review. Table II shows that the Registered Dietitian was able to make the same or similar recommendations for participants, regardless of the method of recording. Several studies have assessed the validity and reliability of two methods of food journaling over a period of time (Gersovitz et al., 1978; Illner et al., 2012; Parent et al., 2012; Yang et al., 2010), however this is the first study, to our knowledge, comparing nutrient outputs from different 3-day journaling methods.

In a study by Johnson, Hackett, Roundfield, and Coufopoulos (2001), it was found that over a three-month period, and on three separate occasions, the FIQ could be used reliably to assess a person's diet consistently over time. Johnson et al. (2001) performed Pearson correlations and found significant correlations between energy intake and fat intake as a percentage of energy intake and sugars (carbohydrate) intake derived from 3-day diaries. This is consistent with the results of the present study where macronutrients and energy intake (kcal) demonstrated high levels of consistency between methods, and over the period of diary recording. In another study, assessing the reliability and relative validity of food frequency questionnaires completed over a two-week period, participants completed the FFQ twice, with results demonstrating good to excellent short-term test-retest reliability (Wong, Parnell, Black, & Skidmore, 2012).

Diet Classification

While categorizing nutrients is beneficial for assessing a diet, equally useful is classifying food items consumed by type: fruits and vegetables; processed foods; and healthy fats. For this reason, we developed the sufficient/insufficient classification for fruits and vegetables, processed foods, and health fats were included in the Dietetic Assessment form. For example, it has been demonstrated that highly processed foods had a negative effect on our overall diet. In a study completed by the Pan American Health Organization, researchers looked at the link between body mass and increases or decreases in the sales of ultra-processed foods in 12 Latin American countries, which revealed a strong correlation between changes in sales of ultra-processed foods and changes in body mass between 2000 and 2013 (Pan American Health Organization, 2015). Moreover, a study including a cohort of Spanish, adult, university graduates demonstrated that consumption of ultra-processed food was associated with higher risk of being overweight and obese and an increased risk for hypertension (Mendonça et al., 2016). In Canada, Moubarac, Batal, Louzada, Martinez Steele, and Monteiro (2017) examined the dietary intake of 33,694 individuals, over the age of 2, to understand food consumption patterns of Canadians. Consumption of ultra-processed foods were high amongst all socioeconomic groups, and ultra-processed foods were described as "grossly nutritionally inferior to diets based on unprocessed or minimally processed foods" (Moubarac et al., 2017, p. 519). Furthermore, Moubarac et al. (2017) found that "a significant positive relationship was found between the dietary contribution of ultra-processed foods and the dietary content in carbohydrates, free sugars, total and saturated fats and energy density, while an inverse relationship was observed with dietary content in protein, fiber, vitamins A, C, D, B6 and B12, niacin, thiamine, riboflavin, as well as zinc, iron, and magnesium, calcium, phosphorus and potassium."(Moubarac et al., 2017, p. 518). In 2008, only 43.9% of the Canadian population (adults over the age of 12) recorded themselves as having

consumed fruits and vegetables five or more times per day, according to Statistics Canada (Statistics Canada, 2016). This is a continuing trend, noted by Garriguet (2004), that about half of Canadian adults fell short of consuming the recommended five servings of fruit and vegetables per day. The Registered Dietitian also looked at the consumption of healthy fats in each participants' diet. Fat is one of three macronutrients from which our bodies draw energy, and so are required in each person's diet. High consumption of trans- and saturated fats is not good for personal health and can increase the risk of heart disease, and raise the level of LDL cholesterol in the body (Health Canada, 2016).

Understanding the types of food a person consumes is critical to preventing non-communicable diseases and obesity. Particularly, because when considered in context of recommendations from Canada's Food Guide, and the impact of a person's diet on their health, ensuring that people consume enough fruits and vegetables not only meets the RDI, it contributes to overall health. In fact, in a study by Blouin et al. (2017), they estimated that the annual cost of excess health care utilization and excess disability of obese adults in Quebec, including more frequent hospital stays, more frequent visits to physicians, and higher drug consumption compared to normal weight adults, is more than CAD $2.9 Billion in 2011; an economic impact they found to be comparable in other provinces across Canada. This is important because it is a result of the current issue that Canadians are not meeting the RDI for fruits and vegetables, generally. When Canadians under-consume fruits and vegetables, there is a link to increases in non-communicable diseases that are predominant in the Canadian population, and as indicated by Blouin et al. (2017), it causes a significant financial impact on Canadians each year.

In line with data from Statistics Canada (Statistics Canada, 2016), just over half of all participants consumed five or more servings of fruit and vegetables per day. The Registered

Dietitian was able to make similar recommendations for individual participants for both journal methods suggesting that both method can be used to assess fruit/vegetable consumption patterns. This type classification adds another layer of clinical assessment, which can provide useful, behavioral feedback for clients when addressing diet and lifestyle choices.

Surprisingly, processed foods did not correlate between methods; we believe this is a result of food choice between methods since they were recorded at different times. Since the AV method is a novel method of food recording, the methodological impact on behavior is not yet known. However, as noted by Burke et al. (2011), participants tend to modify their diet when recording their meals using a written journaling method, such that is it easier to record food items. Burke showed that participants increased their selection of processed food items when recording their meals using the written method, because they were easier to record; this finding requires further exploration with future research.

When considering fat consumption by participants in this study, results indicated that participants had inappropriate levels of unsaturated fats in their diet, which are not considered to be within the normal range for healthy fats in their diet based on RDI. This is seen by 33% of participants consuming sufficient levels and 67% consuming insufficient levels using the AV method. When using the written method, 44% of participants consumed sufficient health fats in their diet, whereas 56% of participants consumed insufficient quantities of health fats in their diet.

Questionnaires

Participant feedback is a useful addition to this research. The act of photographing food and posting it on social media is becoming more prevalent, and previous research utilizing the

photographic method of food recording reported that participants preferred photography to written journaling (Ehrmann et al., 2014; Higgins et al., 2009). Therefore, we were surprised that in this study participants reported preferring written or a combination of methods to the AV method alone. While some (n=3, strongly agree/agree, n=4: neutral) participants did “strongly agree” or “agree” that they would prefer a different method of recording, some participants elaborated in written responses, noting that they found it awkward to speak about the foods that they were consuming. Disclosing the food aloud made them self-conscious, similar to barriers experienced by participants using other traditional methods of food journaling (Cordeiro et al., 2015; Mohr et al., 2014). Importantly, 61% of participants indicated that they would prefer a method combining both AV and written technologies, and elaborated by suggesting the elimination of the voice recording, and incorporating a written component or provide drop down menus for food selection.

Implications for Research and Practice

The AV method provides a novel way to visualize diets for assessment. In research and clinical scenarios, it is possible that this method of recording food would provide benefits for better nutrition studies and dietary assessments.

Specifically, studies have shown that people modify their eating patterns when manually recording food items to simplify the process (Burke et al., 2011), that the public is poor at estimating portion sizes (Huizinga et al., 2009) and that written food journals are an effective tool in modifying food behaviours for weight loss (Burke et al., 2011). This raises the question whether this ‘gold standard’ is truly representative of a participant/patient diet. The AV method might therefore be considered as an alternative to manage these problems. The present study suggests that this method can be used as an alternative to written journaling; however, it is

currently unknown whether audio-video-recording of food has the same behavioural effects as written journaling. Comments provided by participants regarding the audio listing of foods suggest that this method would have some level of behavioural effect on the participant. Future research should aim to address these questions.

Some participants indicated that it would have been easier to record their meals using their own personal recording device. The study could be adapted such that participant could send their recordings to the researcher and/or Registered Dietitian following each day of recording using a mobile application. This would facilitate large collections of food data, which could be analysed on a community-based level.

Limitations

From a methodological perspective, and as suggested by Zepeda and Deal (2008), some participants modify their food consumption behavior when visual feedback is provided by photographic food journals, since it provides a more holistic perspective on what, where, and when they were eating (Zepeda & Deal, 2008). Likewise, written journaling can induce food behavior changes (Burke et al., 2011). Given the crossover design of our study, participants could have modified their food patterns prior to the second food journaling session, particularly given that some of our participants suggested that recording their food made them more aware of their food choices, and less likely to consume more food beyond the initial serving.

Furthermore, the sample size of this study was relatively small. In the future, it would be beneficial to recruit more participants and cover a larger demographic. The participants in this study all reside in northern Ontario and most were university students. This may be significant because it suggests that all of these participants are highly literate and are of a higher than

average socio-economic status than the general population. In addition, the participants in this study were all familiar with using iPod touch technology. Integrating this method may be a barrier for those who are unfamiliar with the technology; but may be an asset for those with low literacy. With that, it is important to note that only two Dietitians were consulted in the Diet Analysis of the participants' food journal records. Given that this is reflective of o small population of Dietitians, it would be important to complete a feasibility and reliability study whereby a larger number of Dietitians assessed the same food journals to determine if this method could be used broadly, in clinical practice or nutrition counselling.

It is important to note that the researcher interpreted audio-video food diaries for portion size and quantity when the participant did not provide them. This may cause some discrepancies between the nutrient outputs after entering the food items and their quantities into NutriBase because whereas written journals were recorded solely by the participant, the AV journals were recorded in part by the participant whose portion size estimations likely differ from the researcher. Given that the literature shows that the general public is poor at estimating food portions we would recommend that the clinician estimate portion sizes.

Lastly, a concern regarding the AV method is that participants are only recording food before they eat it. Although this provides a good picture of the foods selected, it does not account for food left unconsumed. Depending on the purpose of the study, consideration should be given to whether participants need AV record meals before and after eating to determine the exact amount of food consumed.

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Chapter 5: Discussion

Summary of Findings

To address the research goals, this thesis was completed in two phases. The first phase was to validate the AV method in a cafeteria setting to determine if audio-video method produced nutrient data that is comparable to nutrient data produced as a result of individually weighing food items. The second phase investigated if the AV nutrient data compared to the written nutrient data, such that a Registered Dietitian would clinically asses the person's diet, 'the same' regardless of method used. This was to explore whether or not a Registered Dietitian could incorporate AV technology into clinical practice and whether the AV method was acceptable to participants as a method for recording their meals. Phase two was completed in a free-living setting, where participants recorded their meals throughout the day, for three consecutive days using the AV or written method (randomized order), followed by a 7-day washout period. Participants were given the opportunity to compare methods after completing each. As a result, this research contributed to the development of a validated AV method for recording meals. In consultation with a Registered Dietitian, an assessment form was developed which could be used to provide feedback to patients or clients in a clinical setting.

The first study found that the AV method showed clinically significant correlations compared to the weighed method and as such, we conclude it is a reasonably accurate estimate of kilocalories, micro and macronutrients; when food portions are estimated by a person with training on estimating portion size. The second study explored the potential for this method to replace written journaling in the clinical setting. Our findings show that the diet assessments for the AV method were similar to three-day written journaling. In the future, it would be beneficial to test

this method with a specific population that requires a nutrition or lifestyle intervention, working with a Registered Dietitian to provide food counselling in combination with the AV technology.

This chapter is the continuation of the discussion from the papers in chapters 3 and 4 above, without duplication, in order to expand on additional factors. It includes further discussion around:

1. Historical Context of Research Project;
2. Impact on the Researcher and Lab Work;
3. Impact on the Public;
4. Impact on Clinicians; and,
5. Future methodological and Technical Recommendations.

Historical Context of Research Project

The Centre for Research in Occupational Safety and Health (CROSH) addresses critical health and safety issues using a Field-to-Lab-to-Field research approach. Meaning that to solve relevant work-related issues, we must first understand the problem in the field, before we can test interventions in the lab, followed by confirming successful implementation of potential solutions back in the field setting. Field data collection requires often presents unique challenges, not encountered under controlled lab conditions; however, the development of novel technologies is enhancing capabilities in field data collection. One such study, was interested in understanding the nutrition needs of wildland firefighters. The audio-video method was first used with wildland firefighters in a field study in northern Ontario (Robertson et al., 2017), conducted by researchers at CROSH. Since it was identified that written food journaling methods were not practical in a

field setting, researchers acknowledged the benefits of dietary assessment using photography (Dorman et al., 2013; Gauthier et al., 2013), and developed a novel audio-video method for meal capture and dietary assessment. This modification allowed them to successfully record food consumption patterns at different fire management sites and they had high compliance with this method. Two key problems existed with this approach: i) the AV method itself had not been validated independently for its ability to accurately measure food items; and ii) neither the photographic nor the AV method has been compared against the traditional method with regard to clinical interpretation of the food data. That is – is the AV method acceptable to both clinicians and participants for use in clinical practice, and in a free-living setting? This thesis aimed at addressing both of these shortfalls, and will provide important information on the future field and laboratory application of this method.

Impact: Researcher and Lab Work

One component of the study was completed as a validation of the AV method in Paper 1, was aimed at assessing a novel method of calculating dietary intake in a free-living setting, which is more practical than previous methods. The results from this study suggest that the audio-visual method is a valid method for providing accurate visual and audio information of food selection, allowing a researcher or RD to make accurate estimations of food to determine energy consumption; replacing the laborious nature of food journaling, since it is correlated to precise weights of food items. This is meaningful in the future because by including the AV method of food journal capture, researchers can design studies in remote locations, and in unfavourable conditions where written food journals are not practical. As experienced by wildland FireRangers, it can be challenging to write food journals in adverse weather conditions, where the worker may not have a place to complete a written journal, or if the participant is fatigued

and perceives the AV method as an easier method of food recording. Since we know that the AV method can be used accurately to capture meals and food items for nutrient analysis, further research can be completed by implementing this method. At this time, the AV method is still laborious in nature for the researcher or RD to analyse portion sizes and enter those data into the nutrient analysis software programs.

Impact: Public

Another phase of data collection reported in Paper 2, asked participants to comment on their experience completing both written and audio-video food recording methods. Two questionnaires were administered throughout the data collection process, asking five questions each, expressed on a five-point Likert scale. Additional space was provided for participants to write about anything they felt they were not able to express in filling out either questionnaire. Results of the Likert scales indicated that participants preferred the AV method, but in comments recommended that they would prefer something that could be completed using their own phone. They also noted that it was awkward or uncomfortable to verbally record the unseen items. Similar to other studies which discussed the discomfort of recording meals in public (Cordeiro et al., 2015), it would be important to consider other options for indicated unseen items. Additionally, participants felt that to fully grasp their food behaviours, limiting diary recordings to only three days in a week would not capture the fluctuations of calories or types of food they consume in a week. For example, one participant reported that, “3 consecutive days will include/exclude certain dietary choices (e.g.) Monday-Wednesday will be unlikely to consume alcohol)”. Although we know that typically, participants are more likely to record meals consistently for only three days in research studies (Yang et al., 2010), perhaps in the free-living

setting where we are hoping that people modify behaviour overtime, daily food recordings would be beneficial to provide meaningful dietary feedback.

Importantly, participants echoed our concern for immediate feedback while using any time of food journaling practices. One participant suggested that, “the AV method was easier, however, I found it to lack valuable information (written was better for information output). I would gravitate to something like MyFitnessPal due to being user friendly and instant information output with little effort needed on my part”. Additionally, another participant noted, “I think the combination of AV and written recording would be best, especially when it comes to meals/dishes with a lot of ingredients. Also, when video recording the nutrition labels, getting the label in focus before pressing record button provided a more clear/crisp recording.” These comments suggest that there is room to improve the current AV method.

Impact: Clinicians

In partnership with a Registered Dietitian, the AV method was evaluated beyond the scope of statistical comparison. The Registered Dietitian analysed both written and AV food journals and commented on the acceptability of incorporating the AV methodology in their practice. Mirroring the commentary on food literacy by Boehl (2007), suggesting that a language barrier can be a contributing factor to misunderstanding the concept of the relationship between nutrition and health, and that language can prevent a person from correctly interpreting nutrition facts tables (Boehl, 2007), the Registered Dietitian preferred the AV method because it would allow patients in their care to document their meals free from literacy and linguistic barriers. In the northern and rural communities, populations are often diverse and include Indigenous communities, Francophone populations, and illiterate individuals. The use of AV technology

removes the written component of traditional food journaling, and if a patient cannot verbally communicate a meal, they can video-record their meals and present that to a Registered Dietitian.

At this point, the AV method required a Registered Dietitian to interpret the AV recordings and then input the food items and their portion sizes into a diet analysis software program. Currently, the AV method does not remove the laborious nature of traditional food journaling for the Registered Dietitian. We would recommend transforming the AV method into a mobile application that would automate the process of image and portion size recognition. From this point the Registered Dietitian could still make recommendations to modify diet to improve personal health, and eliminate the laborious nature of inputting portion sizes and food items, and analyzing these in combination with Recommended Daily Intakes (RDIs) by Health Canada. As discussed in the second phase of this research project, the AV method does not account for food left unconsumed. In the future, consideration should be given to whether participants need to AV record meals before and after eating to determine the exact amount of food consume and how that impacts their food consumption decisions.

Future Methodological and Technological Recommendations

The validated audio-video methodology provides a novel approach to documenting meals; although the AV method was developed by modifying the photographic food journaling method. However, the photographic method requires a written component to include items not captured by photographs, including condiments and so as a result, the method becomes more laborious and no longer achieves the goal of being a fast and straight-forward journaling practice. Keeping this modification in mind and knowing that some form of identification must occur to ensure a clinician or Registered Dietitian can capture all food items consumed by a person, the AV method requires participants to verbally record the unseen items. However, in a free-living or

public setting, participants described some discomfort in verbally describing their meals in front of other people, or were in an environment where speaking out loud was not appropriate. A solution to this is to develop a mobile application, which would use item recognition software programming to identify items and through a series or prompts, allowing a user to select food items from categorized drop down menus after recording their meal. Kong et al. (2012) has developed several algorithms for food item photo recognition which would allow a software developer to build a mobile application which could recognize and identify food items while a person is recording their meal, and then produce a nutrient report based on the recording (Kong et al., 2012). This would reduce the burden on the Registered Dietitian whom, using current food journaling practice, would have to assess the videos to identify food items and portion sizes. Improvement and further development of visual food and speech recognition could enhance the accuracy of the AV food journaling method because it would eliminate portion size estimation, which contributes to determining how much a person has consumed in a day. It would also be important to capture the food left over after a meal, to subtract that from the initial recording in the event that a person did not consume their entire meal.

Additionally, since we know that the literature shows that the general public is poor at estimating food portions we would recommend that the clinician estimate portion sizes. The second phase of research highlighted this fact, since participants struggled to accurately and/or consistently estimate and record portion sizes.

In the future, we recommend that researchers should record height and weight, and not rely on participant self-reporting since participants often under-report weight and over-estimate height (Gorber et al., 2007). This has implications on individual dietary recommendations because when an RD inputs participant information, a calculated estimated RDI for total calories and

each macro and micronutrient is measured as a percentage, and so relying on participants reporting of height and weight has the potential to change the recommendations and thus provide inaccurate dietary recommendations for reaching and maintaining a healthy diet and body weight.

We also recommend that researchers estimate portion sizes, or provide instruction to train participants to accurately assess their portion sizes. Ultimately, it is critical to eliminate human interaction by portion size estimation since participants are likely to inaccurately estimate and record their meal food choices. This would be accomplished through the development of the aforementioned mobile application using image recognition software.

Conclusion

Obesity, malnutrition, and the rise of non-communicable diseases can be in part managed and mitigated with changes in food behaviours. In order to encourage participants to record their meals for lasting impact, it is important to develop a method that would encourage daily recording of meals over a long period of time. By developing technology that is fast, easy to use, and fits a person's current lifestyle, we expect that the general public would be more likely to record their meals using a variation of the AV method in the future, and understand the quality and quantity of foods they consume on a daily basis.

In this thesis, we validated the audio-visual method in a free-living setting and found that the AV method can be used as an alternative to written journaling. The results from Paper One suggests that the AV method is a valid method for providing accurate visual and audio information of food selection, allowing a researcher or Registered Dietitian to make accurate estimations of food to determine energy consumption. When comparing outputs from the AV versus written

method of food journaling in Paper Two, the Registered Dietitian categorized kilocalories, and the macronutrients protein and fat 'the same' for 72% of participants, with carbohydrates categorized 'the same' for 78% of participants. Congruency in allocating micronutrients was highest for potassium, sodium and vitamin E, and lowest for calcium, phosphorus and Vitamin C, demonstrating that the AV method captures similar macro and micro-nutrient values to the written method of journaling. With regards to the Registered Dietitians assessment of participants' written and AV journals to provide feedback on the consumption of fruits and vegetables and health fats, there is a high level of consistency between methods.

Before widespread acceptance as a valid method in diverse groups, it would be important to perform both a reliability and feasibility research studies to determine first, if this method could be repeated with consistent results, and second, whether or not it is practice to incorporate in clinical practice or nutrition counseling from both a time and cost savings perspective.

It is currently unknown whether audio-video-recording of food has the same behavioural effects as written journaling, however comments provided by participants in Paper Two of this thesis, regarding the audio listing of foods, suggest that this method would have some level of behavioural effect on the participant. Furthermore, Registered Dietitians agreed that the AV method could be used in clinical practice when performing dietary consultation with clients or patients. Participants recommended that further technological development of a mobile phone application be considered, particularly one which includes both written and AV technologies that could be downloaded to their own personal device as a way to increase usability and increase their likelihood of adhering to diet recording habitually.

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A. Ethics Approval

LaurentianUniversity
UniversitéLaurentienne

APPROVAL FOR CONDUCTING RESEARCH INVOLVING HUMAN SUBJECTS
Research Ethics Board – Laurentian University

This letter confirms that the research project identified below has successfully passed the ethics review by the Laurentian University Research Ethics Board (REB). Your ethics approval date, other milestone dates, and any special conditions for your project are indicated below.

TYPE OF APPROVAL / New X / Modifications to project / Time extension	
Name of Principal Investigator and school/ department	Emily Jago, Human Kinetics, supervisors, Sandra Dorman, Alain Gauthier, Ginette Michel
Title of Project	Validation and assessment of audio-video diet-journaling, for use in clinical applications
REB file number	2016-06-10
Date of original approval of project	August 17, 2016
Date of approval of project modifications or extension *(if applicable)*	
Final/ Interim report due on: *(You may request an extension)*	August, 2017
Conditions placed on project	

During the course of your research, no deviations from, or changes to, the protocol, recruitment or consent forms may be initiated without prior written approval from the REB. If you wish to modify your research project, please refer to the Research Ethics website to complete the appropriate REB form.

All projects must submit a report to REB at least once per year. If involvement with human participants continues for longer than one year (e.g. you have not completed the objectives of the study and have not yet terminated contact with the participants, except for feedback of final results to participants), you must request an extension using the appropriate LU REB form. In all cases, please ensure that your research complies with Tri-Council Policy Statement (TCPS). Also please quote your REB file number on all future correspondence with the REB office.

Congratulations and best wishes in conducting your research.

Rosanna Langer

Rosanna Langer, PHD, Chair, *Laurentian University Research Ethics Board*

B. Food Journal

Food Journal Day 1
Subject ID: _____ Date: _____

Select One: Weekend ☐ Weekday ☐

Food Item	**Amount**	**Calories** (if indicated on packaging)	**Time of Day**

Were you able to record all of the food you consumed on this day? YES NO
Was this a typical day's intake? YES NO
Food Journal Day 2

Subject ID: _____ Date: _____

Select One: Weekend ☐ Weekday ☐

Food Item	**Amount**	**Calories** (if indicated on packaging)	**Time of Day**

Were you able to record all of the food you consumed on this day? YES NO
Was this a typical day's intake? YES NO
Food Journal Day 3

Subject ID: _____ **Date:** _____

Select One: Weekend ☐ Weekday ☐

Food Item	**Amount**	**Calories** (if indicated on packaging)	**Time of Day**

Were you able to record all of the food you consumed on this day? YES NO
Was this a typical day's intake? YES NO

C. Exit Survey and Post-Method Questionnaire

Exit Survey

Please answer the following questions using the Likert scale below, about the food diary method you just completed.

You will be answering these questions based on agreeableness on a scale where 1 = strongly disagree, 3 = neutral, 5 = strongly agree. There is a comment section below where you can comment on your participation if you feel you were not able to express yourself in the questionnaire.

	1 - Strongly disagree	2 - Disagree	3 - Neutral	4 - Agree	5 - Strongly Agree
1. Tracking my food intake made me more aware of the type of food I was eating.					
2. Tracking my food intake made me more aware of the quantity of food I was eating.					
3. Tracking my food intake made me more aware of the nutrients associated with the foods I was eating.					
4. I was consistently compliant in recording my food consumption.					
5. I could complete food recording each day in a reasonable amount of time.					
6. Tracking my food has had a disordered influence on my food consumption behavior.					

Post-Method Questionnaire

Please answer the following questions using the Likert scale below, comparing methods.

You will be answering these questions based on agreeableness on a scale where 1 = strongly disagree, 3 = neutral, 5 = strongly agree. There is a comment section below where you can comment on your participation if you feel you were not able to express yourself in the questionnaire.

	1 - Strongly disagree	2 - Disagree	3 - Neutral	4 - Agree	5 - Strongly Agree
1. I preferred using the written method of food diary recording.					
2. I preferred using the AV method of food diary recording.					
3. I would prefer using a method of food diary recording that incorporated both AV and written recording.					
4. I would prefer a different method of food diary recording.					
5. I would choose to use food diary recording in the future for health reasons					

D. Dietetic Assessment Form

Dietetic Assessment Form

Subject ID Number: _____ Activity Level: _____
Age: _____ Sex: _____
Height: _____ (lb / kg) Weight: _____ (cm / in.)

Nutrient	Low*	Good*	High*
Calories (kcal)			
Protein (g)			
Carbohydrate (g)			
Fiber (g)			
Sugar (g)			
Fat (g)			
Saturated Fat			
Unsaturated Fat			
Vitamin A			
Vitamin B			
Vitamin C			
Vitamin D			
Vitamin E			
Calcium			
Phosphorus			
Magnesium			
Potassium			
Sodium			
Iron			
Zinc			
Folate			

*Based on Health Canada RDIs

Food Consumption Assessment		
	Sufficient	**Insufficient**
Fruit & Vegetable		
“Non-Foods” / Processed		
Healthy Fats		

Recommendation: (heart disease, diabetes, anemia, etc.)

_____

_____

_____

_____

_____

_____

_____

_____

E. Pre-Participation & Demographic Questionnaire

Pre-Participation & Demographic Questionnaire

Name: _____

Birthday (Day/Month/Year): _____

Sex (circle): M / F

Weight: _____ Height: _____

Your typical physical activity level	How often are you physically active?	Weekly training amount	Activity class
No physical activity	-	-	0
Occasional light physical activity	Once every two weeks	Less than 15 min	1
		Less than 30min	2
	Once per week	~30min	3
Regular training	2-3x / week	~45min	4
		45min-1h	5
		1-3h	6
	3-5x / week	3-5h	7
		5-7h	7,5
Daily training	Almost daily	7-9h	8
		9-11h	8,5
	Daily	11-13h	9
		13-15h	9,5
		More than 15h	10

Please circle yes or no to the following questions:

1. Do you or have you ever had an eating disorder (e.g. bulimia, anorexia, preoccupation with body weight) YES / NO

2. Have you used a food journal in the past? YES / NO

If yes – what type _____

3. Have you tracked your food consumption in the past? YES / NO

If yes, How? _____

4. Have you recently changed your eating behaviour? YES / NO